

SCIENCE AND CULTURE

MONTHLY JOURNAL OF NATURAL AND CULTURAL SCIENCES



INDEX TO VOLUME 5

(July 1939 to June 1940)



Edited by:

M. N. SAHA J. C. GHOSH A. C. UKIL
B. C. GUHA S. K. MITRA

In collaboration with:

S. P. AGHARKAR, G. N. RANGASWAMI AYYANGAR, K. D. BAGCHEE, K. N. BAHL, T. P. BHASKARA SHASTRI, S. S. BHATNAGAR, K. BISWAS, J. M. BOTTOMLEY, N. K. BOSE, R. N. CHOPRA, K. N. DIKSHIT, G. S. GHURYE, B. S. GUHA, S. HEDAYETULLAH, M. A. P. IYENGAR, W. A. JENKINS, R. B. LAL, C. G. LEWIS, L. MASON, S. K. MITRA, H. K. MOOKERJEE, P. PARIJA, G. R. PARANJPE, BAINI PRASHAD, KAMTA PRASAD, M. QUDRAT-I-KHUDA, P. RAY, H. L. ROY, S. M. SULAIMAN, B. SUNDARA RAJ, V. A. TAMHANE, D. N. WADIA.

Conducted by the

INDIAN SCIENCE NEWS ASSOCIATION
92, UPPER CIRCULAR ROAD
CALCUTTA

JL
Am 2, N35
N40.5



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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

JULY	1939
VOL. V	NO. 1

COMMERCIAL GAZETTE PRESS
6, PARSHI BAGAN LANE, CALCUTTA

Development of Communications in India

SINCE the invention of electric telegraphy by Morse in 1848 the technique of electrical communication has been progressing principally in two channels viz., telegraphy and telephony. The study and proper understanding of the property and behaviours of communication lines and cables on the one hand and the improvements in the design and manufacture of telegraph and telephone instruments on the other have been responsible for the perfection of the modern communication system. Development of automatic switching, successful application of thermionic valves in the design of telephone repeaters and amplifiers and the discovery of low-loss insulating materials for the manufacture of cables have equipped the present-day communication engineer with powerful tools which enable him to face and solve almost every kind of communication problem, even though economic considerations may not always allow these solutions to be applied in practice. Some of the wonders of these developments are the teleprinter, facsimile telegraphy, automatic telephony, long distance telephony, international trunk switch-

ing plan, multiple utilisation of lines and cables with the help of carrier currents, wide band cable telephony, television transmission and wireless beam telephony.

Besides telegraphy and telephony with their ramifications, wireless broadcasting has also not only outgrown the amateur stage but has created a distinct place of its own in the life and culture of every civilised nation.

Progressive nations of the world early realised that the lines along which modern civilisation was advancing demanded the development of reliable methods of quick transmission of news and they spared no money or intellectual effort to establish and extend communication network in their respective countries. Efficient system of electrical communication is now an essential aid to administration as it keeps the central government in touch with the affairs in the remotest corner of the country. In times of internal disturbance or in case of war, it is an indispensable means for directing either the

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police or the army with the least possible delay or danger. Its rapid growth has been very largely responsible for stimulating trade and commerce by supplying quick information regarding the state of the market and by helping the regulation of demand and supply of commodities.

The amazing growth of telephone communication is some of the big countries and cities of the world will be apparent from the following table, collected from the *Electrical Communication*, Oct. 1938.

Telephone Development of some Countries and Cities of the World, 1937.

Countries or Cities.	Total number of Telephones.	Telephones per 100 population.
United States	18,433,400	14.39
Denmark	408,875	10.89
Germany	3,431,074	5.08
France	1,481,788	3.51
Japan	1,197,129	1.70
Washington	214,308	37.43
Oslo	55,967	22.39
Paris	428,844	15.13
Berlin	539,662	12.67
London (city and county) ..	637,235	15.87
Tokyo	236,228	3.88

Compared with this the following figures will show how backward India is in this respect.

The total number of villages in India is 696,831 whereas according to the annual report of Indian Posts and Telegraphs, 1933-34, the total number of telegraph offices including combined post and telegraphs, railway offices, departmental telegraph offices and canal offices is only 10,294. According to the same report there are 25 telephone exchanges in this country owned by private companies with a total of 37400 telephone connections. Exchanges owned and maintained by the Government are 330 in number with 19414 straight line connections and 3390 extension telephones. This has grown in 1936-37 to a total of 73146 telephone connections of which as many as 42245 are supplied by licensed companies and 30901 only are supplied from the Government systems. But still this gives only about one telephone per 5000 of population in British India. While in a

big city like Calcutta, the second city of the British Empire, there are 15,000 telephones which mean barely 1 telephone per 100 of population.

It is worthwhile considering a little closely the earnings of the organisations which maintain these communication systems. Government telegraph working shows an annual net loss of Rs. 38,96,500. Radio telegraph working also shows a loss of Rs. 4,01,739 over a receipt of Rs. 7,44,721. In contrast to this the Government trunk telephone working has been showing a steady growth of profit since its introduction in the year 1921. The private telephone companies all give handsome dividends after funding a considerable portion of their profits as reserve and depreciation. The Bengal Telephone Corporation, for instance, distributed a total of Rs. 9,02,345 as dividend at 8% and a bonus dividend at 2%, both free of income-tax, in the year ending June, 1937.

The simple fact that emerges out of these figures is that though telegraph working appears to be a losing proposition, telephonic communication, whether local or long distance is by no means so, and it can be asserted that even from purely business point of view there is excellent scope for expansion of telephone system in this country both local and long distance. If besides this the important role played by a well-organised communication system in the industrial and cultural growth of a nation is considered, the need of this expansion is felt to be all the more urgent and necessary.

India is now on the threshold of industrialisation. The various provincial governments and the Indian National Congress which controls the policy of seven of the major provinces, have instituted enquiry committees to devise ways and means for the industrial regeneration of the country. Now, the basic factors on which the industrial growth of a country is dependent are

- (a) Cheap and abundant supply of electric power,
- (b) Efficient transport facilities,
- (c) Well-organised marketing systems.

The development of all these demands the simultaneous development of communication facilities.

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Thus, planned largescale electrification of a vast country like India by the introduction of national grid systems cannot function properly and efficiently without an elaborate communication system for the control and regulation of power supply. Modern transport systems whether by rail, road, air or water are again wholly dependent for their efficient working and security on the facilities which an equally efficient communication system, incorporating the very latest technical developments, can offer. Lastly the elaborate marketing organisations, scattered throughout the country including the big exchange markets of capital cities and port towns have to be supplied with adequate communication facilities to meet the demands of an expanding trade that is bound to follow an industrial drive. Considered from all these points of view one feels that time has now come to seriously consider the present position of the communication systems of the country and the possibility of their future expansion. The Government Posts and Telegraphs Department, it is true, has for sometime past been trying to develop the trunk and the local telephone systems in this country. But the progress has been rather slow. Thus according to Mr H. P. Bhaumik, former Postmaster General, Madras, (see Development of Trunk Telephony in India, *SCIENCE AND CULTURE*, July, 1938) "there is always a great demand for new connections once a telephone system is installed. The demand increases still further when the system is brought on to the trunk network of the country." Regarding trunk telephone service, the same author remarks that there is such an eagerness among the Indian commercial communities "to secure priority of service in making trunk calls" that "sometimes the Posts and Telegraphs Department are hard put to it to counteract the dubious methods adopted by them. This trouble is a direct result of a paucity of trunk circuits between the various trade centres." Thus if the present trunk facilities be so barely able to meet the existing demand, they are bound to prove absolutely inadequate to meet the demands of any future expansion of traffic. Now, since there is demand for local and long distance telephone facilities, it is regrettable if "want of proper resources stood in the way of further development."

By its very nature, the operation of large telephone systems, makes at times rather heavy and sudden demand on capital expenses and if the central State budget is not flexible enough to meet then it may be advisable to make the Department altogether independent of the State budget for its working. Examples of this may be found in the working of the German Reichpost which was separated from the general State budget in 1924 when the German State found it impossible to supply the requisite capital to the Reichpost. Since then it has been obligatory for the Deutsche Reichpost to balance its own budget and also to pay to the State coffer certain sum as a sort of interest on the assets received from the State. In a similar manner in France and Belgium also the electrical communication department's finances have been separated from the general State finance.

While the development of the trunk telephony in India has rested entirely with the Posts and Telegraphs Department, the working of local telephone exchanges, specially in large populous cities, has been in the hands of licensed companies. In 1933-37 the total royalty paid by all the private companies was about 4½ lakhs whereas revenue earned by them was more than 94½ lakhs. The Posts and Telegraphs Department has recently been very keenly feeling the serious loss to its revenue due to this arrangement, and has stopped further grant of license to private companies even in the smaller cities. This step, though it has its justifications, will not always be wholesome for the growth and expansion of local telephony. The Posts and Telegraphs Department is not infrequently handicapped for want of funds and private capital cannot also come forward to supplement the work of the Department. Both the State and the private company forms of working are in operation in the different countries of the world and both have their advantages and disadvantages. It is difficult to settle which is the better method of working under Indian conditions without a thorough enquiry.

As a matter of principle however indigenous capital and enterprise should always be encouraged by the Government to work and develop public utility concerns. Private capital therefore ought not to be debarred from the working of communication systems. But it should do so only under proper

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control because public utility concern must not be the means of making excessive profit by any body.

The development of communication system raises an important point regarding the purchase of stores and equipments. The capital that has been invested by the telephone organisations of the world is estimated to be about 60 milliard rupees and the major part of this capital has been spent in the purchase of equipments. This works out to a capital expense of about Rs. 600/- to 1,000/- for each telephone connection. It is therefore worthwhile considering how far it is possible to purchase these equipments inside the country. At present there is no firm in India that manufactures communication instruments and equipments except what the Telegraph Storeyard at Alipore, Calcutta, does. It is high time that the question of manufacture is thoroughly investigated and a company is established by the Government in co-operation with indigenous capitalists and industrialists for the manufacture of communication instruments and equipments. If required, the requisite right of working the various patents may also be purchased.

The facts and figures detailed above point to the need of instituting without delay a committee of enquiry by the Government of India for investigating and reporting on the following aspects of telegraph and telephone communications in the country:—

- (1) The existing condition of the telegraph and telephone organisations in India.
- (2) The planning of a comprehensive scheme of communication system for the whole of India to be developed in course of next ten years.

- (3) The desirability of establishment of a Federal Communications Commission for exercising a unified control over all the communication organisations of the country, private or State.
- (4) The adequacy or otherwise of the existing centres for the training of communication engineers and technicians.
- (5) The possibility of manufacturing communication instruments, systems and cables in this country.
- (6) Establishment of a central communication research organisation for developmental and standardisation work.

The personnel of the committee may be as follows:—

- (1) Representative of the Governor-General-in-Council.
- (2) Representatives of the Army.
- (3) Representatives of the Posts and Telegraphs Department.
- (4) Representatives of the Railways.
- (5) Communication experts not in the employ of the Government.
- (6) Representatives of private telephone organisations.
- (7) Independent physicists of repute.

When the findings of this enquiry committee are available, a committee of technical experts with high theoretical and extensive practical experience may be set up to formulate a detailed scheme for carrying out different projects in connection with the development of communications in this country which, as the figures reveal, are at present in an extremely backward state.

The Indus Valley 5000 Years Ago

At the present day, except for some of major parts of Africa and a few rather backward regions of Asia, almost the entire inhabitable area of the globe is populated by civilised people; the standards of civilisation in different parts, however, vary to a considerable degree. Some ten thousand years ago, the world was inhabited by savages, and even five thousand years ago civilisation had dawned only in a few isolated river valleys. Until recently, among such areas were included the valley of the Nile (Egypt), the land between the Tigris and the Euphrates (Mesopotamia), and the valley of the Karun river in Persia (Elam with capital at Susa). To this list has now to be added the Indus valley and possibly also the valley of the Hoang-ho river in China. The island of Crete (Minoans) and Asia Minor (Hittites) probably started their era of civilised life at a somewhat later date.

What are we to adopt as the criteria for civilised life? It goes without saying that man must be grouped in well-formed communities, should be governed by sound social, moral and political laws and must have belief in an existence higher than the mere animal life. Further, the requisites of life which lead to the evolution of a civilisation are that man must live in villages and cities, practise agriculture, industry and commerce, and above all should possess some kind of writing. Essentially it is the art of writing that distinguishes a civilised people from the savage. The latter has no means of communicating the experience and knowledge of one generation to another and to posterity except by direct contact. Every generation begins its career as Nature's own children just like animals which are incapable of modifying their environment to the changing needs and conditions. But this is not the case with people who can store up their knowledge and experience in some form of writing and transmit it to the succeeding generations. In such communities each generation stands as if on the shoulders of the previous one, and thus can make fresh contributions to the progress of civilisation.

In lands where civilisation dawned five thousand years ago, *e.g.*, in Egypt, Babylonia or in the Indus valley, we invariably find that some form of writing had been developed along with the progress of civilisation.

Egypt

Before the discovery of Mohenjo-daro which has established beyond doubt that highly civilised communities lived in the Indus valley nearly 5000 years ago, it was known for a long time that Egypt and Mesopotamia were the cradles of the most ancient civilisations of the world. For a proper appreciation of the Indus valley civilisation it is necessary to know something about the state of civilisation in contemporaneous Egypt and Mesopotamia.

Five thousand years ago, the whole of Egypt consisting of the delta and the upper Nile valley had been united under a strong centralised monarchy, the ruler being called the Pharaoh (*lit.*, the great house). In commemoration of the union of the two regions, the Pharaohs, after Menes, the founder of the First Dynasty, wore a double crown symbolising upper and lower Egypt. The king and the nobles lived in well-built houses in large cities, and society was divided into definite classes, depending mainly on professions. The Egyptians believed that after death, man was led before the great divine judge, Osiris, and his soul was weighed in the balance of righteousness. If found wanting, the soul was consigned to the flames, but if found all right it was allowed to enter the court of Osiris, and enjoy the company of gods. They further believed that for enjoyment in after life, the soul requires its earthly body. Under this belief they took great pains in preserving their bodies, and after death embalmed the bodies and interred them in suitable places along with the personal belongings and furniture of the dead. This explains the reason why the great pyramids, by which ancient Egypt is best known, were built. The ruler of the country wanted that his body, and the body of his queen and favourite

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attendants should be preserved perpetually along with his personal belongings, so that in after life he might enjoy all the amenities of his earthly life. Later on the pyramids were replaced by vaults cut into the rocks lining the basin of the river Nile. It is the discovery of these royal remains within the pyramids and the rock cut vaults which has opened up a new chapter regarding the life of the Egyptian society some five thousand years ago and after, up to the fifth century before Christ. Afterwards Egypt became a subject nation and her ancient civilisation gradually dwindled away.

From these antiquities we learn that the Egyptians had developed considerable knowledge of chemistry, engineering and geometry and other useful arts. Their laws which are preserved in their *Book of the Dead* were marked by humanity. Breasted, in his *Dawn of Conscience*, has shown that even many of the teachings ascribed to Christianity are found word for word in the ancient Egyptian scriptures. They believed in numerous gods whose temples were to be found in the big cities and the religious secrets were jealously guarded by a priestly class. In material civilisation they were almost in no way inferior to the Europeans of the early medieval times, but in metallurgy they did not progress beyond the use of copper and bronze, iron being comparatively unknown till the twelfth century before Christ.

The Egyptian system of writing apparently looks very different from ordinary writing as we have it now. Many people have probably seen the Egyptian hieroglyphics.

They look like a curious assortment of animals, reeds, running water and so forth. In reality, the writing was complex; it mostly consisted of alphabetic symbols representing consonants only, the vowels had to be filled in by guess. Besides, they had word-signs (like £ in English) and determinatives which were practically pictures defining various objects. The reason why the symbols look so queer is that probably the writing was first pictographic, but later grew into alphabetic. The story of the first decipherment of Egyptian hieroglyphics by the French scholar Champollion in 1822 is highly interesting. An obelisk bearing on its base

a Greek inscription showing that it belonged to a king Ptolemy and his queen Cleopatra was brought to the notice of Champollion. Two ovals were found on the obelisk and it was concluded that the hieroglyphs within these two ovals contained the names of Ptolemy and Cleopatra who, though Greeks by descent, had adopted Egyptian customs. By comparing them with the Greek spellings of Ptolemy and Cleopatra, Champollion proved that the Egyptians possessed an alphabet and not merely signs for whole syllables or words.

 = smooth breathing, like h in "honor." As vowel, see below	 = ch (like ch in German "ich")
 = y (in Greek times it was used as vowel)	 = kh (like ch in Scotch "loch" or German "Bach")
 = guttural, pronounced in back of throat; not used in English	 = s
 = w (later f was also used; both signs as vowels, see below)	 = s (originally of slightly different sound from the preceding)
 = b	 = sh
 = p	 = g (in Greek times also used for k)
 = f	 = k
 = m (later n was also used for m)	 = g
 = n	 = t
 = r	 = th
 = l in late times (originally r or rw)	 = d
 = h	 = dh or dsh (like j in "jug")

Fig. 1.
The Egyptian alphabetic signs or letters. There were twenty-four letters in the alphabet known in Egypt long before 3000 B.C.
[From Breasted's *Ancient Times*.]

Babylonia

Civilisation appears to have bloomed in the land between rivers Tigris and Euphrates about the same time as in Egypt, but it appears to have been of a quite different character. The cause of the early flowering of civilisation was, as in Egypt, the extreme fertility of the land, and easy availability of water, which was carried by intricate, and highly developed irrigation canals to all parts of

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the country. This facilitated the early development of agriculture and enabled the communities to gather into cities and large villages. Mesopotamia was from the very beginning a country of small City States, the earliest of which were Nippur, Kish, and Ur of the Chaldees, mentioned in the Bible as the place whence Abraham, the reputed ancestor of the Hebrews set out on his journey into Canaan (Gen. XI. 31, XV. 7). From the earliest times the country was inhabited by two distinct races, the Sumerians in the settled cities of the

A	B
Oval containing name of Ptolemy in hieroglyphics	Oval containing name of Cleopatra in hieroglyphics
	
PTOLEMAIOS I II III IV V VI VII VIII IX	KLEOPATRA I II III IV V VI VII VIII IX
 (I and S) = P in both names	 (r) = K in one name
 (II) = T in one name	 (s) = E in one name
 (III and e) = O in both names	 (b and q) = A in two places
 (IV and z) = L in both names	 (z) = T in one name
 (VI) = M in one name	 (s) = R in one name
 (VII) = AI in one name	 (ro) = {unpronounced signs placed at end of all feminine names}
 (IX) = S in one name	

Fig. 2.
Champollion's first decipherment of Egyptian hieroglyphics.
[From Breasted's *Ancient Times*.]

south, and the Semites in the north and the surrounding desert regions. The Sumerians were a clean shaven people, somewhat like the South Indians in appearance; according to some authorities, they were Proto-Dravidians, according to others they were Turanians, but both these theories have been disputed.* The Semites, on the other

* To ethnologists, however, the terms *Proto-Dravidian* etc., indicate only linguistic divisions and not racial types like *Negrito* or *Mongoloids*. Also the discovery of the Sumerian skeletal remains has made these theories doubtful.

hand, were beards, and were the prototypes of the later Arabs and Jews. Their civilisation was almost as advanced as that of the Egyptians, and like them, they were acquainted in the early stages only with copper and bronze. They believed that the world was governed according to some fixed order, and worshipped gods representing the sky, the mountains, deep water, the sun, the moon, stars and planets as well as forces of Nature very much like the Aryans.

The civilisation was almost certainly the work of the Sumerians, who developed the arts and crafts of city life, a system of writing known as the Cuneiform, and an abundant religious literature. Throughout the whole historical period prior to 2000 B.C., there continued to exist a perpetual enmity between the Sumerians settled in the cities and the nomadic Semites, who were trying to pitch themselves on Sumerian establishments, and a rivalry amongst the City States; another important factor was the perpetual fear of invasion from the surrounding countries. About 2800 B.C., the Semites under Sargon succeeded in uniting the land under an empire with capital at a city called Agade but the dynasty was overthrown after 200 years by the Sumerians, who had their capital at Ur. As a result of constant warfare the Sumerians appear to have been wiped out by about 2100 B.C., and a Semitic dynasty under the great ruler Hammurabi became supreme at Babylon. This city, hitherto not very prominent, now became the mother-city of the land, and the inhabitants became known as the Babylonians. Babylon existed as a great city under foreign and indigenous dynasties up to 550 B.C., when it lost its independence, and passed under the yoke of the Iranians. It later had many masters, the Greeks, the Persians, and the Arabs till about 600 A.D., when it became a heap of ruins. The Sumerians had developed an extensive volume of literature consisting of hymns to gods and incantations, social laws and religious scriptures consisting of stories of creation, some of which were later incorporated by the Jews in the Bible. When the Sumerians passed away their language was adopted as a sacred language by the Semites which, however, was known only to their priests. One of the characteristic beliefs of the Babylonians was that human destiny was controlled by the movements of

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planets and hence they took great pains in observing carefully the motions of heavenly bodies, particularly of the sun, the moon and the planets and thus they laid the foundation of the science of astronomy. They were also great irrigation experts and intersected the whole country with a network of canals, which resulted in abundant crops of wheat, barley and date palm. Their system of writing, however, was entirely different from that of the Egyptians and passed through several stages.

	1	2	3
I	Foot turned around in 2		
II	Donkey		
III	Bird; turned over with feet to the right		
IV	Fish		
V	Star		
VI	Ox; turned over in 2		
VII	Sun or Day		
VIII	Grain; top of stalk turned over		

Fig. 3.

Early Babylonian signs showing their pictorial origin and transformation of picture signs into cuneiform signs.

Column 1. oldest form.

Column 2. departure from picture and appearance of the signs as the lines become wedges.

Column 3. later forms.

[From Breasted's *Ancient Times*].

Originally the writing appears to have been pictographic, i.e., objects were represented by their actual pictures. Later it underwent change in form due to their habit of writing on clay, and received the arrow-like forms (Cuneiform). A number of such modified pictographs (about 600) were chosen as syllables, and all the sounds in the language could be written down as combination of such syllables. Thus the word for star was An, and the symbol was ★ The word for mountain was Kur, and symbol Δ. Both these symbols underwent changes to cuneiform types but a man or an object bearing the name Kuran, would be simply written in syllables expressing a mountain and a star, though his name might have nothing to do with either. This writing was used in all international correspondence (e.g., in the treaty between Pharaoh Ramses of Egypt and the Hittite King about 1200 B.C.).

The Indus Valley

European scholars up to 1923 always used to belittle the claims of India as the home of any ancient civilisation. Until about twenty years ago, very few pre-Mauryan antiquities were known or recognised in India. At the suggestion of Sir John Marshall, the late Rai Bahadur Dayaram Sahni, in 1920, started excavations at the site of Harappa near Montgomery in the Punjab where peculiar seals had been found; but it remained for the late Mr Rakhaldas Banerji to recognise the importance of this find. It was a great surprise when in 1923, Mr R. D. Banerji dug out a city in the Indus valley, which showed that even 5000 years ago, when formerly only Egypt and Babylon were known to be civilised, in the Indus valley communities lived in well-built and well laid out cities, consisting of houses made of burnt bricks and containing an elaborate system of drainage. Accounts of this great discovery were published in many popular journals. Between 1928 and 1931 this place has been further re-excavated by Mr E. Mackay under the guidance of the Archaeological Survey of India, and as a result, we have two sumptuous volumes dealing with the civilisation in the Indus valley 5000 years ago. They are in continuation of the three volumes edited earlier by Sir John Marshall which gave a first account of the relics of Indus valley civilisation. These two volumes have been prepared under the general editorship of Dr E. Mackay assisted by the late lamented Mr N

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G. Majumdar and several other scholars, namely H. L. Srivastava, C. C. Ray, C. S. Hemmy, besides officers of Archaeological Survey of India. Sir L. L. Fermor assisted in the identification of rocks, Col. Seymour-Sewell and Dr B. Prashad in the identification of zoological objects and Dr B. S. Guha the skeletal materials.

Mr Mackay thinks, as was also surmised by Mr R. D. Banerji, the first discoverer of this civilisation, that the ancient city was situated either on the banks of the Indus river or on a branch of riparian connection in the shape of ghats or wharves. The city appears to have suffered from disastrous floods several times during its lifetime, which is estimated to have come to an end about 2500 B. C. This date is arrived at from certain recent discoveries by Dr Frankfort at Tel Asmar, a mound to the east of the ancient city of Kish in Mesopotamia, which show that the upper level of Mohenjo-daro were contemporaneous with certain buildings which he had excavated at Tel Asmar. The latter have on very good grounds been attributed to the Dynasty of

Sargon of Agade. The principal object of interest found in these excavations, which seems to serve as a link between the two places, is a cylinder seal, obviously of Indian workmanship, bearing the figures of elephant, rhinoceros and fish-eating crocodile, animals that are peculiar to India and are not found in Mesopotamia. This seal must have been made for his own use by an Indian trader staying at Tel Asmar about 2500 B. C. The lowest level of Mohenjo-daro has been assigned about 3000 B. C. on the strength of the find of a vessel of a greenish grey stone having an intricate matting pattern carved upon it. A duplicate of this pattern was found at Susa, layer No. 2, whose date is supposed to be 3000 B. C. It is thus seen that Mohenjo-daro like many other Indian cities situated on the banks of rivers had rather a short life. Further, the discovery of the Indus valley seals at many old sites of Mesopotamia shows that there was extensive trade between the two countries five thousand years ago. An echo of these commercial intercourse is preserved in the *Jātaka* stories (*Baveru* or *Babylon Jātaka*) written about the first or second century B. C.

(To be concluded)

Poisonous Plants of India

R. N. Chopra

Director, School of Tropical Medicine, Calcutta.

INDIA probably presents a greater variety of meteorological conditions and features than any area of similar size in the world. No wonder then that plants containing active and medicinal principles grow abundantly within its bounds. More than 2,000 such plants have been enumerated in the literature. Many among them contain powerful and toxic principles, which under certain conditions act deleteriously and may even cause death or serious impairment of bodily functions by virtue of their chemical constituents. To endeavour to compass within the scope of this short article even a comprehensive bird's eyeview of poisonous plants of India would be impossible. It is therefore proposed to discuss briefly some of the more important aspects of the problem.

Cryptogams (the flowerless plants)

The toxicological aspects of the cryptogamic flora of India are very little known.

(a) *Algae*:—The algae which cause poisoning are mostly those which are found in stagnant waters. The normally offensive odour may be sufficient to indicate their presence but only a microscopic examination can determine just what the forms of algae present may be. Blue green algae as a group are perhaps the most pronounced in their toxic effect. Some authorities maintain that of the organisms, which produce objectionable and deleterious qualities in waters, the microscopic ones are the most important and that very few cases have been

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observed in which really serious trouble in water supplies could be attributed directly to the growth of larger plants. The question of growth of algae in water reservoirs is very important from the point of view of public health. Their growth can be prevented, at any rate considerably reduced, by covering up the reservoirs and cutting off sunlight which is one of the essentials of algal growth. Growth of algae can also be successfully prevented by the addition of copper sulphate in dilutions of one to five millions or even higher, which does not render the water deleterious for man and animals.

(b) *Fungi*.—Among the fungi likely to be harmful are (i) those which attack food and fodder plants, such as rusts, smuts, ergot of rye, etc., (ii) those found in mouldy foodstuffs; and (iii) the mushrooms. Very little information is available with regard to the poisonous mushrooms growing in this country and in spite of cases of poisoning little attention has been paid to the subject. There are probably many more poisonous species than have already been reported in India but on the whole their number may be smaller than is generally believed. If washed in water and macerated in vinegar before cooking and eaten with plenty of bread there is almost no danger in most cases. The safest method, however, is to learn to recognise the edible species and never to eat a mushroom until its identity is certain.

(c) *Other cryptogams*.—As regards the *liverworts* and *mosses*, little or no information is available, while the Indian representatives of *lichens*, *ferns* and allied plants are also practically an uninvestigated field.

Phanerogams (the flowering plants)

The toxicological aspects of flowering plants are better known and these may be divided into two main groups:—(a) *Plants poisonous to man and livestock*, and (b) *Plants poisonous to insects and fishes*. With regard to the first group, so far as the plants poisonous to man are concerned, our knowledge is fairly well advanced and many of these are used in medicine in small regulated doses. Cases of poisoning due to accident, ignorance or intention are met with but these are not common. Our knowledge regarding poisoning of livestock, however, is very

meagre as compared with other countries. There are hundreds of plants connected with the food supply of roughly 220 millions of the bovine population out of a total of about 730 millions in the whole world. The fodder supply for this livestock amounts to at least 33 million maunds daily (excluding the concentrates). Even in its present unsatisfactory condition the cattle industry contributes roughly about half of the annual agricultural income of 20,000 million rupees of this vast country. No figures are unfortunately available of the loss suffered through poisoning with plants in India but these must be enormous. It may be interesting here to give the example of two States, Montana and Colorado in the United States of America which may give us some idea of the possible damage. In that area it has been computed that the loss inflicted to livestock industry by plant poisoning is in the neighbourhood of 220 million dollars annually, a very large figure considering that the size and extent of these States as compared with India is less than one-sixth, and the fact that the knowledge with regard to the poisonous plants is well advanced in those States and preventive measures are there in vogue. The conditions existing in India may be imagined from this.

Though the number of plants which have markedly poisonous properties is perhaps small as compared with the total species included in Indian flora, there are many which are of common occurrence and which no doubt produce serious losses by death or illness they cause among livestock. The toxic effects produced may be accompanied by reduction in the yield of milk, or the milk may become unpalatable through excretion in it of toxic substances or may even become poisonous, and thus become unfit for consumption. The animals do not instinctively select toxic plants as forage but in some cases they do acquire a depraved appetite for harmful plants especially when the fodder supply is scarce, a condition which is of frequent occurrence in many parts of India.

The measures for preventing poisoning by plants are to keep away the animals as far as possible from dangerous areas and to exercise special care during the drought season. Eradication of poisonous plants is a difficult matter but wherever possible cutting down of lower branches of trees within reach of

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animals (and children) is advocated. The indiscriminate importation of ornamental plants has recently increased the number of poisonous plants in India. Time perhaps is not yet ripe to agitate for a law prohibiting the importation of poisonous plants for the gardens nor to take measures to forbid the cultivation of those already introduced but sooner or later it may have to be considered.

Besides the plants which produce symptoms of poisoning when taken in small quantities there are some which are commonly utilised as food and fodder but which under certain conditions produce harmful effects and a few examples may be cited in this connection. *Khesari dal* (*Lathyrus sativus*) is an important article of diet for man and animal. Moderate amounts of this pulse can be taken with impunity. But if taken in large amounts, especially to the exclusion of other foods or fodders, it produces dangerous symptoms of poisoning in man and livestock. Examples of lathyrism in man in form of spastic paralysis are commonly seen every day in the streets of Calcutta and its toxic effects in horses and cattle are well known. Grasses form an important part of the food of animals. Some of these develop dangerously large quantities of hydrocyanic acid under certain climate and soil conditions especially at times of drought or when the plants are wilting or stunted. The younger and more succulent ones are often more likely to contain lethal doses of hydrocyanic acid. If well dried they are generally without danger. Outbreaks of poisoning due to the Indian millet (*Sorghum vulgare*) and Johnson grass (*Sorghum halepense*) are frequently recorded in India. Linseed plant and the residual cake after the extraction of oil from the seeds have occasionally caused poisoning of livestock due to hydrocyanic acid. It is unsafe to feed the cattle on the plant especially when wilted. Cakes after extraction of oil should be treated with boiling water and should be given only in small quantities at a time. Mustard cake which is fed to the cattle after extraction of oil may produce chronic irritant poisoning, colic, lassitude, etc., if fed in large amounts and over prolonged periods. The danger seems to be less in the case of *sarson* cake than in the case of *rai* and the black-mustard. Several members of the cucumber family are edible but bitter varieties are occasionally met

with. The latter are strongly purgative and should be discarded. The leaf-blades of rhubarb and fresh leaves of beet-root have occasionally caused poisoning in man and livestock respectively. Sprouting potatoes should be discarded as they develop dangerous quantities of solanine in this process. Buck wheat under certain conditions, which are not yet fully understood, becomes toxic and gives rise to inflammatory swellings of the face, eyelids and ears.

Of the vegetable insecticides of proved value or the plants poisonous to insects may be mentioned *chrysanthemum* (pyrethrum), *derris*, *nicotiana* (tobacco) *tephrosia*, *picrasma* (quassia), *delphinium* (larkspur), *veratrum*, etc. There are also a number of plants which are utilised as insect repellants e.g. roots of *saussurea lappa* (costus), essential oil from *eucalyptus*, leaves of *pogostemon heyneanus* (patchouli) and *azadirachta indica* ('neem'), etc.

The insects do incalculable harm to man in many ways. It would be no great exaggeration to say that insects have been responsible for more loss of life and destruction of property than that caused by wars, floods, earthquakes, fires and famines in the history of man. On a moderate computation the annual loss caused to India through insect pests has been put at 2,000 million rupees and over a million and a half of human lives. An effective defence against these enemies of social and economic progress will materially reduce enormous wastage and facilitate national development. One of the items for fighting against this menace is to find cheap and effective insecticides commensurate with the means of great masses in India whose economic condition is very low. For several reasons vegetable insecticides are preferable to mineral ones. Those from vegetable sources are undoubtedly less deleterious to human beings and other warm-blooded animals generally. The larger the number of effective insecticides and insect repellants we discover from among our poisonous plants, the greater will be the chances of their being brought into extensive use by the people for medical, veterinary, agricultural and household purposes.

At the present time our knowledge of plants bearing insecticidal and insect repellent properties in this country is very meagre. A thorough enquiry into this aspect of poisonous plants is therefore of prime importance to the country. There are also a

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number of plants that are poisonous to fishes. Some of these piscicides are also insecticides and *vice versa* and a systematic study of this group may repay investigation.

A good deal of work has been done in connection with the poisonous plants in Europe, America, South Africa and other countries while little or no systematic work has so far been attempted in India. Unfortunately it was not possible to start even a general survey of this group till a few years ago when the Imperial Council of Agricultural Research gave a grant and added a botanical section to the already existing unit composed of chemists and pharmacologists paid by funds generously given by the Indian Research Fund Association twelve years ago. A list of seven hundred plants reputed to be poisonous to

man, livestock, insects and fishes, etc., has been prepared which is by far the largest so far collected in this country. Chemical analysis and pharmacological experimentation of these is now being done at the School of Tropical Medicine so far as is possible by funds generously given by the Imperial Council of Agricultural Research and the Indian Research Fund Association. A thorough and comprehensive study of all these plants is the work of many years, perhaps several generations. A monograph, however, is being written wherein all information, botanical, chemical and pharmacological, in connection with poisonous plants growing in India together with all references in the literature is being collected. The monograph when completed, will serve as a basis for further work on these plants.*

* Based on a lecture delivered at the Indian Museum.

Hormones and their Miracles

M. C. Nath

Department of Physiology, University of Dacca.

THE subject of hormones and the miracles worked by them in the human body is not only interesting but is of great practical importance for our everyday life in controlling various activities of our system. It is well known that just after the attainment of a particular age *i.e.*, the age of puberty, a boy or a girl begins to experience a change in his or her person. The question arises here whether the change is through the magic influence of some external cause or due to some cause operating within. Through modern scientific investigations it has been proved beyond doubt that activities in various directions of our lives, especially during the onset of puberty, are the effects of some chemical reactions and transformations within our body. In plain language, they are due to the production of some chemical compounds in some special glands called

ductless glands or endocrine glands, so called as they have got no ducts or channels leading to the digestive tract.

These chemical products when carried through the medium of blood stimulate the activity of various organs of the system and bring about rapid body-growth and development of secondary sexual characteristics *e.g.*, growth of beard (in males), harshening of voice, development of the mammary gland (in females), etc. These active compounds have been designated as 'hormones', ('hormao' means 'to excite'). The important glands occurring in the human system from above downwards are:—pineal, pituitary, thyroid and para-thyroids, thymus, suprarenals or adrenals, islets of Langerhans (pancreas) and gonads (testes and ovaries). Each of the glands secretes hormones for specific func-

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tions and in case these glands are affected the result is the development of symptoms of several diseases.

Pituitary Gland

The pituitary gland seems to hang like a grape just beneath the base of the brain and rests on the cavity of the sphenoid bone. It has two lobes, the anterior and the posterior. The anterior lobe gives rise to the hormone having activities in various lines, one of the main functions of which is to stimulate growth. Decreased activity *i.e.*, hypoaactivity of this gland or its partial removal in childhood causes pituitary dwarfism when there is stunted growth, failure of mental development and accumulation of fat in the body. Infantilism and under-development of the sex-organs may sometimes occur due to the compression of the gland by a parahypophyseal tumour. This condition is known as Frohlich's Syndrome. Hypofunction or destruction of the anterior lobe results into what is known as Simmond's disease. There is rapid breakdown of the body tissue and loss of sex-activity. This can be cured by injecting pituitary hormone. Progeria which is accompanied with thickening of the skin is also caused due to the decreased function of the anterior lobe. If there is hypopituitarism in old age, basophilism or adeposity develops. If by some means, however, the activity of the pituitary gland is increased at an early age, symptoms of what is known as gigantism develop. Scientists have been successful in preparing giant rats and giant dogs in the laboratory by injecting the potent extract of this gland. But if the gland is affected after the body growth is at an end, the bones especially of the face, hands and feet develop disproportionately and results into what is known as acromegaly. The posterior lobe also secretes hormone which exerts the following effects upon the body:

- (i) Raises the blood pressure.
- (ii) Decreases the volume of urine in men.
- (iii) Can cause a contraction of the muscle of the uterus; hence used by physicians during parturition.
- (iv) Causes an increased flow of milk on injection to lactating mothers.
- (v) Can cause a slight rise of blood sugar.

Thyroid Gland

This contains two elongated oval lobes each being 5 to 6 cm. long. It is particularly conspicuous in its effect upon general metabolism and well-being of the system. If the gland does not function well or undergoes atrophy in early life a condition known as cretinism results, when there is cessation of skeletal growth, ill development of body and mind, and signs of idiocy and infantilism occur. A cretin even when adult behaves like a child of three or four. If insufficiency of thyroid activity occurs in adults, a condition known as myxedema is the result, of which the symptoms are lowered metabolism, sluggishness both of the mind and the body, and the skin becomes thick and dry, the hand and face becomes puffed and swollen and the hairs fall off. Its treatment consists in the administration of thyroid hormone or thyroxine for a very long period.

There is sometimes observed obesity in early life due to disturbed function of the thyroid gland. In case of thyroid hyperactivity again there is emaciation of the body due to the fatal increased metabolism. Hence the extract is used as fat-reducer. Sometimes over-activity of the thyroid brings into what is known as Graves' disease or exophthalmic goitre. These may be remedied by partial removal of the gland.

Parathyroid Glands

Parathyroids are small bodies, four in number, length of each being 6 to 7 mm. It has been suggested that these glands form and secrete a hormone, parathormone, which in some way or other regulates calcium metabolism so that normal concentration of calcium in the blood is maintained. But if the activity of the glands be increased beyond a limit or if excess of parathormone is administered, the blood calcium will rise very much at the cost of the bones which are the store houses of calcium in the body. The result is that the bones become soft and tend to bend and may sometimes give rise to serious disorders of the system.

Thymus and Pineal Glands

The thymus has got the maximum size at the time of birth and it gradually undergoes atrophy along with the advancement of age. The pineal

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gland, on the other hand, is very small in size during infancy and attains the maximum size at about the seventh year; after this period and particularly after puberty it begins to disappear gradually. The thymus unchecked has a tendency to produce too rapid body-growth before adolescence as well as development of sexual glands, while the pineal has been found to retard or check the growth, thus acting as a balance wheel for the thymus. Extract of thymus has been injected on rats for generations and it has been found that in the fifth generation the growth exceeds the growth of controls by 100%. Quite opposite results have been obtained with extract of pineal gland. When the pineal body is removed, the thymus acts without disturbance and accelerates the growth of sexual glands. It may be inferred that 'meditation' and 'recitals' as practised by *sannyasis* may have some effect in increasing the pineal activity and thus decreasing the sexual activity.

Suprarenals or Adrenals

These are two triangular bodies each resting on the upper border of the kidney. These glands have been found to be very important on account of their activities in maintaining blood pressure. In cases of heart diseases when the blood pressure falls to a great extent the hormone of these glands-adrenaline-is of great relief. In addition to the above, there are various other functions played by adrenaline (e.g., effect on alimentary canal, on metabolism, on respiration etc.).

But the most interesting and the striking feature is its effect upon the sex glands. It has been found that development of beards in ladies, which is sometimes noticed, is the result of over-activity of their suprarenal glands. This view has been substantiated by recent investigation in this line. It was found recently that a boy of seven had such precocious sex-development that he became a menace. On examination it was found that there was a tumour in one of his suprarenals, removal of which caused a marked reduction in the lad's sexual excesses. Addison's disease is a result of hypo-activity of this gland.

Islets of Langerhans (Pancreas)

These are active in preparing a hormone named insulin, which controls the absorption of sugars which are the ultimate products of digestion of carbohydrate (e.g., the principal constituents of rice, bread, potato etc.). If by some means these glands are diseased a condition known as diabetes mellitus (sweet diabetes) results. Discovery of this hormone which can now be extracted in the purified condition, has done much to rid diabetes of its terrors.

Gonads

The truth of male-hormone activity due to gonads, and the process of castration was known in ancient India. People knew that on castrating a boy, his voice could be maintained sweet as in early life and development of secondary sexual characteristics could be checked for good.

The *nawabs* would make eunuchs by castration who could be safely trusted as the body guards for their *begums* and as chamberlains of their *harem*, for such castrated persons were deprived of masculine characteristics and tendencies.

Scientists now have not only been successful in isolating the male hormone in purified condition from testes alone, but they have also prepared this from urine of males and very recently from a class of substances called sterols or solid alcohols in the laboratory. The female hormone as well has been isolated from ovaries, from corpus luteum, from pregnancy urine and ultimately from chemical compounds such as sterols or solid alcohols. Days are nearing when the fruits of researches in these lines will suggest remedies to do away with the terrors of infirmity and will prolong the stay of youth for all.

Knowledge of Hormone Activity in Ancient India

The ancient Hindu works on "*Tantric yoga*" developed the idea that the whole human system is controlled by the activities of six centres or "*shat-chakras*". The practice of "*tantric yoga*" or "*kundali yoga*", which is also known as "*bhut Shuddhi*" aims at regulating and setting the physique in proper order. For attaining the "supreme end" (*Shuddhi*) one has to practice that system of "*yoga*" which is technically known as "*shat-chakraheda*" or piercing of the six centres or

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regions by arousing the "*kundalini sakti*" or the divine cosmic energy sleeping in the body. These centres are (from the bottom):—*Muladhara*, *Svadhishthana*, *Manipura*, *Anahata*, *Visuddha* and *Ajna*. It would be interesting to compare the ancient Hindu views and the modern scientific truths on hormones and their glands.

The Chakras	Situation as described in "Yoga".	Corresponding endocrine glands.
1. Ajna	Spinal centre of the region between the eye-brows	Pineal
2. Vishuddha	Of the throat	Thyroid and Parathyroids
3. Anahata	Of the heart	Thymus
4. Manipura	Of the navel	Suprarenals
5. Svadhishthana	Above the genitals	Islets of Langerhans (Pancreas)
6. Muladhara	Below the genitals	Gonads (Testes and Ovaries)

In the above table of the "*chakras*" there is no provision for the pituitary gland. But in "*Yoga*" there is a mention of one "*sahasrara*" or *sahasra*

padma dala (lotus of thousand petals), the seat of which has been located above the "*sushumna nadi*." This lotus has been supposed to hang with its head turned downwards and to shed a constant and profuse stream of nectar like essence. It is through this essence that the "*yati*" or the "*self-controlled person*" realises the oneness of the "*Jivatma*" and the "*Paramatma*".

In the light of modern investigations it has been clear that the anterior lobe of the pituitary gland which hangs from the base of the brain secretes a hormone which through its miraculous influence stimulates all other hormone secreting glands (the functions being somatropic, thyrotropic, adrenotropic, gonadotropic and so on) to activity and thus govern the whole system in general and help to bring the body and mind in unison with each other. The posterior lobe of the pituitary gland has also been found to exert several important effects upon the system. Thus in one word it can be said that the pituitary gland has thousand functions to perform and can claim to be the "*sahasrara*," the lotus of thousand petals of thousand activities.*

* Based on a lecture delivered under the auspices of the University of Dacca.

Vegetable—The Sustainer of Life

K. Biswas
Superintendent, Royal Botanic Gardens, Howrah.

In the leading article in the April, (1939), issue of SCIENCE AND CULTURE the editor laid particular emphasis on what he calls "mineral civilisation". He remarks, "Probably Mr Wells meant our dependence to a very large extent on agriculture, i.e., on the plant world for food, clothing, housing, and other necessities and luxuries. The Indian leaders also, by mainly emphasizing on agriculture, on rural life and on village crafts, have shown themselves incapable of understanding the way in which the world progresses." The fundamental question

lies in what we consider the highest civilisation and what we mean by real progress. It is indeed a debatable point if the present run towards mechanisation of life would be for the ultimate good of humanity. It appears discord prevails everywhere, wants are felt and to remedy the circumstance envy proceeds aiming at the resources which others have, and hence the cause of feuds between man and man and nation and nation. Civilisation, as I understand, is to gain real knowledge in order to realise the truth and the self,

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and finally the world at large. Through evolution and by proper control over the passions man should be superman when he will enjoy perfect peace of mind undisturbed by envy, anger and temptations. The present machine civilisation is merely a phase in the life of the world and it is difficult to declare with certainty if such a materialistic advancement is superior to spiritual advancement. We read in the *Mahabharata* that ultimately the absolute spiritual force reigned supreme over the brute force for it is the spiritual force which is the only source of peaceful and healthy mind of individuals and nations. If we take it for granted that we here in India should compete with the other nations of the world, in a rather vicious circle, the question will still remain doubtful if India can be safe. The adverse examples are before our eyes these days.

Vegetable civilisation is the basis of machine civilisation. Man with his live-stock has to depend on agriculture from the dawn of civilisation. He will have to depend on the plant world for food, clothing, housing and other daily necessities and luxuries of life. Is it not a fact that the vegetables have kept up the machine world going? The raw plant products feed many industries which are of vital importance to the life and advancement of nations. Is it not a fact that the present powerful nations realise that the vegetables and plant products are of greatest importance for increasing national wealth and strength? It may not be a far-fetched conclusion that acquisition of more vegetable wealth is one of the prime motives that prompts a powerful nation to expand their empire in order to feed and clothe their increasing population. We are also aware that the vegetable kingdom by modern improvement of agriculture and horticulture sustains to a large extent the life of nearly two thousand millions of human beings inhabiting the globe at the present time.

It is not a mean natural advantage of India to have at her disposal such vast fertile lands ranging from the hottest to the coolest climates. The fertility of our motherland with sufficient men to work it out is a great potential asset to our nation. It is therefore not erroneous for wise statesmen to divert their due attention to the improvement of

agriculture. In fact, much more attention is required to discover and domesticate new economic plants. These will then have to be cultivated on scientific methods on our land much of which is not properly utilised. The vegetable produce should thus be made more profitable by internal consumption and external trade development. The United States of America and Russia have made phenomenal advancement in this direction. I am therefore in full agreement with Capt. F. Kingdon Ward in his following remarks published in the *Gardener*, Vol. III. No. 2. p. 62. 1939.- "Every plant is a chemical laboratory, producing some substance which may have use in the economy of mankind. Hitherto our energies have been mainly devoted to discovering and classifying the vegetation of the earth—a task by no means finished. An immense number of plants are known to yield useful substances; but this number must be small compared with the number of unknown plants which will some day yield valuable products. The forests of India probably contain undreamt of wealth of such plants. They may be discovered by accident, or by design; but discovered they will surely be. The Indian biochemists of the future will search with the most ruthless patience for new sources of certain drugs, vitamins, enzymes and the like; and the entire plant world, on which we all ultimately depend for life, will be subject to the most minute scrutiny, the most exacting analysis.

How, or where, does the gardener in India come into the picture? As I conceive it, he comes into it at least in one important connection. That is, if he is enterprising. I began this article by talking about fruits and pointing out that many so-called "vegetables" are actually fruits. And I have always held that there is great scope for a gardener in India to experiment, not only with new flowers, but with fruits and vegetables.

* * *

Gardeners in India will gradually realize their opportunities which are second to none. More and more will they experiment and make known to the scientific world what plants can be grown, under what conditions. That is important. It is a serious and essential contribution to knowledge. There must be hundreds of economic plants which could be usefully and profitably cultivated in India, but

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are not. That is one role the gardeners can fill. There is another—the improvement of plants which are already in cultivation. Improvement is the result of good cultivation, careful selection of the best types, judicious hybridization, and grafting on to the best stocks. In this work the gardener is ably assisted and indeed stimulated by the best firms in the trade, nurserymen and seed merchants, who are anxious to provide him with something new each year. He can rely on them, and help on the work they do. The enthusiastic gardener in India has a romantic future unfolding before him."

In conclusion, I would lay stress, for the advancement of the country, on the development of both our vegetable and mineral resources. The former like the latter too supply "fodder" to all large scale industries which need to be established and developed in the light of the modern advancement providing employment to our countrymen. I am sure by laying emphasis to "mineral civilisation" our learned and respected editor intends to

draw greater attention to profitably utilising the particular kind of our natural resources. Resting on the solid rock of truth, knowledge and spiritual force, let us advance and uphold the great tradition of our motherland.

[We fear the author has somewhat misunderstood us. Nobody will dispute the fact that agriculture is an essential adjunct to human life and vegetable produce constitutes a source of raw materials for the manufacture of many useful products necessary for civilised life. We have never deprecated attempts or attention paid to the improvement of agriculture. What we wanted to point out is the unsoundness of an undue emphasis which is laid absolutely on agriculture and rural crafts in certain quarters in our country. When the present day world, by virtue of rapid advance of transport and communications has been so closely knit, we can not afford to be ostrich-like and to revel in ancient habits and customs of a secluded people, while our neighbours are living a better standard of life, and may be for selfish motives do not shrink from preying on others' homes. There is a material aspect of life which is governed by the surrounding conditions. The age-old philosophy of life, endorsing plain living and high thinking, is quite good provided we can cut adrift from the rest of the modern world and are defended from foreign aggression by a spiritual belt.—Ed. Sc. & Cul.]

The Analysis and Measurement of Noise in Engineering Problems

With special reference to electrical machinery

B. B. Ray

THE elimination of unnecessary noise from machinery or other apparatus in factories, offices and vehicles of all kinds is now receiving systematical attention, for it is well known that unwanted noise in workshops and offices greatly reduces the efficiency of the workers. During recent years, therefore, considerable thought has been devoted to the question of noise and its elimination with a view to obtain a marked improvement in general efficiency. The object of this paper is to explain, as far as

possible in non-technical language, the main problems involved and the apparatus employed in the quantitative measurement of noise.

At the outset it is essential to realise that an exceedingly small amount of energy is required for the production of sound. As an example, the mean energy output from an average public speaker is only 24 microwatts, and in the case of a very powerful public speaker, about 60 microwatts.

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The human ear is not equally affected by sounds of different frequencies, the sensitivity being greatest around 2,000 cycles per second, as shown in fig. 1. The lower curve represents the minimum energy component of any frequency that the ear can

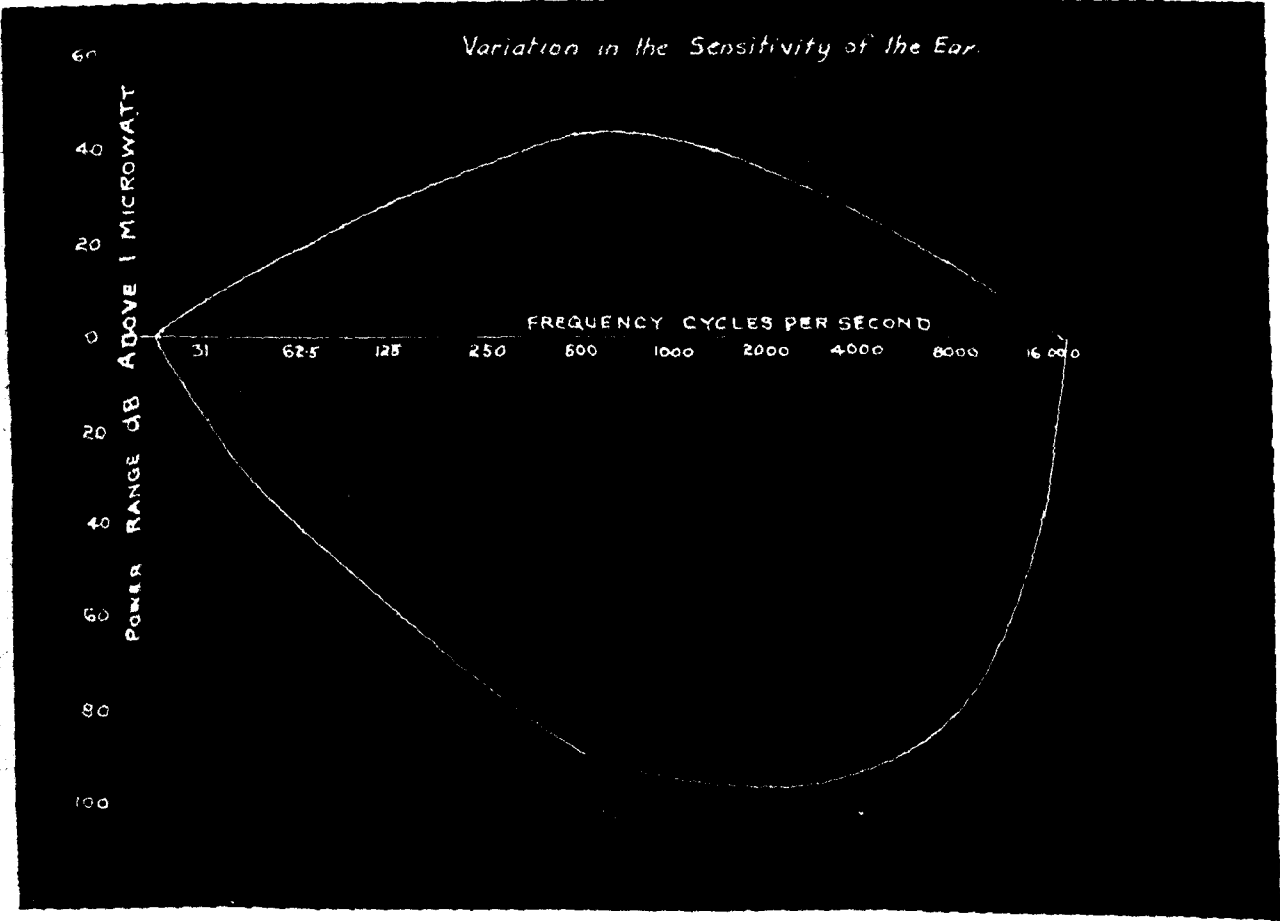


Fig. 1.

detect, and the upper curve represents the sound level at which the sensation of hearing gives way to pain, and the sound is detected more by feeling than by hearing. The ear, in a similar way to other organs associated with the body, obeys an approximately logarithmical law, so that if we reduce the energy expended in noise output from a machine by 50%, the corresponding decrease in audibility is very small.

Units of Measurement

Owing to the enormous range of sound intensities which the ear can detect, it is customary to specify the level of decibels above a certain level. The intensity level is then

$$10 \log_{10} (p/p_0)^2 = 20 \log_{10} p/p_0$$

where p = measured sound pressure, p_0 threshold sound pressure in dynes per sq. cm.

The threshold value p_0 is arbitrary, but the recent recommendations by the Acoustical Society of America suggest a value of '0002 dynes per sq. cm. This value has been generally used in all measurements and tests given in this paper.

In order to prevent any ambiguity which might arise owing to the fact that the decibel merely

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expresses a ratio and for this reason is meaningless unless the reference value is defined, a new unit of equivalent loudness has been adopted, called the 'Phon.' This unit is defined as follows:

"The frequency of the standard tone shall be 1,000 cycles per second, the standard tone shall be a plane sinusoidal sound wave coming from a position directly in front of the observer; the listening shall be done with both ears and the intensity level of the 1,000 cycles standard tone shall be measured in the free progressive wave. The reference level shall be taken to be that corresponding to a sound pressure of '0003 dynes per sq. cm., the value approximating to the normal threshold of audibility for the 1,000 cycle pure tone observed in the manner described. When under the above conditions, the intensity level of the standard tone is n decibels above the standard reference intensity, the sound under measurement is said to have an equivalent loudness of n phon." The primary standard has now been made available by the British Standard Institution and the unit is known as the British Standard Phon as per B. S. S. 661/1936.

As already mentioned above, the decibel unit measures only sound intensity and does not give an idea of loudness. Many attempts have been made to evolve a loudness scale which accurately represents the physical stimulus to which the ear is susceptible.

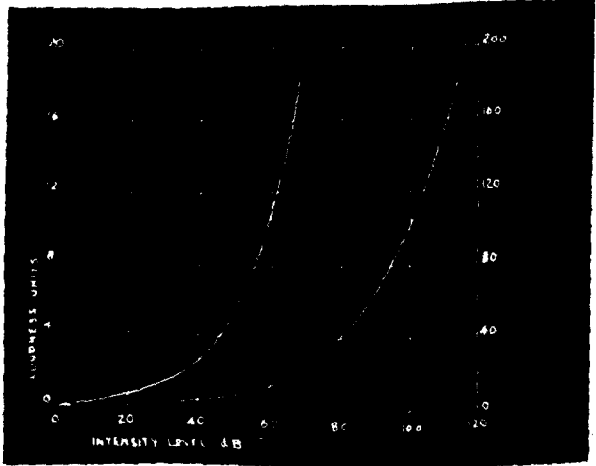


Fig. 2.

Relation between Loudness Units and Intensity Levels.

In fig. 2 relation between loudness units and intensity level is shown which was obtained as follows:

Observation is to be started with a sound of low intensity, and to note the increase in intensity which is necessary to produce a sound which appears to be twice as loud as the original. This procedure is then repeated until the full intensity range covered by the ear has been examined. Tests were carried out on a large number of individuals.

Typical Noise Levels

Before proceeding to analyse noise from different types of electrical machines it is interesting to compare noise originating from different types of sources.

TABLE 1.
TYPICAL NOISE LEVELS.

Origin of Noise.	Level (db)	Conversation Level.
Aeroplane—Ford 3-engine, 110 m.p.h. .	127	Impossible— not even shouting.
Aeroplane—open cockpit type, 90 m.p.h. .	124	
Elevated train, N.Y., passing express train	114	
Steel-tank manufacturing shop	100	Possible—by shouting.
Machine room near large turbo sets	100	
Pump house	102	
Heracles—London-Paris, 90 m.p.h.	95	Possible—with difficulty.
Train dining-car, 80 m.p.h. in tunnel	95	
London tube train, 35 m.p.h.	95	
Turbine test bed, 5,000 kW., running	90	
Train dining-car, 60 m.p.h.	85-90	Possible—with little effort.
Busy city street with trams passing	85	
Closed motor-car, 30 m.p.h. concrete road	80	
Office adjoining street—weekdays	70	
Quiet office	50	
Street—residential district—day	50	
Silent room (for testing gramophone motors near manufacturing shop)	30	
Street—residential district—night	30	
Threshold of hearing	0	

In the above Table noise originating from different and varied sources are given in decibels. It will be found from the Table that conversation is possible with difficulty when the noise level is about 95 decibels and below 85 decibels it is possible to converse without any difficulty.

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(iii) Indirect noise due to the transmission
of vibration from the feet of the
machine into the foundations whence it

TABLE 2.

Typical Noises in the Phon and Loudness Scales.

	Phons 110	Loudness 160		
Near concrete drills			Box factory—two circular saws	Workshop with large machines.
In aeroplane	100	100	Large generating station and boiler house	
	90	59	Steel fabrication shop	
Motor horns	80	33	Automatic machines shop	Workshop with small or no machines.
In the train	70	17	Generating station—control room	
	60	8	Armature coil shop	
Busy city street	50	3	Erection shop	Busy offices.
Saloon car Conversation.	40	1	Busy office with typists, people walking about and talking.	
	30	1/4	Office without typists	
Average street	20	1/32	Small very quiet office, no machines near	Quiet offices.
Quiet street	10	1/1000		
Very quiet still night in the country.	0	0		
Very quiet bedroom at night.				
Threshold of hearing				

The above typical noises are given in phons and
corresponding loudness units and it will be noticed
that about 60 phons corresponding to 8 loudness
units give impression of "noisy office." whereas a
quiet room corresponds to 40 phons and the loud-
ness unit is 1.

Noise from the Electrical Machinery

With the increasing use of electrical power
plants in private houses, hospitals and offices it is
absolutely necessary that their operation should be
as silent as possible. Thus the design of silent
motors and the analysis of the sound spectra
have become an important branch of electrical
engineering.

Rotary Electrical Machinery: In general, noise
from a rotating electrical machine may be classed
under 3 different types,

- (i) Direct windage noise, due to the turbul-
ence of the air,
- (ii) Magnetic noise, and

may be conducted to some remote part
of the building, giving rise to a
secondary vibration due to resonance.

Windage noise is caused by siren effect between
the radial ventilating slots and the rotating poles in
the case of salient pole machines and rotor slots in
the case of induction motors. The relative motion
between the radial slots and the rotor poles or slots
causes the slots to be alternately cut off and opened,
giving rise to a noise of frequency $s \times n$, where s =
number of slots in the stator and n =revolution per
second. The windage noise can be reduced by shap-
ing the pole tips and having a long radial air gap.
A certain amount of noise is produced by the turbul-
ence of air as it leaves the ventilating holes. This
can be reduced to a certain extent by lining the
outlets with a material which does not reflect sound.

The most common cause of magnetic noise in
electrical machines is due to the alternating magnetic
flux, noise being proportional to the fourth power of
flux density. It is not possible in a paper of this

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nature to deal with mathematical treatment of the
problem, but suffice it to say that:

Frequency of the note= $2fn$, where f =frequency
of the machine and n =nearest integer to the number
of slots per pole.

the noise can be considerably decreased by increas-
ing the air gap by a small amount depending on the
ratio of

s/g where s =slot width and g =air gap.

Dealing with transmitted noise through founda-
tion it is evident that when the natural period of
vibration of the foundation happens to be in reson-
ance with one of the harmonics of magnetic traction

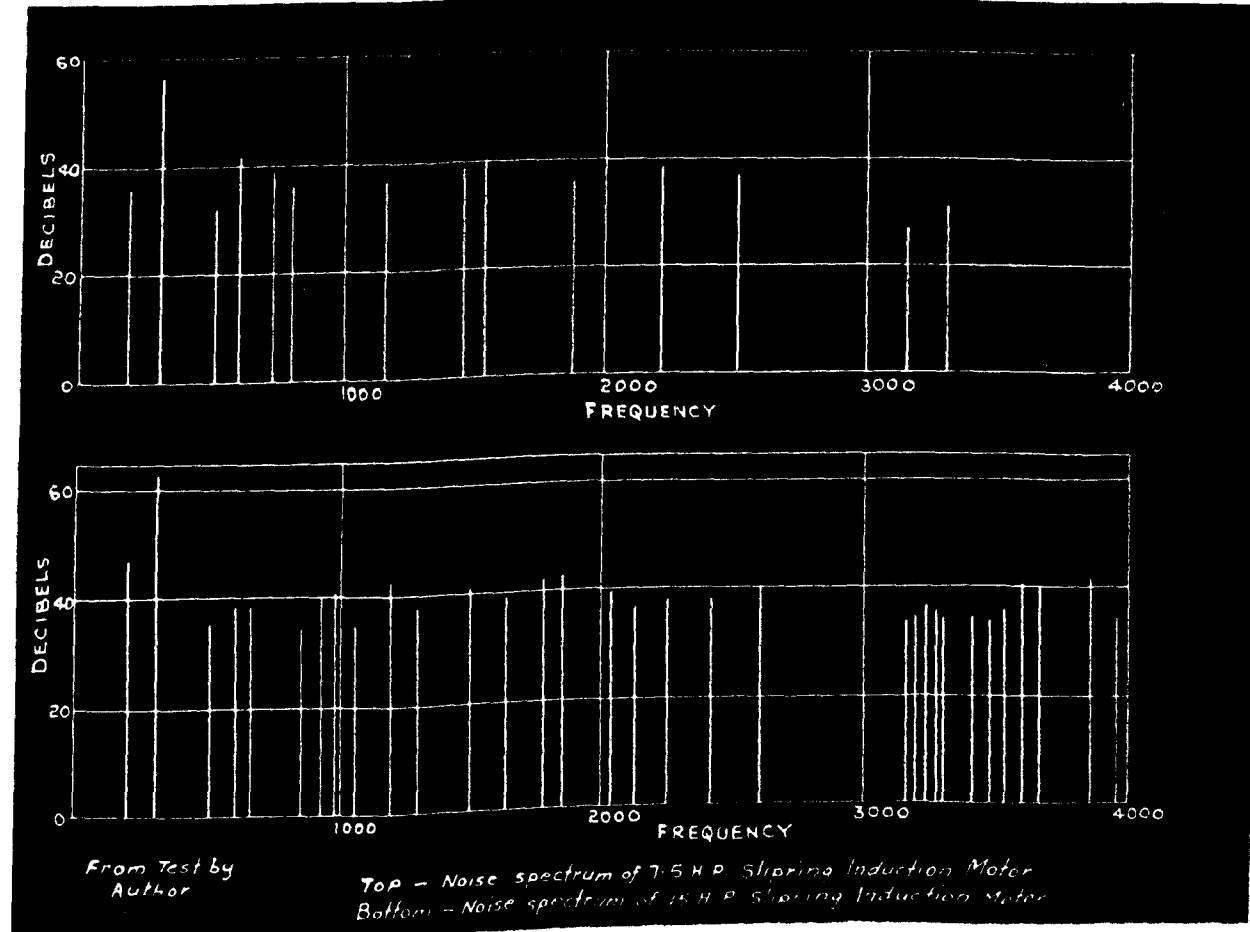


Fig. 3.

The magnetic noise can be reduced by making
the rotor pole equal in width to an integral number
of armature slots. The number of slots per pole
should not be an integer plus a large or small
fraction. The ratio of slot opening to air gap should
be as small as possible and the iron at the back of
the stator slots should be as deep as possible. It has
been found that in the case of noisy induction motors,

in the motor, the transmitted noise is immensely
augmented. This can be avoided by separating the
building foundation from the machine by means of
elastic foundations.

In addition to the above causes, noise is caused
to some extent by badly fitting bearings, chattering
of brushes and sliprings and chattering of laminated
core, due to stamping not being properly clamped

together. These, however, are not inherent in their nature and are due to mechanical causes and can be avoided.

In fig. 3 noise spectra of two induction motors are shown; these were drawn from experimental results carried out by the writer by means of a noise analyser described later in these pages. From the spectra it will be noticed that the noise from a machine consists of complex noises with one harmonic peak at about 150 cycles due to the magnetic flux and large components at about 3,000 cycles due to bearing and brush noises.

In fig. 4 variation of noise with field current in a d. c. motor is given and in fig. 5 variation of slot frequency component with speed for the same machine is shown.

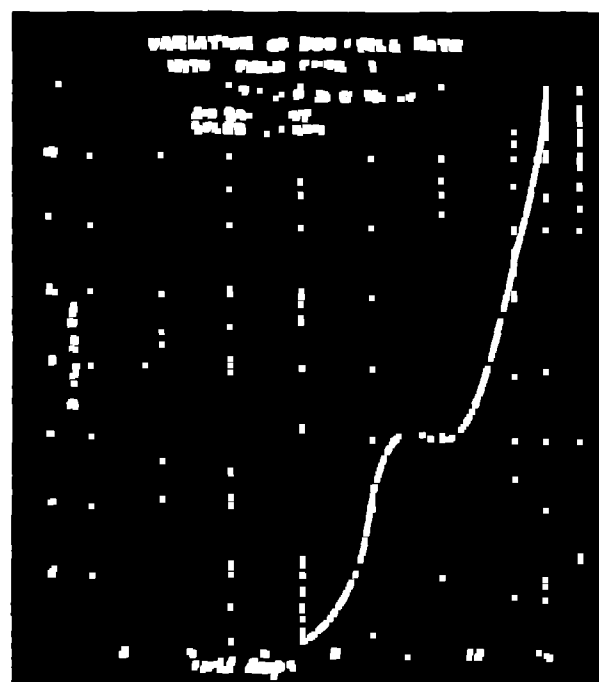


Fig. 4.

Transformers: Vibration in the core, which have their origin in the cyclical changes of flux, are transmitted to the tank, both by direct con-

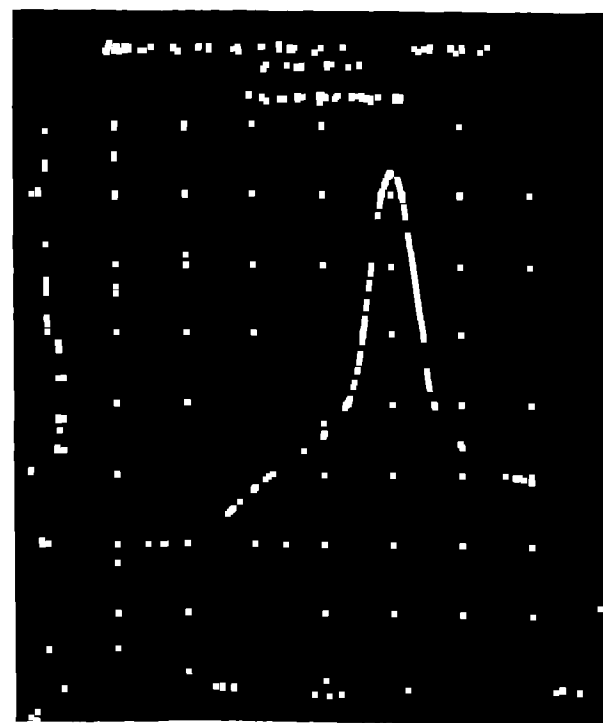


Fig. 5.

tact and through the oil, where they are radiated as sound waves. It has been found that generally noise from a transformer varies with its size and that load on the transformer has negligible effect on the noise output. Even with very efficient clamping of the punchings, it is found that irregularities in the punchings cause a certain amount of rattling noise between the laminations with an air-cooled core. Under oil, however, such phenomena appear to be severely damped. The noise emitted from transformers consists of a 100 cycle fundamental note and a series of harmonics, usually of a decreasing magnitude, this being applicable to 50 cycle machines. It has been shown that the mean frequencies in transformer noise are from 200 to 500 cycles per second. These are equivalent to wave lengths ranging from about 2 to 5 feet, and such wave lengths require large radiating surfaces for efficient sound radiation. Thus the greater part of the sound is radiated from the tank and the cooling tubes. The three chief methods available for reduction of noise from transformer are as follows:

- (i) Reduction of flux density,
- (ii) Separation of cooling equipment and sound insulation of that part of the structure which radiates the sound, namely, the tank,
- (iii) Reduction of magneto-strictive effect of transformer steels,

This method of noise reduction entails a considerable amount of fundamental research of transformer irons, and a programme of research on this subject is being carried out in different parts of the world.

and to this the following fourth method may be appended,

(iv) Resilient mounting of transformer base.

Measurement of Noise

The total noise which accompanies the operation of electrical machines may be determined by objec-

will give the energy components of all the frequencies which exist to make up the complex noise under consideration. A noise analyser has to be used for this purpose.

Objective Method: In the objective method the sound is picked up by a microphone and each frequency component is then adjusted in intensity to correspond with the varying sensitivity of the average human ear by a specially designed filter network. The energy levels of all the components are then added by the output meter. The filter network is designed on data obtained experimentally, which gives the intensity level of pure tones which produce the same loudness sensation at different frequencies. In fig. 6 a diagram of an objective noise meter is placed at a given distance from the sound source, with the microphone facing the sound, and the attenuators are adjusted until a reading is obtained on the output meter. The noise level in decibels can then be computed immediately from the attenuators and output meter indications.

Subjective Method: A second method of assessing total noise utilises the ear as the final judge of

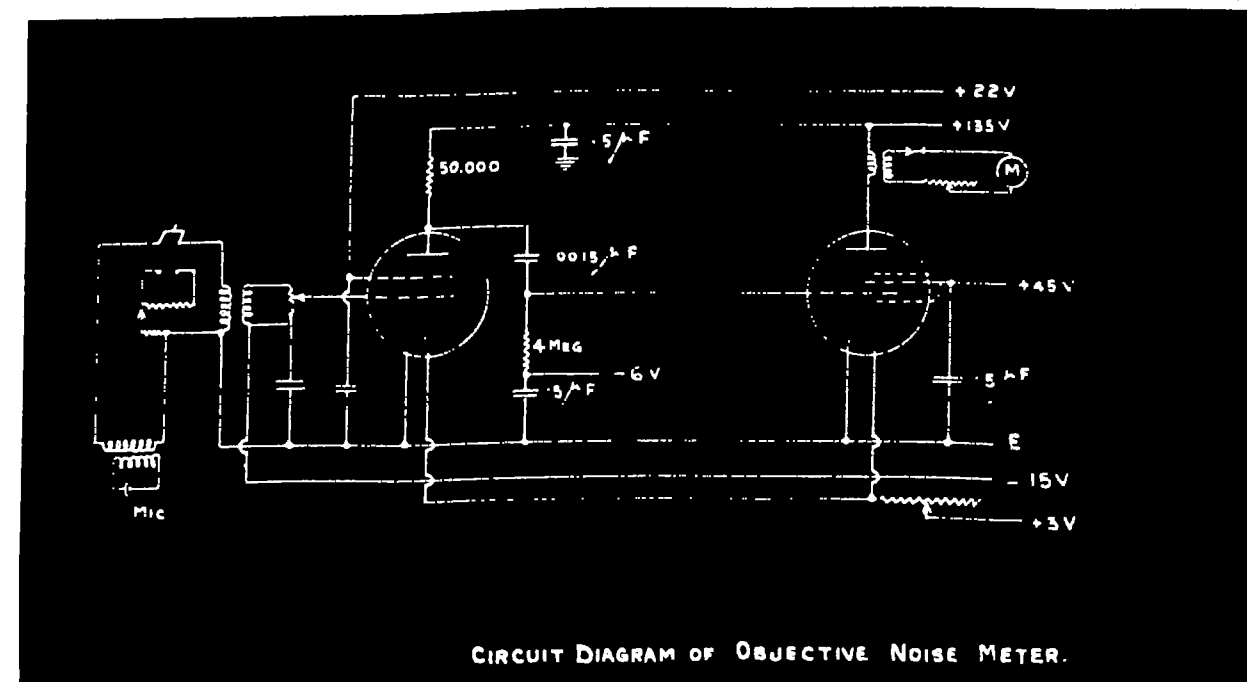


Fig. 6.

tive or subjective methods. In all noise problems, the essential procedure is to make an analysis which loudness. The method may be broadly split into two classes, masking methods and aural balance

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methods. In the masking method arrangements are made for one or both ears to pick up the complex noise and a standard reference tone simultaneously. This is usually accomplished by fitting the reference tone into a telephone ear phone which is fitted to a special ear cap to permit external sounds to reach the ear. Arrangements are made for adjusting the reference tone for the full range of audibility by means of suitable attenuators. In practice the reference tone is varied in intensity by the observer until it is completely masked by the sound under observation. The readings are calibrated giving intensity level in decibels. This method of measurement offers, however, one or two serious disadvantages, and for these reasons it is generally accepted that a method using aural balance is to be preferred. A typical example of this method arranges for one ear to be presented to the source, while the second ear is covered by a single ear phone excited by the reference tone. The reference tone is then adjusted until it appears to be equally loud with a noise under test. The attenuator controlling the reference tone is calibrated directly in decibel loudness levels of an equivalent 800 cycle or 1000 cycle reference tone.

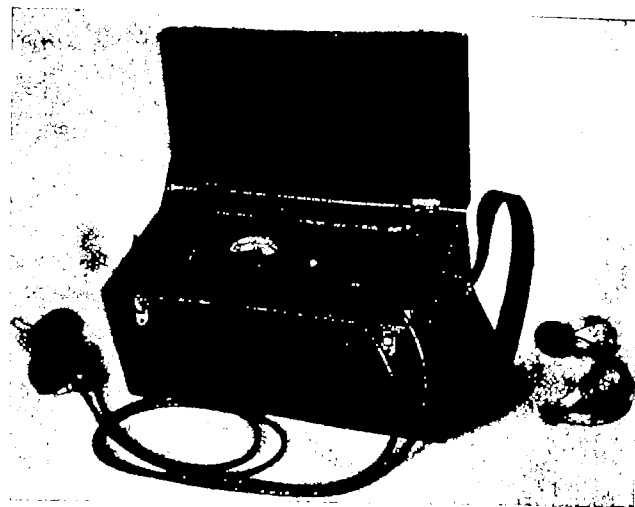


Fig. 7.
Subjective Noise Meter.

The picture of such a meter is given in fig. 7. All measurements of total noise in decibels referred to in this paper have been taken by means of a meter of this type.

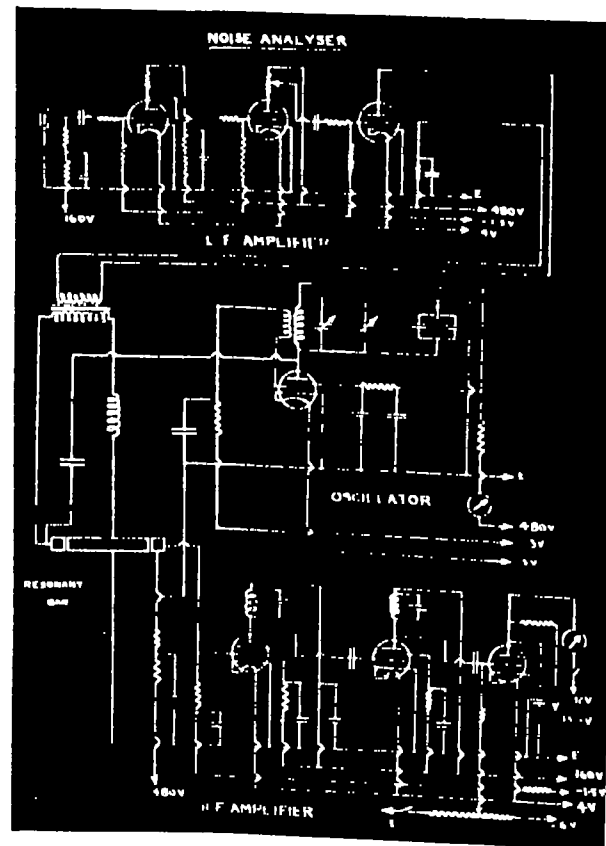


Fig. 8.
Noise Analyser.

In all noise problems it is necessary to analyse the energy under consideration, so that the exact source and frequency of the higher components may be determined and steps may be taken to eliminate them. The noise analysers are used for determining the noise spectrum in the same way as an optical spectrometer is used for analysing the light spectrum. A general layout of a noise analyser is given in Fig. 8, and all experimental results given in this paper were determined by using this analyser. The noise to be analysed is picked up by a microphone and amplifier. An auxiliary oscillator is provided, the frequency by which can be finely adjusted. The auxiliary voltage is modulated by the noise voltage so as to produce frequencies which consist of the sum and the difference of the auxiliary and the noise component frequencies. This modulated voltage is applied to drive a mechanical resonating system of fixed frequency, the amplitude of motion of which is then measured by a microphonic device and an amplifier system.

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The frequency of the auxiliary voltage is then adjusted experimentally until one of the modulation frequencies agrees with the resonating frequency of the mechanical system. The frequency of the noise component can then be deduced from the known constants of the apparatus, and its amplitude from the indicating amplitude of motion of the mechanical system.

It is not possible to give a wathematical treatment of the analyser in a treatise of this nature, but it might be menticned that in order that component frequencies, a few cycles apart, may be separated, the mechanical resonating system must have a very high degree of selectivity. The resonating system consists of a cylindrical steel bar, adjusted to such a length as will give longitudinal resonating frequency of 16,000 cycles. The driving mechanism consists of a short steel cylinder rigidly held about .0004 inch from one plane end of the cylinder. The voltage applied across the air gap so formed creates an electrostatic force on the bar and sets it to longitudinal vibration. The microphonic device for detecting this motion consists of a similar vibrator held at the other end of the bar, but with a d.c. polarising voltage across the gap. The combination of this forms an electrostatic microphone.

A very high amplification is necessary to detect the minute motion 10^{-8} cm. of the bar and this is obtained by the combination of a screened grid valve and tuned anode coupling. With careful tuning an amplification factor of 80,000 to 1 may be obtained.

Method of Analysis

The machine to be tested is placed in a "silent room." The floor, ceiling and walls of this room are lined with jute fibre, 3" thick and the room for all practical purposes is sound-proof; and is provided with a false wall with an intervening air chamber. There is very little noise, if any, due to reflection. The machine under test is coupled through flexible coupling to a load or a driving machine outside the room, the shafting being brought through the wall. The baseplates of both the machines are to be especially constructed and must be separated from the main flooring.

The microphone should be situated about 2 feet from the machine under test. The volume control stop on the analyser is turned to that corresponding to maximum amplification, and the main tuning condenser is slightly rotated from its position until the deflection is obtained on the microammeter. The condenser should be then tuned carefully in order to obtain the peak reading. From the readings the frequency and amplitude in dynes per sq. cm. can be calculated.

Conclusion

Whilst selecting a machine for installation in a particular place, it is always necessary to know the background noise present in the place, since how much noise is permissible for the machine to make depends on the background noise. Though the analyser and the audiometer give some measure of the noise, the exact character of the noise; however, remains undeterminable, since no instrument can interpret the physiological and psychological effect of noise on the human ear.

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The Age of the Mahabharata

P. C. Sengupta

IN the March issue of vol. IV of "SCIENCE AND CULTURE," M. N. S. in his paper on "The Age of the Mahabharata" has criticised my paper, "Some Astronomical References from the Mahabharata and their Significance," published in the J. R. A. S., Bengal, Letters, vol. III, no. 1, 1937.

In my paper, I have used certain astronomical references collected from the battle books of the Mahabharata, which I still hold to belong to the oldest strata in the great epic, and they are only incidental and not directly stating the positions of the equinoxes or the solstices of the Pandava times. I have established in my paper that these references justify the conclusion that the Bharata battle was fought in 2449 B. C., and between the dates, the 4th and the 21st November of that year.

The striking astronomical consistency of the references has led M. N. S., to propound the theory that these were all later additions by the epic compiler of about 400 B. C., made with the help of an astronomical assistant of his time. I am, however, of opinion that such a hypothesis as to their origin is not justifiable.

Firstly, these astronomical references are not all collected at any single place: they are scattered over the battle books from the Udyoga to Anusasana.

Secondly, the knowledge of astronomy, developed in India from the earliest times up to 400 B.C., could not enable any astronomical assistant to determine the set of those astronomical references which I have used in my paper. So far as my studies go, neither the astronomy of the Brahmanas, nor of the Vedangas, nor of the Paitamaha-Siddhanta as summarised in the Pancasiddhantika of Varahamihira, was equal to the task. I set forth the arguments in favour of my position as briefly as possible.

From the Mahabharata references cited in my paper, I have evolved two astronomical data for the determination of the year of the Bharata battle: (i) that the year of the battle was similar to the year 1929-30 A. D., of our times in so far as the moon's phases near to the fixed stars are concerned, and (ii) that the observers of the sun appointed by the Pandavas were satisfied that the sun had turned north exactly after a lapse of 50 nights from the evening on which the battle ended.

Before the battle broke out there was a new-moon near the star Antares, from which the lunar month of Agrayana began in the year. Thirteen days later in the evening the moon nearly full, was observed near the star group Kritikas or Pleiades. The battle began from the next morning. On the night following the fourteenth day of the battle, a crescent moon rose a little before the daybreak. On the 18th or the last day of the battle the moon was conjoined with Sravana or Altair. Exactly fifty nights after the battle ended, Yudhisthira was satisfied that the sun had turned north or that the sun had reached the winter solstice one day earlier. The true anniversaries of these events are exhibited in the statement on the next page.

As regards the repetitions of the moon's phases, they occur at intervals of 19, 160 or 1939 sidereal years. Hence by the mere repetitions of these phases of the moon near to the fixed stars, no date of any past event can be determined. Coupled with these repetitions of the lunar phases, we must exactly know where the winter solstice day stood in relation to these phases or the lunar months of the year in which the event happened. Here, as shown in the above statement from January 1, to February 20, of 1930, the interval is exactly 50 days. Now if we suppose or assume that the true anniversary of the winter solstice day of the battle year was February 19, 1930, we can determine the year of

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happening of this event. Nowadays, the sun reaches the winter solstice on December 22; hence the total precession of the winter solstice day is readily found to be 59 days. If we adopt the rule that the solstice days preceded by one day in 74 years, then 59 days of precession would indicate a lapse of 4366 years till 1929 A.D. Hence the date of the Bharata battle would be near to 2438 B. C. We have here used a rough proportion which may be intelligible to all. Accurate methods, however, would yield the year 2449 B. C. itself, as the year of the battle.

Astronomical Events of the Battle Year.	True Anniversaries of the Events in 1929-30 A.D.	Remarks.
New Moon at Antares.	December, 1, 1929.	Agrayana begins.
Conjunction of Moon with Pleiades.	December, 14, 1929.	Battle begins from the next day.
Crescent Moon rises before sunrise.	December, 28, 1929, in the night following.	
Conjunction of Moon with Altair.	January, 1, 1930.	Battle ends in the evening.
First day of Sun's northerly course.	February, 20, 1930.	Sun reached winter solstice the day before.

I now proceed to show that the interval of 50 days between the end of the battle and the first day of the sun's northerly course of the year, could not be predicted by the astronomical knowledge that developed in India from the earliest times up to 400 B. C. In Vedic times, for starting the five yearly luni-solar cycle or lustrum, a peculiar synodic month of Magha was used from about 3500 B. C. This lunar Magha had these three important features (i) that it should have for its beginning the new moon at Dhanistha (Delphinis), (ii) its full moon at the star Magha (Regulus) and (iii) its last quarter at the star Jyestha (Antares). In spite of these well-pronounced characters, it could not be a sidereally fixed lunar month. In our times such a month of Magha happened truly according to our estimate in the years 1924, 1927, 1932 and 1935 A.D. The beginning of this standard Magha oscillates between the 2nd and 6th of February, and

its end between the 3rd and 7th March. According to Varahamihira such a Magha came in the year 2 of Saka elapsed or 80 A.D., and this year was similar to 1935 A.D., of our time. If we allow a slightly greater latitude, the year 1929 had also this type of Magha from the 9th of February to the 11th of March. Hence both the years 1924 A.D., and 1929 A.D., were suitable for starting the Vedic five-yearly cycle, the former being more suitable than the other.

Now 1924 A.D., had the same lunar phases as 2454 B.C., and 1929 A.D., the same as the year 2449

B.C. This latter year has become the year of the Bharata battle according to our finding. Between the years 1924 A.D., and 1929 A.D., we had a Vedic luni-solar cycle of 5 years, and a similar lustrum existed between 2454 B.C., and 2449 B.C. Here the battle year was similar to 1929 A.D., as has been shown already, and the year exactly preceding battle year by one lustrum was similar to 1924 A.D.

(1) First, let us suppose that the full-moon day Magha and the winter solstice day, were the same day in the year similar to 1924 A.D., exactly one lustrum before the battle year* similar to 1929 A.D., Hence the five-yearly Vedic cycle started therefrom would end on the full moon day of Magha of the battle year. It would then be

* The reference is here to the age when Pleiades and Regulus were respectively near to the vernal equinox and the summer solstice, i.e., about 2450 B.C.

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usual to start the Vedic lustrum anew from the day following the full moon day of *Magha* of the battle year, and this full moon day would be taken for the winter solstice day according to the reckoning used. Now one Vedic year consisted of 12 lunations *plus* 12 nights; hence the estimated day of the next winter solstice would be the 27th day of lunar *Magha* to come. The 28th day of this *Magha* would be the first day of the sun's northerly course. This day would correspond with the 27th February of 1930 A.D., of our time. Hence the predicted first day of the sun's northerly course, and the last day of the battle which corresponded with January 1, 1930 A.D., would have between them *an interval of 57 and not 50 days as found by observation*. Thus the predicted day of winter solstice could not generally agree with the accurately observed winter solstice day in the Pandava times. This is also illustrated from the following verse of the *Mahabharata*,** which contains Krishna's prediction of the first day of the sun's northerly course on which Bhishma was to expire.

"O chief of Kurus, there still remain 56 days more of your life: then laying aside this body you will attain those blissful worlds which are the fitting rewards of your good deeds in this world."

This verse of the original saga is found displaced from its proper setting in the present recension of the *Mahabharata*. Krishna must have addressed these words to Bhishma at the conclusion of the fight or on the day following.

(2) Secondly, let us suppose that 5 years before the beginning of the battle year, it was found by observation that the day of new moon of *Magha* began with the winter solstice day*; then at the end or termination of the five yearly cycle at the starting of the battle year, the new moon day of *Magha* began and it would be reckoned as the winter solstice day. The estimated winter solstice day for the beginning of the next year would be the 12th *tithi* of the coming *Magha* and the first day of the

sun's northerly course would be the 13th *tithi* of *Magha* and in our gauge year 1929-30 A.D., it would correspond with the 11th February, 1930. Between the ending day of the battle (corresponding with January 1, 1930) and the first day of the sun's northerly course, there would intervene *41 days as predicted and not 50 days as observed*.

Thus judging by the methods of reckoning of the Vedic and post-Vedic followers of the five yearly luni-solar cycles, it was not possible for an Indian astronomical assistant by any back calculation to furnish the *Mahabharata* compiler of 400 B.C., with the set of astronomical reference which I have used to establish that the Bharata battle was fought in 2449 B.C.

M. N. S., has devoted long columns to establish his general indictment on epic writers and I am not disinclined to agree with him in certain respects. For a set of astronomical data giving the year of Bharata battle I had to go to the *Mahabharata* as I could not find it elsewhere, and this set yielded the year 2449 B.C., as the battle year, producing a unique agreement with the Vriddha-Garga tradition. Many though, are the sins of the epic writers, it may not, for the matter of that, be quite impossible to find truth in their works preserved from the original ballads. But in this connection, I fail to discover why M. N. S. has not dealt with the sins of the Puranic writers in the same critical spirit and how he could give his dictum in the form: "The only correct tradition which is preserved in the Puranic literature is that the battle occurred 1015 or 1050 years before the time of the Nandas." He has not examined what was the chronological order in which the modern Puranas came into being, has not settled what exactly was the intention of the Puranic summariser as to the interval between the birth of Pariksit and the accession of Mahapadma Nanda, has not examined what this interval is according to the dynastic list of Magadhan kings as given in the *Puranas* and how far these lists are reliable or consistent and how far they are complete. There is a difference of at least half a millenium in the Puranic summariser's statements as to the interval between the times of Pariksit and Nanda. In short, M. N. S. has not really given us his correct estimate of the truth in the Puranic writings.

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Lastly, I can not agree with M. N. S., when he says that "the *Mahabharata* writer of the 4th century B.C., while inserting the astronomical references, merely calculated back on the assumption that the Great War was fought when Pleiades formed the vernal equinoctial point, because this was an older tradition." In my paper in the *J. R. A. S., Bengal*, on page 102-115, I have established that the battle was fought in 2449 B.C., and have found the battle calendar also, but had no occasion to use any data like this that Pleiades then formed the vernal equinoctial point. I may remark here that such a data cannot lead to any accurate determination of the year of any past event.

We can here explore the possibilities of M. N. S.'s assumption in the following way. The year of the *Brahmanas* and the *Vedangas* consisted of 366 days and a quarter-year was thus of 91½ days. If the *Krittikas* or Pleiades were at the vernal equinox, then a full moon at the *Krittikas* would be the day of autumnal equinox, and the winter solstice day should come after 91½ days according to this mode of reckoning. Now in order to interpret the *Mahabharata* astronomical references we take a gauge year in which the full moon of *Kartika* took place very near to the *Krittikas*; this year would be 1934-35 A.D. The day of full moon of *Kartika* would correspond with 21st November, 1934. The predicted day of winter solstice would correspond with the *21st of February*. According to the *Mahabharata* references, the anniversary of the last day of the Bharata battle would be January 6, 1935, and of the winter solstice day the date would be the *25th February 1935*. There would thus be a clear difference of 4 days between the *estimated winter solstice day and the Mahabharata-stated winter solstice-day*. Here if we take the *Mahabharata* date for winter solstice to be correct, we get a total precession of the solstice amounting

to 65 days, representing a lapse of 4810 years till 1935 A.D., and the date of the battle is pushed up to 2876 B.C., nearly, which gets no anchorage at either of the Aryabhata or the Vriddha-Garga tradition. Hence M. N. S.'s hypothesis cannot explain the possible finding of the *Mahabharata* references as used in my paper, by the epic compiler or his astronomical assistant of 400 B. C. It is noteworthy that from the full moon day of *Kartika* to *Mahabharata*-stated winter solstice day, the interval must always be 95 days, and a quarter-year was equal to 91½ days according to the calculation of these ancient times.

As to the date of the Bharata battle, epigraphic evidence, if ever discovered, would be most valuable and will put an end to all controversies relating to it. But we are not sure if such would be forthcoming in the near future. Again if any epigraphic evidence be really discovered, it may not be possible to interpret them. In the absence of such evidence we have to depend on the *Mahabharata* and the *Puranas*. We have to sift out truth from a mass of literature in which it is mixed up with fiction and mere conjectures. I have critically examined the Puranic evidence as to the date of the Bharata battle in a paper named "*Bharata Battle Traditions*" recently read before a meeting of the Royal Asiatic Society of Bengal. I have carefully weighed those Puranic evidences in the balance and have found them wanting. The *Mahabharata* astronomical references I have used in my paper can be explained only on the assumption that they were the results of really observed events which occurred in the battle year and incorporated originally in the *Mahabharata* saga. They can not be held as deduced by any back calculation. They lead directly to the conclusion that the battle year was 2449 B. C. I have found that there is a "real music" in these references which is totally wanting in the Puranic writings. I trust M. N. S.'s rule of "No truth in epics" is here proved by an honourable exception.

** *Mahabharata, Santi, 51, 14.*

* Reference is here to the time, about 1400 B.C., the date of the *Vedangas*.

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Discoveries at Paharpur

A profusely illustrated monograph on the results of the excavations at Paharpur, Bengal, from the pen of Rao Bahadur K. N. Dikshit, Director-General of Archaeological Survey just published has added a new chapter to the artistic and cultural history of Bengal.

The Paharpur mound and its enclosure were protected by the Archaeological Department nearly 20 years ago. The great height of the mound, which is known locally as the *pahar* or hill, has given the name to the neighbouring village Paharpur. The systematic excavation by the Archaeological Department begun in 1925 was only recently concluded, and the place has now revealed a great four-storeyed temple with a unique plan and a gigantic monastery containing nearly 190 cells enclosing it. Another mound known as the Satyapir Bhita at a distance from the mound has yielded structures and antiquities which are identified with the temple of the Buddhist goddess Tara. Bathing ghats, gateways and a sanitary block are amongst several structures brought to light. The plan of the main temple at Paharpur consists of a square shrine in the centre with cross-shaped adjuncts on each side and projections between each side. The whole is constructed in four terraces, and the type of architecture supplies the missing clue so prevalent in Burma, Java and the Malayan archipelago. There is no doubt that the great Bengal example furnished the model to the architects of greater India.

The most important discoveries at Paharpur are the stone images in the lower basement of the main temple, which revealed a new school of art in the 6th-7th century A.D. It is astonishing that in a monument which, there is no doubt, must be identified as the Buddhist *vihara* built by the well-known Pala

Emperor Dharmapala at the end of the 8th century A.D., such a remarkable series of sculptures consisting mainly of Brahmanical figures should have been found embedded in the walls in such good preservation. A large number of these panels refers to the exploits of Krishna's childhood, and what has been identified as a representation of Krishna and Radha is unique and must be considered as some of the earliest representations of this divine pair. Stories from the Hindu epics, *Mahabharata* and *Ramayana*, various forms of Siva, Ganesa and guardians of the quarters are given in these panels. No other examples of the same type or school of art have till now come to light anywhere else in Bengal.

The most numerous specimens of artistic work found at Paharpur are the terracotta plaques, of which nearly 2,800 were found, over two-thirds being still *in Situ*. These plaques play a prominent part in the scheme of decoration of the walls in each terrace of the temple. The variety of subjects depicted in the plaques is bewildering, consisting of deities, both Brahmanical and Buddhist, semi-divine beings, composite animals, stories current in folklore, men and women engaged in different occupations, animals and flowers and other objects. A complete picture of the world as known to these humble artists of 1200 years ago can be traced from these.

Mineral Springs in India

ATTENTION has recently been drawn to the occurrence of two sulphurous springs in Riasi district, Kashmir by the Geological Survey of India. One of the springs situated about a quarter of a mile above Khar along the Tawi river, discharges hot water only during winter and precipitates a good deal of milk

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of sulphur. The water of another thermal spring at Tattapani, is believed to be possessed of certain therapeutic properties for curing skin diseases and gouty affections. The water gives a strong sulphurous odour and maintains a constant high temperature of 70° to 80°C.

The name Tattapani is familiar in various parts of India—as in the Sutlej valley north of Simla, in the coalfield of this name on the northern border of Sirguja, in the Kopili valley in Assam etc.—at places where thermal mineral springs occur. There are, however, numerous other localities spread throughout India, some of the well-known places of pilgrimage, where hot springs are among the chief attractions because the waters have been found efficacious in the treatment of diseases.

Several years ago the Geological Survey of India compiled a catalogue of the hot springs in this country, but there is need of additional information both with regard to the radio-active and mineral character as well as the medicinal properties of the waters from a medical point of view. Before the Italian occupation of Abyssinia, an officer of the Geological Survey of India made a special investigation of several hot springs in that country on behalf of the Emperor of Ethiopia who then contemplated establishing a health resort in his territory. The special apparatus for ascertaining the radio-active property of spring waters in the field employed in Abyssinia is now in the possession of the Geological Survey of India. The department also claims to possess delicate laboratory apparatus for this kind of work and officers who are already familiar with investigations of this nature.

It is understood that an exhaustive examination of the mineral springs of India is under consideration and it is hoped that the Geological Survey of India will shortly be able to arrange a programme. But the determination of the physical and chemical constitution of the mineral waters must be supplemented by an investigation of the cures which are believed to have been effected by the various waters and for this purpose close medical collaboration is necessary to complete the investigation to give the final findings greatest values.

Mineral springs have till now attracted little public attention in India. In Europe spas and hydros have grown up at numerous places where mineral springs

occur and the therapeutic properties of the waters are beyond dispute. In India also if health resorts are established at suitable places where mineral springs occur they are sure to prove highly popular with those who seek health and holiday.

Survey of India During 1938

THE general report of the Survey of India for the year ending September 30, 1938, states that for the last few years surveys have been carried on at the rate of about 36,000 square miles a year and up to date a total of 11,71,649 square miles have been surveyed in India since 1905, when a programme of modern surveys to cover the whole of India was decided on. This Survey was expected to be completed in about 25 years, but the War retrenchment measures, and a variety of other causes have, however, retarded progress. If the present rate of progress is maintained the work may be finished in another decade.

An innovation has been the large scale air surveys of the towns of Bettiah and Jamshehpur in Bihar undertaken in co-operation with the Indian Air Survey and Transport Company. The use of air survey in modern town planning is typical of what may well be described as the purely civil aspect of air survey. The increasing recognition given to its importance is indicative not merely of the interest taken in it but also of the development that is taking place in India. Research into methods of air survey and its more military aspects are also being developed by the Survey of India in co-operation with the Army and Royal Air Force and air surveys were carried out of tribal areas of the North West Frontier not accessible to ground surveyors.

The department as usual extended co-operation and assistance to explorers. During the year the results of expeditions by Mr Eric Shipton and Mr Michael Spender in the Karakoram mountains, by Colonel Schomberg in the area east of Leh, and by Mr F. Ludlow and Mr Ronald Kaulback in the Assam Frontier Tracts and eastern Tibet were received for incorporation in existing maps. Dr Filchner, the well known German scientist and explorer, on return from an adventurous journey in Central Asia, during which he was held captive in Khotan for seven months, also contributed the results of his magnetic and other observations to the Geodetic Branch at Dehra Dun.

The Geodetic Branch carried out the more purely scientific work of the department including the prediction

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of tides at numerous places on the coast of India in addition to Rangoon and Aden, astronomical observations, primary triangulation and levelling of high precision and observations to determine the deviation of the plumb line and the force of gravity. The last named observations have yielded results which are of great practical value to geologists and prospectors.

In its drawing and map reproduction activities, in Calcutta alone, the Survey of India produced during the year over 650,000 copies of maps which comprised 131 new publications and 380 reprints of regular departmental maps. Since the commencement of the 1905 survey programme 3,192 topographical maps have been published on the one-inch, 958 on the half-inch and 324 on the quarter-inch to a mile scale.

The Mathematical Instrument Office of the Survey of India turned out a large variety of optical and scientific instruments for use not only in the Survey Department but also in the Public Works Department, Army, Railways and other Government departments. The output of this office, which is the pioneer in manufacturing, testing and repairing numerous kinds of precise scientific instruments in India, has shown a steady increase during the last three years.

Shell Fisheries in the Andamans

INVESTIGATIONS lately concluded on the shell fishery of the Andamans and Nicobar Islands by the Zoological Survey of India, bring to light the possibilities of a new industry which yet remains to be exploited by India. Round the reef-bound islands of the Bay of Bengal, there occur beds of two large species of marine snails, the Top-Shell and the Turban-Shell of commerce, known to zoologists for many years as *Trochus niloticus* and *Turbo marmoratus*. The shells of the snails, as well as those of the pearl-oysters and similar animals, are largely used in China, Japan, the Philippines and other parts of the world for inlaying and other forms of ornamental work and in the manufacture of buttons, studs and tooth powder, etc. The best grades of shells are sold at Rs 600/- to Rs 800/- per ton in the Singapore shell market. Between 1930 and 1937, the shells fished under licence in the Andamans and Nicobar areas exceeded 1,200 tons, valued at Rs 8,50,000.

The discovery of the Top and Turban Shells in the Andamans and Nicobars, goes to the credit of the enterprising Japanese fishery companies of Singapore. Fishing was allowed under licence and the Japanese fishing companies started operations in the Andaman and Nicobar territorial waters, giving royalties amounting to 10 per cent of the market value of the shells collected.

The authorities realizing the importance of conserving the shell fishery as a permanent source of revenue to the Government got into touch with the Zoological Survey of India at Calcutta for advice on the protection of the fishery. The problems of the fishery were many-sided, a thorough study of the species of shell fish concerned in their natural habitat, as well as under laboratory conditions were deemed necessary. With the help of a small research staff at Port Blair, Andamans, some important facts concerning the life-history of the shell fish and the fishery were gathered during the six years 1930-35 and these facts have been published in "*Consolidated Report on the Shell-fisheries in the Andamans*." A detailed account is given of the genesis and decline of the shell-fishery, of the results of the fishery in successive years, of the control measures based on observed facts, of the growth and breeding habits of the shell fish concerned, and of the measures recommended by the Survey with a view to check the decline of the fishery and of the results of similar shell-fisheries in other parts of the world.

As a commercial proposition, the shell-fishery has suffered a set-back mainly as a result of excessive fishing in the earlier period, which has considerably thinned out the shell population of the sea. The indiscriminate removal of all shells, whether young or in the breeding stage, has likewise been the cause of the decline of the shell population. The shell-fishery in the Andamans has been at a low ebb for the last five years and it seems that nothing can rehabilitate it except prolonged rest from fishing for a period from three to five years. The Indian sea, rich with its abundant, valuable animal products, which grow in it, is a great self-cultivating area, independent of the vagaries of the monsoon, of soil conditions and fertilizers and of ploughing, sowing and weeding, and it will be a misfortune if this source of wealth remains unexploited in this country.

Prehistoric Finds in Malaya

SINCE the prehistoric survey of Malaya was started in 1935, the excavation of a new palaeolithic

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site last year at Kota Tampan in Upper Perak is said to be the most important. For several years past stone implements of the pre-neolithic "round-axe" type and artificial flakes have been known to occur on the beach at Tanjong Bunga on the south coast of Johore, on which they were washed out of the soil by wave action. An area of about forty feet wide and extending back from high water mark twenty feet was excavated, and at a depth of about three feet were found artefacts which included small, ground neolithic axes, flakes, pieces of haematite, resin and quartz microliths. Two more round-axes were found on the beach but none occurred in the excavation. The composition of the culture found at Tanjong Bunga is completely different from any encountered previously in the Peninsula. Ground neolithic axes of rectangular shape are well known but have not been found before in association with round axes. Numerous sherds of pottery, small glass beads and some iron implements have been found in two slab-graves under the road at Slim River, Perak, indicating in accordance with the evidence from previous excavations of slab-graves that the graves belong to the early Malayan Iron Age.

From the high-level river-gravels underlying a deposit of volcanic ash on Kota Tampan Estate, near Lenggong, Upper Perak have been found a number of very crude and primitive stone implements of palaeolithic type, and some others from adjacent gravel deposits outcropping at the surface of the ground. New occurrences of implementiferous gravels boulder beds on the estate and at various other localities on the west side of the Perak River valley even as far north as Grik have been discovered. The great number of these very crude artefacts associated with occasional specimens of a more advanced and easily recognizable type, leaves no room for doubt that here we have a culture representing a very ancient and primitive type of humanity that existed probably more than 100,000 years ago.

Applications for Patents

THE annual report of the Patent Office for 1938, which has just been published, reveals a growing tendency among Indians to protect their rights in the matter of inventions. The total number of applications for patents filed during the year was 1,243, and of these, 313 originated in India. The increase in inven-

tions relating to chemical industries was steadily maintained. Nearly 50 per cent of the total number of applications falling under this head originated in Germany, while about 15 per cent and 6 per cent respectively, originated in the United States of America and the United Kingdom. The proportion of application from Indian inventors was 6 per cent. A large number of applications relating to medical and surgical appliances originated in India. Considerable interest was taken by applicants, both Indian and foreign, in inventions relating to gas masks, useful for protection against inhalation of dust and poisonous and noxious gases. Underground shelters, with arrangements for preventing the entry of poisonous gases into the living chamber, earthquake-proof buildings and air-conditioned buildings constituted the subject matter of a number of inventions relating to buildings and structures.

There was a number of inventions concerned with rail joints to reduce the jolting when vehicles pass from one rail to another, as also inventions which aimed at preventing unauthorized interference with rail connexions. In the textile section there was a marked revival of interest in inventions relating to artificial silk. The quest for new synthetic textile fibres continued, and certain types of vinyl resins were claimed to be good substitutes for natural textile fibres. A number of applications related to the manufacture of artificial textile fibres from casein, attention of the inventors being directed mainly to processes for increasing the stability of the alkaline casein solutions and to improvements relating to processes for the coagulation and the spinning of such solutions. There was also an increase in inventions relating to processes for the waterproofing of textile fabrics. Inventions relating to the *Charka* dwindled in number but there was a slight increase in inventions relating to looms. There was an increased activity in inventions relating to dress and wearing apparel. Interest was also shown in the designing of musical instruments. Most of these inventions originated in South India and were concerned with stringed instruments.

League's Pavilion at the World's Fair

AN international exposition which has for its purpose the celebration of the 150th anniversary of the inauguration of the first President of the United States of America and of the establishment of the national government in the city of New York has recently been

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opened in that city. The theme of the exposition is 'Building of the World of Tomorrow'. It is intended to present a clear idea of the mesh of interdependence and interrelation in which all men, all peoples and all nations are caught and to show the tools with which the much-desired better world of tomorrow is to be built by shattering the barriers that fence people from their neighbours. The aims of the League of Nations being identical with the above object the League was cordially invited and it decided to participate in the exposition. In the planning of the League pavilion the underlying idea which has been attempted to be brought home to visitors is that the League marks the climax of a long historical process reaching back to the origins of human society. As human organisation grew more and more complicated the need for an international order was dimly realised and eventually became an urgent necessity and the League of Nations is the expression of this pressing problem. The architectural form of the pavilion has been chosen so as to symbolise the two planes on which the League has evolved. A pentagonal base illustrates the work accomplished in the five continents and the superstructure of circular shape suggests the universalising aims and ideals of the League. The pavilion comprises five rooms distributed round the circumference with a central circular hall. As visitors pass through the rooms they will be able to follow the development and activities of the League. In the first room are hangings illustrating the advance of humanity from the smallest group the family, to the village clan, the mediaeval state, the nation and ultimately the federation. There are also portraits and quotations from texts and documents recalling some of the great men and historical events that have helped the idea of international organisation. In a second room devoted to the League's public health work are represented the five important spheres of activities viz., the activity of the Eastern Bureau, the Centre of Epidemiological Information, the campaign undertaken by the League against malaria, biological standardisation, serodiagnosis and the treatment of syphilis and the campaign for improvement of nutrition in co-operation with the various Governments. In the walls of the circular hall have been illustrated works of the League on mandates, abolition of slavery, refugees, narcotic drugs, child welfare and the campaign against the traffic in women. In another room are shown the League's

work in the sphere of economics to combat both national and world wide depressions. The last room has been devoted to the League's work for peace and attention has been directed to the necessity for international organisations for the moral preparation of closer union in political and intellectual spheres between nations.

Study of Demographic Problems

THE Committee of Experts on demographic problems, appointed by the League of Nations, held its first session at Geneva from April 14 to 18, under the chairmanship of Prof. J. Smolenski of Poland. The Committee's terms of reference were "to study demographic problems and specially their connection with the economic, financial and social situation, and to submit a report on the subject which may be of practical value to Governments in the determination of their policies".

After a general discussion the Committee agreed upon undertaking a study of the problems which present themselves in countries with rapidly increasing populations and in those threatened with diminished populations and lastly the problems which present themselves in countries with a population which is small relatively to the production area or to the natural resources. The Committee will select several States from among those with rapidly increasing population and will study their demographic structures and its effects on economic and social evolution. Detailed investigations are intended to be carried out in regard to the size and density of population, birth and death rates, rates of fertility and reproduction, standard of living of the population etc. Identical investigations will also be carried out in countries where the population is decreasing or are sparsely populated in relation to natural resources. The countries which have been asked to supply information on the above points include India as well. It is a matter of common knowledge that the vast population of India is steadily increasing and if this rapid increase is maintained, within a very short time the pressure of this increasing population will become serious. With the removal of illiteracy and adoption of other measures of rural uplift in the country there is bound to be a gradual decrease in infantile mortality and death rate. If the birth rate remains as high as at present, the increase in population will not only be maintained but will be much more rapid. The authorities and the public men

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in India upto now have paid little attention to the inevitable consequences of this rapid increase in the already too large population. Collection of demographic statistics in India has been sadly neglected; as for example, data relating to rates of fertility and reproduction are incomplete, inaccurate and unreliable. We hope that India will fully co-operate with the League of Nations Committee in the collection of demographic data. Equipped with accurate statistics and knowledge of facts established in other countries in connection with similar questions she will be in a far better position to tackle this problem of large and ever-increasing population.

New Development of Radio Meteorology

DUE to rapid and extensive growth of aviation, accurate weather forecasting today requires collection of aerological data not only at ground level but also at heights utilized by air-crafts. Previous methods of collecting aerological data for such heights consisted in utilizing sounding balloons or aeroplanes carrying special recording instruments to note the temperature, pressure and humidity at various altitudes. A recent report entitled—"The Radio-telemeter and its importance to aviation" circulated by the United States civil aeronautics authority gives the description of an apparatus developed by the Blue Hill Observatory of Harvard University for the determination of aerological data by radio-sounding balloons. Transmitters are attached to the balloons which emit signals giving indications of the meteorological instruments for determining temperature, pressure and humidity. At the ground station the signals are received in a pen-writing recorder and aerological information can be observed while the balloon flight is in progress. Using the apparatus it has been possible to obtain records from balloons at a height of even 14 miles. A network of teletypewriter communications disseminates the data to other meteorological stations and the data are also broadcasted for the benefit of airmen.

Telephone and Telegraph Statistics of the World

FROM the figures taken for January, 1937, the telephone development of the world by countries shows that of the total number of telephones

in the world, North America possesses nearly 54 per cent, the United States alone being responsible for 50 per cent, Germany 9.25 per cent, Great Britain 7.5 per cent, Germany 0.25 per cent, France 4.0 per cent, Italy 1.5 per cent, and Russia 2.6 per cent. The whole of Asia possesses only 4.6 per cent of the world's total of which nearly three quarters go to Japan. In the U. S. A. there are 14.4 telephones per 100 of the population, in Great Britain, France, Germany, Italy and Russia there are respectively 5.9, 3.5, 1.3 and 0.6 per 100 of population. India seems to be nowhere on the map. The number of telephones per 100 of the population for large cities is also given. Washington and San Francisco head the list with 37, Stockholm comes next with 35, New York with 22, London with 16, Paris with 15, Berlin with 13, Rome with 8, Tokyo with 4, Moscow with 3.5. In this connection we draw the attention of our readers to the leading article on "Development of Communications in India" appearing in this issue of our journal, where the problems of communications in this country has been discussed and lines for future development have been suggested.

Dr A. M. Heron

AFTER 32 years service in India, Dr A. M. Heron, lately Director of the Geological Survey of India, has proceeded on leave preparatory to retirement.

Born in Edinburgh on July 31, 1884, Dr Heron was educated at the Royal High School and at the Edinburgh University where he took the degree of B.Sc. (Engineering) in 1906 and D.Sc. (Engineering) degree in 1919. He joined the Geological Survey of India in December 1906 and has worked principally in Rajputana, Central India and the Punjab. During the Great War he was engaged on munitions work in the Tavoy and Mergui districts of Burma, on operations to supply tungsten. Dr Heron accompanied the first of the Mount Everest Expeditions, led by Col. Howard Bury in 1921, as geologist, his services being lent by the Government of India. He was appointed Director of the Geological Survey of India in 1935. Dr Heron was President of the Mining, Geological and Metallurgical Institute of India, the Calcutta Geographical Society, Chairman of the Eastern section and Vice-president of the Himalayan Club, Vice-President of the Royal Asiatic Society of Bengal and of the National Institute of Sciences of India, Fellow of the Royal

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Society of Edinburgh, the Geological Society of London and the Royal Geographical Society. He presided over the Geology Section of the Jubilee Session of the Indian Science Congress.

Dr Heron is a prolific writer, among his publications being the *Geology of North-Eastern Rajputana*, *Biana-halsot Hills in Eastern Rajputana*, *Gwalior and Vindhyan Systems in South-Eastern Rajputana*, *Geology of Western Jaipur*, *Soda-rocks of Rajputana*, *Vindhyan of Western Rajputana*, *Mineral Resources of Rajputana*, *Geology of South-Eastern Mewar-Rajputana*, *Pre-Vindhyan Geology of Rajputana*, *Geology of Daulta, Palampur and Idar States* (with Dr P. K. Ghosh), *Geology and Ore-deposits of Tavoy* (with Dr J. Coggin Brown), *Geology of the Himalaya Mountains and Tibet*, and *Geological Results of the Mount Everest Reconnaissance Expedition*.

National Physical Laboratory

THE report of the National Physical Laboratory for the year 1938 which has been just published gives a summary of the important researches and investigations undertaken in the Laboratory and completed during the year. Last year Dr C. G. Darwin, F.R.S., lately master of Christ's College, Cambridge was appointed director of the Laboratory in succession to Dr W. L. Bragg, F.R.S., who became the Cavendish professor of experimental physics in the University of Cambridge. In the present report many examples will be found of researches carried out in the Laboratory which have immediate application to specific problems arising in industry. Also a number of broader investigations which affect the well-being of the community as a whole or which are allied to industry in general were included in the programme of research and were carried out on behalf of or in collaboration with various Government departments and research organisations. In the physics department the past year has been one of activity in various directions. Particular attention has been given to problems on thermal conductivity, and high temperature investigations on certain thermal properties of steel for the Alloy Steel Research Committee are yielding a collection of important thermal constants. Measurements of the latent heats of fusion of certain refrigerants have been completed on behalf of the Food Investigation Board. In the radiology division work

has been continued on the study of the application of the X-ray crystal diffraction method to industrial and other problems. In the electricity department the study of the fundamental dielectric properties of insulating materials has been continued and attempts have been made to connect these properties with the structure of the material. In the high voltage laboratory work has been continued on behalf of the Central Electricity Board on the various problems relating to high voltage power transmission by overhead lines. A study of the relative merits of light of different colour for various kinds of work and the determination of the value of illumination at which workers find it necessary to supplement day light by artificial light are under progress. The main part of the programme of the radio department in accordance with the requirements of the Radio Research Board of the Department of Scientific and Industrial Research included the development of a constant frequency oscillator not needing outside control. Another interesting item carried out for the meteorological office of the air ministry was the development of a light radio-transmitter for attachment to balloons for investigation of the upper atmosphere. The engineering department has given considerable assistance to industry in the investigation of problems relating to the mechanical properties of materials, the causes of failures, efficiency of mechanisms and ventilation and lubrication. Much work has been done in connection with the investigations of acoustical problems in co-operation with the Building Research Station of the Department of Scientific and Industrial Research. As a result of the study of many buildings from the acoustical point of view it has been possible to suggest remedial measures to be applied to existing buildings and precautions to be taken for the avoidance of acoustical defects in the completed structure. The wide experience of the Laboratory makes it possible for information to be given on many points arising in industrial work and the Laboratory always answers inquiries which fall within the scope of its activities. A collection of abstracts of the papers communicated from the Laboratory during 1937 numbering about 140 has been published in continuation of the series already started.

Announcements

DR J. D. Cockroft has been appointed Jacksonian professor of natural philosophy in the University of Cambridge in succession to Prof. Appleton who left

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sometime ago to join the post of Secretary of the Department of Scientific and Industrial Research. During the last ten years Dr Cockroft has contributed in a remarkable degree to the promotion of physical research in Cambridge. He collaborated with Kapitza in designing the equipment used in the production of intense magnetic fields and with Walton in the experiments on nuclear disintegrations by artificially accelerated particles. He has also been responsible for the recent construction and development of the Cambridge cyclotron.

AT a recent meeting of the Royal Society the following were elected to the foreign membership of the Society: Prof W. Bradford Cannon, Professor of Physiology, Harvard Medical School, Boston; Prof. George Von Hevesy, Professor in the Institute of Theoretical Physics, Copenhagen; Prof. Herbert Freundlich, University of Minnesota, Minneapolis, U.S.A.

THE next meeting of the British Association will be held in Dundee during the week beginning on August 30. The President Sir Albert Seward will deliver his address on "The Western Isles through the mists of ages." The subjects of the presidential addresses in the sections, so far as they are announced, are as follows: Section A: Mr R. S. Whipple on 'Instruments in Science and Industry'; Section B: Prof. E. K. Rideal on 'Film Reactions as a new Approach to Biology'; Section C: Prof. H. H. Read on 'Metamorphism and Igneous activity'; Section D: Prof. J. Ritchie on 'Perspectives in Evolution'; Section G: Mr H. E. Wimperis on 'The Future of Flight'; Section H: Prof. W. E. Le Gros Clark on 'The Scope and Limitations of Physical Anthropology'; Section I: Prof. D. Burns on 'The Assessment of Physical Fitness'; Section J: Mr R. J. Bartlett on 'Measurement in Psychology'; Section K: Prof. D. Thoday on 'The Interpretation of Plant Structure'; Section L: Dr A. P. M. Fleming on 'Education in Industry'; Section M: Sir Thomas Middleton on 'Practice with Science. The Farmer's Position and the Scientific Worker's Programme'. The new Division for the Social and International Relations of Science, established last year at the Cambridge meeting,

announces an afternoon session for papers and discussion on the co-ordination of scientific research, and on population, and it is understood that the possibility of a discussion on international co-operation in science is also under consideration. An evening meeting on Sunday, September 3, will hear an address from Sir Richard Gregory, chairman of the Division, on Science and Social Ethics, and on Wednesday morning, September 6, a session of the Division will be devoted to a discussion on nutrition, which will form a complement to sectional discussions in this field already mentioned. A new feature of British Association meetings will be the delivery by Dr Isaiah Bowman, president of Johns Hopkins University, of the first of the lectures to be given under the arrangement concluded last year with the American Association for the Advancement of Science, by which, in alternate years, a speaker from America is to be invited by the British Association, and one from Great Britain by the American Association. Dr Bowman has chosen his subject 'Science and Social Pioneering.'

THE date for admission to the post-graduate courses of the Imperial Agricultural Research Institute, New Delhi, has been changed from November 1 to October 1 from the next session. Facilities are provided at this Institute for post-graduate training in agricultural botany with special reference to plant-breeding and genetics, sugarcane-breeding and study of the sugarcane plant in all its aspects, agricultural chemistry and soil science, entomology, mycology and plant pathology, and farm organization, farm management and general farm engineering. The courses last for two years except that one in farm organization and management which is for a period of 12 months. The Institute having been recognised by the several Universities in India, as a place from which thesis for higher degrees can be submitted, facilities are also afforded to *bona fide* research workers for carrying out researches of a definite character.

THERE has been an increase in the membership of the Institute of Physics, London, amounting to 15 per cent of the last year's strength and the recent report of the Institute has pointed out the growing appreciation of the importance of physical science in almost every branch of modern industry which has been reflected by the rise in membership.

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"Aspects of National Planning"

IN course of his presidential address on 'Some Aspects of National Planning' delivered before the Bihar branch of the Institution of Chemists (India), Dr H. K. Sen stressed on the necessity of securing a few chosen individuals who could wholly and entirely devote their time to the formulation and critical examination of industrial schemes for an appropriate period of time undisturbed by other demands of public and private life. On the formulation of these schemes depends to a very large extent the future of the country. Not that suggestions from other individuals are not necessary or important but that the question of national planning has to be scrutinised from so many different angles that the undivided attention of a number of stalwarts is absolutely essential, if we want to avoid pitfalls.

As agriculture is a very essential occupation in our country, lands should be made to yield more and the application of manures, natural and synthetic, should claim our most immediate attention. For this purpose, the coal resources of the country may be utilised for starting a synthetic nitrogen industry. Apart from the low temperature carbonisation process yielding primarily ammonium sulphate, coke oven gas or water gas can be made the source of hydrogen and atmospheric nitrogen can be obtained by the liquefaction of air, which will go to synthesise ammonia. We are at present somewhat handicapped for dearth of sulphur but the utilisation of gypsum (calcium sulphate) in fixing the ammonia (Haber process) would give us a cheap product. Dr Sen further refers to the Thylox process which has been used for extracting small proportions of sulphur that are present in gasses like hydrogen sulphide from the coke ovens and other carbonisation processes. Coal carbonisation gives by-products each of which may foster the growth of a full

fledged industry. Sulphur being an essential component of heavy chemical industries, Dr Sen urges intensive researches into its extraction from coal or other minerals like gypsum, pyrites, zinc blende etc. In Assam, however, there is some deposit of tertiary coals rich in volatile sulphur (4-5%). Speaking about power production, Dr Sen suggests that off peak load can always be utilised for electrolysing water and by transmitting the hydrogen generated over long distance through thick-walled small diameter steel pipes, the gas may be used for combustion in stationary engines. When air is used for combustion, high temperature steam and practically pure nitrogen are obtained. The use of hydrogen in internal combustion engines has been made in some of the Erren Company's engines and Heinze's report on these tests makes out a clear case for the use of hydrogen for power production in the future (*Engineering*, 19, 607, 1932). The thermal efficiency of hydrogen consumed in internal combustion engines is of the order of 40-45%, i.e., of the 350 B.t.u. per cubic feet of hydrogen, theoretically possible on combustion, 157.5 B.t.u. are reproduced as brake horse-power, 20 cubic feet of hydrogen having, according to Heinze, produced one brake horse-power.

Japan's Radio Industry

IN 1924, Japan imported broadcasting equipments for the first station which was put into service in that country. But now local makers have been supplying not only the special designs for Government use but also all kinds of transmission and receiving instruments for long or short wavelengths and accessories for ships, aeroplanes, international communications etc. Recently the co-operative efforts of electro-technical laboratory of the Japanese ministry of communications, Waseda University, Hamamatsu Higher Technical School, the Japan Broadcasting Association and the Tokyo Electric

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Co., have been successful to experimentally transmit and receive images and television broadcasting is scheduled to be inaugurated in the country soon. This co-operative effort is still to be put to practice in our country though there seems to be no dearth of talents at the University laboratories.

Drying by Electric Light

TUNGSTEN filament 250 Watt lamps are now used for drying the wet surfaces. The Ford Motor Co., have arranged such lamps in tunnels of gold-plated parabolic concentrating reflectors mounted from 9 to 18 in. from the automobile body. The prime coat on the car is dried in 7 min. as against 30 min. previously. Finishing coats require about 14 min. as against 80 min. with methods formerly used. Instead of a temperature of 3000 K used for illumination the lamps are run at a temperature of 2500 K. The light output is only one-third of the standard lamps, and the life of these drying lamps vary from 10,000 to 20,000 hours. The lamp at the above temperature gives out rays which are effective for vaporising the commonest solvent and washes. These rays lie near to the infra red region and the drying effect is due to the fact that the energy of the wavelength is wholly absorbed as heat by an appreciable thickness of water. Evaporation proceeds at a speed in this case more than when heated only at the surface line. There are wavelengths which may pass through wet surface without being absorbed but the temperature as referred to above represents a suitable balance between absorption and penetration and it also lies satisfactorily below the melting point of tungsten, which is 3817 K.

Position of Jute Fibre

INFORMATION contained in the bulletin of the Indian Central Jute Committee reveals that less and less jute is being consumed nowadays in countries where the export of jute had been heavy. In Ecuador sisal bags are finding more use for handling cocoa, rice, coffee etc., and a surcharge tariff of 50% is levied on jute imports. In accordance with the German Government regulations in the jute spinning mills the proportion of hemp and flax mixed with jute is gradually increasing and the import of jute fibre is being restricted. Similarly in

Italy jute is giving way to other fibres. In Sweden, on the other hand, kraft paper bag is coming into vogue, for which purpose the country is fully rich in raw materials.

Moreover, an artificial fibre made from straw has been reported from Germany. It is named zell-jute and has a diameter of 30 denier, a staple length of 25 cms. and a colour similar to that of jute fibre. Previously this fibre was only produced in the experimental plant of the Hirschberg company. Production on a larger scale, however, will begin this year in Wiltenberg and an annual production of 12,000 metric tons is planned. The price of the new fibre will be more than 3 times that of jute. In order to spread this difference in cost over as many shoulders as possible a general admixture will be required and in fact an admixture of 14% is foreshadowed. This difference in price may be considered temporary for as soon as large scale production has been achieved further reduction in price of the new fibre will be possible. Also better and cheaper methods may be evolved with the progress in production.

New Chemical for Wool Processing

A new chemical has been announced by an American chemical concern for use in wool processing. It is known as dipotassium phosphate and is said to perform the service heretofore rendered by olive oil. The use of dipotassium phosphate, which is readily soluble in water, eliminates the necessity of putting the spun yarn through the rigorous soap scouring operation which is necessary to remove olive oil. Consequently, the fibres are left more nearly in their original soft and fluffy state. Tests made on actual spinning operations during the past year indicate that dipotassium phosphate is fully as good a lubricant as olive oil and that worsted thread of the finest count known can be spun with the same facility as when olive oil is used.—
N. K. S.

Waste Heat from Diesel Engines

RECOVERY of waste heat from Diesel engines and their different uses formed the subject matter of a paper read at a meeting of the Diesel Engine Users' Association of England, which was reported in the *Electrician*. Waste heat boilers are attached to the

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exhaust pipes of the Diesel engines thus utilising the hot exhaust gases for heating water or generating steam. The waste heat recovered in the form of steam from 7 Diesel engines in a large power plant is being used to operate a 250 k.W. steam dynamo thus increasing the thermal efficiency of the plant. Even small Diesel engines can provide waste heat to advantage. For instance, a 10 h.p. engine operating at an Australian broadcasting station produces steam from the exhaust waste heat, by means of a small boiler, which steam is condensed to provide distilled water for the accumulators. In several cases steam from the exhaust of small Diesel engines has proved to be a paying proposition when used instead of town gas for heating electroplating vats and the like. In one case, the heat recovered from a 50 h.p. engine, working 10 hours a day, saves 20 s. worth of gas per week. In a farm in London, use is made of all the waste heat which is possible to recover from 8 Diesel engines generating over 3,000,000 units per annum by circulating the cooling water in a closed circuit through (i) lubricating oil heat exchangers, (ii) engine jacket heat exchangers and (iii) waste heat hot water boilers. The quantity of water heated by the heat recovery equipment attached to these Diesel engines amounts to an average of 900 gallons per hour, and the rise of temperature is from 60°F. to 177°F. per 255 k.W. of electrical load. This represents a heat recovery of 36.5 per cent of the fuel used in the engine, and taking into account the heat units in the current generated, total thermal efficiency is in the vicinity of 70 per cent.—

N. K. S.

Sand for Greater Speed

IN one year 30,000 tons of sand have been used by engines belonging to an English railway system as reported in the *Meccano Magazine*. The sand has been used to aid friction between the rails and the engine wheels, otherwise the wheels may spin around ineffectually on the rails. The peripheral area of a locomotive driving wheel, 70 inches in diameter excluding the flange, is approximately 800 sq. in. The area of the wheel in contact with the rail at any time is only about one third of one square inch or approximately the size of a thumb nail. Each of the driving wheels pushes against this very small area and the entire tractive effort is the result of the successive

contact of the six, eight or twelve wheels on the railway tracks of the locomotive. Unless the rails resist the motion of the wheels at these small points, the power of the engine may be dissipated or when brakes will be applied, wheels may slide. Sand is deposited when starting, stopping or slowing down the train; the need for friction is then the greatest. Before the sand can be used, a packing of moist sand in cylindrical mould after baking should crumble without lumps by the application of slight pressure. It should not also contain loam. Sand is pumped to the rails by air blasts. The number of sand boxes, traps and pipes vary with the number of driving wheels and the type of locomotives. Steam is also applied instead of air pressure which has the added advantage of clearing grease on the rails. Further, a jet of water is used to remove the sand after the passage of the driving wheels. This prevents interfering with track circuits and reduces resistance to the passage of the wheels of the train. The higher speeds with which the trains in Europe and America move, however, are not generally experienced by us here.

Nitride Hardening of Steel

FOR many years it has been customary to produce moving parts from hardening steels, and particularly from case-hardening steels giving the combination of a tough core and wear-resistant surface. Case-hardening is, however, subject to some drawbacks which frequently render its use impracticable. This process entails the necessity of heating to a high temperature of 850°C.—900°C., and a further necessity of quenching from a high temperature of 760°C upwards, and these may induce internal stresses, which may result in marked distortion or warpage. With work of difficult form, the quenching, moreover, is liable to lead to formation of haircracks. This will make the percentage of rejects higher which will render case-hardening uneconomical. These disadvantages of case-hardening, i.e., hardening stresses, warpage, crack formation and hardening rejects, can be avoided by employing the newly patented nitriding process. By this process, the work, completely machined and annealed to free it from internal stresses, is placed into an electrically heated and automatically regulated resistance furnace, in which it is heated to about 500°C. in an atmosphere of ammonia gas for a period varying with the desired depth of case between 5 and 90 hours. The nitrogen split

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off from the gas penetrates or diffuses, so to say, into the steel and there forms metal-nitrogen compounds (nitrides) which are insoluble in the iron base metal, and produces an extraordinary increase in hardness in the surface zone. Upon completed nitriding, the parts are allowed to cool in the air still in their box. The high heat and quenching required in case-hardening are therefore completely absent, and therewith all of the untoward effects to which reference has been made. This excellent surface hardness is reflected in a remarkable resistance to wear and in highly favourable running properties of nitrided parts. These qualities have opened up for the nitriding process a wider field of use for such treated steels, including the production of crankshafts of most complicated design. The nitrided machine parts show a marked degree of corrosion resistance, specially in superheated steam. A further point of superiority over case-hardening is that nitrided parts are not subject to changes in form from subsequent ageing.

At the same time it must not be overlooked that only steels which are alloyed with metals, such as aluminium, chromium, vanadium, and molybdenum, can be nitrided with good results. With unalloyed steels the absorption of nitrogen does not induce perfect surface hardening.—

N. K. S.

Nonmagnetic Engines for R. R. S. Research

THE Royal Research Ship, *Research*, has taken water on the 4th of April, 1939. The principal work for which the ship has been designed is the continuation of the investigations into terrestrial magnetism and atmospheric electricity, on which the American research yacht, *Carnegie*, was employed up to the time of her loss by fire in 1929. On account of the nature of the duties for which she has been designed, and the delicacy of the instruments which will be carried on board, the use of magnetic materials in her construction and equipment has been avoided with the most detailed care. The vessel is brigantine rigged, with auxiliary propelling machinery consisting of a Diesel engine of the four cylinder two-stroke type, with direct air reversing, developing 160 B.h.p. at 375 r.p.m. The engine which is under construction will drive a two bladed propeller of the feathering type, which will be used mainly when

the vessel is entering and leaving harbour, or when becalmed, sail being relied upon for propulsion in normal circumstances. The engine is approximately 16 ft. in length and will weigh about 12 tons 9 cwt. Non-ferrous materials have been extensively used in the final design, principally bronze, aluminium and bronze alloys, and over 99.5 per cent of the metal used in the engine is nonmagnetic. Actually only 250 lbs. of magnetic materials are embodied in the engine. The bed plate is a massive one-piece casting in bronze alloy. The flywheel is of solid bronze, and weighs 2,350 lbs. The crank shaft and lay shafts are manufactured in manganese-nickel-chrome-steel. The crank shaft presented one of the greatest difficulties, and it is stated that it has cost 16 times as much as a standard steel shaft. The cylinder heads and crank-case castings, together with other parts subject to high stress, are in aluminium bronze, while castings in phosphor bronze and gun-metal are also employed. The gear wheels, bolts and nuts are in bronze alloy. Centrifugally cast Ni-Resist iron is used for the cylinder liners, the cylinder blocks in aluminium alloy being cast around the liners. There are two other auxiliary Diesel engines of similar type and of 9 and 18 B.h.p., which will be used for light, pumps, and other general purposes. About 14 tons of fuel for the engines will be stored in tanks made of nonmagnetic material. This quantity of fuel is sufficient for a range of 3000 miles at a cruising speed of 6.5 knots per hour. The hull is composite, of teak planks on frames of brass, and is subdivided by eight water tight bulkheads. The keel, and the stem and stern posts are also of teak. The anchors and cables and wire rigging, are of aluminium bronze, and the fresh water tanks, which hold 37.5 tons, are of teak. Even the cooking and table utensils, containers for foods, the razor blades, ship's typewriter and the nails in packing cases are of nonmagnetic nature. She will first carry out investigations in the South Atlantic and then will make a circuit of the Indian Ocean.

N. K. S.

Temperature Indicating Paints

ALTHOUGH paints such as those containing metallic iodides have been known and used for some years for indicating rise in temperature on machine bearings and in other cases where visual warning is desirable, their uses have been limited to cases of low or moderate temperatures. These earlier paints were also not very

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sharp and definite. Considerable progress, both in the development of new temperature-indicating paints or "thermocolours" and in the technique of their use, has been made during the last year or two by the I. G. Farbenindustrie. These new paints are of particular interest for the designing of air cooling guides in aircraft engines. They also have a wide field of application in electrical heating apparatus and in other directions where indication of temperature-changes and distribution is necessary. The paints up to date developed are mostly metallic salts and cover a temperature range of 80° C to 450° C. It is hoped that with

further research others will be found which will be applicable for much higher temperature, namely 650° C or even higher. The new thermocolours satisfy the exacting requirements of being reasonably sharp, clear, and definite in their colour changes at fairly definite temperatures, i.e., within an error margin of $\pm 5^\circ$ C. The time factor or duration of heating is, of course, an important consideration in the use of these thermocolours. Some of the colours under the influence of atmospheric moisture, slowly revert to their original shades, and do so quickly or immediately when wet with water, but the colour change for most of them, which have been so far developed, are permanent.—N. K. S.

Industry of Plastics

M. N. Goswami

Department of Applied Chemistry, Calcutta University

We are in a plastic age. The plastics include a variety of materials which can be moulded into definite shapes. Clay is the first and foremost natural plastic. Glass is the first inorganic synthetic plastic. Lac is the foremost natural organic plastic. Imitation of lac has been the subject of research in Europe and America for a long time and substitutes have appeared in the market which have threatened the lac trade of India. Imitation of Nature is not only characteristic of mankind but also dictated by necessities. The last Great War necessitated the preparation of synthetic ammonia, nitrate, petrol and rubber in Germany as she lacks in those commodities. In this way natural indigo and camphor have had their synthetic substitutes.

Besides lac the following are some of the important natural organic plastics:—(a) Asphalt; (b) Rosin; (c) Copal; (d) Dammer and other resins, and (e) Natural waxes. In addition to the moulding qualities of these plastics they are extensively used for the preparation of varnishes and polishes. In fact, high polish is one of the characteristics of plastics. This property of attaining polish is specially present in

moulded articles in which it is associated with hardness. Some plastics cannot be moulded at ordinary temperature to hard stuffs. They require high temperature. In these cases they are called thermoplastic. Thermoplastic substances soften at high temperature under high pressure in the mould and the moulded articles can only be taken out of the mould after cooling to ordinary temperature. Important instances of these are the following:—(a) Lac; (b) Celluloid; (c) Glyptal resin, and (d) Vinyl styrene resin. Some plastics under heat and pressure soften and are at once transformed into substances having higher softening point. In such cases the mould need not be cooled; the articles can be taken out in the hot state. The synthetic amino-plastics are members of this class. This behaviour of instantaneous transformation is called thermo-hardening. This thermo-hardening property may be limited or unlimited. In the case of unlimited thermo-hardening property the sudden transformation leads to substances having no softening point. Notable instance of such kind of permanently thermo-hardening plastic is Bakelite. Besides this and other plastics noted before, mention may also be made of methacrylate resins, lactoloids

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and cellulose esters. Various types of these plastics have been placed on the market under various names and it has been calculated that their number has already reached about 1250.

The impetus to the researches in synthetic organic plastics has been primarily due to the idea of ousting the natural plastic, shellac,* of which India practically holds the monopoly. Over 90% of the world's production i.e., about 30,000 tons comes from Behar and Bengal. The rest comes from Burma, Siam and Indo-China. It is secreted by the lac insect, *lucifer lacca*, which lives on certain plants as parasite. The resin lac is purified by grinding, washing and hot-filtration through cloth bag. One third of the total output is used for the preparation of gramophone records. It is also used for the preparation of bangles, for the purpose of giving decorating polish to boxes, table tops and tea trays and for the preparation of varnishes. Formerly all the world's gramophone records used to be prepared from shellac which then fetched good price. Now synthetic substitutes have made great inroads with the result that the price of shellac has come down.

Serious attempts are now being made in the Lac Research Institutes in Namkum and London to find out other avenues of its uses. The greatest drawbacks of lac are the following:

- it is thermoplastic and hence preparation of moulded article takes much time for cooling†
- its softening point is very low,
- it deteriorates on keeping,
- it is attacked by water, but its electrical properties are incomparable and if the foregoing defects could be modified or corrected it would save a big industry of India.

The next important natural plastic is asphalt. There are two varieties—soft and hard. With coal-tar pitch and petroleum pitch they are extensively used in road making. Asphalt and petroleum pitch are also used for varnish making. Substitutes of these plastics

* Name of purified lac.

† From private information we gather that this defect has been somewhat remedied.

have also been prepared. Recently it has been announced from the Cawnpore Technological Institute that pitch substitutes have been prepared from molasses and that the process has been patented. The process is not new as it follows the earlier process of Vesquez. The other natural plastics viz., Rosin, Carnauba, Paraffin, Beeswax, Montain wax are used for the preparation of polishes and varnishes.

Organic plastics, synthetic and natural, have variety of uses in the manufacture of products of which the following may be mentioned:—

- Artificial silk;
- Gramophone records;
- Electrical goods;
- Varnishes and polishes;
- Sealing wax;
- Toys;
- Soap cases, bottle caps, cork tops, table tops, etc.;
- Combs, boxes, etc.,
- Artificial glass;
- Acid and alkali resisting vessels and
- Photographic films, tea trays etc.

It is not therefore surprising to note the recent announcement of Mr Henry Ford that in future he would prepare the majority of motor parts from synthetic plastics. How rapidly the industry of synthetic plastics has grown may be gauged from the following figures:—

World's Production of Synthetic Plastics.

1921	..	..	60,000 cwts.
1925	..	..	120,000 "
1928	..	..	200,000 "
1931	..	..	340,000 "
1933	..	..	440,000 "
1935	..	..	1,200,000 "

A glance at the India's import figures would show the enormous consumption of synthetic plastics and the products derived therefrom.

Import in India in 1935.

Toys	valued at Rs.	40,00,000/-
Artificial silk	"	94,79,513/-
Insulators	"	44,00,000/-
Resins and waxes	"	50,00,000/-

Artificial silk and toys are derived from cellulose esters as also celluloid. The basis of the latter is nitro-cellulose. Celluloid is extensively employed for the preparation of combs, soap boxes and other articles of

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luxury. The following table gives world's production of celluloid in 1933.

Japan	..	..	178,000 cwts.
U. S. A.	..	..	106,000 "
Britain	..	..	44,800 "
Germany	..	..	94,000 "
France	..	..	39,000 "

For its preparation, nitrocellulose of nitrogen content 11-11.5% is incorporated in molten camphor in 1:1 proportion under great pressure. Japan's progress in this industry due to her natural sources of camphor, has been phenomenal. In 1924 the production of celluloid in Japan and America were respectively 20,000 cwts. and 340,000 cwts. Within ten years Japan assumed the supreme position. But it seems that the days of celluloid are numbered. In 1913 world output was 30,000 tons and although there was slight increase after the War (1924—35,000 tons) it gradually came down to 20,000 tons in 1932. There has been only slight increase recently and in 1935 it assumed the figure of 1913. This check in the progress of celluloid industry has been largely due to its inflammable nature and to the discovery of substitute composed of cellulose acetate. The latter with cellulose xanthate and cuprammonium cellulose have also given us artificial silk. Japan is gradually assuming supreme position in this commodity also.

Bakelite plastics and glyptal or alkyl resins are being specialised in U. S. A. The former is prepared from phenol and formaldehyde and the latter from glycerol and phthallic anhydride. The following are the production figures of the U. S. A.

	1935	1936
Bakelite	35,000,000 lbs.	52,000,000 lbs.
Glyptal resins	16,000,000 lbs.	28,000,000 lbs.

There are 3 stages in the preparation of these resins, namely A, B and C, indicating more and more polymerisation. The moulding is done with 'B' stage powder which under heat passes into 'C' stage which

is practically infusible in the case of bakelite. This is the characteristic thermo-hardening property referred to above.

England is specialising in amino-plastics. Prepared from urea and formaldehyde, these are clear and transparent like glass and are being much used as its substitute. The following are the figures for production:—

1933	1934	1935
8,190 tons.	12,000 tons.	17,000 tons.

Of late, England and specially Germany are entering in the bakelite field with vigour. The latter country as also Russia in particular is specialising in vinyl styrene resins. These resins are prepared from acetylene and other unstaured hydrocarbons. Russia is utilising her vast resources of natural gas from petroleum wells and Germany is utilising her acetylene from calcium carbide, which industry is growing there with rapid strides.

Italy is specialising methacrylate resins. The starting point for the preparation of these resins is acetone. The figures for vinyl styrene resins and methacrylate resins are not available.

The 'Tailaj' resin discovered by the author towards the close of 1937* is prepared from any kind of vegetable and animal oils. When they are heated with catalysts they are quantitatively transformed into the resin. By controlling time of heating and temperature the author has been able to prepare greases and waxes. The moulding property of the resin has been found to be good. By improving the resin the author has prepared moulding powder of limited thermo-hardening property and as such it can now be moulded just like bakelite. The insulating properties of moulded articles are being tested and the results so far obtained have been found to be very good. Patents have been applied for in India and abroad and it is hoped that commercial exploitation of the resin will begin soon and the cost price of the moulding powder will not exceed -/1/6 a pound as against -/8/- annas to -/10/- annas of imported bakelite powder.

*See SCIENCE AND CULTURE, 3, 495, 1938.

MEDICINE AND PUBLIC HEALTH

Diphtheria Immunity

INTERESTING observations have been made at Chicago in connection with the attempts to eradicate the mortality and morbidity of diphtheria. The experiments were carried out with (i) toxin-antitoxin (three 1 c.c. doses weekly), (ii) plain toxoid (two 1 c.c. doses weekly), (iii) non-precipitated alum toxoid (two 1 c.c. doses weekly), (iv) alum precipitated toxoid (one 1 c.c. dose), (v) alum toxoid (two 1 c.c. doses weekly), (vi) alum precipitated toxoid (one 1 c.c. dose) and (vii) plain toxoid (first dose 0.5 c.c. and other two 1 c.c. doses monthly). Each type was tested on a large number of subjects and protection against diphtheria was determined by Schick test on inoculated children at intervals from 2 to 6 months and also by measuring the units of antitoxin content per cubic millimeter of blood. It was indicated by the data obtained that both from the standpoints of the amount of antitoxin in the blood and from the result of the Schick test, those children who received three doses of toxoid a month apart were better protected against diphtheria than those with other types of inoculations. It has been further observed that the time interval between immunisation and the Schick test decreased by the integral variant of 1, while percentage relapses decreased by roughly 6 per cent a year. The value of Schick test has been criticised inasmuch as that the test is negative when the antitoxin content of blood is more than 1/250 unit per cm. blood whereas to be well protected against diphtheria, a child should have at least 1/25 units of antitoxin per cm. blood. Therefore Schick test cannot be relied on as a definite measure of immunisation status.

Antiscorbutic Limitations of Synthetic Ascorbic Acid

INVESTIGATING the reaction to a daily dosage of 300 mg. of ascorbic acid in twenty-nine patients

showing a haemorrhagic dathesis (revealed by Göthlin's capillary test) and a low ascorbic acid of the serum (Lund and Lieck test) it has been shown that after an interval of ten days the haemorrhagic reaction of Göthlin was no longer demonstrable, and the ascorbic acid content of the serum was restored to normal in twenty-six cases. But in the remaining three cases no such improvement was observed, even when the oral administration of ascorbic acid was followed by the intravenous injection of 300 mg. of ascorbic acid daily for ten successive days. When the three patients, however, were given the juice of ten lemons daily for ten days, the response was rapid. A characteristic feature of all three cases was intestinal disease which had lasted for several years. After giving details of these three cases (in the *British Medical Journal*, 214D, 4020, 1938) conclusions have been reached that the absorption and retention of ascorbic acid require the presence in the body of a substance, a co-vitamin, which is evidently present in lemons and perhaps in small quantities in other articles of food, but is absorbed with difficulty by patients suffering from certain intestinal diseases. There is possibility of this substance being identical with the vitamin P found by Szent-Gyorgvi.

Sulfanilamide in Streptococcal Meningitis

STREPTOCOCCAL meningitis usually spreads from a primary focus in the ear or nose. The method of spread in very acute cases, is usually by means of blood-vessels, or by preformed or traumatic spaces. In less acute cases, diseased bone in contact with the meninges will be the cause. An appreciation of these different pathways of infection is an important factor in deciding the correct line of treatment to adopt. The clinical features can be followed in three stages with the cerebro-spinal fluid changes. The speed with which these stages follow one another depends

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largely upon the route taken by the disease. The importance of early diagnosis by examination of the cerebro-spinal fluid far outweighs the theoretical danger of dissemination of disease by the cautious withdrawal of a few c.c. of cerebro-spinal fluid for examination. Treatment may proceed by neutralising the infection, draining off excess cerebro-spinal fluid, and by eradication, as far as possible, of the primary focus.

Marked improvement in the recovery rate has been found with the use of sulfanilamide. Although sulfanilamide is undoubtedly the most potent agent available in the treatment of streptococcal meningitis, it is very strongly urged that it should not be used as a substitute for surgery in appropriate cases. The decision whether eradication of the primary focus is required in addition to sulfanilamide and spinal drainage is made easier by a knowledge of the way in which the disease has spread from the primary focus. For any treatment its chance of success will be increased if it is instituted early, before the disease has had time to overwhelm that most important factor, the natural defence of the body.

Acute Interstitial Pneumonitis

THE observations made at the Cornell University Infirmary regarding acute interstitial pneumonitis show it to be communicative when cough is present but its causative organism has not been determined. Pathological investigation could not identify this disease with pneumococcal pneumonia. The clinical and radiological investigations also failed to establish their identical nature. This disease has been described according to clinical and radiological findings in three groups: (i) the first group of lesion is characterised by a fan-shaped localised accentuation of and linear increase in the linear pulmonary markings extending from hilus into the lungfields but never reaching periphery, suggesting merely a picture of intense congestion and never a true consolidation usually clearing up in one or two weeks, (ii) cases where the infiltration in the fan extends more frequently to the periphery of the lung with irregular areas of markedly increased density, suggestive of lobular involvement. Cough is usually present in these types but the sputum is remarkably lacking. The resolution in this case is correspondingly slower, and

(iii) cases of the severe and true toxic type, with similar picture as above but with a diffuse spread in addition, throughout the remainder of the lung, with partial or complete involvement of the other lung and with decided tendency to some involvement of the interlobar pleura. This was definitely interstitial inflammation. Clinically, though rales were markedly present, sputum was very much less in proportion, lacking entirely in "rusty" or of "the cherry juice" appearance of the sputum of pneumococcal pneumonia. The resolution in this group was still slower demanding one to two and half months. The total and polymorphonuclear leucocytic increase was much milder than in case of pneumococcal pneumonia. The fever was intermittent and defervescence of temperature was by lysis. The disease was more communicable than pneumonia usually is. It has been suggested that in area, where, "acute interstitial pneumonitis" is found, all patients with infection of respiratory tract and slight fever (101° — 102°) should have a serial X-ray examination for excluding pneumonitis or making possible a more definite prognosis.

M. L. C.

Intersexuality

ROBERT C. Mochling and Norman M. Allen report (*J. A. M. A.* 112, 1938, 1939) an interesting case of intersexuality (Pseudohermaphroditismus masculinus internus i.e., a male individual having also Fallopian tubes, a uterus and a vagina). In this case the patient had, in addition, well-developed ovaries with fimbriated ends of the tubes patent, as discovered during appendectomy. This patient had a fully developed prostate but no testes and had also a desire for females and for orgasm but without spermatogenesis. X-ray examination of skull, of chest, and of the urinary tract were essentially negative. There was no suggestion of adrenal tumour. Gonadotropic assay of urine was unsuccessful on account of bacterial infection due to persistent cystitis of the patient. The physical appearance was very much like that seen in achondroplastic masculine dwarfs with short muscular arms and legs. He could micturate only in sitting position. The interest of the case lies, apart from academical consideration, in the fact that the subject was reared up as a girl up to the age of 12 and then "changed over" and treated as a male subject.

M. L. C.

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Sulfanilamide in the Treatment of Erysipelas

A series of two hundred and seventy cases of erysipelas was treated under controlled conditions with (a) ultra-violet, (b) sulfanilamide. There was an even distribution of the individual cases in the treatment groups in respect of factors known to influence the course of the disease, such as (a) the duration of the disease before admission to hospital; (b) the age of the patient; (c) the severity of infection; (d) associated diseases. The average total case dosage of sulfanilamide was 41.6 Gm., given in 14.4 days. The drug was administered in 1, 2 or 3 gm. doses four-hourly thrice daily until the case was dismissed. Cyanosis occurred in 29.6% of cases; it was more frequent when the larger doses of sulfanilamide were given. Sulfanilamide is of benefit in securing curtailment of (a) the duration of primary pyrexia; (b) the duration of toxemia. The administration of sulfanilamide reduced the incidence of complications and diminished the tendency to recurrence. An effective method of treatment is to give 1 Gm. of sulfanilamide by mouth at four-hourly intervals until the cessation of primary pyrexia, and thereafter 0.75 Gm. by mouth thrice daily until final cure is determined.

Announcements

THE third All India Obstetric and Gynaecological Congress will be held in Calcutta in December,

1939. The principal subjects of discussion are (1) anaemia of pregnancy, (2) functional uterine (haemorrhage and (3) maternity and child-welfare. The provisional scientific committee have formulated a scheme to facilitate investigations on these subjects. All communications about it and other information about the session are to be made to Dr S. Mitra, Secretary, Provisional Scientific Committee, 3, Chowringhee Terrace, Calcutta.

THE sixteenth International Congress of Hydrology, Climatology and Medical Geology, will be held at Strasbourg, on and from the 8th to 11th October 1939. The Congress will discuss papers on (i) hydro-mineral treatment of dermatoses (ii) permeability and mineral waters (iii) indications and contra-indications for winter sports (iv) mineral waters of petroliferous areas (v) evolution and use of thermal institutions in France during the last 20 years. Allied subjects not on the agenda will also be considered, if approved by the office of the Congress. The Congress will be followed by an Exhibition of hydromineral, marine and climatic stations and of treatment centres; of physiotherapeutic instruments and appliances; literature; nutrition etc. Excursions to interesting places have been arranged for and concessions on railways will be available for the purpose. Dr A. C. Ukil, one of the members of our board of editors, has been invited to become a member of the committee of patrons, which he has accepted.

The Problem of Malaria in Bengal*

A. C. Chatterji

Director of Public Health, Bengal

Malaria is caused by the injection into the blood stream of an unicellular organism through the bite of a particular type of mosquito, viz., the *anopheles*, which like all mosquitoes breed in water. The breeding places are very varied, viz., borrowpits, tanks, *dobas*, slow

moving streams, decaying *beels*, ditches, drains, rice fields and stray collections of water. Certain mosquitoes thrive under shade while the majority does not. The source of this infective organism is the human body, that is, the person who has become infected and has not been cured. If an *anopheles* bites such a person, it becomes infected itself and then after a

*Based on a lecture delivered at the Calcutta Rotary Club.

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period of, say, a week or ten days if it bites again a healthy person, this latter person becomes infected. After a few attacks the spleen becomes enlarged. A chronic sufferer looks pot-bellied, pale and becomes emaciated. After prolonged suffering the patient becomes emaciated and the progeny becomes puny and less virile. Thanks to the immortal discoveries of Laveran in 1880 of the causative organism, the plasmodium, and of Ross in 1897-98 of the mosquito cycle (in Calcutta), malaria is today a preventible disease.

Present Condition

In Bengal with a population of about 50 millions, about thirty to forty million cases of malaria occur every year and nearly half a million deaths occur from the same disease. In fact, on an average, Bengal produces cases and deaths due to malaria to the extent of nearly 40 per cent of the total number of cases and deaths that occur from this disease in the whole of India. During the interval of thirty-one (1906-37) years there has been a great increase in the incidence of the disease. Although the number of dispensaries and hospitals increased nearly three times during the period, the number of malaria cases increased to about 5½ times. This increase is partly relative and partly absolute. Relative increase is due, firstly to the increase in the number of dispensaries and consequent increased facilities for diagnosis and treatment; and secondly, due to the phenomenal increase in the population, while the absolute increase is largely due to the spreading of the disease to the areas which were healthy until very recently. It is a serious matter that malaria is spreading towards the eastern and southern parts of this province into those districts which were comparatively healthy only a few years ago. Districts like Dacca, Mymensingh, Noakhali and Bakarganj were comparatively healthy even as late as 6 or 7 years ago than what they are now. A serious epidemic of malaria broke out in Mymensingh and in Bakarganj 3 years ago. The spleen index in some parts was as high as 60 per cent and in others even more. If the present conditions are not tackled properly and early, and are allowed to continue, history will repeat itself and these areas will meet the same fate as those of western and central Bengal. One of the principal factors which have led to the present

condition regarding the spread of malaria in the province is the alignment as well as the method of construction of roads, railways, canals and embankments which are very defective. Railways and roadways have been constructed right across the spill area of the rivers of this province, and they have been constructed over embankments and in some places have to be protected by other embankments. These prevent the spill and flood water during the monsoon from draining away and killing the mosquito larvae with silt. Any one who has travelled either by railway or by road or along canal in this province had noticed these high embankments along which innumerable isolated borrowpits have been dug where prolific mosquito breeding takes place. Adequate flood outlets have not been provided, the culverts are too small, the invert level of the floors of the culverts and of the bridges is much too high for the free flow of water especially when it is at a low level and in many instances the bridgehead embankments have been carried too far into the bed of the river almost strangulating it as it were. The construction of marginal embankments for protecting the low lying lands which are not yet fully formed and therefore are unsuitable for human occupation have not only condemned these low areas to remain low for ever where water stagnates and results in mosquito breeding but are also killing the adjoining rivers by helping the filling up of their beds with silt which the river would have deposited in the low lying deltaic areas, had the embankments not been constructed.

Rural Bengal is dotted over with millions of tanks and shallow ponds, the vast majority of which have been dug indiscriminately by the villagers to obtain earth for building their huts and for their supply of water. They are not well kept and often covered with vegetation. Indiscriminate killing of fish and lack of systematic pisciculture contribute further to the spread of malaria. In the absence of any law the fish are killed indiscriminately without regard to types or seasons. To make things worse, with no systematic pisciculture there is marked diminution of fish particularly of the type that eat up the mosquito larvae and thus keep down the mosquitoes. There are also endemic foci of malaria in the adjoining provinces, namely, those of Assam, Orissa and Bihar and from the last two provinces, viz., Bihar and Orissa, we have a large migratory labour population who come into this province every year. With the present-day easy means of

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communication, e.g., railways, buses and steamers both the human reservoir as well as the infected mosquitoes are easily carried.

In a deltaic area a certain amount of change in the course of rivers is almost inevitable because of the natural forces. It is the function of a deltaic river to form land. After a river has raised the level of its adjoining low lying areas to a sufficient height, it does not get the benefit of scouring action of silt-free flood water, with the result that its own bed gets silted up gradually. In an active deltaic region it is bound to happen. But when this natural agency is forced or markedly accelerated by the hand of man himself, the danger of maladjustment and attending evils come in. The change of a course of river can also occur as a result of an earth-quake as in the cases of the Brahmaputra and the Teesta.

Besides the rivers, the *beels* are becoming shallower and smaller. This phenomenon can be observed in several districts and is principally due to lesser amount of water reaching them from the rivers due to change of their course or because of their ceasing to be active rivers. The net result is that the mosquito gets a better chance for breeding due to smaller and shallower collection of water in them. Rainfall and flood have also a peculiar effect on this problem. In the higher lands, e.g., in the west of the province an increased precipitation was followed by an increased incidence of the disease. For example, the heavy rainfall of 1933 was followed by an epidemic of malaria in those regions. Whereas in areas which are subject to inundation normally every year, lack of rains means lack of floods and consequent increase of malaria. And the converse is also true. Real trouble starts when the flood water is held up.

Helping Factors

Due to the great fertility of the soil and to climatic conditions in this province vegetation grows up very quickly, and in the plains if not kept constantly under control the areas are converted into jungle in a comparatively short period of time. Added to this, the immense increase of population due to (i) large excess of births over deaths and (ii) immigration has made the problem complicated. During the last intercensal

period (1921-31) the population has increased practically by one per cent every year. In a malaria stricken area this meant more victims on the altar of this fell disease.

Lack of education and proper knowledge among the masses as well as dearth of broad vision amongst the engineers and other educated persons are partly responsible for this misdeed. Had the engineers imbibed the knowledge regarding the etiological factors of malaria and of the actions of deltaic rivers one may expect that they would not have constructed the railways and roads in the manner they have done which has resulted in the killing of many rivers and *khals*. In any case there is no justification for them now to dig borrowpits indiscriminately and allow them to remain as they are. Similarly a large number of landlords, majority of whom are educated, have put their vested interests above those of the community.

The ignorance and lack of suitable education amongst the masses is colossal. Because of this they cannot appreciate the harm they are doing themselves by killing fish indiscriminately and by not giving willing co-operation to any measure of tackling the problem. There is a lack of community feeling and self interest is dominant. The blame, however, cannot be levied at their doors completely. The lead, if necessary even by legislation, should come from the leaders of the public in whose hands the well-being of the people lies.

In recent years large blocks of low lying lands in the south and in the east of the province have been allotted to the raiyats who being ignorant occupied them greedily. For a time, everyone was happy, but as marginal embankments protecting these low areas grew higher and higher, trouble began to appear. The rivers are decaying, and the area remaining low water stagnates there and breeds mosquitoes in millions. The raiyats have become a prey to malaria and if matters are allowed to drift as has been done in the past, history of Hooghly and Burdwan will repeat itself in those newly populated regions before long. It is a very serious problem though capable of solution.

Evil Effects

The principal effect that has resulted from the long continuous suffering due to malaria is the physical unfitness of the Bengalees, which deficiency has been

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taken advantage of by people from other provinces. It is estimated that over a crore of rupees is sent out every year from Bengal in small money orders by wage earners like labourers, industrial workers, durwans, etc. The economic loss that results from the terrible wastage of human sickness and life is a great concern for the province. For example, if we take two amas as the wage earning capacity of a labourer and take a period of two months on an average as the period during which he is disabled from earning his livelihood, and taking about ten millions out of the lower figures of 80 million cases as the number of adult men and women who are capable of earning a livelihood, we get a figure of about seven crores of rupees annually. This is not the only loss that is suffered. One has to remember that the wage earner during the period of his sickness not only does not produce any wealth but consumes wealth produced by others and that taken even at two pice a day comes to over a crore of rupees. As a result mainly of this continued deterioration in physical fitness, Bengal imports several lacs of labourers from Chota Nagpur, Bihar and Orissa both during the transplanting as well as the harvesting period and also for industrial and other labour. This means further economic loss to the province. The tragedy is gradually accentuating as time goes on. A large number of the people who come as labourers settle on the lands as agriculturists either because the original tillers of the soil get eliminated due to death or emigration to other parts to escape from the unhealthy surroundings or the owners become so physically unfit and impoverished that they cannot possibly maintain the lands themselves and their children take up other avocations of life. This has resulted in the gradual insidious replacement of indigenous population by the population which has come from outside the province. In other words, so to speak, Bengal is being reconquered.

During the period 1901-31, the percentage of increase of the indigenous population in Bengal was 18.2 while that of the non-indigenous population was 28.9. The figures of 1931 census show that there are 19 districts (excluding Darjeeling and Chittagong Hill Tracts) where there was a marked increase of the non-indigenous population, while in 7 there was a decrease. According to 1931 census in 9 districts, the non-indigenous population formed 1 to 10 per cent of the total

population, in 8 districts 10 to 20 per cent while in 8 districts the percentage was between 20 to 45 per cent. As a matter of fact, as circumstances are, it is inevitable that the stronger and more virile men would replace the weak. The health and welfare of a country do not merely depend on a few persons on the top. It would be entirely wrong if we judge the soundness of the population from that narrow angle of vision. The real stability lies in the vast masses that form the huge bulk of the population. Their physical fitness and welfare is the true index of the country's prosperity. That index is undoubtedly poor so far as Bengal is concerned. It is not only poor but is decreasingly so.

Remedial Measures

Before we can expect to achieve success in tackling this problem of malaria there must be a co-ordinated policy between all concerned, that is, the railways, the different departments of the Government, the district and municipal boards with regard to the new alignments, of railways, roadways and waterways and repair of existing ones. So far as the new railway and road projects are concerned, Government have accepted the principle that there should be preliminary consultations, but we cannot get over our difficulties completely until there is close co-ordinated policy as well as a thorough supervision when the work is being executed. It is not sufficient that the engineer lays down the road or the railway simply at the cheapest cost. He must take care of the public health aspect. His project must fit with the surrounding conditions. It should provide for adequate drainage even if it means more initial cost. It costs much more in life and money if his mistakes have to be rectified later. Even now at this late hour, railways, communications and works department of the provincial Government and district and municipal boards go on making borrowpits indiscriminately all over the place. Similarly trouble arises during the repair of roads, railways, embankments, etc. And yet we worry about malaria! Putting up of embankments, whether marginal or cross should be regulated. Excavation of tanks and *dobas* without the specific sanction of a competent local authority should be prohibited to stop the indiscriminate digging of earth for erecting huts in villages. We may adopt the same procedure as in the Punjab, where every village community has one or more selected areas wherefrom earth is excavated. This practice will immensely reduce the number of breeding grounds.

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Two ancillary measures which should also be ensured are

- (a) prohibition of growing of jungle in the plains, and
- (b) keeping the water edges clean by ridding the tanks, *beels* etc. of water-hyacinth and other weeds.

A good deal can be done in the resuscitation of decayed rivers, *khals* and *beels*. Such work should be considered in the same light as the repair and improvement of roads. We must remember that we have nearly twenty-five thousand miles of waterways and more revenue as a result of increased trade and commerce should accrue if we can exploit as fully as possible this gift of nature. There should be systematic re-excavation of tanks every six or eight years. A drive should be made to diminish the number of *dobas* in the villages and filling up may be accelerated by permitting the villagers where practicable to cultivate. All borrowpits should be drained into a channel and in the last resort, if this process fails these should be stocked with fish. During repairs endeavour should always be made for wider bridges and culverts and for lowering the invert level of the culverts and bridges.

To combat against the infection adequate treatment facilities should be provided for by establishing more treatment centres which should be combined units for preventive and curative medicine. At these centres greater supply of quinine should be provided as it is still the best efficacious remedy.

Initiation of a bolder policy of integral land reclamation, or in other words "Bonification" may strike at the root of the problem. If once infection is checked from spreading, it will be less difficult to treat the already infectious cases. But this work has many aspects to cope with, namely, health, transferring of population, engineering, agricultural, etc. It is by adopting comprehensive measures based on a long-range policy that we would be able to reclaim the lands that

have been devastated by malaria. We shall have to repopulate them with people transferred from the low lying areas in the deltaic region thus giving a chance to the latter areas to improve themselves naturally and become fit for human habitation again in course of time. Further there should be greater impetus to anti-malaria works by local authorities and voluntary organisations. Co-operative anti-malaria societies are useful for educative work.

The lead, however, in this task should necessarily be taken by the State. In order to carry out the work systematically, as outlined above, suitable legislation would be necessary. As an example of State help, it may be said that the appointment of a Government fishery officer and establishment of Government fisheries will help towards systematic pisciculture, which will not only provide larvicidal fish but will also increase this very important article of nutrition. Similarly, by other agencies we may proceed to fight the menace step by step. Lastly, we should have an Anti-malaria Fund to which all should contribute—the Government, the local bodies and the general public. This Fund will help in carrying out a sustained policy in anti-malaria work, spreading knowledge regarding the prevention of this disease and in giving grants to recognised voluntary organisations who will be recommended by competent authorities. In most of the civilised countries, apart from any humanitarian considerations, sickness is considered to be an economic loss and expenditure incurred to safeguard the physical fitness of the population is therefore naturally considered to be a national investment. That is the correct attitude. I do not see any justification for us to adopt a different one.

It is evident that a co-ordinated, concerted and sustained policy would have to be followed by all concerned, namely different departments of the Government, local authorities and the public, if we want to tackle this problem of malaria which is widespread in this province and is the principal cause of the physical unfitness. Economic loss resulting from this preventable disease is so colossal that any money spent on tackling this problem effectively should be considered as an investment.

RESEARCH NOTES

Nuclear Transmutation of Boron by Slow Neutrons

An interesting work on the nuclear transformation of boron by slow neutrons has recently been performed by W. Maurer and J. B. Fisk (*Z. f. Phys.*, 112, 436 1939) in the laboratory of Professor W. Bothe in Heidelberg, Germany. With slow neutrons three different particle-disintegration processes are energetically possible for boron. These are ${}^3\text{B}^{10} (n, \alpha) {}^3\text{Li}^7$, ${}^3\text{B}^{10} (n, p) {}^4\text{Be}^{10}$ and ${}^3\text{B}^{10} (n, 2\alpha) {}^1\text{H}^1$. From the known-mass data occurring on both sides, one obtains the energy balances $Q=2.98$ eMV and $Q=0.41$ eMV respectively for the first two reactions. The third reaction is evidently much less frequent than the other two as it involves a double process. The first reaction has been experimentally studied by many authors using a cloud chamber and they have directly estimated the sum of the ranges $R_\alpha + R_{\text{Li}}$ from the photographs of the tracks of the out-going particles. The energy of the incident slow neutron may be taken to be zero here, and the kinetic energy of the out-going α -particle can be found from the length of its track by using the standard range-energy relation for α -particles. Hence the energy-balance of the reaction can be approximately computed from the above cloud-chamber studies. The Q values obtained however by most of the authors in this way range between 2.15 to 2.6 eMV, all of which are too low compared to $Q=2.98$ eMV obtained from mass-data, and the discrepancy cannot be accounted for as being due to experimental error. This fact leads one to think that the rather infrequent emission of α -particles in which the final nucleus Li^7 is formed in the ground-state has probably been mostly missed in the cloud-chamber, the tracks recorded being those in which Li^7 is formed in one of its excited states. Consequently

the estimated kinetic energy of the outgoing particle is less than its maximum value by the excitation-energy of the Li^7 nucleus above the ground state. Further if the range of the α -particle from the first reaction and that of the proton from the second reaction become accidentally almost equal, as is found to be the case here from the present work, there will be a serious confusion between the α - and the p -tracks in the cloud chamber photographs. The Q values of the two reactions being widely different, a consistent value of the energy balance from the cloud chamber data cannot be expected.

To avoid these difficulties Maurer and Fisk have adopted the alternative method in which the out-going particles are studied by means of an ionisation-chamber filled with BCl_3 gas in conjunction with a proportional amplifier and *Schleifenscillograph* and the oscillograph deflections are continually photographed on a moving bromide paper. In this the oscillograph deflections are constantly calibrated by means of $\text{Po-}\alpha$ -particles of 5.3 eMV energy. A strict linearity between the particle-energy and the oscillograph deflection being attained in this arrangement, the photographic record of any track gives at once the energy of the corresponding particle. A large number of particles is photographed in a comparatively short time and an energy distribution curve of the emitted particles is obtained with sufficiently small statistical error.

The energy distribution-curve obtained by Maurer and Fisk indicate the presence of 5 distinct energy-groups of particles at 2.90; 2.70; 2.49; 2.26 and 2.06 eMV with relative intensities 1.0; 1.4; 1.6; 2.0;— . To identify the nature of the particles forming each group a novel method is adopted. The pressure of the BCl_3 gas in the ionisation chamber is

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varied at five different values, namely, 70, 80, 130, 157 and 210 mm. of Hg and the distribution-curve is obtained at each of these pressures. It is seen that at lower pressures the high energy groups gradually tend to vanish. This is due to the fact that as the gas pressure is lowered down gradually the energy-loss of the high-energy particles in passing through the ionisation-chamber gradually diminishes and therefore less and less number of ions are produced in the chamber. The manner in which the intensity of a group diminishes with the fall of gas-pressure gives a rough estimate of the range of the particles forming the group. Further the energy of the particles are directly known from the length of the deflections they produce. The range and the energy of the particles thus obtained independently are now tried to be fitted into the range-energy curve of different known particles (*e.g.*, the α -particle, the proton, the deuteron, etc.), and the nature of the particles in question is at once fixed.

A critical discussion of the distribution-curves based on this principle leads the authors to the conclusion that in the transmutation of boron by slow neutrons both α -particles and protons are emitted, the relevant reactions being ${}^3\text{B}^{10} (n, \alpha) {}^3\text{Li}^7$ and ${}^3\text{B}^{10} (n, p) {}^4\text{Be}^{10}$ respectively. The energy-balance of the two reactions are found to be 2.90 and ~ 0.4 eMV respectively from these curves, which are in good agreement with those obtained from mass-data, namely, 2.98 and 0.41 eMV. It is shown further that the first four groups of particles mentioned above are due to the (n, α) -process. The first of these corresponds to the formation of Li^7 in the ground states; its intensity is low, but still sufficient to be detected accurately by the very sensitive method employed. The other three groups correspond to the three excited states of Li^7 at 200, 610 and 640 eKV. These excited states of Li^7 are in good agreement with those obtained for Li^7 by various workers from other reactions like $\text{Li}^7 (\alpha, \alpha+\gamma) \text{Li}^7$, $\text{Li}^6 (d, p) \text{Li}^7$, etc. The fifth group of particles indicating an excited state of Li^7 (?) at 840 eKV is doubtful. The protons emitted in the (n, p) -process do not show any discrete group structure.

If the analysis of the excited states of Li^7 given by the authors is correct, the (n, α) -process should

be accompanied by the emission of γ -quanta of various energies. Much further work is, however, necessary to show if γ -rays of the required energies and intensities are really available in the transmutation of boron by slow neutrons.

N. K. S.

Zinc and Beriberi

It has been shown that the average amount of zinc ingested per day in a balanced diet is about 12 mg. and that this figure agrees with the average amount of zinc found by several workers to be eliminated daily in the faeces and urine of normal individuals.

W. G. E. Eggleton [*Biochem. J.*, 33, 403, 1939] working at Shanghai proved that each of the three foods, sea fish, cooked polished rice and cabbage, which form the bulk of the diet of the poorest class of the Chinese in South China, contains less than 6 mg. zinc per kg. of food as eaten. Since the amount of food consumed in a day by a person existing on such a restricted diet would not appreciably exceed 1 kg., it may be assumed that this represents the approximate daily zinc intake. Small additions of other foodstuffs richer in zinc will not materially augment this figure. As there is strong evidence of a positive correlation between the zinc and aneurin contents of foodstuffs, a diet supplying inadequate aneurin should also supply subnormal amounts of zinc and it would be reasonable to suppose therefore that sufferers from beriberi would show a reduction in the zinc content of their tissues.

Since epidermal structures are obtainable with equal ease from the living as from the dead and since they show little post-mortem change compared with internal viscera, Eggleton conducted experiments to test the suggested correlation by investigating the zinc content of epidermal structures of patients with beriberi and of normal individuals. The samples were obtained partly from autopsies and partly from living persons. The normal subjects were chosen from healthy living persons or from healthy accident cases or suicides showing no gross pathological changes. The author finds that in beriberi the zinc contents of the toe nails, finger nails and skin are reduced to half their normal value and there is a strong indication that the ash content is increased.

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Data are produced to show that the amount of zinc in natural foodstuffs is positively correlated with that of aneurin. It is suggested that zinc deficiency may be a factor in the beriberi syndrome.

H. N. B.

Antagonism of Salts in Plants

In the study of mineral nutrition of plants many instances of the interdependence of absorption rates of the elements and their antagonistic effects have been observed and investigated. Of the various instances, antagonism of calcium and magnesium is an outstanding one. Many have tried to explain the antagonism of calcium and magnesium on the concept of simple mass effect i.e., 'the mass effect of an essential element on the proportionate intake and utilization in organic syntheses of a toxic element sufficiently similar chemically as to preclude any considerable selectivity'. Large effects can be expected only with major essential elements which are absorbable in large quantities without injury

to the plant. The total intake of the essential element and the other toxic element is probably determined by the gradient established by the metabolism in the plant brought about by the intake of the essential one, and the intake of the toxic element decreases in consequence with increasing availability of the non-toxic one as has been shown between selenates and sulphates. Experimental details in case of some other antagonisms have recently been provided by *Hurd-Karrer* in his recent investigations (*Plant Physiol.*, 14, p. 27, 1939). An attempt has been made to explain the antagonism of chemically similar salts, such as, inhibition of arsenic toxicity by phosphorus, that of rubidium by potassium and inhibition of strontium toxicity by calcium on the concept of 'mass antagonism'. It has been found that in nutrient solutions arsenic injury is a function of the available phosphates in the proportion of 1:5; rubidium injury is a function of the available potassium in the proportion of 1:2 and strontium injury is a function of the available calcium in the proportion of 1:1.

B. K. K.

Lamps and Lumens in the United States

The use of artificial light, with corresponding although not parallel rate of growth in kilowatt-hour consumption, has increased enormously in the United States. Multiplying the total number of lamps by the average watts per lamp shows an increase in kilowatt consumption of about 50 per cent during the period 1933-7. Correspondingly, the average lumens or quantities of generated light per unit have increased as represented by a growth of 11 per cent. If the average annual increase for the past 15 years should be approximately the same during the next five years, there would be an expectancy in the United States of a growth in incandescent lamp consumption of between 15 million and 20 million lamps (bulbs) annually. Contrary to some popular fallacies, there is no deadlock between reduced prices for lighting and

increased consumption of power. Neither one awaits the overtures of the other, but both go hand in hand under the incentive of increased volume of production and consumption. In the decade between 1927 and 1937 the American consumer of domestic electric power for household use found his payments for kW.-hr. reduced on the average from 6.9 cents to 4.5, cents. Part of the explanation for increased lighting usage is traceable to lessened cost of electric lamp bulbs, which, since 1908, experienced an almost unbelievable reduction. Neither has the lumen output per lamp been neglected, for a 60 watt lamp that produced less than 500 lumens in 1908 had grown to 550 lumens in 1915, 620 lumens in 1922, 700 lumens in 1930, and about 835 lumens today.

—From *Journal of The Franklin Institute*.

SCIENCE &
CULTURE

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PROCEEDINGS AND PUBLICATIONS

Indian Chemical Society

(*Calcutta, March, 1939, J.I.C.S., 16, 117-161, 1939*)

MATA PRASAD AND D. M. DESAI: The effect of the addition of non-electrolytes and of temperature on the times of setting of some transparent inorganic gels.

SISIR KUMAR GUHA: Dyes derived from acenaphthenequinone. Part VII. 2-(chloro) thionaphthene-acenaphthylene-indigos.

M. N. RUDRA: Manganese content of Indian foodstuffs and other materials.

N. L. VIDYARTHI AND M. NARASINGARAO: Chemical examination of the wax from sugarcane.

DURGAHAHARAN CHAKRAVARTY AND NIRANJAN CHAKRAVARTY: Constitution of halogenated resacetone and propiophenones.

DURGAHAHARAN CHAKRAVARTY AND BROJESWAR MAJUMDAR: Limited applicability of Kostanecki's reaction. The influence of halogen atom on the reaction.

S. RANGASWAMI: A note on methyl- β -resorcyate.

M. NARASIMHAM AND S. N. PAL: A note on the analysis of certain algae.

(*Calcutta, April, 1939, J.I.C.S., 16, 165-222, 1939*)

R. N. MITTRA: Formation of periodic precipitate in the absence of a foreign gel. Part II. Ferric hydroxide sol by different methods.

R. N. MITTRA: Cupric hydroxide sol.

PRAFULLA KUMAR BOSE AND JOGENDRALAL BOSE: Natural flavones. Part III. On the constitution of Tambulin.

K. P. BASU AND M. K. HALDAR: Supplementary relation between the proteins of pulses and those of milk by the balance-sheet and growth methods.

K. P. BASU AND M. K. HALDAR: Biological value of the proteins of *Cicer arietinum* (Bengal gram) and *Cajanus Indicus* (Arhar) by the balance-sheet and growth methods.

SISIR KUMAR GUHA: On the preparation of 7-methyl-3-hydroxythionaphthene and its condensation with isatin.

National Academy of Sciences, India

(*Allahabad, December, 1938, Proc. 8, 93-125, 1938*)

R. C. CHATTERJI: Annotated list of the helminths recorded from domesticated animals of Burma. Part I—Trematoda.

SIKHIBHUSAN DUTT: Composition of patent still molasses fusel oil of Indian origin, Part I.

B. P. PANDE: On two new trematodes from Indian cyprinoid fishes with remarks on the genus *Allocreadium* looss.

B. P. PANDE: A new strigeid trematode of the genus *Crassiphiala* V. Haitzma, 1925 (Family: Diplostomidae Poirier) from an Indian King Fisher.

JAGAT NARAYAN TAYAL AND SIKHIBHUSAN DUTT: Chemical examination of the essential oil of *Ocimum canum sims*.

(*Allahabad, March, 1939, Proc. 9, 1-28, 1938*).

V. L. VARMA AND S. DUTT: Indigoid dyestuffs derived from chrysoquinone.

K. B. MATHUR AND G. R. TOSHIWAL: F-region ionization in June 1938 at Allahabad.

R. BEHARI: Osculating quadrics of a ruled surface.

B. P. PANDE: On the trematode genus *Lyperosomum* looss, 1899 (Dicrocoeliidae) with a description of two new species from India.

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B. P. PANDE: Two new species of trematodes from *Anhinga melanogaster*, the Indian darter or snake-bird.

Royal Asiatic Society of Bengal (Calcutta, 5th June, 1939)

EILEEN W. E. MACFARLANE: Marriage symbols from the West Coast of India. Exhibit of silver replicas of talis of 22 communities from Cochin.

B. S. GUHA: 'Simphak'—The bark cloth of the Garos of Assam.

R. R. MOOKHERJI: Two combined pottery and basketry specimens from Upper Assam.

CHINTAHARAN CHAKRAVARTY: A Tantric story about the origin of Vijayanagar.

RESEARCH WORK IN INDIA Forest Research Institute, Dehra Dun

During 1938-39 the most important investigations by the Entomological Branch at the Forest Research Institute, Dehra Dun, were made in Madras, where pests of teak, mahogany and sandal have received attention.

The insectary at Nilambur determined the monthly parasitism percentage of defoliators of teak and undergrowth in teak plantations. Biological control has greatly improved in recent years, and it is estimated that nowadays complete defoliation of teak occurs on an average over less than 7 per cent of the total area annually. This represents a saving in increment valued at Rs. 50,000 a year. Two more species of parasites were introduced from Burma, one a tachinid, *Ptychomyia remota*, direct and the other a braconid, *Apanteles malevolus*, after multiplication at Dehra Dun. Two species, *Diocetes gardneri* and *Goniozuz montanus*, were sent from Malabar to Burma. This line of work is being extended to Bombay and Coorg in 1939.

A thorough study of *Pagiophloeus longiclavis*, the collar borer of mahogany, *Surietenia macrophylla*, has revealed its life-history. We now know that pulling up attacked mahogany plants is useless as a control measure; the pest breeds in great abundance in toon trees (*Cedrela toona*) and this alternative

food-plant can be used to trap the beetles; and it can be controlled by the same conditions of overhead and lateral shade as apply also to the shoot borer, *Hypsipyla robusta*. There is every possibility of establishing plantations of mahogany for the European markets now that we know how to control these pests.

Great progress has been made in eliminating species of sandal insects suspected as vectors of spike disease, which has in the past 40 years caused a loss of two crores of rupees. Symptoms deceptively like spike have been produced experimentally by four species of forest insects but other evidence suggests that the vector is derived from agricultural crops. An interesting method of trapping sandal insects in North Salem, Madras, is by means of sheets of sticky paper screened by 1/4 inch mesh wire gauze. An account of the *Heteroptera* of sandal was published in the *Indian Forest Records*, Ent. Ser., Vol. III, No. 2. This is the 34th paper on the insect fauna of sandal, *Santalum album*.

In the Punjab, insectaries were maintained in irrigated plantations of shisham, *Dalbergia sisso*, to determine the distribution of the natural enemies of shisham defoliators, *Plecoptera reflexa* and *Dichomeris eridantis*. The parasitism percentage was found to be higher in the northern plantations and particularly in crops with a high admixture of other plants especially mulberry, whereas in the more arid southern plantations the parasitism percentage is low and some species of natural enemies are missing. The colonisation of these missing species of parasites and predacious beetles and mantids has been started.

Heavy grazing in deodar forests near Simla was found to be the cause of prolonged epidemics of the deodar defoliator, *Ectropis deodurac*. Under such conditions direct control, e.g., grease banding, has to be adopted.

Field work in Assam discovered that other species of *Magnoliaceae* are alternative hosts of the champ bug, *Urostylis punctigera*, and that it has only two species of enemies, one parasite, *Pachyneuron pentatomivora*, and one predator *Calvia tricolor*.

The biologies of 350 species of borers of the family *Cerambycidae* were published of in the *Indian Forest Records*, Ent. Ser., Vol. V, No. 1: these attack 568 species of Indian trees, shrubs and climbers.

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All these investigations have required a considerable amount of work in systematic entomology; over two and a quarter lakhs of specimens were identified during the year mostly derived from the field insectaries; 411 new species of insects were added to the collection.

Allahabad University

In the mathematics department of the Allahabad University investigations have been concluded into the condition necessary for the formation of spiral arms in the case of a rotating spheroidal central mass of finite dimensions and uniform density surrounded by a spheroidal structure of rotating compressible gas of variable density. Work has also been extended to determine the effect of ionisation on the formation of spiral arms. It is found that when the spiral arms are thin, ionisation will hardly have any effect on the figure of the arms, but in the case of heavy arms, the effect of ionisation will be to open out the arms a little more. It is also found that the equatorial diameter of the central nucleus in the case of our galactic system cannot be greater than 35 parsecs, whereas in the case of the Andromeda nebula the equatorial diameter of the nucleus may have the upper limit 600 parsecs.

Taking account of the variation of the angular velocity in specifying the polytropic configuration of a rotating gaseous model, the shape of the boundary of the configuration and its oblateness

have been determined, and further, mass, volume, and mean density of the configuration have been calculated.

Two models of Jupiter's atmosphere *viz.*, adiabatic and isothermal have been considered, in which the variability of the period of rotation of the atmosphere and the variation of gravity have both been taken into account. The relations between pressure and density at any depth below the datum level and at any height above the datum level, the datum level being the effective radiating and absorbing layer, have been investigated. In each of the two cases, *viz.*; (i) when the atmosphere consists of methane only, and (ii) when it consists of a mixture of one part of methane and six parts of hydrogen, it is found that the total thickness of the atmospheric layer cannot, in any case exceed 1900 kms, and possibly it is below 1300 kms.

A formula has been worked out for the intensity of ionisation in the earth's atmosphere by taking account of the variation of gravity and by assuming that the earth's atmosphere can be divided into three regions *viz.*:

- (1) From 82 kms. to 300 kms. above the sea-level, temperature is taken to increase linearly with the height.
- (2) From 11 kms. to 82 kms. the temperature is assumed to be more or less constant and equal to its mean value over this range.
- (3) From sea-level to 11 kms., the region is taken to be adiabatic.

BOOK REVIEW

PHYSICS OF TODAY—by J. A. Clark, F. R. Gorton and F. W. Sears. (Constable and Company Limited). London, 1939. Pp. xxvi+632. Price 8s. 6d. net.

Evidently meant to be an introduction to the study of physical science, the authors of this book have shown in an admirable manner how the fundamental laws and principles of physics may be taught to beginners in a simple and interesting way. The experimental method of approach, undoubtedly best suited to young learners, has been used throughout; large number of experiments have been described and generalisations have been deduced from experimental results.

The different chapters of the book are devoted to mechanics, forces, motion, gravitation, work, energy and power, machinery, heat, sound, light, electricity and magnetism. The arrangement of matter though in places somewhat unorthodox seems to be perfectly logical. One welcome feature of the book is that everywhere attention has been paid to practical application of physical principles and those principles have been attempted to be illustrated by examples of every day experience. This naturally arouses the interest of young readers and makes their understanding of the subject clear and easy. The book contains a very large number of illustrations showing class room experiments and other natural phenomena and also neat diagrams explaining the working of physical instruments and familiar machines. As one who has to teach physics to beginners, the reviewer has often felt the want of elementary books like the one under review. The book, though not meant to meet the requirements of the syllabi of the Indian universities, will certainly be of great help to our intermediate students.

The printing and get-up of the book is good.

S. D.

INDUSTRIAL ENTERPRISE IN INDIA—by Dr Nabagopal Das, Ph.D., I.C.S., (Oxford University Press). Pp. vii+165 with bibliography and index. Price Rs. 7/-.

Lately the idea of industrialisation of the country has received a great impetus because of the planning committees and the controversy raised over Dr Meghnad Saha's fighting speeches on the subject. But the present position of Indian industrialism may be realised from the fact that over seventy per cent of the exports of the country consist of raw materials and foodstuffs, that about three-fourths of imports consist of wholly or partially manufactured goods and, according to the census of 1931, only 11 per cent of the population live in towns or industrial centres. There are four times as many people employed in agriculture compared to those who are employed in trade, transport and industry.

Indian industrialism, however, has received increasing attention in the hands of competent scholars. One of the latest studies is by Dr Nabagopal Das of the Indian Civil Service, which is under review. The author had a brilliant academic career at Calcutta and London and the present work is abridged and adapted from the thesis approved for doctorate in economics of University of London. He discusses from an original and objective angle some of the problems of industrial organization in India and ably removes some of the misconceptions and brings into relief certain recent developments.

The book begins with a straightforward chapter on the financing of industrial enterprises in India and the Indian money-market. This is followed by an analytical study of methods of financing industries in foreign countries and an able discus-

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sion of the possibility of introducing mixed banking for India on the German model. He notes the predominance of the cash credit system in Indian business and the unpopularity of commercial bills but expects that in another twenty years' time many of the joint-stock banks will take to some of the mixed banking activities.

The author's discussion of the managing agency system is illuminated by the discernment of the rise of a new class of entrepreneurs, notably in the sugar, cement, paper, chemical and match industries. How far this class of entrepreneurs will be able to oust the managing agency system, already blighted by the recent Indian Companies' Act, is yet to be seen. There is a short chapter on the economic significance of the new Companies' Act and a concluding chapter on some 'Broad problems of industrial finance and management in India'.

It will not be much of a disparagement to note that for descriptive and analytical information Dr Das's rather slender book is of little value. For that the student must look elsewhere. Nor does the author do adequate justice to various cognate topics e.g., the several State-sponsored moves to help industries, for there is only a slight reference to the Industrial Credit Corporation of his own province and not even to the U.P. experiment. But these criticisms are possibly beside the point; in a short compass Dr Das's is a creditable performance.

B. N. B.

LECTURES ON QUANTUM MECHANICS, Vol. 1.—by M. Raziuddin Siddiqi, M.A. (Cantab), Ph.D. (Leipzig), Fellow of the National Institute of Sciences, India and Professor of Mathematics, Osmania University. (Osmania University Publications). Pp. 293. Price Rs. 6/- net or 8s. 6d. net.

Thanks to several foreign publications, specially German, American and English, we have at the present moment no dearth of good books on the subject of quantum mechanics. But as a matter of fact these books are scarcely meant for those who are taking the subject for the first time. The author of the book under review is to be congratulated for his having written a very good introduction to the

study of quantum mechanics; and the author promises us, so far as we are aware, it is the first book of its kind published in India and written by an Indian. Although in this volume some recent developments in quantum mechanics have not been incorporated, its companion second volume, which will appear shortly, will be made up to date, especially with regard to developments in scattering phenomena and nuclear physics. In the present volume the fundamental principles of old and new quantum mechanics as well as that of special relativity theory have been presented in a neat and succinct style. The book is devoted to eleven big chapters, dealing with the theory of relativity, general theory of dynamics, structure of the atom and its nucleus as discovered up to date, the quantum theory of radiation, Bohr's and Heisenberg's quantum mechanics, the wave theory of matter, the Schrödinger wave mechanics and perturbation theory, Heisenberg's principle of indeterminacy, and relativistic quantum mechanics. The author has included in these chapters such important topics as the theory of the photo-electric effect, the theory of the Compton-effect, atomic magnetism, the spectra of heavy atoms, Pauli's exclusion principle, the algebra of matrices, Dirac's relativistic theory for a free electron, etc., and we believe the paths traversed by him are sure to pave the way for a clear understanding of the present standpoint of mathematical physics. In the course of presentation of the subject-matter in mathematical language the author has not lost sight of the important landmarks of the historical development, and the mathematical works have been given in a rigorous and complete way.

A good feature of this book is detailed reference to original works and treatises given towards the end of the book under bibliography. While appreciating the author's intentions, we cannot but suggest that it would have been better if the relevant references were appended towards the end of each chapter. The index to this volume has been very carefully arranged. A few typographical errors and other mistakes that have been overlooked during the course of proof-reading, we hope, will be amended and rectified in the next edition of the volume. The book, as it stands, will surely prove to be a good introductory manual to the subject of

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quantum mechanics, and in view of the volume of matter contained the price is moderate.

K. B.

INDUSTRIAL LABOUR IN INDIA,—(Studies and Reports, Series A, No. 41). *International Labour Office, Geneva, 1938. Pp. viii+324 and an index. Price 7s. 6d.*

Since the Whitley Report was issued (1931), significant developments have taken place in the Indian labour world, and also in the constitutional position *vis-a-vis* labour. The Calcutta University Readership Lectures delivered in January 1937 on 'Principles and Problems of Indian Labour Legislation' by Dr R. K. Das, recently published by the University, gave a lucid exposition of the principal problems of Indian labour legislation and particularly of their social significance for the present as also the future. The International Labour Office has also issued a volume which would be welcome for an impartial presentation, with a wealth of details, of the position of industrial labour in India.

The I. L. O. volume under review, however, is not quite up to date. Statistics relate up to the year 1935-36 and portions of the work might have been prepared even earlier. Though the preface seeks to suggest 'the new era in the constitutional history of India' as the *raison d'être* of the publication, even the principal changes in the position of labour under the new constitution are not adequately mentioned. But this lacuna can not seriously detract much from the value of the publication which can be gauged even by a glance at the ten chapters of the book. With a brief survey of the geography, demography, social institutions, political organisation, and industrial systems of the country as the background, the treatise describes the rise of wage-workers with special reference to those who are employed in organised industry, such as plantation, factory, mining and transport, and who form the subject-matter of this study.

The development of industrial labour has been followed by the rise of labour legislation, both

specified or in relation to the workers in some specific industry and general or in relation to the workers in general irrespective of the industry in which they are employed. The development of all the labour measures is described, their provisions analysed, and the methods of their enforcement indicated.

The survey reveals that there is at present sufficient labour supply for organised industry except the tea gardens in Assam, which still largely depend upon the recruitment of emigrant labour under Government control. Steps are being taken for the suppression of the abuses of indirect recruitment of labour in certain industries. The migratory habit and the illiteracy of the Indian workers makes the organisation of employment difficult, and largely accounts for the excessive absenteeism and turnover, as well as for the inefficiency of the workers; but industrial unemployment, in the country though in existence, has not yet become an important problem.

One of the most illuminating chapters of the book deals with the standard of living of the workers and the collection of material relating to the subject is not available in any other single volume. Reading the chapter in conjunction with the analysis of the rates and levels of wages, one notes the great leeway still to be made up in India. The State has a heavy responsibility in the matter, for a few welfare activities, whether undertaken by workers, the general public or employers, to increase worker's amenities can scarcely cope with the vastness and the intricacies of the situation. There are moreover important sociological and social problems which were partly noted in the Whitley Report; these require a thorough investigation by experts and finding out the principles of a bold comprehensive labour policy.

B. N. B.

PHILIPPINE SUGAR INDUSTRY—with a plea for research for the healthy development of Indian Sugar Industry—by C. P. Gupta, B.Sc., Dip. R.T.C. (Glas.), *Sugar Technologist*. (Association for the Development of Swadeshi Industries, Delhi). Pp. 85. Price Re. 1/-.

In this booklet, while stressing the importance of research in sugar industry, the author has com-

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pared the agricultural and manufacturing results obtained in India with those of other advanced cane-sugar producing countries and has also indicated several avenues of research and certain improvements which should be taken up in India in connection with the sugar industry.

The major part of the book has been devoted to a narration of the various aspects of the Philippine sugar industry. Starting from the historical origin of the industry in the islands, the author has given every detail regarding the climatic conditions, the varieties of cane grown, the irrigation and the systems of cultivation prevalent in the island. The administrative control over the industry has also been dealt with and it has been shown how a rational system of administration can maintain an equitable balance of interest between the planters and the capitalists. Under the able guidance of a capable board of administrators the marketing and production of sugar is controlled to the best interest of the cultivators and the capitalists.

The object of devoting the major portion of the book in dealing with the Philippine sugar industry is probably due to the fact that the Indian sugar industry may have to face, as soon as the tariff duty on Java sugar is lifted, similar struggles as the Filipinos were confronted with owing to the restriction of the free trade with the U.S.A. as a result of the Independence Law of March 1934.

The author has also given an account of the technique followed and the standard equipments used in the islands. One very outstanding factor attained by the Filipinos is the huge saving in

bagasse, which is the chief source of fuel in sugar factories, though the fibre content of cane is between 9.3 and 13, a figure low in comparison to that in India. The huge amount of extra fuel, besides bagasse, that is consumed by most of the sugar factories in India is undoubtedly due either to wrong design of furnaces in our country or to bad manipulation in steam generating plants. It would have been well, therefore, if the author had devoted a few lines in describing the details of the steam generating stations in Philippine sugar factories. A short description of the condition of employees and the methods of employment in sugar factories and plantations has also been included in the book.

The last chapter has been devoted to describe the chaotic and the deplorable condition of the industry in India. The author has ably criticised the mentality of the Indian mill-owners and has pointed out the intrigues, nepotism and the arbitrary methods practised by some mill-owners in India and the consequent unstable nature of employment in Indian sugar factories.

The author's scheme regarding the formation of a committee of representatives from among the technologists, the capitalists and the Government, for framing out rules and regulations and fixing the scales of pay for technical staff in sugar factories is original and well thought of. We do earnestly hope that this painstaking endeavour of the author will draw the attention of the persons for whom it is meant. The printing and get-up of the book should have received some more attention.

B. K. M.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

Possible Effect of the Earth's Electric Field on Intensities in the Absorption Spectrum of the Earth's Lower Atmosphere.

Chree¹ has shown that visibility of terrestrial objects or atmospheric transparency varies inversely as the potential gradient of the earth's electric field when the air is pure, and the "world-wide" component of the field is independent of changes in atmospheric pollution². A comparison of Rayleigh and Spencer Jones' measurements³ of the intensity of illumination from the night sky at Terling and at Canberra, and the potential gradient of the earth's electric field for corresponding periods in the comparative neighbourhood of those places^{4,5} also confirms the above view (see figs. 2 & 3). It is known that light of the night sky mainly originates at the upper layers of the atmosphere⁶ and the upper atmospheric radiation has been found by Medi⁷ to vary, directly as the potential gradient at the earth's surface. It may be possible that variations in their³ readings for the most part were due rather to selective absorption by the lower atmosphere⁸ than to any change in emission at the source of night sky light, i.e., they were due to

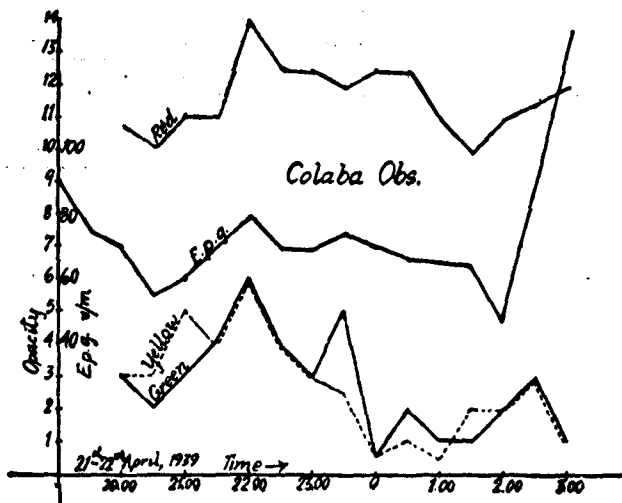


Fig. 1

Indicating the correlation between earth's potential gradient and atmospheric opacity.

changes in the opacity* of the intervening lower atmosphere, under the influence of the earth's electric field¹. On this assumption the writer, using red, yellow, green, blue-green, and blue-violet filters, measured the intensity of the sky at half-hour intervals during the night directly over the potential gradient room of Colaba Observatory as close to the ground as lighting conditions would permit, taking in the portion in which the earth's potential gradient is the greatest. Readings were taken with a modified Rayleigh photometer on all consistently clear nights during the week around the new moon of 19th April, 1939, and fig. 1 is an almost typical curve thus obtained.[†] The correlation was again apparent. The blue-

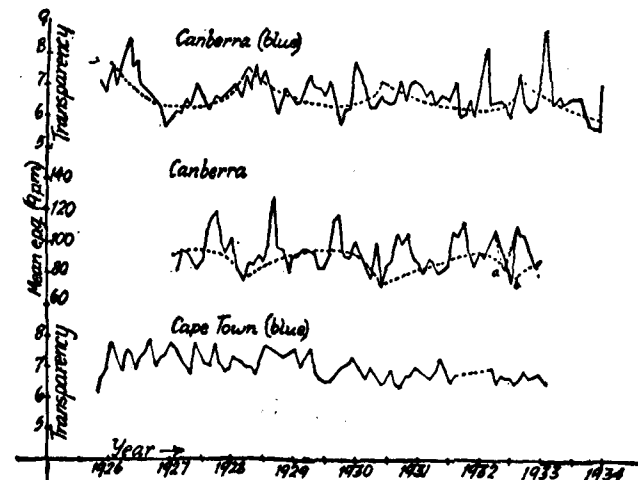


Fig. 2

The bottom curve indicates a 120-day period; and the two upper ones a roughly 2.15-year periodicity.

* Compare also the 1931 section of the Kew curve in fig. 3 with that of determinations of the atmospheric absorption co-efficient for 1931 over several wave lengths made "across the Channel" by J. Duclaux, *Jour. de Phys. et le Rad.*, ser. VII, T. VI No. 10, Oct. 1935, Table II, p. 402. The resemblance is striking.

[†] Taken directly from the electrograms of Colaba Observatory by courtesy of the Director, for potential gradient readings.

LETTERS TO THE EDITOR

green and blue-violet readings, though less systematic, have been erased to indicate the correlation more clearly on the same graph. Furthermore, these and other curves indicate that the correlation is not uniform but such as to suggest that the field has a selective effect on the spectral composition of molecules of the intervening lower air when viewed with the feeble light of the night sky as background.

It would be too early, in the absence of detailed knowledge

obtaining a confirmation or otherwise of these "effects" from other workers cannot be too strongly urged.

Colaba Observatory,
Bombay, 15-5-39.

Alfred B. Arlick.

¹ C. Chree, *Proc. Roy. Soc.* 95A, 210, 1918.

² C. Chree and R. E. Watson, *Proc. Roy. Soc.* 105A, 311, 1924.

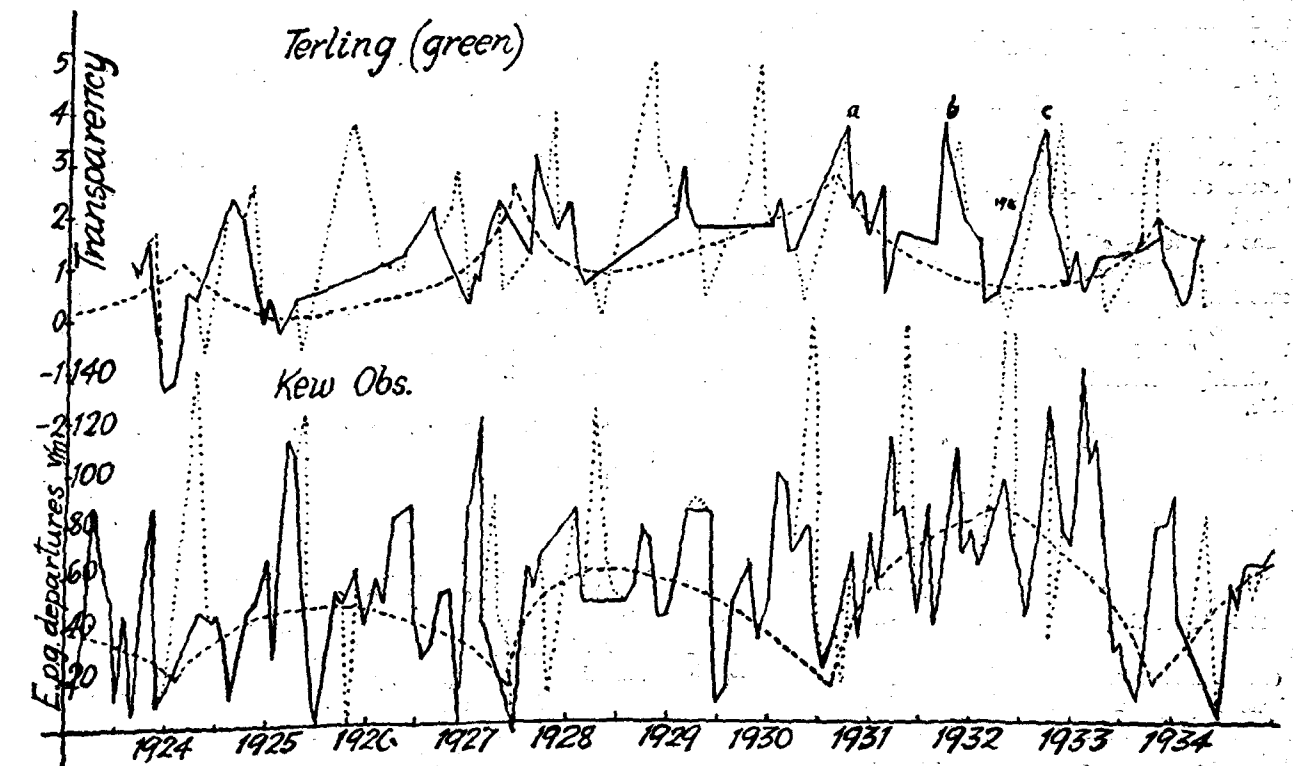


Fig. 3

Note that to every "trough" in the night sky curve there is a corresponding "crest" in the curve of the earth's potential gradient, indicating an inverse relationship.

of variations of the energy distribution in such an absorption spectrum of the lower night air, adequately to account for this phenomenon. In an introductory paper to be published elsewhere in which this problem is dealt with, the writer examines several existing theories of molecular energy levels which might be adapted to explain the effect of a weak external field on changes either in the band intensity or in specific regions of their spectral composition and it is hoped that a plausible explanation will follow the spectroscopic investigations to be undertaken shortly. However, since the selective action of the earth's electric field is of significance in atmospheric conductivity, in the formation of condensation nuclei, the estimating of visibility¹, atmospheric refraction in the visible², and the attenuation of ultra-short radio waves³, the importance of

¹ Lord Rayleigh and H. Spencer Jones, *Proc. Roy. Soc.*, 151A, 22, 1935.

² *The Obsv. Yr. Bk. England 1923-1934*: "Diurnal inequalities of the earth's potential gradient at Kew Observatory: departures from the monthly mean for 21'00 hours."

³ *Memoirs of the Mt. Stromlo Solar Observatory, Canberra, 1934*. "Diurnal variations (atmospheric potential gradient observations) for 21'00 hours each month" 1927-1932, Table 5, p. 36.

⁴ J. Cabannes, *Helv. Phys. Act.*, 8, 405-420, 1935.

⁵ E. Medi, *Ricer. Scien.* 2, Aug. 1938, p. 139.

⁶ M. C. Holmes, *Jour. Frank. Inst.*, 225, 310-313, 1938.

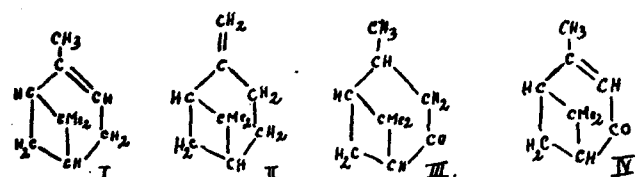
LETTERS TO THE EDITOR

Total Synthesis of Verbenone, α - and β - Pinenes.

The synthesis α - and β -pinenes (I and II) from the elements cannot be said to have definitely achieved; the claims of Ruzicka and Trebler's complete synthesis of pinocampnone¹ and thus of the pinenes² are based on the conversion of α -campholenic acid to l-pinonic acid³ by Tiemann which has been proved to be erroneous.⁴ The conversion of linalyl chloride to β -pinene⁵ appears to be singularly unique. In the absence of full experimental details, and lack of confirmatory evidence e.g., characterisation by the insoluble sodium nopinate obtainable on oxidation, this work needs repetition.

One of the three partial syntheses described in literature, of α -pinene and β -pinene, is from verbenone (IV) which is reduced to verbenol and dehydrated to verbenene; dihydro-verbenene obtained by reduction of verbenene should be α -pinene⁶.

The complete synthesis of verbanone (III)⁷ via, that of α -pinononic acid⁸ and the conversion of verbenone into pinenes having been already achieved, for the total synthesis of pinenes, it is only necessary to convert verbanone into verbenone. This has now been achieved viz., verbanone has been directly converted to verbenone by the action of selenium dioxide.



It is interesting that such a conversion is effected in a single step wherein oxidation of the active methylene group to CHOH first takes place, with subsequent dehydration to verbenone (IV). This is reminiscent of the mechanism of formation of β -pinene from α -pinene by the action of selenium dioxide, as suggested by Dupont and Zacharewicz⁹ (cf. Lydia Monti¹⁰).

Department of Organic Chemistry, P. C. Guha,
Indian Institute of Science, P. L. Narasimha Rao,
Bangalore, 17-5-39.

¹ *Helv. Chim. Acta.*, 3, 756, 1920; 4, 666, 1921; 7, 489, 1924.

² cf. Dupont and Zacharewicz, *Compt. Rend.*, 200, 759, 1935.

³ *Ber.*, 29, 3015, 1896.

⁴ Komppa and Beckmann, *Ber.*, 69B, 2783, 1936.

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Generation of Ultra-High Frequency Radio Waves by Electronic Oscillations.

Radio waves of ultra-high frequencies have recently secured a wide application in connection with broadcasting of television and aeronautic communications, and also in modern therapeutics. It has now become customary to call the waves having lengths below 10 meters as 'ultra-short waves' and those below 1 metre as 'micro waves'. The exact mode of production of these waves seems to be still inadequately determined and requires thorough theoretical and experimental investigations.

Radio waves of length less than 1.5 meters may be very satisfactorily produced by the use of electronic oscillations either in triodes or with magnetron valves. The method of production of ultra-high frequency waves by using triodes was first discovered by Barkhausen and Kurz¹ and also by Whiddington², nearly simultaneously, in 1919, by applying a high positive potential to the grid compared to the filament and anode. Using cylindrical grid and anode Barkhausen and Kurz obtained a formula showing the dependence of the wavelength produced on the diameter of these electrodes and the potentials applied to them with respect to the negative end of the filament.

Since the production of ultra-short waves by Barkhausen and Kurz, various investigators³ have tried to verify the laws of electronic oscillations of this type, and sometimes, several anomalous results have been obtained which do not completely satisfy the original relations of Barkhausen and Kurz. Gill and Morrell⁴, for instance, reported in 1922 that the lengths of the high frequency waves produced by Barkhausen and Kurz oscillations were not definitely independent of the external circuit connected with the valve and thus predicted that the relation given by Barkhausen and Kurz was not adequate in all cases. Two types of electronic oscillations have now been generally recognized; viz., the Barkhausen and Kurz type, which is independent of the associated external circuit and the Gill and Morrell type, which depends on the external circuit constants.

The present note describes the results of a preliminary study of these waves produced by electronic oscillations of the Barkhausen and Kurz type in a triode valve. The various relations with the wavelengths produced, the grid potential applied and the emission current, as mentioned above, have been critically studied and it has been observed that the consideration of emission current is as important as the grid potential in predicting the wavelength produced. A new relation connecting the wavelength produced and both the grid potential and emission current derived by the combination of the equations of Barkhausen and Kurz and Tank has been found to agree more closely with the observed results for a considerable range of grid potentials. It has also been observed that the oscillations are not completely independent of the external circuit contained in the Barkhausen and Kurz oscillator, the details of which are, however, not included here.

LETTERS TO THE EDITOR

The relation of Barkhausen and Kurz for the wavelength generated in a triode valve with cylindrical grid and anode is given by,

$$\lambda = \frac{10^3}{E_g^{\frac{1}{2}}} \left\{ \frac{d_a E_g - d_g E_a}{E_g - E_a} \right\}$$

where E_g and E_a are grid and anode potentials in volts, d and d_g are the diameters of the grid and anode in cms. respectively, and λ is the wavelength generated in cms.

For a simplified case, as employed in the present investigations, when the anode is kept at the same potential as the filament, we get,

$$\lambda^2 E_g = \text{Constant} \dots \dots \dots (1)$$

The relation of Tank for the wavelength and the emission current is given by,

$$\lambda^3 I_e = \text{Constant} \dots \dots \dots (2)$$

where I_e is the emission current.

From equations (1) and (2) we have,

$$\lambda E_g^{\frac{1}{2}} I_e^{\frac{1}{3}} = \text{Constant} \dots \dots \dots (3)$$

The above equation (3) was verified experimentally under different conditions and a typical record of observations is shown in Table I below.

TABLE I

Grid potential (E_g) in volts.	Emission current (I_e) in milliamps.	Wavelengths (λ) in cms.	$\lambda E_g^{\frac{1}{2}} I_e^{\frac{1}{3}}$
80	50	174	573.3
80	68	156	569.5
80	76	152	590.2
100	52	152	582.2
100	70	144	593.4
100	98	128	589.6
120	52	144	588.0
120	115	100	586.1
120	160	94	576.5
140	65	120	570.9
140	110	106	587.2
160	80	106	577.9

The arrangement of the apparatus was essentially the same as that of Barkhausen and Kurz after the modification of Gill and Morrell. The two ends of a pair of Lecher wires 130 cm. long and spaced 5.5 cm. apart, were connected to the grid and anode of a triode valve which were made of concentric

cylinders encircling a straight filament at the common central axis. A sliding bridge, consisting of a fixed condenser of about 0.002 μ F capacity was placed on the Lecher wire system. The end of the fixed condenser which went to the grid was connected to a high positive potential and the other end which went to the anode was connected to the negative end of the filament. Two milli-ammeters were connected in the grid and anode circuits in order to measure the total emission current. After the filament was heated to the desired amount the potential applied to the grid was measured by an electrostatic voltmeter to avoid any leakage of current through the instrument. The sliding bridge condenser was placed at a suitable position where the energy available of the oscillations was large.

The wavelengths generated were measured by an auxiliary Lecher wire system loosely coupled to the oscillator. Two ends of the auxiliary Lecher wires were joined to the heater terminals of a vacuum thermo-junction which was connected to a sensitive mirror galvanometer. A metal sliding bridge was moved on the auxiliary Lecher wire system in order to get the positions of maximum current in the galvanometer from which the wavelengths were determined.

It will be observed from the above Table that the values contained in the last column are fairly constant, showing thereby that the wavelengths experimentally observed and those theoretically calculated from the new equation (3) closely agree. This indicates that the knowledge of the emission current is necessary for the computation of wavelengths generated by electronic oscillations of ultra high frequencies. The details of the investigations along with the other observations concerning the external circuits will be published elsewhere very shortly.

Physics Laboratory,
College of Science,
Benares Hindu University.
12-6-39.

S. S. Banerjee:
A. S. Rao.

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Obituary

Dayaram Sahni

Rai Bahadur Dayaram Sahni M.A., C.I.E., late Director-General of Archaeology died suddenly on the 7th March of heart failure at Jaipur where he was employed as Director of Archaeological Researches since 1935. Rai Bahadur was the first Indian to be trained in the modern methods of archaeological excavation and by his death India loses a most experienced archaeologist.

Rai Bahadur belonged to a respectable family of Khatri from Bhera in Shahpur District, Punjab. He was born on 16th December 1879. After passing his M.A. from the Oriental College at Lahore with Sanskrit as his main language, he was selected for the archaeological scholarship instituted by the late Lord Curzon's Government with a view to preparing suitable Indian scholars for archaeological work. Sir John Marshall who was then organising the first systematic campaign of excavations in India found in Rai Bahadur a willing and capable assistant. He worked at the excavations conducted by the Department at Sarnath near Benares, Kasia the scene of the Great Buddha's decease, Sahet Mehet, the ancient Sravasti, Rajgir in Bihar, Mandar near Jodhpur and Rampurva in Champaran. At Sarnath Mr Sahni studied the finds and prepared a comprehensive catalogue and a guide to the ruins. After a year at the Lucknow Museum where he worked as Curator, Mr Sahni's services were lent to the Kashmir State, in December, 1912. During the next four years Mr Sahni studied the agricultural remains in Kashmir, and excavated at places, among these may be mentioned Avantipur, the city of Avantivarman, Hushkur, and at Martand the well-known site of temples in classical style. In 1917 Mr Sahni returned for work to (Lahore) where he took over the

Hindu and Buddhist monuments in the United Provinces and the Punjab in his charge. After carrying out important archaeological work at Deogarh, Sarnath and other places in the United Provinces, Rai Bahadur Sahni then commenced a series of excavations at Harappa which was shortly afterwards recognised as the foundation of our knowledge of one of the earliest cities of the Indus Valley culture. Since 1925, Rai Bahadur Dayaram Sahni was engaged at the Headquarters of the Government of India, first as Deputy-Director-General and finally in July 1931, he became Director-General. Unfortunately his advent coincided with an era of unprecedented curtailment of activities owing to the need of retrenchment and his three years tenure as Director-General was consequently very much handicapped and the lowest watermark of funds allotted to this cultural activity was reached. However he carried the Department through this period and on retirement found fresh scope for his capacities in the almost untapped and rich archaeological field in the State of Jaipur. His excavation at Birat where the unearthed one of the earliest Buddhist stupas in Rajputana were highly successful. He carried out one or two seasons work at the ancient city site of Sambhar near the well-known salt lake and at the time of his death was engaged in another important excavation at Rairth where he had hit upon another site of the early period.

Rai Bahadur was awarded the title of C.I.E., after his retirement in 1935. Besides the two publications on Sarnath, Rai Bahadur contributed numerous other articles to scientific journals, particularly on epigraphical subjects, bringing to light and interpreting many records of the past, particularly from the United Provinces, and Northern India.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

AUGUST 1939

VOL. V NO. 2

Indian Shipping

A look at the map of India shows that it has a large and magnificent system of navigable rivers and an extensive sea-board on three sides, studded with fine sites for harbour accommodations. From time immemorial, people of India took advantage of this favourable physiographical condition and developed an extensive river craft for inland transport and ocean craft for overseas transport. As a matter of fact, before the advent of steamships and railways most of her inland traffic was carried in river boats. Even in sea-borne trade, India was not backward in early times. There are traditions of sea-borne trade in the *Rig-Vedas* and several *Jataka* stories tell of Indian traders undertaking perilous sea voyages to Babylon and Egypt on the west, Ceylon to the south, and the East Indies and Philippines to the farther east. As a matter of fact, both Ceylon and the Eastern Archipelago (and some suspect that even the Philippines) received their early civilisation from Indian colonists. Even in the eleventh century, the navy of the southern Emperor Rajendra Chole dominated the Indian Ocean. But after this

period, Indian people became averse to sea voyages and orthodox communities imposed a ban on the sea voyage. The result was that foreign trade first passed to the Arabs and the Chinese, who in their turn succumbed to the Portuguese and other European nations. If we interpret history correctly, we find that India's present political and economic plight is largely due to the neglect of her sea-borne trade by the people and the rulers alike during medieval times.

But even up to 1860, before the advent of the steamship and the railroad, India had a large mercantile marine and a flourishing shipbuilding industry, employing hundreds of thousands of workmen. But these were completely ruined by competition from railroads and steamships, which are nearly all under non-Indian control. Even the river traffic has greatly dwindled, because the steamships on the navigable rivers are mostly in the hands of non-Indian concerns, leaving only small crafts for Indian enterprise.

INDIAN SHIPPING

Let us analyse the present condition of Indian shipping. Her total tonnage, which is about 95 per cent coastal, is an almost insignificant quantity, and much of it is not Indian at all.

The exact figure according to the League of Nations' Year Book is only 2,15,030 tons, i.e., only '0006 tons per head. This may be compared with the corresponding figures in other countries, and the Table 1 below shows conclusively the great backwardness of India in all shipping enterprises and the possibility of development which a well-thought-out plan holds out.

TABLE I

Country.	Population Millions— (000's omitted).	Total Tonnage Mercantile (in 1000 tons).	Tonnage per Head.	Times India's Average.
United Kingdom	47,288	17,544	.37	617
Denmark	3,749	1,118	.30	500
Norway	2,908	4,348	.15	250
U.S.S.R.*	168,000	1,258	.007	117
Japan	71,253	4,475	.06	100
Germany	68,072	3,937	.06	100
Sweden	6,285	1,502	.02	35
India & Ceylon	376,712	215	.0006	1

* Not including vessels on the Caspian Sea and sailing vessels.

[From the Statistical Year Book of the League of Nations. The Table includes vessels of 100 tons and more].

India has a total coastal and overseas trade of nearly 400 million sterling per year. About 30 million tons of cargo and 3 million passengers are being carried every year in this trade. But of this vast trade, Indian shipping carries hardly 5 per cent. The coastal trade of India should belong to purely Indian shipping by every canon of international law, maritime practice, and the Imperial Shipping Convention. But at present it carries hardly 20 per cent of the cargo and 8 per cent of the passenger traffic. The total Indian tonnage employed in the Indian coastal shipping is only 23 per cent of the total tonnage plying on the coast.

The principle of reservation of coastal traffic for national vessels has been accepted by all the important maritime countries of the world. That coasting trade is the nursery for national shipping has received authoritative confirmation in the Convention of the International Regime of Maritime

Ports of 1923, which acknowledged that the coastal trade of a country is its domestic preserve in which foreigners may be admitted as a matter of grace but never as a matter of right. According to an enquiry conducted by the League of Nations, 27 out of 33 maritime countries have reserved their coastal trade to their own national vessels. Even within the British Commonwealth, the Report of the Conference on the operation of Dominion Legislation of 1929-30 accepted this principle but although India participated in this Conference, its name was definitely and deliberately excluded from the scope of the Report. The Statute of Westminster has given full maritime autonomy to the Dominions which are entitled to regulate their own coastal trade and control their own shipping. Even British shipping which is the most powerful in the world has been demanding and has obtained assistance from the Government and even very recently, a proposal of the British Chamber of Shipping was published, recommending the grant of a subsidy of half a million sterling in five years to coasting tramps as well as a subsidy to coastal liners.

In the overseas trade of India, while the share of British shipping is 64.2%, foreign shipping is only 34.55% and Indian shipping has the negligible proportion of 1.25%. The importance of ensuring a place for national shipping in trade agreements and commercial treaties between two countries is now recognised, as evinced by the example of the Anglo-Soviet Trade Agreement, wherein it was provided that the timber imported by the United Kingdom from Russia should be sent in British ships. In India, however, when the Indo-Japanese trade negotiations were in progress it was British shipping which demanded that advantage should be taken of those negotiations to increase the share of British shipping in the Indo-Japanese maritime trade on the basis of India's bargaining power. But this demand was so preposterous that even the present Government of India turned down this proposal of British shipping on the ground that the Empire or British shipping for which preference was claimed did not include Indian shipping. The Commerce Member of the Government of India also acknowledged in reply to an interpellation in the Central Legislature in September 1937 that India's bargaining power should be utilised in Indian interests. If India's bargaining power based on

INDIAN SHIPPING

India's market can be utilised in Trade Agreements concluded with other countries, it could be and should be done only for the promotion and development of Indian shipping. This is a demand which has been put forward by Indian shipping during trade negotiations and also before the Imperial Shipping Committee. Shipping should be recognised as an integral part of national economy. The shipping freight from India constitutes an important item in the country's balance of payment and in its total indebtedness. Earnings from national shipping in foreign trade would constitute an important item in the invisible exports of India and serve to redress the adverse balance of trade.

Empire maritime policy under which preferential treatment is given to British shipping in the matter of carriage of stores and booking of passages by the Government has no meaning and significance for India because India has practically no share in its overseas trade and because this so-called "Empire" shipping which is really British shipping has hitherto thwarted and hampered the development of Indian shipping even in its home waters and has prevented its entry into the overseas trade of the country. If Britain wants that all parts of the Commonwealth should have proper communications and that the Commonwealth should have a mercantile marine commensurate with its size and economic interests, it cannot merely ask other parts of the Empire to contribute towards the growth of British shipping alone.

The importance of a national mercantile marine in a scheme of national defence cannot be exaggerated in the present delicate and tense international situation. The mercantile marine is a training ground and a second line of defence for an Indian navy. As stated by the Commander-in-Chief in the

Council of State last year it is not possible to have a navy without a mercantile marine which is still in its infancy. One *Emden* rendered unsafe the whole of the Bay of Bengal and created panic on the coast and at the ports. Despite the development of air-craft, the influence of sea power has not yet passed away. The decline in the importance of large battleships does not claim a decline in the art of naval strategy. The need is for redistribution of defence expenditure as between land, sea and air. The national mercantile marine is indispensable for the development of an Indian naval force and fleet.

The difficulties and impediments in the way of the development of national shipping in India are numerous and serious. The commercial safeguards in the New Constitution render impossible the adoption of any effective measures for the promotion or protection of Indian national shipping which has to gain its position inch by inch from vested British interests. While in other countries national shipping is considered as an instrument of national policy, in India Indian shipping in its own waters has to depend for meagre favour and mercy from its powerful competitors, while the Government of the country watch the situation with indifference. The neglectful manner in which the British shipping line treated the Agreement arrived at by the Commerce Member in the matter of *Haj* traffic shows the sentiments which inspire them not only towards Indian interests but also towards authorities in this country. Indian shipping has struggled and is struggling against powerful forces as an element in the national regeneration of the country and hopes to achieve its aims through its own efforts and through the goodwill, support and sanction of the public opinion in the country.

Gaganvihari Mehta.

Planned Economy for Provinces*

Sir M. Visvesvaraya

Introductory

THE object of this note is to urge that the provinces should be induced to take stock of their more keenly felt deficiencies and needs and begin studying the resources at their disposal to remedy or meet them. At a time of public awakening like this, no time should be lost in bringing into existence the requisite organisation in every part of the country to devise practical ameliorative measures and put the nation to work. There is not enough money in the country to carry out even a small fraction of the urgent schemes that will be pressed upon our attention, and comprehensive plans though prepared after great labour cannot be fully utilised for a long time to come. Comprehensive investigation into the country's material wants and resources may go on and should go on. That work will be continuous and must be transferred eventually to a special Department of Government. Individual urgent matters like those recorded by the Delhi Conference of the Ministers of Industries should be given precedence and such measures should be considered separately from the comprehensive plan or scheme contemplated in the questionnaire issued by the National Planning Committee.

The public want to start doing something, they are hungry for work and they should not be left in an unsettled state of mind for lack of appropriate guidance. Attention of the masses should be directed to their real needs and an endeavour made in each local area to drill, discipline and put the people to work. Our first aim should be to induce the Provincial Governments to consider and

decide what wants within their areas are most pressing, what developments they would wish to see attempted and within what time, what organisations and funds are needed for the purpose and how they might be provided. In preparing a scheme of economic betterment, our safest course is to follow, with due consideration to our resources, the paths indicated for us by the experience of progressive countries outside India. With our slender resources we cannot afford to strike out new paths. In the present circumstances it is even risky to attempt new lines of advance.

In preparing statistical information and Tables we should strike to bring our work into line with international forms and standards as far as possible.

What is Planning

To plan for a given area and population in the present case is to catalogue their deficiencies and wants, to decide from the experience gathered from advanced countries what remedies and improvements should be attempted, in what manner, within what time and at what cost; and compile estimates and schedules giving a picture of the advance to be attempted.

Planning is usually and primarily for providing material wants, for economic activities and betterment. Planning for other spheres of development—social, cultural, etc.—may be attempted by bringing parallel organisations into existence separately where necessary but should not be mixed up with the movements and measures devised for economic development.

A schedule will give the developments and estimates contemplated in figures; and a plan, a detailed explanation and description of the measures

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contemplated. Table I is a copy of a schedule of this kind prepared in 1934.

TABLE I

Schedule of Developments for a Ten-Year Plan

The following table gives a provisional list of the principal developments proposed, under an All-India Plan, in the year 1934.

No.	Item	Unit	From	To
1.	National Income (Yearly)	Rs. crores	2,500	5,000
2.	Yearly production from industries—approximate net value	..	400	2,000
3.	Indigenous capital investments in large scale industries	..	300	1,000
4.	Iron and steel	Tons	1,600,000	3,000,000
5.	Coal mined	..	24,000,000	40,000,000
6.	Cotton mill industry— Spindles Looms	Number	9,500,000 200,000	12,000,000 300,000
7.	Automobiles—to be manufactured per annum	..	..	20,000
8.	Yearly production from agriculture—approximate net value	Rs. crores	2,000	2,500
9.	Increase of cultivated area (British India only)— (a) Dry crop area (b) Irrigated area	Million acres	212 49.7	250 60
10.	Roads	Miles	253,125	500,000
11.	Railways	..	42,750	55,000
12.	Electric power plant capacity	kW	1,000,000	2,200,000
	Electrical energy produced	Million kW hrs.	1,800	4,000
13.	Shipping	Tons	271,820	1,000,000
14.	Population supported by agriculture	Million	250	200
15.	Population employed in organised industries	Number	1,500,000	10,000,000
	Population employed in all industries	..	15,361,000	50,000,000
	Population supported in all classes of industries	..	35,300,000	85,000,000
16.	Scholars in Universities	..	92,000	200,000
17.	Mass literacy	Percentage of total population	8	50
18.	Population under instruction	..	4.67	15

Plan and its Operation

There will be four distinct spheres or areas of operation for a national plan, namely: (1) All India, (2) Province, (3) District, and (4) Village group or self-governing unit. The operation of a plan will be different in scope or scale in each of these four spheres and each sphere should have a distinctive plan of its own. The general plan for all-India is made up of provincial plans; and each provincial plan will be the sum total of the district plans; and each district plan represents the total developments contemplated in all the village plans of the district. A plan of development—a Five-Year Plan—may be prepared for each of the four spheres mentioned. The period usually chosen for a working programme is five years. There is no reason why *four* or *six* years should not be chosen for the purpose but *five* years seems a convenient period and it has been frequently adopted in foreign countries in the past.

There is enough material for preparing an initial plan for (i) All India, and for (ii) Provinces. Rough plans can be prepared from the material available for immediate action and they could be perfected as the investigation proceeds. But for districts and village groups, there are no statistics available except under population and cultivated area. Plans for these have to be prepared after local survey or investigation. I have suggested elsewhere a District Development Scheme* which any Province can attempt at once if it chose.

Every province can provide at once, if it likes, sufficient capable staff, resources and funds to work out a comprehensive Development Scheme at least for one district within its area. If several provinces do the same, it will facilitate comparison of the various methods, measures and achievements pursued, to their mutual advantage. Each plan should define the region to which it applies and its area and population. It should specify the conditions at the beginning of the period for which the plan is prepared, the improved conditions which it is its purpose to achieve and the time or interval within which the expected improvement or change is to take place.

* DISTRICT DEVELOPMENT SCHEME—by Sir M. Visvesvaraya, published from the Bangalore Press, Bangalore. Noticed in the Book-Review columns of SCIENCE AND CULTURE, June, 1939.

* A note submitted before the National Planning Committee and published with the kind permission of the Chairman.

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A plan for each official year should be prepared separately in consonance with the Five-Year Plan for executive measures, in each of the four spheres mentioned. This yearly plan has to be approved before the beginning of the official year by an Economic Council or Board, and sanctioned by a duly constituted higher authority.

Main Heads of Development

The more essential and urgent wants of the country may be considered under three heads as follows:

(A) In the initial stages, we are chiefly concerned with developments connected with production, income and economic betterment generally. The following four heads of development are fundamental and should figure prominently in any plan for a sphere:

(a) Education, (b) Industries, (c) Agriculture, and (d) Defence. Intense activity should be stimulated in the rural population to achieve substantial results in as short a time as possible in these four occupations and professions. Reviews of progress backed by actual figures of measurement should be published or recorded regularly once a year and where possible as often as once a quarter. A spirit of emulation should be encouraged in rural tracts to achieve rapid results.

(B) The following specific results under the same main heads should be steadily kept in view:

- (i) Raising the standard of living of the poorer classes, the masses of the population;
- (ii) Pursuit of industries, besides *Khaddar*, which supply the cardinal necessities of the rural population (Vide Appendix ii);
- (iii) An efficient industrial organisation to develop new occupations and new units of work.
- (iv) Transfer to other occupations of one half of the population now solely dependent on agriculture;
- (v) Increasing population dependent on industries from 10 to 30 per cent;

(vi) Increasing production of steel, steel products, machine tools and agricultural and manufacturing machinery.

(C) Other economic activities and results which are criteria for prosperity are:

- (i) Size of population, state of its education and capacity for initiative and enterprise;
- (ii) Income and wealth;
- (iii) Production under industries and agriculture;
- (iv) Heavy industries—their number and variety and capital invested in them;
- (v) Iron, steel coal and machinery—quantities and value of yearly products;
- (vi) Cotton mills—number of looms and spindles and value of products;
- (vii) Exports and imports—character and value;
- (viii) Bank resources and deposits;
- (ix) Railways, public utilities;
- (x) Shipping employed in trade;
- (xi) Electric power plant capacity.

Progress under the three classes of developments be gauged at suitable intervals by statistics maintained for the purpose. The schedules which accompany the plans should give figures which should show the existing state of advance and the progress which it is proposed to achieve under the plan in a given period, either one year or five years.

Industries in Three Classes

It should be strongly impressed on the mind of the Indian public, both urban and rural, that their speediest course to achieve a higher standard of living lies through increase of production, chiefly production in *industries*. Without industries the country cannot enjoy a balanced economic life. The tendency in Western countries has long been to give increasing importance to industries. Regarding Canada, a country with vast agricultural potentialities, Mr. Thomas Bradshaw, President of the Toronto General Trusts Corporation, writing in a recent (April 1939) issue of "*Industrial Canada*" says:

"There is growing evidence that Canada is entering a new era in its national development. Where formerly agri-

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culture was our leading industry, today the total value of our mining production and of our manufactures taken together is more than double that of our agricultural products. This increasing diversification has enabled us to conserve our national wealth and to find new sources of employment for our population. As we continue to round out our economic structure, it should become less vulnerable to outside influences."

The Dominion of Canada has a population of only 3 per cent of that of India. But how many people in this country are aware that in point of volume and value of production from industries and foreign trade, Canada is already ahead of India? The lesson to us is that there is wealth awaiting this country if industries are systematically and vigorously encouraged.

The proper way to deal with industries under Indian conditions is to consider them under three classes, namely, (a) Large-scale, (b) Medium-scale, and (c) Minor and cottage.

The *large-scale industries* that have yet to be introduced into India are not more than a dozen and all these may be established *within a year or two*, if each provincial government agrees to take up one or two of them according to its aptitude and resources. To have key industries started in this way would be a great gain to the country and it can be done with so little effort and sacrifice. This seems a simple matter and although time is being lost, it is found difficult to bring about a proper understanding in this respect between the leaders and the governments concerned.

The money and reorganisation should ordinarily come from the public but government should be behind the ventures to make sure of their satisfactory growth. Where private initiative fails, Government should find the capital also.

The industries which chiefly fall under this category are:

1. Mining—Coal, metallic ores (manganese, aluminium, lead, zinc, chromium), and petroleum.
2. Iron and steel.
3. Engineering Industries—Manufacture of oil engines, Diesel engines, pumps, etc.
4. Machinery, mill machinery, heavy presses, excavators, agricultural machinery and tools.

5. Railway plant, locomotives and rolling stock.
6. Automobiles and aircrafts.
7. Arms, ammunition and military stores.
8. Electrical industries including hydro-electric machinery.
9. Ship and boat building.
10. Textiles—Cotton, wool, silk and jute.
11. Artificial silk.
12. Chemical Industries.
13. Sugar.
14. Paper.
15. Cement and glassware.
16. Fertilizers.
17. Film industry.
18. Radio.
19. Leather and rubber.
20. Telegraph and telephone.

This *medium-scale industries* should be left as at present to the leading merchants and businessmen to promote. Provincial Governments should give encouragement by subsidies and subventions, by guaranteeing interest to shareholders and in other ways.

The encouragement of *minor and cottage industries* is the most important duty of the State and requires very special attention. This class of industries has not had a fair chance in the past. Several agencies and organisations have been set up but there is no reasoned scheme or co-ordinated effort among all the agencies engaged in the work. Government officials and the public should work in the closest association; and capital, technical advice, and help in organisation should be freely made available to the rural population.

Progress should be watched by frequent collective stocktaking. Such checks are altogether lacking now. This is one grave omission which should be speedily remedied. The public should be able to compare at any time present-day results with achievements in advanced countries as well as with those in past years in our own country.

Development Campaign

The character of development in the four spheres will be similar but, as explained already, the work to be done will vary in scale or standard according to the area, size and capacity of the population affected. The root of all progress is the daily output of work of individual rural families, rural labourers, wage earners, salaried officials, technicians and others engaged in agriculture, indus-

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tries and allied occupations. If production under agriculture and industries increase, other occupations such as trade and transport will also multiply, and employment and income will grow to a corresponding extent.

The reason why people in advanced countries enjoy a higher income is that they use their energy and time in the most profitable pursuits. They work harder, more systematically and under better organisation and discipline, and produce, by all these means, goods and services of vastly higher value than we in this country are able to do. If the people here also work similarly, if they increase their hours of labour, improve their skill, workmanship, organisation, discipline and teamwork, this country too will be able to produce goods and services of far higher value than it is capable of doing at present. Such wholesome habits and practices will automatically lead to a higher standard of living. Unfortunately the reforms and habits wanted in those directions are not receiving sufficient public attention.

As the population in India is growing and no authoritative statistics of its income are available, it is necessary to carry out a production and occupation survey as speedily as possible and obtain a record of the distribution of population and estimates of income in the more important occupations. The results of such a survey and the estimates so obtained will provide a valuable guide to a balanced redistribution of population tending to the relief of unemployment. In the beginning the services of local public-spirited workers, philanthropists and economists may have to be availed of to obtain the estimates needed without heavy expense.

At present a poor family of five persons in a district may be said to be earning about Rs. 12 per month on an average. The great bulk of families fall under this category. By making the people work for longer time and in more profitable occupations, this income could and should be doubled, that is, increased as early as possible at least to Rs. 25. The monthly income of a family of five, taking the average for both rich and poor in a district, at present, may be put down at about Rs. 25. An endeavour should be made to increase

this average also to about Rs. 40 or 50 as early as possible. These figures are the most reasonable that could be suggested, in order to fix attention on the changes to be brought about. They are given here in the absence of any more authoritative data.

If the people of a community are able to choose more profitable employments than they have now and work on it on more efficient lines and for longer hours, the goods and services which they will be able to produce will be larger and the resulting income and standard of living necessarily higher. It is mainly by resort to industries and other profitable occupations that this improvement can be effected. If, in addition to this, self-government and self-help are encouraged as is done in a country like Japan, there will be more initiative in the rural population, and very soon an agricultural district will be able to provide itself with nearly all the necessities of life by its own effort.

Main Lines of Advance Summarised

Of the proposals outlined in the preceding sections of this paper, the following items are fundamental for securing rapid economic advance. Details pertaining to these particular heads would have to be compiled and included, along with others, in the schedules of the Five-Year Plan:

- (1) Establishment of heavy industries, specially those relating to the manufacture of machinery and heavy chemicals.
- Extensive spread of smallscale and cottage industries,
- (2) Providing adequate tariff protection for both heavy and cottage industries,
- (3) Increasing production under agriculture,
- (4) Providing banking and credit facilities,
- (5) Rapid extension of literacy,
- (6) Establishing real self-government in villages,
- (7) Introducing a District Development Scheme as outlined.

The following is a summary of the principal conclusions and recommendations:

(i) Economic Planning is a means to an end. The end is to secure a rise in material prosperity and standard of living.

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A plan for a province will be part of the larger plan for India as a whole. A Five-Year Plan is now suggested both for Federal India and for the provinces.

(ii) Economic planning is part of a larger development, namely, "Planning for Reconstruction and Nation Building."

With the change in political status in the provinces, reconstruction on a planned basis in all three spheres—political, economic and social—becomes a necessity and this will be tantamount to nation building.

(iii) The organisation best calculated to promote the proposed developments in a province will include (a) A Five-Year Plan, (b) A Development Department, (c) A Provincial Economic Council and (d) A Separate Development Budget.

It is not considered safe for any country to regulate its economic affairs in these days without a coherently designed policy and a deliberate plan. Until a proper Federal Plan is evolved and introduced, each province should provide itself with a separate Five-Year Plan of its own and the co-ordination of provincial Plans may be secured, as far as possible by organising periodical conference between the official representative of the several provinces.

The development work under the plan should be kept separate from the ordinary administrative routine of the provinces. So also the Development Budget should be kept distinct from the regular civil budget of the province.

(iv) The Five-Year Plan should give a schedule showing the growth or increase expected in the five-year interval, in income, production, trade, banking, and other occupations and activities within the province as previously indicated.

(v) The main result expected from these improvements is a rise in the standard of living. In the present case, a rise of at least 100 per cent should be attempted within five or seven years. It should be attempted within five or seven years. It would, of course, be more if the Central Government were also autonomous. This large increase in production, income, etc., will be possible only in the early stages of planning. As the resources become used up, the increase will necessarily be at a pro-

gressively diminishing rate. But such diminution can be counteracted by increased technical skill, energy and enterprise on the part of the community.

(vi) In order that small scale and cottage industries may be successfully established, local self-government in villages must become a reality. There should be no hesitation to grant self-government to village populations to the same extent that Japan has done. Rightly directed, the concession would help to stimulate creative power, aspiration and ambition among our rural communities.

To raise the standard of living of the masses, the *District Development Scheme* outlined by the present writer will be found efficacious. That or some other parallel scheme should therefore be speedily brought into operation. This may be done without appreciably interfering with the existing administrative machinery.

(vii) Nation building will be a slow process at first but it is bound to grow as the country gets fuller control of money power, manufacturing power and power of defence. The banks are the mainstay for all growth.

(viii) A beginning in planning may be made in each Province at once by the establishment of a *Development Department* under the supervision of a Minister with a competent secretary and a staff of three or more experts. An Economic Council of local men of experience and influence, financiers, economists and experts should be associated with the Department.

(ix) The Development Department should be able to start surveys and investigations and prepare a provisional Five-Year Plan as well as a plan for action in the first year. The preparation of these two plans by the department under the advice of the Economic Council, or a special Committee appointed for the purpose, should not take more than three or four months at the outside.

(x) The resources of each province in men, material and equipment should be fully mobilised to serve these ends. The services of university and college professors, retired officials, economists, financiers, engineers, chemists and other experts, wherever available in the country, should be freely utilised by constituting commissions, committees, informal 'brain trusts' and the like. The men should be adequately rewarded for their services.

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The population in every part of the country should be put to work and induced by suitable propaganda to respond cheerfully to the call made on them to raise their income and standard of living.

(xi) The huge waste of effort that is going on will be prevented, if the Government also awakens the general public of the fact that in present-day economy, agriculture, though a necessary occupation, plays a less important part than industries. In advanced England, agriculture, though protected and subsidised, is regarded as on the whole unprofitable.

(xii) This is a machine age. It is power machinery that moves heavy railway trains, immense sailing ships, military and naval armaments, automobiles, aeroplanes, mills, pumping engines and a host of other instruments of mechanical production and propulsion. The condition of the country will remain low and primitive until the deficiencies in mechanical equipment and use of machinery are speedily made good.

Conclusion—Recommendations

The preceding gives a general summary of the lines of advance recommended by me for several years past. But as Provincial Governments have power now to some extent to alter policies, the action to be taken at the present time should be more direct and specific. The preparation of a well-balanced national reconstruction scheme will take time and when a comprehensive scheme is ready, it will only be of value to place ideals before the public. Due to paucity of resources, it will not be possible to give effect even to a fraction of the proposals that may be put forward. At commencement, such resources as there are have to be used thriftily for the most urgent needs and in the interests of the poorest classes of the population. The development of a comprehensive scheme should not stand in the way of starting activities in each province on an organised plan to enable its population to work for its more essential and urgent needs. This class of needs should be singled out and placed in the forefront of the programme. The beginning of planned development should not be delayed. With an early beginning for instance, a village or a district may

be able to show increase in its school-going or literate population, at the end of the first year of operation of the plan. It may show an increase of, say, 5 per cent in agricultural produce and 10 per cent in manufactured products. If at the end of the first year the people of an area are taught to think in terms of improvement in this way, a welcome change will have taken place to methods of proved efficacy common in Western countries and Japan and a notable beginning will have been made in planned development.

There is appended to this note a list of statistical tables exhibiting figures which are necessary to give the average citizen a convincing view of his phenomenally low position in the economic life of the world. Early arrangements to spread such information by propaganda will be of no small value to the country's progress.

What is urgently needed is the preparation of a plan for each province to put the people to work. With the co-operation of the highest officials and prominent businessmen in each province, a working plan which would be serviceable for the first year can be prepared in the course of three or four months.

The schedules attached to the plan should provide for the most urgent and important needs and developments, such as, finding new occupations, extending old ones, creating new units of work, finding work for the unemployed; and all this to enable the population to produce more food, more goods and services in the area.

A Five-Year Plan so prepared will not be final. As information and data accumulate it may undergo revision at the end of each year. And it must undergo a thorough revision at the end of the fifth year.

Excluding the Federal sphere, there will be three regions for development purposes under the control of each Provincial Government, namely, village group, district and the province as a whole. Each of these spheres will have to be equipped with a Development Officer and staff, an Economic Council or Board, a budget and a plan. The plan with its schedules will prescribe the work to be done and specifically indicate items of work, rate of progress, rules of operation, etc., for the first year and make provision for the necessary equipment and funds.

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Plans should be lucid and complete, so as to enable the Provincial Governments and popular leaders who accept them to organise measures instantly and put the people to work. If the Government and the people act in harmony on a well-understood plan about which both are enthusiastic, the whole area coming under the plan can be made to hum with gainful activities and business fervour. An intense economic drive like this cannot fail to promote industry and discipline in the population increase its output of work and secure a rapid rise in the standard of living generally.

Appendix I

INCOME FROM INDUSTRIES AND AGRICULTURE

The following table indicates in a rough way the average per capita income from industries and agriculture, respectively, of six of the most progressive countries of the world as compared with India. The figures were compiled before 1934.

Country	ANNUAL INCOME		
	From Industries	From Agriculture	Total
	Rs.	Rs.	Rs.
United States of America ..	830	219	1,049
Canada ..	544	307	851
United Kingdom ..	463	68	531
Germany ..	289	111	400
Sweden ..	384	129	513
Japan ..	167	67	234
India ..	12	59	71

Appendix II

SUBSISTENCE INDUSTRIES

The following are a few typical industries and commodities needed to provide the cardinal necessities of life to the rural population:—

1. Food.—

1. Dairy products
2. Manufacture of jaggery and sugar
3. Flour milling
4. Rice milling
5. Oil mills
6. Food products, fruit canning, ice and aerated waters
7. Fruit growing
8. Cultivation of vegetables
9. Fodder crops
10. Bee-keeping
11. Cattle and sheep breeding
12. Poultry farming

13. Salt manufacture
14. Coffee and tea works
15. Manufacture of agricultural implements

II. Clothing.—

1. Cotton and wollen mills
2. Artificial silk
3. Hand-spinning and weaving
4. Linen
5. Rayon
6. Cotton gins and presses
7. Rubber and rubber products
8. Leather products
9. Shoe making
10. Manufacture of soaps
11. Tailoring
12. Dress making
13. Sericulture
14. Hosiery
15. Blanket and carpet making
16. Laundries
17. Manufacture of buttons
18. Manufacture of brushes
19. Manufacture dyes and colours
20. Ornaments and Jewellery

III. Housing and Furniture:—

1. Iron foundries
2. Vessels of iron or steel
3. Metal works
4. Match manufacture
5. Tiles and bricks
6. Pottery
7. Ceramic industries, including cement, glass, stoneware, pipes, etc.
8. Cutlery and hardware
9. Enamelled ware
10. Candles
11. Domestic fittings
12. Wood work
13. Paints and varnishes
14. House-building on modern lines
15. Furniture of many varieties
16. Hotels, clubs and boarding houses—for travelling public

IV. Education:—

1. Block making
2. Book binding
3. Carbon paper making
4. Erasers
5. Engraving
6. Fountain pen making
7. Inks
8. Ink pads for rubber stamps, etc.
9. Newspaper industry
10. Paper and pulp industry
11. Pens and penholders—nibs
12. Pencil making
13. Pencil sharpeners

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14. Penknives
15. Printing industry
16. Scissors
17. Slates and slate pencils
18. Stamp making—rubber and metal
19. Text books
20. Typewriter ribbons

V. Health and Primary Recreation.—

1. Articles used in games and sports
2. Medical and surgical instruments
3. Photographic material manufacture
4. Soap industries
5. Toilet requisites—Razors, tooth powder and paste, hair, oils, etc.
6. Toy manufacture
7. Musical instruments

APPENDIX III

The World's Daily Output of Work (Millions of Horse-Power Hours).*
 For the Year 1929.

Country	Human	Coal	Petroleum	Water	Total	Population (Mill.)	Daily output per capita HP—HR
1. INDIA	106	34	8	3	151	318.88	0.47
2. U. S. A.	40	1001 (a)	481	121	1643	122.77	13.38
3. Canada	3.3	55	17.6	59	134.9	10.35	13.03
4. Gr. Britain ..	15	270	28.3	4	317.3	47.71	6.65
5. Germany	21	333	9.5	13	376.5	62.34	6.04
6. France	14	127	12.3	24	177.3	40.74	4.35
7. Japan	21	52	7	30	110	62.94	1.75
8. Norway	0.9	3.6	0.6	15	20.1	2.65	7.58
9. Belgium	3	50	1.7	..	54.7	7.99	6.85
10. Sweden	2	7.5	1.9	16	27.4	6.12	4.48
11. Switzerland ..	1.3	3.9	1	11.5	17.7	4.02	4.41
12. Czechoslovakia ..	5	42	1.8	1.5	50.3	14.52	3.46
13. Australia	2.1	10	10	(b)	22.1	6.43	3.44
14. Austria	2.2	12	0.9	6	21.1	6.67	3.16
15. South Africa ..	2.3	16	1.8	(b)	59.7	30.84	1.94
16. Holland	2.5	16	3.1	..	21.6	7.62	2.83
17. Poland	10	48 (a)	1.7	(b)	59.7	30.84	1.94
18. Chile	1.5	2.0	3.8	1	8.3	4.36	1.90
19. Argentina	3.6	4.5	10	0.35	18.48	10.90	1.69
20. Italy	14	23	4.6	27	68.6	41.17	1.67
21. Spain	7.6	13	1.8	8	30.4	22.75	1.34
22. Mexico	5.5	1.5	9.5	4	20.5	16.40	1.25
23. Hungary	2.8	6	0.8	(b)	9.6	8.60	1.12
24. Roumania	6	4.1	6.8	0.8	17.7	17.39	1.02
25. Russia	53	56	35	4	148	158.50	0.93
26. Bulgaria	2.0	2.4	0.3	0.5	5.2	5.60	0.93
27. Yugoslavia	4.4	4.2	0.5	2.0	11.1	13.29	0.84
28. Peru	1.8	0.4	0.9	0.5	3.6	5.50	0.66
29. Brazil	13	3.4	3.0	6	25.4	40.27	0.63
30. China	133	43	4.13	(b)	180.13	400.80	0.45
TOTAL	475.8	2244.5	669.33	358.15	3747.78	1513.87	2.475

(a) Includes natural gas. (b) Too small to be of importance. Hence quantities omitted.

* From "The World's Output of Work" by Thomas T. Reed—an article in *The American Economic Review* of March, 1933. Page 58.

NOTE—In order of importance India stands last but one, taking precedence only over China.

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APPENDIX IV.

DISTRIBUTION OF POPULATION ACCORDING TO OCCUPATIONS IN FOURTEEN COUNTRIES IN 1920 and 1930 (or adjacent years)*

Extracts from *THE WORLD'S ECONOMIC FUTURE* By A. Loveday, J. B. Condliffe, B. Ohlin, E. P. Heckscher, and S. DeMadariaga—Halley Stewart lectures, 1937. (George Allen & Unwin Ltd., London.) Pages 100-101

Countries	Year	I Agriculture, Fishing, Forestry	II Industry, Handicrafts, Mining	III Commerce, Shipping, Transport, generally	IV Public Services, Free Pro- fessions	V House-hold Work & Various	Total
Sweden	1920	40.7	31.0	14.3	5.6	8.4	103.0
.. ..	1930	35.6	31.7	17.5	6.3	8.9	100.0
Finland	1920	68.9	12.8	6.0	2.9	9.4	100.0
.. ..	1930	63.4	14.4	7.4	3.6	11.2	100.0
Norway	1920	36.8	29.0	19.7	5.1	9.4	100.0
.. ..	1930	35.3	26.5	21.8	5.7	10.7	100.0
England and Wales ..	1921	6.8	47.3	24.5	10.4	11.0	100.0
.. ..	1931	5.6	46.2	26.9	10.9	10.4	100.0
Scotland	1921	9.5	49.4	22.9	9.0	9.2	100.0
.. ..	1931	8.9	45.1	26.6	10.2	9.2	100.0
France	1921	41.5	29.9	16.6	8.1	3.9	100.0
.. ..	1926	38.3	33.2	17.1	7.4	4.0	100.0
Italy	1921	55.7	24.3	16.3	6.1	3.6	100.0
.. ..	1931	47.3	29.5	12.9	6.3	4.0	100.0
Holland	1920	23.6	37.4	21.3	8.2	9.5	100.0
.. ..	1930	20.6	38.1	23.4	8.6	9.3	100.0
Switzerland	1920	25.8	44.2	16.7	7.1	6.3	100.0
.. ..	1930	21.3	45.0	19.0	7.5	7.3	100.0
Germany	1925	30.5	42.0	16.4	6.6	4.4	100.0
.. ..	1933	28.9	40.4	18.4	8.4	3.9	100.0
Czechoslovakia	1921	33.7	40.5	10.9	7.9	7.0	100.0
.. ..	1930	28.3	42.2	13.6	8.5	7.4	100.0
United States	1920	28.3	33.4	18.3	6.9	15.1	100.0
.. ..	1930	22.0	30.9	21.1	8.5	17.5	100.0
Canada	1921	35.0	25.4	20.0	9.0	10.6	100.0
.. ..	1931	31.2	26.6	23.4	9.1	9.7	100.0
Japan	1920	53.8	21.0	15.5	5.4	4.3	100.0
.. ..	1930	50.4	18.9	19.1	6.9	4.7	100.0
INDIA	1921	71.8	11.4	7.2	2.6	7.0	100.0
(a)	1931	67.2	10.2	6.7	2.6	13.3	100.0
Average (Circum) ..	1920	35.1	33.2	16.8	7.1	7.8	100.0
.. ..	1930	31.3	33.1	18.4	8.3	8.9	100.0

* From *Statistical Year Book of the League of Nations*.—In the 1935 issue a somewhat detailed discussion of the character of the figures for different countries is to be found. Unless considerations of comparability have led to another treatment, figures refer to trades rather than to occupations proper. As the absolute percentages for different countries are very frequently not comparable, only their changes within each country should be taken into account.

(a) Source: *Statesman's Year Book*, 1938—page 114.

Transfer of Training

S. M. Mohsin

Psychological Laboratory, Patna College.

TRANSFER of training means the influence of training in a given habit on the formation of subsequent habits. It is the problem of determining to what extent learning one thing carries over to more or less related problems. The entire theory of educational procedure rests upon the assumption of a wide transferability of habits and training. It is supposed that to promote the development and growth of the mind, it must be set to difficult tasks assuming that the more difficult the task the greater the disciplinary value. It is also assumed that if an individual is proficient in a certain function in a given situation, he will be equally proficient in others and that proficiency in many fields of subject matter ensures proficiency in a particular sphere. It has been interesting to enquire, therefore, as to how far this assumption of educational theory holds in practice. The question has been asked: 'Does learning to drive an automobile of a given make help or hinder when we try to learn one of a different make? Will a child who is trained to be neat in his dress carry over this particular habit of neatness to his penmanship and his note taking? Does training in algebraic reasoning improve one's ability to reason out legal, ethical and literary problems? Does training our memory for dates and the arithmetical table improve our memory for faces, daily appointments, chemical formulae? A host of experimental materials have accumulated in answer to the above questions and they show that the amount of transfer is not only very limited, but often it is either completely absent or negatively present.

The early method of studying transfer of training was to test an individual or a group in a certain function, train in another, and then re-test in the first function in order to determine the improvement made in it as a result of training in the other. But later an improvement was effected in the experimental technique by the introduction of a control group. Since then two groups are included in the

study, both of which are measured in the first function, but only one receives the training in the other function, the gain made by the control group is compared with that made by the experimental group so that the influence of the specific training may be determined.

The learning of a given habit influences the efficiency of learning of a subsequent habit either in a positive direction or negative direction or not at all—hence positive or negative or zero transfer. Negative transfer is also termed in psychology as retroactive inhibition.

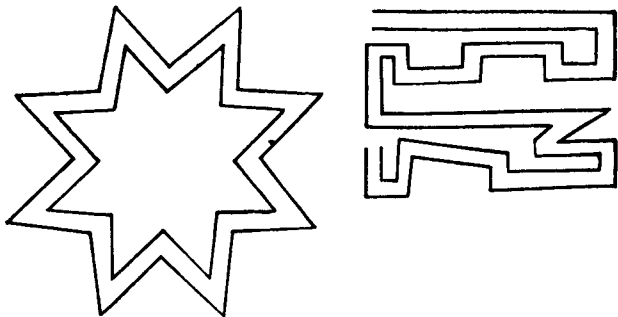
Experiments on transfer relate to transference in motor processes or to transference in mental processes. For studying transference in motor processes the most popular device is the mirror drawing for there we obtain an activity in which previous training is almost absent and the situation is practically novel. In a mirror drawing the subject is instructed to trace a drawing seen in mirror. Now, as the established pattern of eye-hand co-ordination involved in drawing a figure in normal vision is reversed when the figure is drawn as seen in a mirror, the subject experiences a good deal of difficulty at first till he builds up through practice a new co-ordination of eye and hand movements. The mirror-drawing experiment is used for testing two types of transfer: bilateral transfer or cross education and pattern transfer. In the one case the object of the experiment is to see how far training a certain group of muscles influences the subsequent training of a different group of muscles. Results of experiments have shown that practice with one part of the body in performing a skilled act increases the ability of the bilaterally symmetrical part in performing the same act. Practice with one hand transfers to the other, practice with one foot to the other foot, practice with one eye transfers to the other eye and so on. In the other type of experiment the amount of transfer from training in one motor skill to training in another is measured. Thus,

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it is shown as to what extent practice in drawing a certain pattern, *e.g.*, a maze or a combination of letters, seen in a mirror, influences the ability to draw stars in mirror vision. Results of experiments prove that the amount of transfer involved in motor skills is not as much as that in cross education.

The experiments on mental transfer include such mental functions as memorising, observing, discriminating, reasoning, problem solving, etc. The subjects are tested in the ability to memorise, for example, a particular type of material, say a list of nonsense syllables, before and after training period in memorising a different type of material, say meaningful sentences. The improvement on the ability to memorise the first material on practice over another material is thus measured. It has been found that the amount of transfer from one mental function to another is very small and hence it is concluded that specific training is more effective in this field than generalised training.

The problem in the study made by the writer was to measure positive transfer of training in: (i) cross education and (ii) pattern transfer. The apparatus used was the common mirror drawing device containing a mirror fixed vertically to the side of an wooden board. Patterns of drawing inscribed on a paper were fastened to the board. The board was concealed behind a screen so that the subject, while looking to the image of the drawing, could not see his hand or the drawing directly. He was required to trace the drawings as seen in the mirror. The following patterns of drawing (here reduced in size) were used.



The subjects, college adults, totalled 60 and were divided into four equal groups. All the groups

took the same preliminary and final tests in drawing stars using right hand. The initial measure consisted of the drawing of four stars and the final, the drawing of two stars. Group I was tested for cross education and underwent an intermediate practice in drawing eight stars with the left hand. Group II received direct training and had intermediate practice in drawing eight stars using right hand. Group III engaged in pattern transfer and made intermediate practice in drawing eight patterns of the second drawing. Group IV served as control group and made no intermediate practice and had instead a fifteen minute's rest in normal vision. The first four star drawings with the right hand measured the initial ability of the subjects before undergoing the training and the last two star drawings constituted the measure of final ability after transferred training.

The following table shows in seconds the mean time taken by each group in the different trials.

TABLE I

Trial	Initial Measure.				Intermediate Practice.								Final Measure.	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Group I	399	241	162	101	188	132	98	91	94	62	46	48	48	37
Group II	384	240	162	96	72	66	56	48	43	41	36	36	36	36
Group III	364	182	123	101	77	62	59	49	45	45	42	36	61	43
Group IV	395	194	136	86	..	..	..	..	..	..	..	..	74	51

In order to avoid errors due to the 'warming up' effect of the first four trials, the time of the fourth trial was taken as the measure of initial ability for each group. The time of the thirteenth trial is taken as the final measure.

TABLE II

Group No.	Initial Ability Speed on Trial 4.	Type of Intermediate Practice on Trial 5-12.	Final Measure Trial 13.	Amount of Improvement.
I	101 sec.	Cross education.	48 sec.	53 sec.
II	96 sec.	Direct training.	36 sec.	60 sec.
III	101 sec.	Pattern transfer.	61 sec.	40 sec.
IV	86 sec.	No practice.	74 sec.	12 sec.

Table II shows the effectiveness of the transfer in different situations. Group I illustrating cross education improved in average speed from 101 to 48 sec., or an improvement of 53 sec., as a result of

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intermediate practice with the left hand on the same pattern of movement, i.e., mirror star tracing. Group III illustrating pattern transfer improved to the extent of 40 sec. as a result of practice with the same hand on a different pattern of movement. Since direct training represents the theoretical maximum of improvement which can be made in the number of trials available, Group II is used as a standard by which we can estimate the relative effectiveness of the two types of transferred training. Now as the amount of improvement made by Group IV, the control group, from trial 4 to trial 13 is 12 sec., hence we have to subtract 12 sec. from the

amount of the improvement made by the other three groups as being due to direct learning from trial 4 in the same function.

Thus the amount of improvement made by Group I is 41 sec, Group II 48 sec, and Group III 228 sec.

In comparison with the improvement of 48 sec. by direct training, cross education saved 41 sec. and was, therefore, approximately $41/48$ or 85 P. C. as efficient, while pattern transfer was only $28/48$ or 58 P. C. The amount of transfer in case of pattern transfer would have been still less if the types of performance selected for the experiment had not involved as many identical movements.

Upsurges of Human Genius and Weather

Upsurges in human genius, such as occurred during the Golden Age in Greece in pre-Christian times and in the Renaissance in Europe, are linked with long-range changes in the weather by Dr Ellsworth Huntington, Yale geographer, in a theory presented to the Association of American Geographers.

During the two ages of brilliant human activity, among the cultural landmarks of all time, storms occurred with an increased frequency along the northern rim of the Mediterranean Sea. According to Dr Huntington's hypothesis, with the changes in climate the crops grew unusually well, and a

denser population could be comfortably supported. The storms also gave the climate an unusually healthful and stimulating quality. More than the usual number of parents were endowed with great physical vigor; hence from conception onward, their children also enjoyed unusually good health and vigor.

Only by some such hypothesis, he said, can be explained the fact, puzzling to historians, that the "solitary genius is a rarity," and that great geniuses are usually surrounded by people who almost rival them in ability.

—*Science Digest*

Education for the People

K. P. Chattopadhyay

Education Officer, Calcutta Corporation (on leave).

EVERY organism tries to adjust itself to its environment so that it may continue its existence and organisation. Human beings do not form an exception to this rule; only man has devised various ways and means to control and regulate the forces of nature, apart from changes in his own body. The experience gathered in each generation is passed on, by men, not through bodily changes but by traditional and formal teaching. Primitive man arranged for this education in various ways by initiation rites and subsequent training, by attaching adolescent boys as fags and apprentices to grown-up young men in their clubs; and also by a certain amount of teaching in the family group. Modern civilisation has continued most of these practices in education in some form or other—though often refined and masked out of recognition. A very great difference has however taken place owing to the extreme division of labour and the specialisation that is found in modern civilisation. An Australian council of mature men, for example, undertook duties which in advanced cultures are allotted separately to priests, judges, teachers and policemen.

At the very humble level of material culture at which the Australian tribes were living when discovered by the Europeans, it was possible for a single group of men to take upon themselves so many various kinds of duties. But the vast amount of knowledge and experience which has accumulated in most departments of life among people of advanced culture makes it impossible to discharge any of those duties satisfactorily without division of work and specialisation. Organisation on such lines has undoubtedly helped the growth of civilisation. New discoveries have been made as a result of specialisation and rendered effective through social co-operation. But owing to the innate tendency of man to acquire and to keep what he has acquired, there

has been a certain amount of cleavage of society, in all advanced cultures, into a small group of those who have the good things of life; and a much larger number of those who work for the first group. Education, in the sense of handing down tradition and experience has also taken forms and direction fitting in with this social and economic tendency. For education has always been directed by those in power.

Therefore, in formulating a scheme of national education it is necessary first of all to decide what kind of social and economic structure is to be aimed at as the end product of that work. This is defined in very broad outline by the pledge laid down for its members by the Indian National Congress. It shall be our duty to interpret this aim through our scheme of basic national education.

The ideal aimed at by the Indian National Congress is *Purna Swaraj*. It includes not merely political self-determination but social and economic freedom. The basic national education should therefore aim at securing as its end products, adolescents and adults whose mental outlook will impel them to work for freedom and whose mental equipment will enable them to lead a life compatible with such activities. Since the first requisites needed for any man to live and work is food and shelter, we have to consider in any scheme of national education how our students will live at the end of their schooling period.

A reference to the figures of the last census shows that nearly 44% of our people are classed as earners; the rest depend on them for their needs. Of the earners nearly 64% are engaged in agriculture, 2% in cattle and poultry raising, and 10% in crafts and industries. Among artisans and industrial workmen, a fourth work on textiles; nearly another fourth are engaged in dressmaking and allied work,

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and a little over one-tenth make their living by working on wood and bamboo. About five per cent of the earners are found in trade and commerce, while the professions followed by the middle-class—of the doctor, the lawyer the teacher and the clerk—furnish livelihood to barely 3% of the income earning public. Transport absorbs nearly 2% and domestic service 7% of wage earners. The remaining 7% are engaged in occupations which do not promote social welfare.

The figures noted clearly indicate that in a scheme of national education, provision must be made for equipping about two-thirds of the students to be agriculturists. Again grain trade absorbs half the business of our country; while work connected with textiles provide engagement to about half of our artisans and workmen. These facts have also to be considered and taken into account in framing our school syllabus.

It is not, however, sufficient to impart a training in methods of cultivation along with general education; nor will it do to hold a few classes in hand-work or business method. Historically, the systems of "cultural education" familiar to us grew up to develop the minds of children of the upper classes of the society. The boys of this social level had no need to learn crafts. They were destined to make their living in occupations where mental drilling was essential. Agriculture was a comparatively crude occupation; the artisan needed merely skill of hand and eye. Also the amount of labour needed for earning a livelihood in these humbler occupations was such that there was little leisure or energy left over for the peasant or worker to cultivate the mind. Modern science has however furnished us with knowledge which, if properly used, will lighten this labour to such an extent that the peasant and worker will also have leisure and energy to spare for more complex thought processes. Unfortunately our country, with its political, economic and social servitude has not so far been able to utilise the beneficent discoveries of modern science in this direction. Although in the provincial governments some power has come to the ministers, yet it is not sufficient to effect any such far reaching changes immediately. A beginning can, however, be made

with the resources that are available; and one of the steps that can be taken is to educate the mass of the people by starting a sufficient number of primary schools. This is being done in many of our provinces. It now remains to be decided what should be the syllabus of such primary schools. Clearly, the syllabus designed for education of a "cultural" type, in its elementary stage is not suitable for a boy who will live as a peasant or a craftsman. It is not suggested that the same kind of logical training of the mind is not suitable for prince or peasant. But it is an important matter whether the vehicle of this training will be a structure mainly composed of images linked with the life of the peasant and artisan, or of the upper social classes. Strictly speaking, the modern textbooks deal with images and subjects not specially biased towards any class. But education has for centuries been associated with the leisurely life of the upper classes. Hence it is necessary to give a positive bias away from this direction, in the imagery and ideology used in the lessons.

There is a more important reason for such a procedure. As I have noted before, the future peasant and artisan will compose 70% of our students. If they are taught agriculture and any craft, apart from general education, the two groups of subjects will remain in separate compartments. The student will not be able to take an intelligent interest in his vocational work. In other words, it will not have the same stimulating effect on his mind as pure cultural studies and will therefore be automatically evaluated as less valuable except of course for a livelihood. If however the cultural studies be not taken up apart from agriculture or the craft in question, but be approached through them, the position is changed. It is, therefore, desirable to centre our basic national education round a craft or crafts including agriculture. As regards the type of craft suitable, the answer is furnished by the census figures noted earlier. The most widely practised crafts after agriculture are those connected with dressmaking and wood and bamboo work. They should therefore come into our syllabus, next to agriculture. The problem now to be considered is that of teaching. How can we centre education as a whole round a craft in the primary stage? Obviously, we cannot teach a craft,

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in its advanced form, to a class of young children. Apart from their inability to handle tools before the age of ten or eleven, there are even more cogent reasons for not introducing such training earlier. Biologically this age may be said to mark the third and last period of rapid growth and subsequent filling in ending in the adult stage. Certain bones of the upper part of the human body and also of the lower part do not fuse until puberty. These bones are the shoulder blade and the hip bone. No boy or girl with these bones not yet fused in one piece should be put to strenuous muscular work. Intensive craft work can therefore begin only two or three years later. The simpler and less strenuous forms of the craft may, however, be taught earlier. Advantage should also be taken of an important change that takes place at this earlier period in the mind and behaviour of the child. It is the period when the child seeks to express itself through its social or group activities.

We may now proceed to a more detailed consideration and discuss how education may centre round agriculture which after all is the most important vocation in our country. As we know, children learn best by doing. Also, whenever any information is to be imparted, it should be from the familiar to the less familiar, and finally to the unknown. Children cannot of course cultivate land with the plough, nor can we stimulate their mind with technical details of ploughing. But a child will be extremely interested in the story of evolution of agriculture. We can begin with the stage when man lived by collecting fruits, roots and sundry animal food. Pictures may be shown of such primitive folk, choosing examples from India—such as the Kadirs of South India, or the jungle Veddahs of Ceylon and the Andamanese Negritos. Until recently they lived mainly on jungle produce. In order to make the lesson more impressive we can dramatise the stories and children can play at being members of these tribes. The teacher can show how a simple branch of a tree, broken off from a bigger limb has a natural sharp end and comes handy both in digging up roots and also in piercing game. The branch may be trimmed to make it a club, to hit game or to protect one's own self. A hunter's dance, a vegetable digging dance and

game, and similar play activities can easily be worked into the series of lessons. Geography can be associated with this stage, not as a formal lesson but through place names and the location of these areas or sites in different directions starting with the school as centre.

The teacher can now pass on to the beginnings of domestication of plants. This story again can be dramatised; and children can play at being tribal folk; and actually dig up the ground with simple tools; and plant seeds. With a properly graded syllabus, based on the history of further development of cultivation, there will be sufficient work for six years. History and geography, arithmetic, geometry and drawing may be studied at the same time linked with the progress of the craft at each stage. The teacher can also trace the value of social co-operation indicating how practical effect could be given to the ancient discoveries of agriculture and domestication of animals only through joint work of larger and larger units of human beings in society. Such teaching may be emphasised by co-operative gardening by students at schools such as is common in Denmark.

I have noted greater details than are usual in such an essay. But the very great scepticism prevalent among teachers in this country with regard to the possibility of centering education round a basic craft has made it essential. I should conclude this section by noting that the six years' primary and post-primary course should end in a seventh years' work of intensive training in the craft.

I have so far laid stress on one particular vocation and indicated how any scheme of national education is bound to be mainly concerned with agriculture as its basic craft. It is nevertheless a fact that there are in society smaller but quite important groups of earners whose life activities centre round other work. For example, even in agriculture, there will be a small group of workers who will cultivate special and valuable crops like tea, coffee, rubber, sugarcane, fruits and flowers. Brains count for more in these professions than mere ability to put in strenuous physical labour. The training for such work cannot be undertaken in post-primary schools; but in special advanced institutions teaching up to standards comparable to university work in applied subjects.

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Again as noted before, five per cent of our earners are engaged in trade and commerce; and half of these people are connected with the business of distribution and consumption of agricultural products. In the cities and urban areas, there should be arrangement for a somewhat different course after the purely primary stage of four years. If education starts at seven in these schools, the break will come at eleven which is the suitable age for it on psychological and biological grounds. In place of the more practical training in agriculture and of education in general through it, we can lay the emphasis on movement of people over the world in the early days and their contact and exchanges of culture and cultural goods. We can easily cover two years through a graded course of study of barter, exchange and commerce, leading from early primitive to modern systems. Here again, we should arrange at the end of it a full year's course of training in commercial work. Grain trade, as I have said, is the basis of half the business in our country. The school should, therefore, associate with its work a study of the commercial activity of the surrounding areas. In course of time it should also be possible to link up the work in the rural schools, in the later stages, with work in such central towns or urban areas, and thus complete the study of production and distribution of grain. As in the case of agriculturists, there will be a small group of earners in trade and commerce for whom special training in advanced institutions will be required.

I shall not discuss how, and what special training should be imparted to those who will aim at being artisans and craftsmen. In the case of such students, as well as those who will go in for the so-called 'genteel' professions, the stress should be shifted at the end of the four years' primary course already outlined, to cardboard, wood and bamboo work and to some extent the smith's craft. Here the historical method of approach of the crafts as such will not be particularly useful; but the Swedish Sloyd system furnishes an effective alternative method of training for a part of the course, including work in mathematics, drawing and designing. Instead of a historical approach, we may introduce the geographical distribution of types of tools and styles of

products, linking the latter up also with distribution in time. This will enable us to centre the teaching of other subjects round the crafts and complete the post-primary work. For the artisan and craftsman, the value of such training is beyond cavil. For the student who will go in for study of law, medicine, engineering, pedagogy or pure academic research, such training will be valuable. It will have given him a skilful co-ordination of hand and eye; and a habit of planned work, essential for success in any sphere of life. Such training I may add further, stimulates the brain deeply and helps co-ordination of individual activity in general.

I shall conclude with a reference to the question of education of women. As girls are more easily liable to fatigue, and are less strong than boys, the selection of handwork and training in craft should be made keeping these facts in mind. The early training in the purely primary section need not differ much. But it may be broadly recognised that women are not associated in primitive societies even, with ploughing, woodwork and smithy. Simple garden culture, handmade pottery and weaving are generally associated with women in such cultures. We have already provided for a practical study of garden culture in the primary stage, and of a study of other subjects through it against the background of primitive and early societies. For girls, we may therefore associate the break at eleven with the introduction of weaving and dyeing textiles, approaching the subject a little earlier through the evolution of spinning, and plaiting in lowly cultures. Clay-modelling and clay work may be put in the primary stage and will prove, as educational practice shows, equally suitable for boys and girls.

It is, however, necessary to remember that the principal vocation which is followed by most women, and certainly in our country, is that of the house manager or the housewife. Such work is not classified under the head "earning" in the census reports. But obviously it is a definite contribution to national welfare and wealth. The family is still the fundamental social unit all over the world—in the humblest as well as the most advanced culture. On the efficient management of the affairs of the family—represented by the home—depends the health, happiness and welfare of the nation. Instruction in house craft is,

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therefore, essential in girls' schools in any scheme of national education. A part of the work may be introduced in the two years of post-primary course along with other handwork. The approach here,

again, may be mainly geographical to integrate the work in the different subjects. A year's course at the end may be given specially to fit the girls on leaving school to undertake intelligently various household duties, which most women are expected to perform.

Genealogical Tree of the Animal Kingdom

Earlier work in connection with the relationships of the various groups of the animal kingdom was mainly confined to reducing the chaotic condition of our knowledge into order, with a view to arriving at some general plan. Several characters such as structural peculiarities, colour of the blood, habitat, food, etc., were utilised for the classification of the different groups, and a number of more or less tentative systems were evolved. The real advance, however, resulted from attaching special importance to the study of the developmental stages of the various classes of animals. In these studies it was not considered sufficient only to find out the resemblances or differences, but the relative importance of such resemblances had to be evaluated, particularly in regard to the relationships of the several groups, one with the other. As a result of these studies, various classes of the animal kingdom came to be regarded as successive steps in the evolutionary history, and it became possible to trace the course of evolution of animals from the lowest to the highest forms. A genealogical tree, based on this knowledge, graphically shown as a vertically trunk, represented the main stem and indicated the course of evolution from amoeba, the lowest form of the animal life, to the highest evolved mammal *Homo sapiens* or man. On the right and left of this main stem various classes of the animal kingdom were arranged as lateral branches. Such a genealogical tree, though it presented only a somewhat problematic phylogenetic picture of the animal kingdom, was of great value in indicating the

advance in the earlier human ideas, and greatly influenced the development of the generally held views regarding the position of man in nature.

Recently a genealogical tree on an entirely new plan has been prepared by Dr Heintz in collaboration with Dr L. Störmer for the exhibition gallery of the Palaeontological Museum at Oslo. This is intended to give the visiting public an orientation of the generally held ideas regarding the relationships of the different animal groups and also to indicate the main lines of development in the animal kingdom. The entire phylogenetic picture is represented not by a single tree with one main stem and many branches, but as a bush from the root of which the different classes have developed as many branches of an almost equal status. Such a bush-like arrangement of the evolutionary diagram has previously been utilised in palaeontology for the representation of the developmental stages of a number of larger and smaller groups of the animal kingdom, but no attempt had so far been made to represent the relationships of the entire animal kingdom in this way.

The several branches are connected with one another on a novel and entirely new plan, and give a very good connected picture of the phylogenetic development of the animal kingdom. Naturally it was hoped that palaeontology would provide various connecting links between the different classes, but unfortunately this hope has not been fulfilled. Already in the Cambrian, which is the oldest fossil-

GENEALOGICAL TREE OF THE ANIMAL KINGDOM

bearing formation of the earth's strata we find almost all the important classes of the animal kingdom represented. This means that the separation of a number of the main branches had taken place very early in earth's history. This was followed by a further division of the main branches into smaller branches during the later periods, but with our present knowledge it is not possible to trace the root and the earlier developments of the phylogenetic bush.

As is known, normally all organisms start life as single cells—the fertilised ova. All groups can, without difficulty, be traced to this stage, and this type can be considered as the starting point for the entire bush of the animal kingdom.

As the protozoa throughout their entire life remain as single cells, it is easy to derive them from the fertilised ovum, and they can, therefore, be regarded as forming the first main branch. At the present day the flagellates are considered as the central group of the protozoa. Amongst them are found some forms which, owing to the presence of chlorophyll, are also regarded as plants. In view of this it is concluded that the division of the organic world into the plant and animal kingdoms had taken place at about this stage.

In all the many-celled animals or metozoa the contogenetic development starts with the fertilised

ovum, and, with certain modifications, continues through the morula and blastula stages to the gastrula stage. In view of this, these three embryological stages are regarded as being the hypothetical, ancestral types from which all classes of the metozoa were later evolved. In the chart all the classes are arranged as side branches of the main bush or subsidiary bushes, and it has thus been possible to indicate more precisely the origin and relationships of all the classes of the animal kingdom. Each class is given a distinctive number and in the case of the extinct classes the numbers are enclosed within circles. Classes whose relationships are doubtful are distinguished by a sign of interrogation being placed after their number.

The aquatic classes are separated from the terrestrial forms by a wavy line running across the chart throughout its entire length, and the level of this line roughly indicates the relative proportions of the aquatic to the terrestrial types. The drawings of the animals are carefully executed and it is, therefore, quite easy even for the lay public to distinguish the different classes.

The chart (120cm.×180cm.) is printed in colours and copies of it are available from the publishing firm of O. Norli, Oslo, Norway, at a cost of 15 Norwegian Kroner.¹

B. P.

¹ Based on a paper by Dr Anatol Heintz in *Naturwissenschaften*, 27, 223, 1939.

The Indus Valley 5000 Years Ago

(Continued from the last issue).

The City and the Buildings

A large number of buildings has been excavated and hordes of typical seals and pottery utensils, vases and cups, and copper implements, jewellery etc., have been unearthed.

The mortar used in the buildings was generally mud-mortar, but selenite (gypsum) mortar has been found as well as a composition of sand, clay and lime. Mud was exclusively used for the plastering of walls. Every house was provided with a brick built well having a standard size of 2 ft. 2 in., and there is evidence that the steerings had been raised from time to time due to rising of the city level. There are at least two instances where instead of raising the brickwalls of a well to accord with the rise in the level of the mound, a short staircase was constructed to lead down into the well-room. It has been found that the structures which were formerly identified as 'ablution pavements,' or bathrooms, were not always used for that purpose. Some of the smaller ones were undoubtedly privies,—they are similar in every respect to those used in Sindh today, even to the chutes built in the thickness of the walls. The bathroom chute was sloped, while that from the privy is vertical and chimney like. Roofs of the houses were all flat. The whole area of the excavation was well drained and not only is the pointing of the lower part of the cesspit skilfully carried out but the surfaces of bricks were also very carefully rubbed down. In the masonry of chutes there are instances of the actual stepping of decline, an interesting anticipation of spillways of modern dams and barrages. With one exception the streets and lanes of the ancient city consisted of unpaved earth. Since the levels of streets and lanes of the area must constantly have been raised in order to get at the drain beneath, it is not to be wondered at that they were left unpaved. Little heaps of sand besides the drains prove that they were regularly cleaned. A city which covered such an extensive area, so well planned and administered, was also efficiently policed and there

is evidence of the existence of watchmen's quarters, mostly single rooms on corner sites in important thoroughfares. Provisions for supporting lamps, including a niche to hold a lamp, to light the awkward down-steps of the stairways have been found. There are remains of kilns for making and repairing tools and weapons and also for baking pottery. The kilns used by the Sindhi potters of the present day in the villages are much inferior to those used five thousand years ago. The dead were not buried beneath the floors of the houses, as was the common custom in the Near and Middle East in ancient times (*e.g.*, in contemporary Ur, and Kish in Babylon). The absence of any burial chambers suggests that the bodies might have been cremated.

Mohenjo-daro appears to have been the first planned city in the world; for if we take the contemporary cities of Ur and Kish in Babylon, or those in Egypt, it is found that with the exception of the Royal Palaces, or Temples of Gods, the rest of the city was a mere collection of miserable hovels, made of sunbaked bricks and the narrow winding streets were without any system of drainage or conservancy. The houses in Mohenjo-daro were well-built, the streets were straight and 36 ft. in width, and even the lanes were more than 9ft. in width, and they cut each other at right angles. Further, the city was served by an excelled drainage system, the best of its kind in the world even two centuries ago. On the other hand, no spectacular remains like the Pyramids of Egypt or the huge temples of El-Irak, have been found showing probably that there was no centralized authority like the Pharaoh, or the Universal Monarch, but probably the wealth was shared by an oligarchy of merchants much as in medieval Venice or Genoa.*

* Certain writers have identified the Mohenjo-daro people with the *Panis* mentioned in the *Rigveda*. They were supposed to be a trading community living to the south of the Aryan settlements, and they had seized cattle belonging to the Aryans, and shut them up in caves. Indra, the Vedic chief god, sent to them his messenger Sarama, asking them to release the kine, or be prepared for his wrath. The *Panis* tried to seduce Sarama to their side by sweet words.

Pottery

Among the pottery of Mohenjo-daro, straight and angular shapes are the exception. Owing to the scarcity of unbroken painted jars it is uncertain as to how exactly the motifs were arranged. The bead pattern was generally favoured, and had a wide range of variation. Then there was the sun-motif, either a simple circle or with a plain or serrated spot in the centre and often with a serrated outer edge. Plant or tree motifs also appear very frequently on the pottery of Mohenjo-daro. They are always associated with representation of animals so as to present natural surroundings. But often motifs appear having no connection with floral devices. Curiously enough very conventionalized forms were not favoured. The other pattern was a series of intersecting circles. Scale patterns derived from bracts of buds, feathers or scales of reptiles were also favoured. Birds and fishes have been found very scarcely.

The human and animal figurines that have been unearthed show that the fan-shaped head dress so common in other old civilisations was also in vogue in the Indus Valley. The pannier-like additions on either side of the head, however, are unique. Male figurines are usually bareheaded. None of the female figurines are entirely nude, as it was the case in Babylon even up to very late times. They usually wear a short plain kilt, but are sometimes ornamented with medallions which were attached to the upper edge of the skirt above the girdle. Nursing mothers, crawling children, gamesmen, dogs, turtles, humped oxen, ordinary oxen, elephants, pigs, rhinoceros, hares, sheep, goats, buffaloes, monkeys, doves, fowls, peacocks, ducks, geese are all represented, though of same, one or two specimens only have been found.

The Animals on the Seals

No less than 388 seals contain the beast shown with one horn only. The identification of this beast has been a matter of some difficulty. At one time, it was supposed to represent the mythical unicorn; but amongst the seals discovered by Mackay the same beast has been discovered with two horns (seals 234, 359), hence the supposition appears to be correct that the depiction of the animal with one



Fig. 1.
Urus ox, *Bos Primigenius*

horn was only a particular style of representation, may be for ceremonial purposes, which was favoured by sculptors of this period including those of ancient Sumeria. These animals consist of two types, one type being identified by Friedrich in "Alte Orient" 1933, pts. 32, 33 page 32 with the Urus ox (Auroch), the *Bos Primigenius* of zoologists. He has arrived at this identification from the observation that like the Auroch, the animal on the seal shows a long powerful body, the tail ends in a tuft, and horns bend upwards, forwards and again upwards. This type of ox is now extinct almost everywhere, but at one time was found in great abundance in Europe and Egypt, and the zoologists suppose that it spread to the West from India. The next largest number of seals is found with the figure of a short horned bull, shown both in the upright position with a crib before it, sometimes with its head lowered as if charging, and is supposed to represent a cross between the ox and the bison like *Mithin* of the Chin hills, Burmah. One seal shows two such oxen in combat, and on a copper amulet, is shown such a bull charging a man who appears to be defending himself with a spear, and a shield.

Another similar animal with a shorter body, longer leg, and not so strongly curved horns is identified by Friedrich with *Bos Namadicus*, a middle Asiatic species of the Urus ox that was once found in large numbers in India (particularly in the Nerbuadda valley whence it derives its name) and has been recognised in the bone remains from Anau, a Central Asian focus of prehistoric culture which was probably contemporaneous with Mohenjo-daro.

Friedrich also concludes from the shape of the horns and the markings on the head and the neck that both these types of bulls were under the control of men, not necessarily domesticated, but held captive for some religious reasons. As a proof of captivity he cites the crib and stable rack which are represented always before these animals on seals. The variation in the shaggy hair on the head and neck suggests that the animal had been domesticated for a considerable time while an animal showing the characteristics of both these two types on some of the seals shows that sometimes the two animals were crossed.

One of the most interesting seals also found previously at Harappa contains a solar symbol with six



Fig. 1 (a)
Urus ox, *Bos Primigenius*, as it appears on one of the seals, and on another where the solar disc stands in place of one of the horns (Below) with the solar disc beside the horns.
(Copyright, Archaeological Survey of India)

rays, one of which is substituted by the head of the Urus ox. This kind of six-rayed solar symbol is also found on punch-marked coins which, as Mr Durgaprasad has shown, is associated with the ancient kingdom of Kosal. This probably suggests

that the Urus ox had something to do with the solar cult. On certain seals in place of one horn of the Urus ox, a symbol, which according to certain authorities represents a solar disc or is probably the sign of divinity is found. This also confirms the connection of the bull with the same solar cult.

The Siva Cult at the Indus Valley

A fresh number of seals has been obtained containing a seated human figure in *Yoga* posture

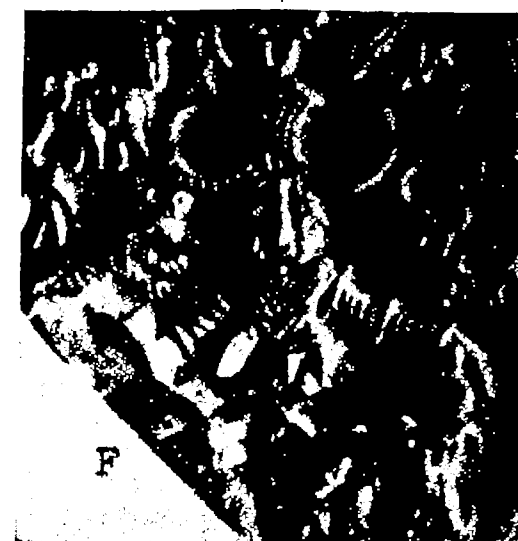


Fig. 2.
Siva in *Yoga* position surrounded by departed spirits in the form of animals.
(Copyright, Archaeological Survey of India)

with horns on his head (symbol of divinity) surrounded by animals such as the tiger, elephant, rhinoceros and the Urus ox and a man going away from the figure. The figure is supposed to represent Siva Pashupati, whose cult flourishes even today in India. The animals are supposed to represent the *Bhutas* or spirits of departed men. Those who have read Mr H. G. Wells' Stone Age stories will recollect how universal the idea was amongst the ancient folk that spirits of departed people entered into the bodies of animals, and used to revisit their clansmen either for revenge or out of affection. Thus the supposition that there was some sort of a cult of Siva, as Bhutnath or Pashupati, at Mohenjo-daro, and that this cult is pre-Vedic is further confirmed by these findings. It has been known even before the discovery of the Indus valley civilisation that Siva is a new comer to the Vedic pantheon and his entry

THE INDUS VALLEY 5000 YEARS AGO

was probably at first resisted by the orthodox votaries of the Vedic gods.

Boats and Ships

One seal contains representation of a ship. The vessel portrayed on the seal is boldly but roughly



Fig. 3.

Representation of a ship, first of its kind found on a seal from Mohenjo-daro.

(Copyright, Archaeological Survey of India)

cut. It has a sharply upturned bow and stern, a feature which is present in all archaic representations of boats like those on the early Minoan seals or on the pre-Dynastic seals of Egypt. The boat is shown lashed together both at its bow and stern, indicating perhaps that it was made of reeds as in Egypt and southern Babylonia. The absence of a mast suggests that the boats were used for river traffic, like some of the wooden boats on the Indus river at the present day.

The Cult of the Tree

The trees represented on the seals appear to be the *pipal* and the *neem*, and there appears to have been a widely prevalent tree-cult. On one of the most interesting seals is shown a tree-god (*Vriksa devata*) with a devotee and a number of female followers engaged in some sort of worship. (see next column).

Sumerian Connection

No progress has been made in the proper interpretation of the seals except that it has been confirmed that the symbols thereon had nothing to do with the animals represented there. Some of the seals clearly show Sumerian connection as for example seal No. 74, which represents a hero or a devotee of very muscular appearance gripping by the throat a tiger on either side of him. This recalls the

Gilgamesh epic of Mesopotamia excepting that the lions of those countries are substituted by tigers; the lion being apparently unknown in the Indus valley. Not a single figure which can be identified with the lion has yet been discovered. This confirms the belief that the climate of the Indus valley five thousand years ago was widely different from what it is now. It appears to have been moist, and overgrown with jungles, for the tiger, the elephant, and the rhinoceros which appear to have been so abundant in Sind 5000 years ago, flourish only in a comparatively moist climate, while the lion frequents rather dry areas. The India Meteorological Department appears to be of the opinion, that the cold air-stream from the Mediterranean Sea which now passes over the Punjab, and gives the province its winter monsoon, apparently extended over Northern Sind five thousand years ago. The wide desiccation of Southern Persia, Baluchistan, and Sind, appears to be due to the deflection of this air-



Fig. 4.

Vriksa devata with a devotee and a number of female attendants.

(Copyright, Archaeological Survey of India)

current northwards, as these regions also, particularly Baluchistan, show ruins of ancient water-storage works, which could have been needed only in case of a good annual rainfall.

Metallurgy

A large quantity of metallic articles were

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unearthed during these excavations, mostly from the lower strata. These objects contain household implements, ornaments and other objects made of copper, bronze, silver and occasionally of gold. No trace of iron has been found and this proves that the metallurgy of iron was completely unknown during this period (2500 B.C.). Several bronze objects have been discovered containing as much as 22% of tin, which shows that the tin was purposely mixed up with copper. The metallic hoard contains household objects like pans, dishes, frying pans, scale pans, knives, saws, razors, sickles, fishhooks, chisels, drills, awls, reamers, needles, bolts, mirrors, spatula, all made of either copper or bronze. Defensive and offensive weapons like swords, battle-axes, blades, axes, knives, and daggers, spear-heads, arrow-heads, lance-heads have also been discovered. These show that about 2500 B.C. the Indians of the Indus valley used to fight with bronze and copper weapons very much similar to those used by the Homeric Greeks nearly a thousand year later (1200 B.C.). Further,



Fig. 5.

Inscribed Bronze implements.
(Copyright, Archaeological Survey of India)

the discovery of so many well-constructed weapons of offence and defence show that the Mahenjo-Daro people were not probably as unwarlike as has been thought. Copper seems to have been smelted by the open hearth process with charcoal over a cavity in the ground into which the metal ran. Utensils were prepared both by hammering and by casting and a number of raw ingots and castings have been unearthed. The edges of the swords and knives as also of the battle axes appear to have been hardened by some chilling process—the hardness approaching that of mild steel. The ingots appear to have been worked on lathes to give them the proper shape. Some of the implements are inscribed and Mackay thinks that the inverted U-sign in these inscriptions was used to denote ten as in ancient Egypt, while vertical strokes were used to denote digits.

Varying types of spindle-whorls of metal, wood and shell point to the spinning of wool and cotton (the latter has been discovered as wrappers for metal tools and implements). An interesting tool that has been found in recent excavations is a saw whose teeth and the adjoining point of the blade are set alternately from side to side, an arrangement not previously known anywhere earlier than the Roman times.

Of household objects, tools and implements, we find a long list, similar to those in use at the present day, but some of them were very crude. Two finds point to their being used as toilet stands, and one of them was very carefully finished. No heads or weapons of flint have, as yet, been found, and the Indus valley civilisation has been termed purely Chalcolithic as copper and bronze had practically entirely ousted stone. It is of course possible that Mahenjo-daro was founded when the Chalcolithic civilisation was pretty mature and that we must look to other sites for the Neolithic beginnings of the Indus valley civilisation.

Weights and Measures

Cherts were the favourite material for making weights. Invariably they were very carefully shaped and polished, and some of them are beautifully veined. Indeed they show that the working of this difficult stone had been developed to a fine art at Mohenjo-daro, though with the advent

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of copper the use of stone for making tools and weapons had long since fallen into abeyance. As for the shape of the weights the great majority of them were cubical, though other shapes *e.g.*, spherical with flattened top and base, cylindrical with flat top and base, barrel shaped and conical weights have also been found. The barrel shaped weights may have been imported from other parts of India, perhaps from places nearer the coast which had easy communication with Elam and Sumer, where barrel shaped weights were popular.

The weights found at Mohenjo-daro form a series in the following ratios: 1, 2, $\frac{8}{3}$, 4, 8, 16, 32, 64, 160, 200, 320, 640, 1600, 3200, 6400, 8000 and 12800. The unit weight has the calculated value of 8570 gms and the largest 10970 gms. The unit of weight had not changed during the whole period of the occupation of the site. The weights in the great majority of cases were made with considerable accuracy much more so than in other countries at that period.

A measure of length has been found at the site which shows some remarkable features. The scale is made of shell, not liable to warp or crack or be worn and the rod is divided up on a decimal system. The division lines are carefully cut and the accuracy is remarkable. The system of weights and measures discovered at Mohenjo-daro show that the people reached an advanced stage of development and were capable of precision and mathematical accuracy in their work.

Conclusions

The occurrence of the seals found in Mohenjo-daro, which have been discussed earlier focusses attention on the links that were probably established by trading intercourse between the Indus valley people and their neighbours of Sumer and Elam. There are also indications of communications with Baluchistan. No direct connections with Egypt, however, has yet been established. The period of the Indus civilisation is contemporaneous approximately with the sixth Dynasty of Egypt which came into power after the great pyramid builders had passed away. Certain objects and motifs suggest

indirect communication through other countries. It may be that some people migrated from the regions of Sumer and Elam to Egypt and their association with the Egyptian civilisation gives some similarity of patterns and designs in the long list of articles excavated at the regions.

The civilisation of the Indus valley, the date of which has now been narrowed down between 3000 B. C. to 2500 B. C. appears to have been quite as advanced, nay, in some respects more advanced than in contemporaneous Egypt, El-Irak and Elam. While showing certain similarities with these civilisations, some of its features are exclusively Indian, though pre-Vedic and pre-Aryan, and probably many of the current beliefs and cults of India, can be traced to this civilisation. The inscriptions which are still silent await the discovery of a Rosetta Stone and the genius of a Champollion. In fact, Indian prehistoric archaeology is now in the same stage as those of El-Irak at the time of Layard and Botta about a hundred years ago, and promises to be far richer, for the civilisation has been found to have extended nearly to the foothills of the Himalayas (up to the Ruper Tehsil in the Ambala district), and to Gujrat in the south. Further, some of the sand-buried cities of Rajputana may also go back to these dates. The period between 2500 B.C. to 3000 B.C. when we come down to the Mauryan times, is up till now perfectly blank, so far as the Indian archaeological finds are concerned. Probably in the stories preserved in the *Vedas*, *Upanishads*, the *Mahabharata* and the *Puranas*, we have echoes of mighty happenings that took place within this period, just as the *Bible*, a work which was compiled out of old traditions in the centuries following the Babylonian captivity (550 B.C.), preserved memories of ancient Egyptian and Sumerian civilisations. But this gap in our knowledge requires for its illumination the light of the archaeologist for many long years to come.*

*The author expresses his deep gratitude to the Director-General of Archaeology in India for his kind permission to reproduce some of the illustrations here from Dr Mackay's *Further Excavations at Mohenjo-daro*, Vol. II, from Vol. I of which most of the materials of the article have been gathered.

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OBITUARY

SIR FRANK DYSON, F.R.S.

SIR Frank Dyson, Astronomer Royal, from 1910 to 1933, died at sea on May 25 last, whilst on the voyage home after a visit to Australia. Born on January 8, 1886, he was educated at Bradford Grammar School and Trinity College, Cambridge. He was awarded a Smith's prize and elected to a fellowship at Trinity College and later to an Isaac Newton studentship. In 1894 he was selected for the post of Chief Assistant at the Royal Observatory, Greenwich. Dyson's first important work was a new edition of Groombridge's circumpolar catalogue. The Groombridge stars were reobserved at Greenwich and the proper motions of the stars were derived. Kapteyn at this time announced his important discovery of star streaming from the analysis of proper motions of bright stars observed by Bradley long ago. The proper motions studied by Dyson enabled A. S. Eddington, who succeeded him as the Chief Assistant in 1906, to confirm the existence of star streaming amongst these fainter stars extending to a very great distance from the sun. Dyson also published a number of papers on problems of stellar motions in relation to the distances and luminosities of the stars and to their distribution in space. He took a considerable part at Greenwich in the international plan for photographing the heavens and preparation of an astrographic catalogue. His works on the spectra of the chromosphere and of the corona were important contributions to the subject. After his retirement he wrote a book, *Eclipses of the Sun and Moon*, which is considered to be the best book on the subject.

Dyson was president of the Royal Astronomical Society, 1911-13; President of the British Astronomical

Association, 1916-18; and Vice-President of the Royal Society, 1913-17.

GENERAL C. G. BRUCE

THE death has occurred on July 12, of Brigadier-General the Hon. Charles Granville Bruce, C. B., who was well-known as the leader of the two Mount Everest Expeditions. Born in 1866, he was the youngest son of the first Baron Aberdare. One year after taking his commission he was sent to India in 1888. After a long record of campaigning in India, he became a Himalayan mountaineer. He was an authority on the mountain region in northern India. In 1922 he organised and led an expedition to climb Mt. Everest but the climbers failed to get beyond 27,300 ft. In 1924 he organised another attempt when two members of the party reached 28,200 ft.

HAVELOCK ELLIS

WE regret to record the death of Henfy Havelock Ellis, the noted English sociologist. Born in Croydon, in 1859, he passed his early years in Australia. Returning to London in 1881 he studied medicine and took his degree in 1889. At this time he wrote for reviews and magazines, and edited the Mermaid Series of Elizabethan dramatists and the Contemporary Science Series. His books, *The New Spirit*, *The Nationalization of Health* and *Men and Women* were published before he undertook the publication of his famous works, *Studies in the Psychology of Sex* in 1897. In those days it was regarded as a scandalous publication and a bookseller who had sold the book was prosecuted. He suspended the publication of the later volumes in England and these were issued in America and Germany where his work was much more appreciated. In his books on sex he avoided the extremes of the prurient and

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the preacher. He did not believe in the Freudian theory that the sexual impulse was the sole root of every emotion and aptitude. His other books include *World of Dreams*, *The Nineteenth Century*, *Affirmations*, *The Soul of Spain*, *The Task of Social Hygiene* and *The Dance of Life*.

Sir Leonard Woolley's Report

SOMETIME ago the Government of India invited Sir Leonard Woolley, the excavator of Abraham's city, Ur of the Chaldees, to come over to India and report on the working of the Archaeological Survey of India. Sir Leonard has written an adverse report on the working of the department. Archaeology could and should play a far more important part than it has hitherto done in the life of the Indian people, says Sir Leonard. The Department ought to arrange for publication at cheap price, of small monographs which will bring ordinary reader up to date regarding the discoveries and problems of Indian archaeology. The other channel through which the Archaeological Survey can fulfil its educational functions is the museums and so a closer association should be established between the department and museums maintained by provincial Governments or learned societies. A closer co-operation with universities and educational institutions in the country is also recommended. The policy of local museums on excavated sites has, in the opinion of Sir Leonard, proved a failure. The functions of a museum are to house and preserve antiquities, to further by means of its collections the advances of science either through studies carried out by the museum staff or by giving facilities for study to other scholars and to be an educational centre for the instruction of the general public. Considered in the above light the museum at Mohenjo-daro, Harappa, Nalanda, and Nagarjungkonda fail to fulfil their proper functions due to inaccessibility of the places. Sir Leonard recommends the closing down of these museums and redistribution of the unique collections at present housed there to other museums which are easily accessible to the public. He also recommends the establishment of a central National Museum at Delhi which should house worthily the magnificent archaeological materials available in India. The excavation policy hitherto followed by the department has been criticised as being rather sporadic and a radical change in excavation policy has been recom-

mended. There are gaps in knowledge of some periods of Indian history which require to be filled in before a complete cultural framework may be established and in future sites for excavation should be selected mainly with the object of discovering the missing links in the cultural chains. Of the various well-known sites in northern India where excavation may be started, Sir Leonard considers Ramnagar in the Bareilly district of United Provinces to be best suited for systematic and scientific excavation. In south India, however, no single site is likely to produce a continuous type sequence and in his opinion the start should be made with a late site so that work may advance from the known to the unknown. Sir Leonard also recommends that a detailed archaeological survey of the whole country should be undertaken in course of which sites of every-kind should be listed, mapped and a record compiled of objects collected at each site. This would later enable a programme of future work to be drawn up, calculated most surely to answer to the varying demands of advancing knowledge.

India possesses a vast amount of archaeological material which it can not afford to excavate itself and greater encouragement should be given to excavation by foreign scientific expeditions. In the Near East liberal treatment has succeeded in attracting foreign expeditions and Sir Leonard recommends that in India also a statutory provision should be made guaranteeing a half share in all antiquities discovered in expeditions by foreign museums. There should, of course, be more stringent rules for the control of expeditions to ensure that they have the requisite finance and technical ability for scientific excavation work.

The effect of the financial retrenchment in this department since 1931 has been serious. There has been depletion in the cadre of officers. Strengthening of the headquarters' staff has been recommended which will make possible the differentiation of function and abandonment of the present practice which demands of the same officer expert knowledge in excavation, museum work, conservation and general administration.

Sir Leonard praises the work of the department on the conservation of historic monuments. But in museum work, in excavation, and in some aspects of conservation work he finds evidence of inexperience and there is an urgent need of training. Student apprentices with sound academic qualifications should be recruited and given a rigorous training before being

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taken on the permanent staff. Two travelling scholarships should be provided annually to enable members of the staff and senior student apprentices to obtain first hand knowledge of foreign methods and ideas. Finally Sir Leonard recommends the appointment of an advisor in archaeology from abroad for a period of five years. Within that period the whole staff could be so trained as to make it capable of doing its work on its own initiative. The department has been the subject of strong adverse criticism, and however unpalatable some of the remarks of Sir Leonard may be, they certainly deserve close attention. We reserve further comments for a subsequent issue of the journal.

Manufacture of Power Alcohol in Bihar and U. P.

THE problem of utilisation of molasses for the manufacture of power alcohol has been engaging the attention of the public and the Governments of Bihar and the United Provinces and a committee consisting of Drs N. R. Dhar, S. S. Bhatnagar, N. G. Chatterji and a few representatives of the sugar industry in the two provinces was set up by the two Governments to go into the whole question. The report of the committee has been recently submitted to the Governments. The most important points discussed by them are whether manufacture of power alcohol from molasses is an economic proposition and how to dispose of the power alcohol when manufactured.

The total quantity of molasses produced in vacuum pan sugar factories in U. P. and Bihar has been estimated at 300,000 tons of which nearly 200,000 tons are discharged as waste. The value of the molasses lost at four annas a maund comes to more than 13 lakhs of rupees annually. If power alcohol were to be manufactured from molasses the output would be 60 gallons from one ton and hence Bihar and U. P. can produce 120 lakhs of gallons of power alcohol from the molasses that is now wasted. The committee however recommends that at present only as much alcohol should be manufactured as can be absorbed in the two provinces. The minimum economic unit for manufacture should be a plant of capacity of 22,00 gallons per day and the cost of manufacture would come to about 3 annas per gallon. Allowing for the price of molasses and the cost of transport the cost of production of one gallon comes to As. -/5/6. Considering the excise

duty and the actual distribution and selling costs the actual selling price will come to Re 1/3/- a gallon which is lower than the price of petrol in Bihar and U. P. The only practical use for power alcohol is as a motor fuel mixed with petrol. An admixture of 20 per cent of power alcohol with petrol is found to be unobjectionable from the point of view of motor industry and the Governments of U. P. and Bihar propose to undertake legislation to make such admixture compulsory in their provinces. At present 90 lakhs of gallons of petrol are consumed annually in the two provinces and of these 18 lakhs of gallons can be replaced by power alcohol which will result in the utilisation of about 30,000 tons of molasses. It may be possible later to arrange to supply power alcohol to other provinces also at a price which is not higher than that of petrol. In many European countries which have to depend on supply of petrol from foreign countries, large quantities of power alcohol are being consumed as substitute for petrol. The total output of petrol in India forms only a small fraction of her total consumption and she has largely to depend on foreign supplies. Manufacture of power alcohol in the country will therefore serve the double purpose of utilising a huge waste as well as making India at least partly independent of foreign supply of petrol. It will be interesting in this connection to read the articles on Power Alcohol and Synthetic Fuel Industry in *SCIENCE AND CULTURE*, 4, p. 228, and p. 573, 1938-39.

All India Forest Products Show

THE Commercial Museum of the Calcutta Corporation recently arranged an Exhibition of All-India Forest Products which opened up before the public an interesting field of economic activities which have great possibilities in this country. In India we have magnificent forests which are valuable national assets. Of the forest products, bomboos are largely used for paper making; pine, deodar, teak, and oak are utilised for building purposes, making furnitures and boxes and building ships and railway trucks. Also large quantities of resin, gum and rubber are extracted from trees. But unfortunately sufficient attention has not been paid to proper exploitation and development of the country's forest resources which have enormous possibilities. Enough research work has not yet been done to utilise our forests for the growth of suitable timber though we are still dependent on supply of timber from Burmah and the Andamans and even other foreign countries.

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This province still depends exclusively upon bamboos and straws for construction of huts in villages and nothing has been done to find out to what extent cheap building planks may be available as substitutes for construction of huts. Another important aspect of forest utilisation to which the attention of the people and the Government should be directed is proper scientific planning and reservation so that too much or too rapid deforestation which would affect the climate and soil condition of the country adversely may not take place.

The Forest Research Institute at Dehra Dun has been doing useful and important work, but the problem calls for efforts on a much larger scale. Khan Bahadur Azizul Haque, Vice-Chancellor of the Calcutta University, when he opened the Exhibition stressed on the usefulness of having a Forest Research Department in connection with post-graduate training in the Calcutta University. If the proposal of the Khan Bahadur be really given effect, it will mark a forward step in establishing a real contact between the University and an important aspect of the industrial development of the country.

Age of Election to the Royal Society

A very interesting study of the age of election to the Royal Society has been published in the *Notes and Records of the Royal Society*, (April 1939, London). In 1925 Sir Arthur Schuster published in the *Proceedings of the Royal Society* (Vol. 107, p. 368) a study of the life statistics of fellows of the Royal Society. From Schuster's tables it can be calculated that during the period 1848-72, the 'median' age of election was 42, i.e., as many elections occurred below 42 as above it. From 1873-1897 the median age of election was about 43, from 1897-1922 it was 44½. For the years 1920-1938 it was about 47. There has been a steady upward rise for 90 years. It would be interesting to see the effect of recent increase from 15 to 20 in the number of annual elections to Royal Society. Before the year 1848 only a part of the fellows were scientific and limited annual election was adopted from that year; so no comparable calculations

* The 'median' age of election i.e., the age below which as many are elected as above it is considered because the 'average' age of election is too greatly affected by a few late elections to be significant.

for an earlier date can be made. The following are approximately the median ages of election to the different categories during the period 1920-38: mathematics 42, physics 39, engineering 55, chemistry 45, botany 51, zoology 48, geology 53, physiology and medical subjects 48, and for all sections 47. This present median age of 47 is the resultant of a number of different ages in the various categories varying from 39 for physics to 55 for engineering. Though it would be dangerous to speculate on the causes of the difference, it must be admitted that some groups can contribute more effectively than others to preventing a rise in the age of election. A necessary consequence of late elections is a smaller number of active or living representatives of a subject and in future the policy of early or late elections would depend on whether election to fellowship is to be regarded primarily as a prize to be awarded for services rendered or as appointment to a living working community with a function towards science and the State.

In this connection it may be of interest to our readers to know the age of election of the few Indian fellows of the Royal Society. Of the five fellows hitherto elected, Ramanujam and Saha were elected at 32 and 35, Raman at 36, Sahni at 47 and Bose at nearly 60.

The Royal Observatory, Greenwich

THE report submitted by the Astronomer Royal, Dr H. Spencer Jones, for the year ending April 30 1939 gives a summary of the work carried on in the Royal Observatory at Greenwich. Transit circle observations with the Airy transit circle were confined to the sun, moon and planets. The Greenwich observations of the sun from 1750, combined with observations made at other observatories and used in conjunction with observations by the moon and venus and of the transits of mercury, form the data for investigating the changes in the rate of rotations of the Earth. The results are being communicated to the Royal Astronomical Society. A daily series of photographs (begun in 1874) has been secured, in collaboration with the Cape Observatory and Kodaikanal Observatory in South India for the measurement of sunspot positions and areas. There are indications that the peak of the maximum phase of the eleven-year cycle has been passed. Eleven very large spotgroups appeared during the year, and in seven cases a magnetic storm occurred within a few days of the respective

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times of the central meridian passage. Examination of the sun's disc has been made in hydrogen light ($H\alpha$) to detect the sudden occurrence of bright eruptions which show a relationship with sudden ionospheric disturbances. Magnetic activity during the year was considerable, five great storms and twentythree small storms being recorded.

In concluding his report the Astronomer Royal shows great concern regarding the steady deterioration of observing conditions at Greenwich. Long exposure photography is no longer possible owing to increasing brightness of the sky at night. As a result of atmospheric pollution by smoke, many programmes of work are now impracticable. The actual definition of stellar images has suffered. There is a permanent risk of damage by grit to the objectives of all the Greenwich telescopes. The report states that if the Royal Observatory is to continue to make important contributions to astronomy as it has done for the past 264 years, it is essential that it should be removed to a site where astronomical conditions are more favourable. The removal of the magnetic observatory to another site has also become a necessity because of the present level of artificial disturbances. It is understood that proposals for the removal of the whole of the astronomical work from Greenwich and of the magnetic work from Abinger to new and more favourable sites are under consideration.

Short Wave Broadcasting in India

WITH the advent of monsoon conditions in various parts of India there are reports of disturbances of broadcast reception from both Indian and European stations. This disturbance of crackling produced in wireless sets is due to electrical discharges in clouds and usually known as atmospherics or static. At this time of the year atmospherics are troublesome whenever there are any large cloud formations in the sky. The magnitude of these disturbances in India is many times greater than in Europe or America and the disturbance is also much stronger on medium wavelengths than on short wavelengths, and it is principally on this account that short wavelengths have been used for long distance service in India. The 10 kW. Indian shortwave stations at Delhi, Bombay, Calcutta and Madras, which are intended to serve areas up to several hundred miles round

the transmitting station, operate in the new 60 metre broadcasting band at night-time, and in the 31 metre band during the day time. In addition, a 5 kW. shortwave transmitter at Delhi operates on a wavelength of 31 metres at night and 19 metres in the daytime, these wavelengths being especially suitable for reception at distances beyond 400-500 miles but not suitable for nearby reception due to the effect known as "skip distance." The 10 kW. shortwave stations are primarily intended to serve the province or area in which they are located and for this reason it is necessary to use a sufficiently long wavelength to avoid "skip distance." The 60 metre band is the shortest wavelength which can be used at night.

Measurements recently carried out by the Research Department of All India Radio on the various wavelength bands suitable for broadcasting and their relative suitability for use by the Indian stations show, that the use of wavelengths even in the 49 metre band would result in a serious weakening of signal strength at distances up to several hundred miles from the transmitting station. This has necessitated the adoption of the 60 metre band by the Indian shortwave stations. As listeners to distant shortwave programmes will have found, it is rapidly becoming more and more difficult to separate the various shortwave stations and this position is causing grave concern to broadcasting authorities of all countries which use short wavelengths chiefly for broadcasting beyond their own frontiers. If the All India Radio shortwave services were primarily intended to give good reception outside rather than inside India, great concern might also be felt by the authorities here. But the fact that the Indian broadcasting system is intended primarily to serve Indian listeners demands the use of wavelengths which as it happens are not used by other countries for very long distance transmission or reception. This results in the fortunate position that the new 60 metre band is, and will remain, relatively clear of interference and can be used by the Indian stations at night time, while the 31 metre band, which is not seriously troubled by distant stations during daylight hours can be used for daytime transmission.

As long as the Indian shortwave service employs wavelengths suitable for listeners in India, it is unlikely that serious interference will be experienced. At the same time, although the Indian wavelengths are chosen primarily to provide the best service to Indian listeners,

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they are also received outside India, particularly during the winter months. The 60 metre stations, for example, are well heard in Europe largely because they are free from interference. The reception of the Indian stations is regularly reported in some of the British wireless papers and programmes of the Indian stations are also printed for the benefit of European listeners.

New Iron and Coal Deposits in India

NEW deposits of coal, iron and gold have been discovered in India according to the General Report of the Geological Survey of India for 1938. A new coal area has been discovered in Assam which lies in the south-western corner of the Khasi Hills between the Um Mawblei and the border of the Garo Hills, into which also the coal-bearing strata extend. It is divided structurally into two unequal parts by a strong cross fault. By far the most important areas for development are those of the Langrin plateau east of the fault. The reserves in the Langrin area of 20 square miles have been estimated roughly 4,000,000 tons per square mile in a seam five feet thick. The total reserves of fairly flat-lying coal is not less than 60,000,000 to 80,000,000 tons in one workable seam. The area west of the fault in Nongstoin comprises difficult country in which the coal-bearing strata extend north-westward to the Simsang river east of the important Darranggiri coal-field. In an area of about 20 square miles five feet of workable coal in one seam should be available within a depth of 300 feet from the surface. The coal is of strongly coking quality. The reserves will be the same as in the Langrin area, i.e., roughly 70,000,000 tons in one seam four to five feet thick. The prospects are probably better in this area, although this is not so well placed as the one to east.

The mapping of the iron-ore deposits of the Bailadila range, Bastar State, has been completed. Ore deposits, large and rich enough to be worked economically, occur in numerous places in the Bastar State and in these deposits there are at least 400 million tons of ore. Analyses of samples show the exceptionally high quality of the ores exposed on the surface. Iron deposits have also been found in Ratnagiri district in Bombay Presidency and in small quantities in the north-east Garo and north-west Khasi Hills in Assam.

Gold deposits of Jashpur State have been examined

and according to investigations a total reserve of 264,000 cubic yards of gravels in the bank of the Ib, Maini, Sonajoi, and a few other streams containing about 1,045 oz. of gold valued at £7,552 is estimated. The gold-washers of the State can probably work more economically than could a company with its heavy overheads costs.

The occurrence of gold in the Mardan district of the North-West Frontier Province, even though in small amount, suggests that the alluvial gold of the Kabul river and Kalpani nala may have its origin in the Frontier suite of the alkaline rocks although these rocks themselves may not be workable for gold. Further investigations will be made in the area.

Other discoveries reported are of chromite in Ratnagiri district and Savantradi State in Bombay, bauxite in Baster State, felspar and glass sands in Ratnagiri, manganese ore in Bamra State and of building stones, clays etc., in various places. If ever a railway is built to exploit the iron ore of the Bailadila Range in Bastar State it would be well worthwhile to prospect carefully the local bauxite deposits.

Ancient Ruins In Gaya

A series of rock-cut Brahminical sculptures and one Buddhist temple in ruins, with a seated Buddha at Kaula Dol near the Barabar range of hills, in the Gaya district, Bihar, have lately been brought under protection by the Government of India, by a notification issued under the Ancient Monuments Preservation Act. Situated on the north-eastern side of the Kaula Dol Hill, the ruins comprise a colossal statue of Buddha, a few loose sculptures, 13 sandstone pillars and a number of sculptures of various Hindu deities carved on the northern and eastern faces of the rocks and boulders. The huge statue of Buddha seated in the *Bhumisparsa mudra* is 8 feet 2 inches high with a line of inscriptions in Pala character of the 6th century A.D. The remains of ancient brick walls and stone pillars around the Garbhagriha (*Sanctum-Sanctorum*) bring to light the former existence of an extensive temple and monastery at this place. The ruins are considered to be of great interest from the archaeological point of view.

Astronomical Work of the Kodiakanal Observatory

THE report for 1938 of the Solar Physics Observatory at Kodiakanal which specialises in the study of the

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sun and makes daily visual and photographic observations of its changing features has just been issued. A slight decrease in almost all forms of solar activity was observed during the year except in prominence areas which showed an increase over the previous year's. The sun's disc was not found free from spots even for a single day. The mean daily number of sunspots fell by 16 per cent and the number of new groups by 13 per cent. An increase of 12 per cent was observed in the mean daily areas of calcium prominences, the mean daily numbers of prominences however decreased by six per cent. Photographs of the sun on a scale of eight inches to the sun's diameter were taken on 328 days during the year using a six inches achromatic object glass and a green colour filter. A statistical study of prominence areas has been undertaken to determine the possible influence of the earth on solar prominence. Photometric work on the intensities and contours of selected Fraunhofer lines were also continued. Data of cosmic radiation obtained from measurements at Agra and Kodiakanal have been analysed and its diurnal variation with mean and sidereal times worked out. The Observatory also carried out the programme of the International Astronomical Union.

Announcements

VISCOUNT Nuffield and Mr John Davison Rockefeller have been elected fellows of the Royal Society in accordance with terms of Statute 12, which provides for the election of persons, who in the opinion of the Council "either have rendered conspicuous service to the cause of science, or are such that their election would be of signal service to the Society."

IT was announced at the summer meeting of the Physical Society that a Rutherford memorial lecture will be arranged annually between October and March, the subject of the address to be some topic concerning recent advances in atomic and nuclear physics. The first lecture will be given in the session 1939-40.

THE Cambridge University Press will publish early in the autumn, the authorized biography of the Late Lord Rutherford by Prof. A. S. Eve, a personal friend for many years and formerly professor of physics at McGill University. The author has enjoyed the

est co-operation of Rutherford's colleagues and friends and of Lady Rutherford who has allowed use to be made of the collection of her husband's letters and papers. Earl Baldwin has written a foreword.

THE trustees of the Lady Tata memorial fund announce that, on the recommendation of the scientific advisory committee, they have made the following awards for research in blood diseases with special reference to leucaemia, in the academic year beginning on October 1, 1939. Grants for research expenses: Dr Gorgen Bichel (Denmark), Dr Julius Engelbreth-Holm (Copenhagen), Dr Maurice P. J. Guerin (Paris) Prof Karl Jarmai (Budapest), Prof. James McIntosh (London), Prof. Eugene L. Opie and Dr Jacob Furth (New York) Dr Joachin Wienbeck (Breslau); Dr Werner Jacobson (Cambridge). A scholarship has been awarded to Dr Edoardo Storti (Pavia).

AT the Annual General Meeting of the Institute of Physics the following were elected to take office on October 1, 1939: President, Prof. W. L. Bragg; Vice-President, Prof. A. Fergusson; Honorary Secretary, Prof. J. A. Crowther; Honorary Treasurer, Major C. E. S. Phillips; new members of the Board, Dr H. Lowery, Mr R. S. Whipple and Mr J. H. Awbery.

PROF. S. Radhakrishnan has been elected a fellow of the British Academy. This is the first time that an Indian has been admitted to the fellowship of the Academy.

THE Royal Commissioners for the Exhibition of 1951, have awarded a Science Research Scholarship to Dr Prem Bihari Mathur, D.Sc., of the Institute of Agricultural Research, Benares Hindu University, Benares.

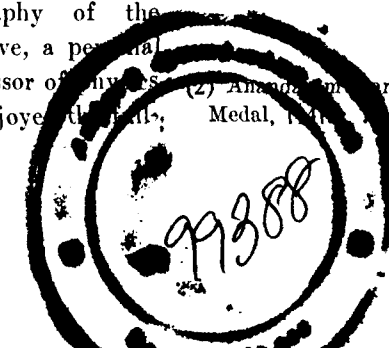
THE following are the subjects selected for submission of theses in competition for the medals noted below to be awarded by Calcutta University:—

(1) Ranee Ramrakshi Gold "The systems of Sankara Medals, 1941 and Ramanuja—a critical study" and "The Sannyasa Asrama."

(2) Ananda K. M. Gold "Asvaghosh as an Epic Poet." Medals, 1941

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(3) Mrinalini Gold Medal, "History of Bengal in the 11th century A.D."

(4) Khujasta Akhter Banu uddin Rumi,"
Suhrawardy Gold Medal,
1941

"The influence of Hindu Philosophy on Muthnabi of Jalal-
Or
"Musalman Vaisnavite Poets of Bengal."

Or
"Bengali Literature under Muslim Patronage."

Or

"Contribution of Muslims to Indian Civilisation."

The theses are to be composed in Bengali and detailed rules regarding the award of these medals have been published in the Calcutta Gazette of June 15, 1939. The medals are open to competition among all persons who have been at any time admitted to a degree of this University.

SIXTH Pacific Science Congress under the auspices of National Research Council of the United States of America, Washington D. C. will be held at San Francisco, California, July 24-Aug 12, 1939. The University of California and Stanford University will act jointly as hosts of the Congress and the Golden Gate International Exposition will co-operate with them. Forty-two countries have been invited to participate in the Congress. The programme is designed to provide for discussion of scientific problems of particular significance to the Pacific area. Arrangements have been made for presentation of formal papers, round table conference and informal discussions of topics of general and special significance. The scientific programme is divided into a series of 8 sections and several subsections. Committees with chairman have been appointed for each section. The sections are:—

- (i) The Pacific Basin; Structure and dynamics; geology and geophysics.
- (ii) The Pacific Ocean; properties, dynamics, life: oceanography and marine biology.
- (iii) Pacific climates, past and present.
- (iv) Man and Culture in the Pacific region; characteristics, dispersal and development, rejection and result of research; anthropology, human geography and ethnobotany.

(v) Terrestrial fauna of the Pacific Islands and bordering lands; characteristics, origin, distribution, human relation: animal sciences. (vi) Terrestrial flora of the Pacific Islands and bordering lands: characteristics, origin, distribution and human relation: plant sciences. (vii) Public Health and nutritional problems of the Pacific region: Tropical medicine and nutrition. (viii) Soil Problem of the Pacific Islands and bordering lands; characteristics, utilization and conservation.

Earlier Congresses were held in Honolulu (Hawaii) Melbourne (Australia), Tokyo (Japan), Batavia and Bandong (Java), and Victoria (Vancouver).

Dr B. Ahmad of the All-India Institute of Hygiene and Public Health, Calcutta, has been invited to participate in the Public Health and Nutrition Section and to report on the nutritional problem in India and Dr B. S. Guha of the Zoological Survey of India has been invited to take part in the discussion on Early Man in Asia and Pacific regions.

AT a preliminary meeting held in the University of Delhi on 8th May, 1939 under the presidency of the Hon'ble Sir Shah Sulaiman, Kt., it was decided to start an association for promoting closer contact between the scientists in India and America. The association will be an entirely non-political organization whose activities will be concerned with bringing about closer co-operation between the scientists of the two countries by arranging exchange of publication, supplying and disseminating news about important scientific events, providing facilities to scientists of one country visiting the universities and institutions in the other country, to organize lectures, and to undertake any other type of work which will help to strengthen the scientific relations between the two countries. A close scientific contact between Great Britain and India has been established, as a large number of students from this country have been, for the last many years, studying at the British universities and distinguished British scientists have often visited this country—the visit of the delegates of the British Association for the Advancement of Science to the Indian Science Congress at its Jubilee session may be specially mentioned as a note-worthy event in the history of the scientific relations between these two countries.

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With a view to build up similar scientific relations between India and America (which is also an English-speaking country), a provisional committee with the following office bearers have been formed.

President.—Prof. M. N. Saha, **Vice-President.**—Sir S. M. Sulaiman, **General Secretaries.**—Dr B. D. Laroia (*Physical Sciences*) and Dr H. S. Pruthi (*Biological Sciences*), **Foreign Secretary.**—Dr D. S. Kothari, **Members.**—Rai Bahadur S. N. Mukerji, Rai Bahadur N. K. Sen, Rao Bahadur Viswa Nath. Mr Govind Behari Lal has been appointed the representative of this association in America. The Committee has been authorised to co-opt other members, whenever necessary, from other centres. Persons interested in the objects of the Association may communicate with the General Secretaries, The Chemical Laboratory, Delhi University, Delhi.

DR (Miss) M. M. Paranjpe Ph.D. (Lond.), has been appointed as assistant lecturer in the physics department in place of Dr Y. G. Naik at the Royal Institute of Science, Bombay.

DR P. B. Sarkar, D.Sc., (Dacca) has been appointed chief chemist at the Technological Laboratory of the Indian Central Jute Committee at Tollygunge, Calcutta. Dr Sarkar carried out numerous investigations on the chemistry of the jute fibre at the Chemical Laboratory of the Dacca University, and his work was recognised by the award of the D.Sc. degree. He has contributed several articles on jute in the columns of *SCIENCE AND CULTURE*, advocating the establishment of a Central Jute Research Laboratory, and the necessity of scientific research on jute. His appointment to the post, though belated, is further recognition of his outstanding contributions to the subject of jute chemistry.

THE appointment of Dr J. C. Ghosh as the Director of the Indian Institute of Science, which was recommended by the Council of the Institute, since, reported in the May issue of *SCIENCE AND CULTURE*, has been sanctioned by the Viceroy in his capacity as Visitor to the Institute. Dr Ghosh has assumed charge from the 1st August, 1939. On the eve of his departure for Bangalore, he was felicitated by the ex-students of the Institute at Calcutta. We join with them and his numerous friends in wishing him a happy and prosperous career in one of the biggest scientific positions of India. It is gratifying to note that Dr Ghosh was on the Board of Editors since the inception of this journal and has been the author of several editorials and other articles published in the journal. *SCIENCE AND CULTURE* is the product of the urgent desire of the country for a medium for disseminating the knowledge of science and its application to regeneration of national life, which objective incidentally agrees very well with the ideal of the late Mr J. N. Tata, the founder of the Indian Institute of Science, where Dr Ghosh now goes to direct its activities.

DR John B. Grant has been appointed to the directorship of the All-India Institute of Hygiene and Public Health with effect from July, 1939. Dr Grant took his pre-medical education in Nova Scotia and completed his medical and public health training at the Michigan and Johns Hopkins University, U.S.A. He has been a staff member of the International Health Division, Rockefeller Foundation, since 1918. The Greater part of his subsequent career has been occupied with public health teaching and administration in China and Japan, where he introduced several useful methods of improving community health. Prior to his present appointment, he worked for sometime as the Representative of the Rockefeller Health Division in the Far East.

SCIENCE IN INDUSTRY

Two Notable Centenaries

THIS year marks the centenaries of two inventions of exceptional significance, one being the centenary of photography, and the other that of the vulcanisation of rubber. Both have become so very intimately mixed up with our everyday life that we are apt to forget their contributions to the progress of science and civilisation.

That light affects silver salts was no new invention hundred years ago, but the actual process of making positives from negatives, i.e., the process of printing copies was discovered by Daguerre in January, 1839, in France. Two men, however, working independently of each other, evolved the first practical process of photography. In France the Government presented to the public working details of the process of Daguerre and awarded the inventor and his partner, Niepce, life pensions. The process, known as Daguerreotype, had a brilliant but limited existence. It was responsible for the metallic mirror-like portraits. Perfect detail was secured by this process, but only one copy of each camera picture was available. In England, Fox Talbot produced a method of photography on paper which, when perfected, allowed positive copies to be taken from a single original negative, made in the camera and developed by methods similar in principle to those used today. Fox Talbot's process, known as "Calotype" or "Talbotype", is the foundation of modern methods, and he may therefore truly be regarded as the father of photography as we now know it. Since then it has developed to a science of immense value to the world. The cinematography and the vast film industry owe their origin to the principles of photography. The eye of the camera has been adjusted to things that are too rapid for the human eye, and thus assists scientific researches, especially now that exposures of 1/100,000 seconds can

be secured. In medicine the use of camera with X-ray apparatus and in conjunction with the microscope has contributed much to the treatment of diseases and accidents. Astronomy, too, owes much to the camera, which by long exposures can reach the farthest stars. Bulky documents and books may be recorded photographically on a considerably reduced scale. The clothes we wear, the food we eat, the water we drink, all rely upon photography as a recording device for research and control of the product. X-ray photography not only provides a means of medical diagnosis, but also enables the safety of the airman to be ensured by the examination of hidden parts of his machine during construction. The photo-engraving industry which provides many of the illustrations in books and papers depends on photographic methods, and the recording of natural colour by the camera is also a difficult and fascinating branch, developing steadily.

The police use photography widely for criminal investigations. The spread of human knowledge has been hastened by the fact that everyone can now see pictures of events and objects which are at long distances or not easily accessible.

The discovery of the vulcanisation of rubber was made by Goodyear in America. It is also claimed that Hancock in England also discovered it simultaneously and independently. The combination of sulphur with natural rubber gave a material of lasting elasticity and resistance to changes of temperature, two properties in which natural rubber was seriously deficient. This invention opened up a wide field of application for rubber as can be seen from countless uses which the material finds today.

Both the preparations of photographic materials and the rubber goods are chemical industries of considerable magnitude, but in the field of manufacture India

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is at the farthest end of the procession though she is not a negligible consumer. N. K. S. G.

Limits of Pressure and Temperature

DURING the year 1918 boilers operating at a pressure of 375 lbs. per sq. in. represented an outstanding advance of about 75 lbs. beyond the regular practice and were recognised as approaching the limit for the type of the then standard design. In 1938, however, at a pressure of 1,375, lbs. and a temperature of 900 degree F. a million pounds of steam per hour were produced from a single boiler. In 1939 boilers are operating at a pressure of 2,000 lbs. per sq. in. and a temperature of 940 degree F. Yet the limit is not in sight, because newer ones with an operating pressure of 2,500 lbs. per sq. in. and temperature of 950 degree F. are under construction.

Compared with these values of temperatures and pressures the recent experiments with electric arcs in gases at the General Electric Laboratory at Schenectady are significant. Working with gases at pressure of many tons per sq. in., temperatures of more than 12,000 degree F., which is much hotter than the surface of the sun, have been attained. At the same time gas velocities of almost unbelievable values have been produced. Also a number of new facts regarding the properties of electric arcs have been discovered. For instance, it has been found that in hydrogen at high pressures it is not possible to maintain an electric arc, even for a short time; the velocity of the gas is so high that the arc is extinguished instantly.

Within a thickwalled cylinder of exceptionally strong steel different gases are compressed to pressures as high as 50,000 lbs. per sq. in. A switch is closed and a heavy current arcs across the chamber. The arc can be seen through a thick fused quartz window while working at relatively low pressures, such as 200 atmospheres, but at higher pressures an oscillograph is used to show what happens in the cylinder. When the arc gas is heated it expands and becomes very buoyant. This buoyancy gives rise to convection currents around the arc. The velocity increases with increase of pressure and though the velocity has not been measured they are believed to be extremely high. Thus by means of high pressures in completely closed vessels, the electrical engineer is able to attain high velocity gas blasts

without the use of pumps and auxiliary equipments. It is expected that the results of these experiments will have a very definite bearing on future circuit breaker designs. N. K. S. G.

Sound Reproduction on Paper

A SYSTEM of reproducing sound by means of paper originated by the Russian inventor Skvortsov, who died before the experimental work was completed, has been so far perfected that a recording has been made of one of the Mark Twain's stories. A description issued by the "Russia To-day" Press Service says that sound waves, increased by the usual methods of a film, are printed and duplicated on ordinary paper. To produce the sound, a ray of light follows the sound track passing through it and falling on to a photo-cell in a light stream of varying intensity. The photo-cell transforms the light waves into electrical waves, which in turn are transformed into sound waves by means of an wireless amplifier. It is estimated that under mass production a paper phonogram giving an hour's sound reproduction would cost one-fifteenth of the cost of an equivalent quantity of gramophone records and one two-hundredth part of the cost of a celluloid sound film giving an hour of sound reproduction. A paper phonogram would occupy one fiftieth of the space of a celluloid film, which is an important factor during transport. A paper phonogram can be played three or four thousand times, whereas a sound film will give only a thousand reproductions, and a gramophone disc much less. Thousands of positives can be printed from one negative in the case of paper, whereas celluloid film negative will only allow of a few dozens positives being printed from it. By means of the paper phonogram, speeches, lectures and any kind of music can be supplied to the public in thousands of copies within twentyfour hours of the original performance.— N. K. S. G.

Autoclaves and Electric Furnaces

Messrs. Chemical Industries & Engineering Co. of Calcutta, have put up in the market autoclaves, electric muffle furnaces, etc., manufactured at their works. We understand several of these are in use in some of the prominent industrial plants and research laboratories, including those of the University College of Science, Calcutta, and satisfactory results of their working are reported by the users. Very often difficulty is experienced in procuring articles of these lines in

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India at short notice and to exact requirements. The firm has therefore removed this difficulty and is perhaps the pioneer in taking up the manufacture of these heating appliances in this country.

A New Metallic Product

A NEW substitute for lead sheets used for packing has been developed in Germany under the name of *Sinterit*. It is made by exposing powdered iron in a reducing atmosphere at a temperature of 1,200 to 1,300 deg. centigrade. At this temperature the iron sinters into a solid sponge-like mass and does not melt. Due to its spongy character the substance is subject to more corrosion than ordinary iron. In order to increase the corrosion resisting properties 95 per cent of this iron is mixed with 5 per cent of a certain type of bitumen and then made into sheets to be used for packing. The finished product is very malleable and resists corrosion to a remarkably high degree. It is claimed that the product will not be expensive to produce. It can also be used to withstand high pressures in water pipes, as a packing material.—
N. K. S. G.

Floors for Industrial Purposes

PORTLAND cement has been found to be attacked by dilute organic acids such as lactic acid given by souring of milk, acetic acid encountered in food pickling industries, tartaric acid dominating in fruit industries, and stearic, palmitic and oleic acids present in oils and fats; hot sugar solutions also have distinct action on Portland cement. Aluminous cement is found to be more resistant however. Use of surface-hardeners such as zinc sulphate, sodium silicate etc., on Portland cement concrete imparts resistivity to abrasion but not to chemical action. Dairies and milk product concerns where the floor is subjected to abrasion owing to the rolling of churns and also to chemical action due to the presence of organic acids and fats, are best built on floors of hard acid resistant granitic asphalt mastic with cast iron grids.

Quarry tiles with aluminous cement mortar joints can satisfactorily resist the chemical action due to fats and brine solutions and at the same time are capable of withstanding heavy abrasion. These are therefore recommended for floors in meat and food preserving concerns. Blue bricks with an aluminous cement joint

is preferred as surfacings in factories handling animal and vegetable oils, sugar jams and fruit juices. Dense timbers like maple, Jarrah, or Gurjan, which are known to possess high resistivity to acids may also be recommended for this purpose but such floors will not be able to effectively withstand the abrasion where there is heavy trucking.

Serious cases of corrosion of reinforced concrete floors and steel works due to infiltration of solutions of common salt through pores and cracks have been observed. It is essential that in factories, where the wash water contains common salt e.g., in tanning and leather curing, the reinforced concrete sub-floors should be protected with an impermeable surface, such as asphalt which is not attacked by salt solution.

Change of volume of floors, due to change in moisture content, forms cracks which allow corrosive liquids, if present, to percolate through the floor resulting ultimately in disastrous effects. A sound practice to avoid this is to use a sand bed below the cement mortar on which the tiles are laid.

Whenever concrete is used it is advisable that the concrete should be dense with suitably graded aggregates and proper proportioning to ensure that the concrete can readily be consolidated. In view of the fact that the concrete must inevitably shrink away from the steel it would be good practise always to provide a protective coating of paint or bitumen to the steel before pouring the concrete. It has also been recorded that clinker concrete filling between steel joists has given rise to serious corrosion of steel. Thick reinforced concrete and hollow tile floors are equally effective in reducing air-borne sound whereas transmission of impact noises can be stopped by having floating floors or by dissociating the floor from the structure by some resilient material. Rubber, cork, rubber-bitumen and lino are recommended for this purpose.—
B. K. M.

Studies in Ghee Making

INVESTIGATIONS of far-reaching importance to the ghee trade are being conducted at the Imperial Dairy Institute, Bangalore. The popular method of manufacturing ghee (clarified butter) by curdling of milk by natural souring produces, at times, ghee of poor quality has been found. An attempt at an alternative method has been made at the Imperial Dairy Institute, Bangalore. The technique aimed at is so

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simple that it can easily be adopted anywhere. Citric acid is used for the coagulation of fresh milk. The product is churned and ghee obtained by heating the butter. The problem is still being investigated.

It has been observed

- (i) that there is a relationship between the rate of cooling and the size of grains;
- (ii) that the temperature at which ghee is made has an influence on the size of the grains. The higher the temperature the larger is the size of the grains on cooling;
- (iii) that repeated heating destroys the power of granulation;
- (iv) that cows' ghee develops smaller grains than buffaloes ghee; and
- (v) that the ideal temperature for making ghee with good aroma, colour and grains is 120°C.

Investigations on making ghee direct from cream are also being continued and the designing of a special ghee boiler for heating the cream is under progress.

A ghee boiler for use in rural areas is being designed, in which the arrangements for pre-melting solid butter or *kuchha ghee*, clarifying it and finally separating ghee from the sediment are being combined, and in addition, an effective device for automatic weighing of ghee obtained is being put in.

Separation of Minerals

AN interesting application of the fundamental research on water films undertaken in recent years is to be found in the new method for separating minerals. This "Sink and Float" method is based on a new phenomenon in physical chemistry, to which the term "tough water" has been applied. It was known for a long time that coal can be separated from slate, etc., by the use of a liquid which is lighter than slate but heavier than coal. These separating liquids must be recoverable. But they adhere to the surface of the minerals so strongly that at all events the losses due to the adherent separating liquid exceed the value of the recovered minerals. But if the minerals are coated previously with an extremely adherent and persistent

film of any other liquid it will prevent the adhesion of the separating liquid thus facilitating the recovery. The name "tough water" has been given to such a water film which is only a few molecule in thickness. This peculiar property of toughness is due to film stabilisers which are added to water. Among such stabilisers tannic acid and starch acetate have proved very effective. A 0.02 per cent starch acetate solution forms a film so tough that even the violent agitation of the minerals while under the disrupting influence of the separating liquid will not break it. So there will be no loss of the separating liquid with the minerals. Among the many advantages claimed is that the method will permit of delivering coal of standard ash content. It is also anticipated that the process will be useful in the treatment of iron ores and some other nonmetallic minerals. The separating liquids used may include halogenated hydrocarbons such as pentachloroethane and tetrabromoethane.—
N. K. S. G.

Newer Uses of Beryllium

THE use of beryllium is gradually increasing. It is being used for preparing special class of alloys with special properties. The most significant development in the use of beryllium during 1938 appears to have been in the wider use for the vital parts of the aeroplane engines. An 80 per cent ferro-beryllium is used for cementing steel. The metal dissolves readily in "gamma" iron and by a suitable technique a maximum penetration of 20 to 25 m.m. can be obtained, with the case-hardened surface showing a hardness exceeding 1,000 Brinell. Films of beryllium oxide are being considered for the prevention of tarnish on silver, but it has already been indicated that aluminium may be just as satisfactory, apart from being much cheaper for these purposes. Steel containing 36 per cent of nickel and one per cent of beryllium is non-heated. The exceptional fatigue resistance and good electrical conductivity of the beryllium-hardened copper provides a very useful material for flat and coiled springs. It has been reported by one manufacturer that vibrator springs heavily stressed 230 times per second and also subjected to severe changes of temperatures has exhibited no measurable alteration in their physical and electrical properties even after two billion vibrations. The world output of beryllium metal is still below 500 tons per year. The United States of America and German

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produce the bulk of the world supply in the form of alloys and Italy, France and Japan have small outputs.—
N. K. S. G.

Prosperous Year for Siemens

THE 43rd annual report of Messrs. Siemens and Halske and Siemens Schuckertwerke A.G., just received by us, is full of interesting facts. During the year under review (1937-38) their total turnover showed an actual increase of 20% over that of the previous year. The volume of business written by them, including their subsidiary companies, is more than 115 crores. A world-wide organisation, Siemens have a staff numbering 180,000. Last year, they secured the contract for installing a power station in Manchukua with 4 hydro-electric generators of 100,000 kVA each. The huge scheme of electrification of Uruguis on the river Rio Negro in South America was also carried out by this firm in the same year. They have also an extensive organisation in India which is too well-known to require any special mention.

Development of Essential Oil Industry

Jitendra Nath Rakshit
Rakshit Gardens Laboratory, Ghazipur, United Provinces.

Penfold, Smith, Baker and Read systematically investigated on essential oil bearing trees and plants grown in Australia and developed economically valuable industry in that country. Correspondingly organised researches are not being done in India, although abundant wild growth of oil bearing trees, plants, and grasses are found in Nature. Some scattered work was done but they are very few in comparison with the vastness of the subject. In the gardens and laboratory of the author there is a scheme of research (Cf. Rakshit, *Perfumery and Essential Oil Record*, July 1937, March 1938, and October 1938), involving (i) collection of oil bearing trees, plants, and grasses, (ii) botanical grouping of the

Essential Oil Industry

MANY of us are not appraised of the economic value of the natural resources of our country which we are allowing to be wasted. Plenty of shrubs, plants and trees that we find in fallow lands contain essential oils which are required in the medicinal, toilet and perfumery preparations. Some of these have been synthesised and are imported to our country. It is unfortunate that no systematic study of the oil bearing plants has been undertaken by the government agriculture departments; nor has any of our industrial magnates up till now paid any attention to such a prospective industry. In this connection we would invite the attention of our readers to the article on Development of Essential Oil Industry by Mr J. N. Rakshit, chemist at the Government Opium Factory, Ghazipur. Mr Rakshit has devoted considerable portion of his time and energy to the study of the subject. He maintains at his own cost a garden for growing these valuable plants and a laboratory to analyse the oils from the plants.

same, (iii) working out details of cultivation of the economically valuable varieties (iv) working out accurate methods of analysis of oils from each kind of plant, and (v) finally establish the mechanism of photosynthesis and influence of life factor in the molecules of the essential oils. Results so far obtained by the author seem to be useful in developing methods of economic exploitation of many of the wildy grown trees, plants and grasses in this vast country. It is needless to mention that it will take long time to work out a full chapter in the chemistry of Indian essential oils. Therefore it was thought that publication of a preliminary report may be helpful in attracting attention of many who are

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interested in the economic exploitation of the available resources of the country in this line, which necessarily requires collaboration of more than one chemist and more than one experimental station. Suitable trees, plants, and grasses were gathered from various sources and grown under supervision in the gardens of the author. About 1,500 gms. of twigs and leaves rich in essential oils were distilled with 2 litres of water in a galvanized sheetiron still of capacity 9 litres. Ordinary Leibig's condenser was used for condensation and distillation was continued till no more oil was seen in the distillate. Oils obtained were subjected to preliminary examination according to the standard methods recommended by the Essential Oil Sub-Committee of the Standing Committee on Uniformity of Analytical Methods. Since requisite quantities of samples of oils are not yet available it has been possible to record only a few important analytical data. Complete analysis of each one will be done after production of oil samples in sufficient quantities in course of time.

Oil Lemon

Three kinds of lemon trees were seen growing in this area,—Zamiri, Kagzi and Surbati. These were cultivated in the gardens, and oils were distilled mostly from fresh leaves and from small green twigs recovered from pruned over-grown branches. Oil obtained from zamiri lemon leaves and twigs was of light yellow colour and had very sweet aroma. The results of analysis are given below.

LEMON (Zamiri)					
Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
12- 9-38	0.20	0.8577	2.9	8.6	30
29- 3-39	0.18	0.8849	2.0	6.2	30
LEMON (Kagzi)					
1-10-38	0.23	0.8741	1.1	7.6	35
LEMON (Surbati)					
14- 9-38	0.25	0.8191	2.2	8.7	30
30- 3-39	0.11	0.8314	1.6	14.2	25

Ocimum Canum

Two kinds of shrubs are found in Ghazipur, both of which are called *Mumri* by the local cultivators. Seeds

of one variety of *Mumri* have been collected this year and it is hoped to grow it in suitable area. The other variety was found in sufficient quantity and was botanically identified as *Ocimum Canum*. This was carefully cultivated in these gardens, and the essential oil distilled was chemically examined (Cf. Rakshit, *Perfumery and Essential Oil Record*, October 1938). The oil obtained was very pale yellow in colour with strong but not unpleasant odour. The sample examined gave $\alpha_{30}^{\circ} 20^{\circ} 0.8914$, $N 20^{\circ}/D 1.4842$, $\alpha_{20}^{\circ}/D 2.66^{\circ}$, acid value 3.4; aldehyde 60% phenol 1.2 per cent; ester value 9.4; metryl no. 2.0. It contained about 50% citral, 16% citronellal, and 15% *l*-linalol. Quantity and quality of oil were found to vary with season. This would be evident from the following results obtained.

Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
10- 9-38	0.30	0.8915	2.4	0.0	45
3-12-38	0.20	0.9648	2.5	44 (??)	70(??)

The anomalous results of phenol and aldehyde determination of the sample of oil distilled in December requires further close examination. Some of the constituents of the oil must have undergone molecular change in course of the methods of analysis.

Ocimum Bacilicum

This plant gave an oil of considerable economic value being composed of about 52% methyl cinnamate and 45 per cent. *l*-linalol. A paper on the chemical examination of the oil was already published in the *Perfumery and Essential Oil Record*, March 1938. Some of its details are also given in *Rakshit Gardens Bulletin*, No. 2, page 8, 1938. The following qualitative and quantitative variation of composition of the oils distilled from the same plants at different season of the year is interesting.

Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
18- 8-38	0.28	0.9669	0.69	12.3	20
20- 9-38	0.36	0.9609	0.44	8.7	20
19-10-38	0.39	0.9689	0.60	9.6	25
26-11-38	0.29	0.9669	0.70	11.1	20
27- 2-39	0.28	0.9631	0.35	11.1	20
27- 3-39	0.20	0.9608	0.49	13.6	5
27- 4-39	0.48	0.9547	1.3	19.0	10

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Ocimum Bacilicum (light purple)

In 1935 a few ocimum plants were found amongst *Ocimum Basilicum* and *Ocimum Canum*, which did not look like either of the two. Probably those plants were products of cross fertilisation of the two other kinds grown in the gardens. These light purple *Ocimum* plants grow vigorously and resist weather conditions far better than the others from which they may have originated. Their colour of stem, twigs, leaves and flowering top differ from that of the corresponding parts of the other plants. These plants were carefully removed, planted separately, seeds collected for the next season, cultivated in 1937 and 1938, oil samples distilled, and preliminary analyses done, the results of which are shown below.

Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
21- 8-38	0.30	0.9666	0.89	11.4	20
21- 9-38	0.43	0.9684	0.62	7.4	25
27-10-38	0.43	0.9659	0.60	13.3	35
29-11-38	0.34	0.9100	1.30	12.3	25
26- 2-39	0.26	0.9920	1.10	12.5	10
24- 3-39	0.21	0.9780	0.68	12.5	10

Ocimum Sanctum (Krishna Tulsi)

Everywhere in the Ghazipur district, U. P. *Krishna Tulsi* grows in bushes. Its purple leaves, soft twigs and flowering top gave oils with following analytical results.

Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
30- 8-38	0.23	1.0112	1.1	76.0	20
12-10-38	0.23	1.0280	1.1	76.1	20
10-12-38	0.21	0.9866	1.64	64.0	25
2- 3-39	0.14	0.9421	1.4	55.0	25
6- 3-39	0.10	0.9738	1.4	45.0	25
4- 4-39	0.22	0.9692	1.4	50.8	15

Phenolic portion of this oil is eugenol, which is very valuable and is now supplied from cloves oil for perfumery, medicine, etc.

Ocimum Sanctum (Sri Tulsi)

Sri Tulsi grows almost side by side with *Krishna Tulsi* in odd places, with its leaves, twigs and flowering tops very light purple in colour being distinctly

different from the other. Some plants of this variety are practically pure green. Its oil samples gave:—

Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
9- 9-38	0.25	1.1242	1.04	75.8	10.0
10-10-38	0.33	1.0118	1.07	74.9	15.0
18-12-38	0.20	0.9681	1.70	64.5	15.0
20- 3-38	0.20	0.9255	1.0	50.0	15.0
20- 4-38	0.21	0.9820	2.4	56.8	15.0

Cymbopogon Citratus (Lemon Grass)

Cymbopogon Citratus is found growing in many houses for use with tea or with any hot drink in cases of cold and fever. This plant is being cultivated carefully in the gardens of the author for the past four years but it has not yet flowered. Therefore its proper botanical identification has not yet been confirmed. Systematically cultivated grass excluding roots gave the following results:—

Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
17- 9-38 (entire grass)	0.24	0.8791	9.4	7.6	95.0
5-10-38 (upper part)	0.34	0.8753	5.3	6.4	85.0
2-10-38 (lower part)	0.23	0.8928	12.9	7.2	95.0
18-10-38 (entire grass)	0.43	0.8841	5.8	5.6	95.0
30- 1-39 (entire grass)	0.47	0.8887	3.3	2.5	90.0

This is a very valuable oil containing a very large percentage of citral. A few local cultivators and other people have formed a Perfume Producers' Co-operative Society. Since last two years they have organised cultivation of this grass in villages and have been able to earn Rs. 20/- to Rs. 30/- per bigha.

Cymbopogon Martini (Motia)

Seeds of this grass were kindly supplied by the Forest Research Institute and College at Dehra Dun. This grass grew 3 feet high including its flowering top. It required very little cultivation and no watering. Its oil is very sweetly scented and is expected to fetch quite high price in the market. Its oil from the stem (without root) gave:

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Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
11- 9-38 (entire plant before flowering top)	0.27	0.7823	2.10	0.04	10
5- 2-39 (flowering top)	0.70	0.8156	3.2	6.6	15
10- 2-39 (lower portion without flowering top)	0.40	0.8788	1.6	6.0	10

Cymbopogon Schoenanthus (Palmarosa grass)

Seeds of this grass were kindly supplied by the Punjab Agricultural College, Lyallpur. In the garden the grass grew without much cultivation and required no watering. It grew about 4 feet high including flowering top. It also gave sweetly scented oil on steam distillation but perfumers attached more value to the oil from *Cymbopogon Martini* (Motia grass) than that from this one. But its oil will be sold at a higher price than lemon grass oil. Samples of oil from portions without root gave:

Date of distillation	Yield %	Specific gravity	Acid value	Phenol %	Aldehyde %
26- 8-38 (entire grass before flowering)	0.13	0.8842	1.7	5.3	30.0
18- 9-38 (entire portion before flowering)	0.19	0.8812	1.8	0.01	30.0
17-10-38 (entire portion before flowering)	0.21	0.8840	1.9	3.1	30.0
22-11-38 (flowering top)	0.98	0.8875	1.6	6.2	25.0
2- 4-39 (flowering top)	0.72	0.8587	7.1	10.0	10.0
28- 4-39 (flowering top)	0.82	0.8733	10.7	10.0	15
23-11-38 (lower portion without flowering top)	0.39	0.8860	1.1	6.8	20.0

2- 4-39 (lower portion without flowering top)	0.53	0.8847	2.3	5.7	10
3- 4-39 (lower portion without flowering top)	0.52	0.8791	1.5	10.0	10
29- 4-39 (lower portion without flowering top)	0.61	0.8797	1.0	8.0	10

This year the Forest Research Institute and College, Dehra Dun, has kindly supplied seeds of *Ahdropogon Martini* and *Veteveria Zizanoides*, which will be cultivated on experimental scale for the purpose of recovering essential oils from them. A superior quality of *Kush* grass and *Datura* plants have grown in these gardens, which contain sweet scented essential oils. In the case of the former the oil is generated in the roots and in the case of latter the oil is only found in the leaves. None of these require any watering and very little cultivation during the monsoon. Required quantities of oil samples are expected to be available next year for analyses and working out corresponding economic value in perfumery.

Although results already obtained are quite encouraging there is still need for further vigorous research on this subject in more than one laboratory. From the preliminary investigations so far done by the experimental cultivation of oil bearing trees, plants and grasses it has been found that, supplies will be possible at competitive rates of geraniol, linalol, citranellol, citral, eugenol, and methyl cinnamate. When researches will be fully complete, it will be possible to utilise these oil-bearing trees, plants and grass which abundantly grow without cultivation mostly on fallow lands, and the proper exploitation of these natural resources of this country according to economic requirements of the trade will lead to the growth of a big industry associated with agriculture.*

* The author desires to thank the Research Fund Committee of Chemical Society of London for the grant which has in part defrayed the cost of these investigations.

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Recent Advances in Medical Science

PROBABLY at no time in the world's history had the average citizen reasons to feel so secure against death by disease as at present. The rapid advance of medical knowledge has given mankind the means of conquering many diseases, of raising the standard of health and physique to a degree never known before and of warding off death itself. It is a great achievement and its promise of success in the future is even greater. Before the advent of advances in medical science human life was a frail thing and the survival of the infant was a rare occurrence. Up to the middle of 18th century, about threefourths of all the children born in London died before the age of 5; today the corresponding figure is less than twelve per cent.

This great progress in terms of human life and health has followed upon the application of experimentally discovered facts of biology to man. With the advance in knowledge the attitude of medical science towards its problems has changed. In the beginning, following the work of Pasteur, Lister and Koch, all diseases seemed to be due to the invasion of some micro organism, a hypothesis leading to great advances in prevention. But as many diseases cannot be explained on this basis and much ill-health is due to chemical unbalance in the body, it is the belief in more recent years that the invasion of the body by pathogenic organisms and the lack of chemical balance of the body are often associated with each other and that health or disease is largely a problem of chemical balance and reaction.

With the building up of the foundation of this knowledge of the body by the physiologists and the pathologists, the applied side of preventive and curative medicine has been developed. The methods of control

of many infective diseases have been evolved and the curative use of synthetic drugs, specific hormones etc., for the treatment of diseases have been established with great success.

A Paradox for the Hospitals

THE advances in sanitation and cleanliness; the application of which, developed by the science of bacteriology and immunology, has further brought many decimating diseases of centuries under control. Nowadays typhoid fever occurs only in a mild epidemic form and there is a sensational reduction in the mortality due to tuberculosis, common infections of childhood and in the general mortality in early and middle life (before the age of 50). However, there is an increased mortality due to diseases of later life e.g., cancer and diseases of the heart and circulation. There are however two diametrically opposite effects of medical advances on hospital and medical practice. On the one hand, the advances in diagnosis and treatment together with public consciousness with regard to health have resulted in the demand for more hospital equipment, which has increased enormously the cost of hospitals and made it more difficult for the sick persons to get the best attention outside. On the other side, these advances have led to a knowledge of prevention of disease which makes hospitals, doctors and nurses less necessary. Though the adoption of prevention is slow and though much less is heard about any discovery of this kind because it is not so dramatic as the discovery of curative methods, yet in near future it is hoped that the elimination of disease by prevention will greatly reduce the need for institutional treatment. In the hospitals we now rarely see cases of diphtheria, measles, whooping cough, scarlet fever etc.

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Future Work of the Doctor

AS the incidence of acute and fatal diseases of early and middle life is falling and as the average age of hospital patients is on increase, the hospitals will tend to become places for treatment of the aged and hence the future work of the doctor will also be changed. The doctor's duty will be mostly directed to protect young people against disease. Unfortunately, method of protection against the common cold or of reducing greatly the high incidence of digestive troubles is yet to be developed. The future of dental surgeons seems even more precarious as the knowledge of method of building up sound teeth, gum and jaws by proper feeding of infants and children becomes established. But the improvement in teeth may actually increase the amount of dental work, because treatment of caries, will be more worth while than at present.

The future of public health services will probably be limited for the provision of centres for the medical care of pre-school children and for controlling supplies of milk and other protective foods to the poor. If tuberculosis maintains the downward progression of the last seventy years the need for treatment centres and public health institutions will disappear by 1960. The treatment centres for venereal diseases will probably also decline greatly. The limiting factor in the success of any State scheme of health is the medical knowledge of the time. With the discovery of greatly improved methods of treatment the incidence of the diseases drops rapidly. As example, the recent discovery of 2-sulphanilylaminopyridine or sulfapyridine which cures 80% of the gonorrhoea in about a week's time and the recent decline in maternal mortality due to the discovery of prontosil and other sulphanilamide compounds and the establishment of the knowledge of puerperal sepsis due to streptococci conveyed to the birth canal from the respiratory tract of medical or nursing attendants may be cited. The present methods of treatment of cancer and some old age diseases should secure more attention now.

The Future of Population

SINCE the end of last century the expectation of life of the newly-born has increased by 16 years,

there is reduction in the birth rate and hence the proportion of old people has steadily risen. It is "Nature's best joke" that medical science is establishing optimum conditions of safe birth and healthy offspring just at the time when fewer babies are being born. Geneticists and psychologists are of opinion that this reduction in size of families is producing a lower average intelligence and economists say that it does not solve the unemployment problem and possibly makes it worse. The conditions for reversing the process are earlier marriage and a desire for larger families. Rejuvenation of old men for active service is not yet an exact process. The problem of degenerative changes in old age is a field which the medical science had not yet seriously tackled. Animal (rat) experiments have already shown that the life span can be greatly lengthened by diet but cardiovascular changes in them cannot be prevented. The problem of degenerative changes in the tissues is not solely one of nutrition but the inability of the cells to build up the special chemical substances of early life. With the advances in hormone physiology this problem does not seem to be beyond man's ability to solve. By finding the chemical process actually responsible for the degenerative changes it may be possible to defer the signs and symptoms of old age and to lengthen the active periods of human life.

Biological Problem in Colonies

IN colonial territories the limiting factor for the success of medicine is not the knowledge of tropical diseases but the provision of enough food for its population. Sir Edward Mellanby, F.R.S., in the course of his Robert Rede lecture on 'Some Social and Economic Implications of the Recent Advances in Medical Science', (a summary of which we have given above under the different headings) observed that most of the political, social and economic difficulties in tropical countries were biological in nature. It was a pity that more men with biological training and outlook did not hold the important administrative posts. He concluded with the remark that the adoption of the teachings of medical science for new discoveries depends on medical leadership, on doctors themselves, on public health authorities and on general intelligence. The medical man should keep pace with the medical literature and the new discovery. Otherwise he will be out of his proper vocation.

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Medical science and medical research have justified themselves. There is no limit to the amount of knowledge to be gained if the medical scientist is given the opportunities and facilities for his work and there should be necessary wisdom to make the best use of this knowledge.

X-ray in Aid of Midwifery

LIVES of mothers and babies can be saved by a method of X-ray diagnosis shown by Drs A. Louis Dipple and Webster H. Brown, of the Johns Hopkins Hospital, Baltimore, which won for them an American Medical Association certificate of merit. By a special method of taking the X-ray picture of the mother during the last three months before the child is born, the Hopkins doctors can tell whether she is likely to develop the dreaded condition of placenta praevia, in which

the "afterbirth" or placenta comes before the baby instead of after. This is one of the most serious complications of pregnancy, since there are no premonitory symptoms. The mother suddenly starts bleeding and the haemorrhage is so rapid and severe that there is rarely time to stop it before the mother dies. The condition occurs in about one of every 250 child-births. In hospitals under ideal conditions only about eight out of every hundred of these patients die, but when the haemorrhage starts when the expectant mother is still in her home, as is often the case, half or more of the mothers are lost and nearly half of the babies. This mortality could be cut to a very low figure, Dr Dipple believes, if every mother had an X-ray made during the last three months before the child's birth is expected. When the X-ray shows that this condition is present, the doctor can perform a Caesarean operation to deliver the baby before the dangerous haemorrhage starts.

Nutrition Studies in India

B. Ahmad

Department of Biochemistry and Nutrition,
All India Institute of Hygiene and Public Health, Calcutta.

During the last few years interest in the problem of nutrition has been steadily growing in India. Among the pioneers in this field were Col. McCay, Sir Robert McCarrison and Dr Chuni Lal Bose. Col. McCay¹ made extensive studies of the Indian diets and emphasized the importance of the protein element in nutrition. He showed in a striking manner the relative poverty in physical stamina of those sections of the Indian population who ate less of protein. McCarrison,² as Director of the Nutrition Research Laboratory, Coonoor, which was founded through his own efforts under the Indian Research Fund Association made classical studies of the condition resulting from nutritional deficiency. Dr

Chuni Lal Bose³ investigated the nutritive value of Indian foods, pointed out the defects of Bengali diet in a popular manner and showed the way to correct them. During these early years the work of the pioneers was like solitary voices in the wilderness. In the meantime the emphasis laid by the Health Organisation of the League of Nations on nutrition studies was gathering strength in European countries. The great drive against malnutrition which followed in the West did not fail to have its repercussions in India. The question of improving the nutrition of the masses which was relegated so much to the background came to the forefront. Further stimulus has been provided by the interest of the present Viceroy, Lord Linlithgow, and

¹Col. McCay wrote the well-known book, *The Protein Element in Nutrition*, 1912, London.

²*Studies in Deficiency Disease*—McCarrison, 1921.

³See *Scientific Papers of Dr Chuni Lal Bose*, Vol. II, 1925, Calcutta.

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an advisory committee on nutrition was set up in 1936 which began to formulate plans of action. In several parts of the country active scientific investigations on nutritional problem were taken up. Prominent among these are the Nutrition Research Laboratory at Coonoor, the Biochemistry and Nutrition Department of the All-India Institute of Hygiene and Public Health, Calcutta, the Indian Institute of Science, Bangalore, the Indian Institute for Medical Research, Calcutta and the scientific departments of the Universities of Calcutta and Dacca. The Indian Research Fund Association financed a number of enquiries into nutritional problems and many provincial governments appointed nutrition officers under their Department of Public Health which are undertaking surveys of diet and nutrition.

These studies of diet and the dietary habits of the people have yielded much valuable information regarding the extent of malnutrition and the nature of the dietary deficiencies that exist. Even more extended investigations are still needed along these lines. But while this scientific spadework is necessary as a first step towards a satisfactory solution,—for only the knowledge so gained form the basis of any sound policy to combat malnutrition in the country,—and while this work is proceeding, another line of work needs to be taken up in right earnest. This important line of work for which little has yet been done, is *nutrition education*—i.e., bringing the modern knowledge of nutrition to the mass of the people and making the people 'nutrition conscious.' Leaving aside the ignorant masses, even the average educated person today does not know much about the fundamental principles of nutrition. Even such traditional food consciousness that existed among the masses has been slowly obliterated.

Not very long ago games and contests of physical strength were a common aspect of village life.⁴ This made young men from their very childhood conscious of acquiring a good physique. Often this consciousness reached to such a pitch that good health and physique became a matter of pride and essential to self

⁴The writer has experience of village life in North-Western India. Wrestling and *Kabadi* were popular games among the villagers for which every young man trained himself and took part in them. Weekly contests and occasional inter-village tournaments in these and other games were common. What was true of these parts probably is true for other parts of India.

respect. It was known that in order to acquire a good physique it was essential to consume liberal amount of milk, curd and *ghee*. No pains were spared to procure these foods. The whole population was 'milk conscious.'

Changing conditions brought changes in all aspects of life. Desire for acquiring strength and physical prowess became confused as the weak and lean petty official from the town became the symbol of power. The supply of milk for village families dwindled with the increasing scarcity of fodder, through the disappearance of pastures and commons and the pressure of an increasing population on the land. With the increased facilities of transportation, milk became a commercial commodity and was attracted to the rapidly growing larger cities with their increasing prosperity and any ready money which became available was spent on the new ideas (cheap Japan made goods) that travelled back along the same channels. Under the new conditions, the consciousness and desire for physical strength has sunk to its lowest level. With economic stress, a large part of the population, is faced with the problem of obtaining enough food. It is not uncommon to see families living for long periods on cereal grains alone flavoured with some condiments to make it palatable. The investigations reveal deficiencies of protein, minerals, and vitamins. There was never more urgent need than today of educating the people in the principles of nutrition, to tell them what they need or how to make best use of what they produce.

With the exception of the deficiencies of protein and minerals which are most general but whose symptoms are somewhat diffuse, the signs of vitamin A deficiency appear to be very wide spread in the country. In most parts keratomalacia⁵ is of common occurrence and is the chief cause of preventable early blindness.⁶ Recent nutrition surveys indicate high incidence of xerophthalmia⁷ and phrynoderma⁸ in certain sections of the population. Night-blindness, especially in mild degrees, which

⁵Hardening of the surface membranes of the eye due to vitamin A deficiency.

⁶It is estimated that there are 4½ millions blind in India, half of which have become so through preventable causes. The great majority of these preventable causes which developed blindness in early life was due to vitamin A deficiency.

⁷Another eye-disease due to Vitamin A deficiency.

⁸Dryness of the skin combined with a papular eruption most probably a result of vitamin A deficiency.

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has been possible to detect only recently by the development of new methods in physiology, is found to be common in the population.⁹

The common sources of vitamin A are fish liver oil, milk and dairy products, eggs and the carotene bearing foods. On account of their higher cost animal foods are not generally within the means of the great majority of the population. With the exception of north-western part, fats generally consumed are the vegetable oils which are deficient in vitamin A. Fish liver oils which are exceedingly rich in vitamin A can only be taken as supplements. On account of the ignorance and the extreme poverty of the vast majority of the population, the improvement of food by such supplements have uptil now been of limited importance. If the people can be educated to its use and the price brought within their means, there is no reason why its use should not become more general. Assays of the vitamin A value of the liver oils of Indian fresh water and sea fishes show that they are exceedingly rich in vitamin A.¹⁰ Indeed the values indicate that most of them are 10-50 times richer than the average sample of medicinal Codliver oil in the market. The production of vitamin A-rich fish liver oils in India to combat malnutrition, especially in such centres where fish can be cultivated or caught in sufficient quantities can be undertaken with reasonable success and should engage the attention of the authorities.

Among the foods, milk and dairy products are the most important sources of vitamin A. Although the total production of milk in India is very high, the production per day per head of the population is only

⁹ Visual purple, a pigment present in the retina of the eye which is responsible for vision in faint illumination has been found to be a compound containing vitamin A. In vitamin A deficiency on account of the loss of function of the visual purple, vision in faint illumination is very much impaired and the person becomes night blind to a degree depending upon the deficiency of vitamin A. The development of recent methods for the estimation of degrees of night blindness by a visual photometer, appears to be a most promising method for the detection of mild and early signs of vitamin A deficiency.

¹⁰ Mr P. K. Seshan of the Biochemistry Department, All-India Institute of Hygiene and Public Health has investigated the vitamin A contents of the fish oils using spectrographic methods.

¹¹ N. C. Wright, *Report on the Development of Cattle and Dairy Industries in India*, Government of India Press, Simla, 1937.

about 8oz.¹¹ as compared to 15-20 oz. for other countries. Only about $\frac{1}{3}$ of this quantity is consumed as liquid milk and the rest being converted into other products. The extent to which milk actually enters into the food of the people is shown by some of the dietary studies. To mention only by way of example, milk and milk products were absent from the diet of 31 out of the 44 representative families of South Indian villagers,¹² while 37 families of industrial workers in Assam which formed a subject of one of the studies showed an average consumption of only half an ounce of milk per head per day.¹³ The desirability of increasing milk production and the consumption of milk and butter by the population needs no comment.

The next important sources of vitamin A are the carotene¹⁴ bearing foods. Nearly all the green-leaf vegetables, carrots, some fruits like mango, papaya, parsimon, palmyra, etc., and an oil obtained from a palm grown in Burma and superfluously in Malaya are rich sources of this vitamin A. The green leaves or the "saks", at least twenty different kinds of which are in common use, are the most important sources of carotene, being also the cheapest vegetable available. Their carotene contents varies from 30-120 mg. per gram i.e., only 13 oz. of the vegetable should be needed to supply adequately the daily requirements of vitamin A. It is somewhat surprising that vitamin A deficiency should still occur side by side with such foods so cheap and so rich in vitamin A. Two questions have engaged the attention of investigators in this connection; (i) the extent to which carotene is destroyed in the ordinary process of cooking and (ii) the extent to which carotene consumed is actually available to the organisms. Evidence is now available that there is no appreciable loss of carotene during cooking of vegetables, while extensive experiments on rats indicate that only 45-60% of the carotene ingested is actually absorbed. This fact however is not of so much importance if a constant and regular supply of the green leafy vegetable can be made available to the population at large. Palm oil as a cheap source of carotene is considered to have possibilities.

¹² Aykroyd and Krishnan, *Ind. J. Med. Res.*, 24, 667, 1937.

¹³ Wilson and Mitra, *Ind. J. Med. Res.* 26, 131, 1938.

¹⁴ It is a yellow pigment, present in all green vegetables, the yellow colour being masked by the predominantly green colour of chlorophyll. It is named after carrots which form a rich source of this substance. In the animal and human body carotene is converted into vitamin A.

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Whether it can be introduced successfully in India as a cheap article of diet is for the future to show.

Vitamin B₁ deficiency does not occur so extensively in India as might be supposed. Epidemic dropsy is found to have no relation to vitamin B₁ deficiency at all. Real beri-beri or vitamin B₁ deficiency is confined to a narrow strip of coastal area on the north-eastern coast of the Madras Presidency, a few areas in Bengal and Assam and to the coast of Burma.

It seems well established that beri-beri is generally associated with too exclusive a diet of milled or polished rice. Where whole, undermilled or parboiled rice is eaten, beri-beri does not occur. It is of special interest that on the west coast of the Madras Presidency where parboiled rice is eaten, beri-beri is quite unknown. Parboiled rice retains much of vitamin B₁ even after milling. Presumably during the process of parboiling the vitamin permeates into the rice grain. The cereals and pulses are the richest sources of vitamin B₁. Since cereals and pulses are consumed in fairly large amounts, the vitamin B₁ intake of the population is generally adequate. The danger of vitamin B₁ deficiency lies only in such instances when cereals are subjected to such treatments which cause removal or destruction of the vitamins. The vitamin is concentrated in the outer coating and the germ¹⁵ of the cereal grain. In case of rice the white silvery coating of the grain, which is removed during the process of milling or polishing, is the seat of the vitamin. The vitamin B₁ content of the rice therefore depends upon the degree of polishing to which it is subjected. When rice is boiled in a large amount of water and 'conje' or water is discarded, nearly half the amount of vitamin is lost in the discarded 'conje'. In the wheat grain, the bran and the yellowish germ contains all the vitamin B₁. Fine flour is therefore deficient in this vitamin. Whole meal bread or at least coarse *atta* should be eaten to ensure adequate vitamin B₁ intake. Recent studies on vitamin B₁ excretion by different individuals indicate that generally vitamin B₁ intakes are adequate and the people are in good state of nutrition with respect to this vitamin.

Vitamin C content of Indian food-stuffs has been quite thoroughly investigated on account of a simple

¹⁵ Tiny part of the grain which develops into the young plant when the grain germinates.

chemical method being available. Indeed this method has made possible to determine vitamin C from leaf to leaf in a vegetable and to discover the variations that exist. Variations from sample to sample in the vitamin C content of most vegetables are very wide. Seasons, climate, soil, manuring and degree of maturity are all contributing factors. The common varieties of mango early in the season (May) contain almost 15 mg. per cent of vitamin C but later varieties (July), the "langra" mangoes attain a value as high as 300 mg. per cent. The average value of cabbage is 40 mg. per cent but samples grown in Coonoor and picked fresh from the garden gave values as high as 125-130 mg. per cent. Indeed the values obtained for fresh vegetables assayed within half an hour of picking are 2-3 times higher than for the product purchased in the market. Thus the value of freshness cannot be too highly emphasized in the case of vitamin C contents of vegetables. There is a rapid loss of the vitamin after picking. Under conditions of temperature which commonly prevail in India almost 50% of the vitamin may be lost during the first 24 hours after picking, and as much as 75% in 48 hours. These remarks however do not apply to sour fruits e.g., orange, lemons, limes, etc. in which case the deterioration is quite negligible. The loss of vitamin C during the ordinary process of cooking is only about 25-30% provided none of the watery extract is discarded.

The assays of common foods show that fruits like guavas, pine apple, papaya, and certain varieties of mango, and among the green leafy vegetables, amaranth, cabbage, coriander, parsley and even green chillies are exceedingly rich in vitamin C. While common foods so rich in vitamin C exist there should be little danger of vitamin C deficiency occurring in the population. Enough surveys of the vitamin C nutrition of the population have not yet been made but there is some evidence that in many areas the intake is not optimum. According to one of the surveys vitamin C subnutrition seems to be quite common in southern India.

Vitamin D in relation to Indian diets and the incidence of disease due to its deficiency have not received sufficient attention in India. A few years ago Dr D. C. Wilson in her extensive and illuminating studies showed that rickets¹⁶ in all its forms and stages

¹⁶ Bony deformities in young children on account of improper calcification. The bones remain soft and are unable to bear the normal stress to which they are subjected in every day life. Therefore they get deformed.

MEDICINE AND PUBLIC HEALTH

occur in northern India and Kashmir. There is a high incidence of rickets osteomalacia¹⁷ in the over-crowded cities of the Punjab with their dark and narrow lanes, high sunless houses, densely populated bazars and among the purdah observing women and girls. In certain other areas of the Punjab, particularly the upper part of the Kangra valley, osteomalacia was endemic. It was widespread even in the villages where there is plenty of sunshine and people usually do sit for long intervals in the sun and the open air. The diet is grossly deficient in vitamin D. A systematic study of the vitamin D content of the diets of the people in those areas needs to be undertaken.

Lastly a few words might be added about the cereals and pulses which form the basic part of the diets all over India. The great majority of the population in India lives on these diets alone. Other articles of food e.g., meat, eggs, dairy products, vegetables and fruit are included in the diet only when the economic level rises. Cereals and pulses are therefore foods

¹⁷ adult rickets.

of considerable importance and needs considerable attention on the part of nutrition workers. How their nutritive value is affected through the treatment to which they are subjected for preparation as food needs fuller investigation. What is the difference, for example, between the nutritive and keeping value of leavened bread (Khamiri 'roti' baked in oven) as compared to ordinary 'chapaty' (freshly made dough baked on a hot plate)? Will the nutritive value of rice improve if it is eaten not in a boiled form in which the 'conje' is thrown away but as 'khichuri' i.e., cooked with vegetables and dal?

A critical examination of the food habits of the people in the light of the modern knowledge of nutrition is highly desirable. Nutrition education should follow in the line of the knowledge gained through such enquiries. The relatively well-to-do families need only to be instructed with the optimum food requirements for health and physical fitness. For the poor it is not only necessary to tell them how to make the best use of what they can afford, but new sources of food need to be explored, and so far as economic adjustments permit, agriculture should be made to serve the cause of better health and nutrition.

RESEARCH NOTES

A Living Fossil

In the May issue of SCIENCE AND CULTURE (4, 626, 1939) the discovery of a living Crossopterygian fish which had recently been taken off the coast of South Africa near East London was described. A very interesting account of the relationships of this form, for which the name *Latimeria chalumnae* has been suggested, was recently published by Dr Walter Gross of Berlin (*Naturwiss.* 27, 226, 1939).

This fish is rightly considered to be the most important zoological discovery of the present century; its morphological importance is even greater than the finds of the frozen mammoths in the ice-bound regions of Siberia, the living Okapi (*Okapia*) in the jungles of Central Africa, the aberrant reptile Hatteria (*Sphenodon*) in New Zealand and the egg laying Monotreme mammals, the Spiny Ant-eater (*Echidna* and its allies in Australia and Tasmania) and the Duckbill (*Ornithorhynchus* in South-west Australia and Tasmania), all of which were discovered during the last century. The morphological characters of special importance of the fish are its highly modified pedunculate paired fins, the peculiar plates covering the body, the lower jaw and the operculum.

The family Coelocanthidae to which the new genus *Latimeria* has been referred, were marine forms; their earliest known representatives are *Euporosteus* from the Middle Devonian and *Diplocercides* from the Upper Devonian. During the last decade the Crossopterygians have received a great deal of attention from several distinguished palaeontologists such as Watson, Stensio, Save-Soderbergh, May-Thomas, Westoll, Jarvik and Romer, and it has been more or less established that they or their near ancestors were the ancestral types from which the four-footed terrestrial forms were evolved. Middle and late Devonian epochs apparently formed the heyday of the Crossopterygian development, and

Stegocephala, the oldest known quadrupeds, were evolved from them during the late Devonian epoch. During the Carboniferous epoch apparently a rapid reversal set in, but all families and genera were evolved before the Upper Permian. The Coelocanthidae occur as late as the Cretaceous, but no Tertiary or recent forms had so far been discovered; the genus *Polypterus* which has often been classed as a Crossopterygian, is really a Ganoid fish.

A close study of the soft-parts, such as the nervous system, the sense organs, the circulatory system, the gills and the air-bladder of the recently discovered *Latimeria*, which is undoubtedly a deep-sea form, is sure to lead to outstanding results in regard to the structure of the ancestral types of the terrestrial quadrupeds.

B. P.

Movements of Salts in Plants as Indicated by Radioactive Isotopes

The study of the movement of mineral salts or elements in plants has been a subject of intensive investigation from a considerable long time. Due to the difficulty of the experimental methods and handling of the plant material no definite results could be obtained so far. Recently the study of the movement of the mineral elements in plants is greatly facilitated by the use of indicator elements which are not initially present in the plant. Bromine and rubidium have been extensively used in experiments on transports and accumulation by Steward. Radioactive isotopes possess certain obvious advantages in following rapid movements of mineral salts because it is possible to conduct experiments with ions which are known to be involved in the normal physiology of plants, and the readiness with which the radioactive isotopes can be detected in extremely small amounts, enables one to make observations on small sample of tissues within relatively short periods of time. The prevailing view of botanists is that

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xylem is the primary channel for the upward movement of the mineral elements but this view has been questioned by Curtis. Clements and Engard (1938) have presented strong evidence based on ringing experiments in favour of xylem as the chief path of upward movement of salt but Gustafson and Darken (1937) observed radioactivity in all parts of the plant whether the plant had a ring of bark or a section of xylem removed. Their general conclusion was that both xylem and phloem function in the upward movement of mineral salts. Recently P. R. Stout and D. R. Hoagland have contributed (*Amer. Jour. Bot.*, 26, 320, 1939) further evidence in favour of xylem as the path of upward movement of mineral salts based on their experiments on upward and lateral movement of salt in certain plants as indicated by radioactive isotopes of potassium, sodium and phosphorus absorbed by roots. The experimental plants were cotton, geranium and willow, grown in culture solutions and the 'stripping technique' was utilised. They found that salts absorbed by roots enter xylem within a very short period and is carried rapidly towards the leaves under the influence of transpiration, so that within an hour or less the radioactivity could always be detected in the uppermost leaves. In their upward movement in the xylem the salts are distributed laterally and this lateral transfer is much more greater than the amounts which move longitudinally in the bark. The same behaviour has been demonstrated by radioactive phosphate, potassium, sodium and bromine ions. The evidence is consistent with the view that xylem is the path of rapid upward movement of salts in plants.

B. K. K.

Influence of Ultra-violet Irradiation on Cholesterol Content

It is well known that malignant tumors are produced by ultraviolet radiation. Many investigators have produced malignant growths in mice and rats by irradiation. Rats exposed to ultraviolet radiation, beginning with a five minute daily dose, and gradually increasing to 20 hours daily, developed tumors on the eyes, ears, and back of the head in 6 to 8 months. These experiments have been repeated and the results verified by producing

sarcomas and carcinomas on the eyes, ears and heads of rats.

Now cholesterol has been of particular interest in the field of tumor chemistry. It has been found that malignant tumors contain large amounts of cholesterol and its esters, while blood serum is lower than normal in cholesterol. In the whole organism of tumor mice there is an increase of cholesterol-esters. Histological methods have also proved the presence of larger amounts of cholesterol in malignant tumors than in benign ones. It has also been reported that malignant tumors contain a much higher percentage of fatty substances—neutral fat, phospholipid, and cholesterol—than less malignant ones. A. H. Roffe (*Amer. J. Cancer* 17, 42, 1933; *An. Facult. Med., Montevideo* 1, 1916 and *Bol. Inst. Med. Exp. Estud. y trat. Cancer*, 7, 22, 1930) has emphasized that cholesterol must play a predominant part in the formation of tumors. This is based on his observations that cholesterol is greatly increased in neoplastic tissue, particularly in tumors of the skin, that it is present in precancerous stages, and that exposure of rats to sunlight and ultraviolet radiation results in great increase in the cholesterol content of the skin. He suggests that cholesterol prepares the soil for subsequent malignant growth by acting as an accumulator of light.

Kundson, Sturges and Bryan (*J. Biol. Chem.*, 128, 721, 1939) exposed adult rats of both albino and piebald strains to ultraviolet radiation. By increasing the dose of irradiation gradually to 20 hours daily they continued the experiments for about 8 months. During the period of irradiation some animals were killed off at varying intervals after irradiation, and skin tissues and blood analysed for total and free cholesterol. Two months after irradiation, skin lesions began to appear and the first tumors occurred in about 5 months. Later other tumours appeared. These tumors developed on the eyes, ears and nose and were of the same type, as those described by previous investigators.

The animals with tumors were killed off at various intervals and the tumors and the skin analysed for total and free cholesterol. The tumor tissue was carefully cleaned, and, if necrotic, this was separated from the rest of the tissue and analysed separately.

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From the experiment detailed above, the authors find that the total cholesterol content of the skin is increased by ultraviolet irradiation, the skin from the face showing an increase, in some instances of several hundred per cent, and averaged about 100 per cent. The cholesterol content of the skin from the back and abdomen is only slightly increased. The tumors formed by ultraviolet irradiation show a high cholesterol content and about 80 per cent is in the free form. In the irradiated rats the total cholesterol content of the blood is somewhat below the normal level, which is in striking contrast to the increase of cholesterol noted in both the skin and tumors of irradiated animals.

H. N. B.

Spontaneous Disintegration of the Mesotron

Many interesting discussions have been made on the spontaneous disintegration of the mesotron into an electron and a neutrino, and it has generally been accepted that the mesotron possesses this natural radio-activity. A mesotron track was reported by Maier-Leibnitz which seemed to have an ordinary electron track starting from where the mesotron track ended. This, if true, may be taken as a direct proof of the spontaneous disintegration of the mesotron. But as the photograph was not taken with a stereo-camera one

cannot be sure that the end of the mesotron track and the start of the electron track coincide.

The main support in favour of the acceptance of the hypothesis of the radioactive mesotron is the so-called agreement between the theoretical value of the life period (0.25×10^{-10} sec.) of the mesotron as calculated from Yukawa's theory and the experimental value (2.6×10^{-10} sec.) as calculated from the difference of intensity of penetrating-cosmic rays in different directions (Euler and Heisenberg). In the theoretical calculation according to Yukawa's theory the interaction between the heavy electron and the light particle field (i.e., the field of the electron and the neutrino) has to be introduced, and the necessary constant is obtained from the decay constant of naturally radio-active elements. But if the same constant be taken for artificially radio-active light elements, the value of the life time of the mesotron comes out to be of the order 10^{-10} sec., a value differing by three orders from the experimental value. Moreover, recent photographs by Maier-Leibnitz (*Zeit. f. Phys.* Vol. 112, heft 9 and 10, 1939) show no electron tracks associated with mesotron track endings. So the position is that there is neither experimental evidence nor theoretical agreement to support hypothesis of a naturally radio-active mesotron. We are, therefore, inclined to doubt whether our attempts at approach towards the theory of nuclear forces has at all been correct.

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PROCEEDINGS AND PUBLICATIONS

National Institute of Sciences of India

(Calcutta, July, 1939, Proc. Nat. Inst. Sc. Ind. 5, 1-165, 1939).

- M. N. SAHA: Solar control of the atmosphere.
 S. R. SAVUR: Seasonal forecasting in India.
 S. BASU: Medium-range weather forecasts.
 S. N. SEN AND H. R. PURI: Air-mass analysis and short period weather forecasting in India.
 S. K. PRAMANIK: Forecasting of Nor'westers in Bengal.
 K. R. RAMANATHAN: Upper air data and weather forecasts.
 N. K. SUR: Latent instability in the atmosphere and its consequences.
 S. P. VENKATESHWARAN: Rainfall due to winter disturbances and the associated upper air temperatures over Agra.
 S. K. PRAMANIK: Upper air data and daily weather forecasts.
 P. R. KRISHNA RAO: Weather forecasting for aviation with special reference to local forecasts.
 S. K. BANERJI: Kinematical methods in weather forecasting.

(Calcutta, July, 1939, Trans. Nat. Inst. Sc. Ind. 2, 1-87, 1939).

MITHAN LAL ROONWAL: Amplification of the theory of multi-phased gastrulation among insects and its applicability to some other arthropods.

Indian Physical Society and Indian Association for the Cultivation of Science

(Calcutta, April 1939, Ind. Jour. Phys. Vol. XIII Pt. II)

- A. C. BANERJI AND NIZAMUDDIN: Jupiter's Atmosphere.
 P. L. KAPUR: A note on the transmutation function for deuterons.
 S. R. DAS AND K. GHOSH: A study of sulphur allotropes by the X-Ray diffraction method (Part II).
 S. K. MITRA AND A. K. BANERJEE: The fringe of the atmosphere and the ultra-violet light theory of aurora and magnetic disturbance.

Indian Chemical Society

(Calcutta, May, 1939, J.I.C.S., 16, 223-260, 1939)

- S. M. MEHTA AND M. B. KABADI: The electrical conductivity of solutions containing zinc hydroxide and sodium hydroxide.
 M. C. NATH AND P. L. MUKHERJEE: Crystallographic investigation of artostenone, the stenone isolated from the Indian summer fruit, *Artocarpus integrifolia* by means of goniometer and X-rays.
 W. V. BHAGWAT: Dissociation constants of some organic acids from solubility measurements.
 PANCHANAN NEOGI AND KANAI LAL MONDAL: Resonance reaction Part II.
 BAIDYANATH GHOSH: Vitamin C and toxins. Part III. The effect of diphtheria toxin on vitamin C metabolism.
 R. K. BAHL AND SURJIT SINGH: Action of fuming nitric acid on iodine.
 S. S. BHATTNAGAR, A. N. KAPUR AND MAHENDRA SARUP BHATTNAGAR: Adsorptive properties of synthetic

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resins. Part II. Adsorption of potassium salts of various anions.

S. R. PALIT AND G. N. BHATTACHARYA: A note on the basicity and molecular weight of shellac.

Royal Asiatic Society of Bengal

(Calcutta, 3rd. July, 1939)

K. B. ZAFAR HASAN: Manuscript copy of the *Diwān of Dārā Shikūh*.

GIRINDRA SEKHAR BOSE: Reconstruction of the *Āndhra chronology*.

BAINI PRASHAD: An old letter from James Prinsep.

RESEARCH WORK DONE IN INDIA

Solar Physics Observatory, Kodaikanal

In continuation of observations and measurements of Intensity Profiles, a photometric study of the changes of magnesium *b* group and other strong Fraunhofer lines from the centre of the sun's disc to the polar and equatorial limb has been undertaken. The 3rd order spectrum of a 20ft. grating spectrograph was used for this purpose. A statistical study of prominence areas to determine the possible influence of the earth on solar prominences is also under progress. The spark spectrum of bromine from 2200 to 6500 Å has been photographed and measured. A new multiplet has been identified and 5D terms located. Precise measures of intensity have been made by photographic photometry for the lines of the above multiplet under varying degrees of excitation.

Compared with the previous year, the number of new groups of sunspots observed showed a decrease of 13 per cent and the mean daily numbers a decrease of 16 per cent. There were no days on which the sun's disc was free from spots. The approximate mean latitude of the spots was 15°2' in the northern hemisphere and 14°7' in the southern. Bright reversals of the *H α* line over the sun's disc observed with the spectroscope in the neighbourhood of sunspots numbered 827 as against 891 in the previous year. The displacements observed in the neighbourhood of sunspots numbered 65 as against

73 in the previous year. Of these 43 were towards the red, 8 towards the violet and 14 bothways simultaneously. D₃ was observed as a dark line on 789 occasions as against 826 in 1937.

Calcium prominence areas show an increase of 12 per cent whereas the numbers show a decrease of 6 per cent when compared with the previous year. The northern hemisphere shows a slight preponderance of activity over the southern. The distribution of areas and numbers in latitude showed a tendency to increase in low latitudes up to 40° and to decrease in zones of high latitudes. During the second half of the year the high latitude peak became unimportant so that the activity was confined mainly to within 60° of the equator in both the hemispheres.

Twenty metallic prominences were observed in the northern hemisphere and 28 in the southern hemisphere and all these were between latitudes 4° and 36°. Displacements of the *H α* line in the chromosphere and prominences observed during the year with the spectroscope numbered 323 as against 369 in 1937. Of these 176 were towards the red, 124 towards the violet and 23 bothways simultaneously. The largest displacements noticed were 6 Å to red and 8 Å to violet. Of the displacements observed in prominences with the spectrohelioscope 97 were in the northern hemisphere and 90 in the southern, and 100 were on the east limb and 87 on the west limb. Displacements to the red numbered 99 and those to violet numbered 88. The largest displacement in prominences observed in 1938 was 4.0 Å to violet.

The greatest height recorded of eruptive prominences on the limb was 13' on May 6, S. E. limb. The prominence of December 24 rose in latitude N 20° on the west limb and poured into a centre of attraction in latitude S 64°. There was no sunspot area in the neighbourhood. A striking feature of the prominence was its spiral structure. The mean daily areas of prominences projected on the disc as hydrogen absorption markings amounted to 10161 millionths of the sun's visible hemisphere as against 9490 millionths in the previous year, showing an increase of 7 per cent. Their distribution in latitude is similar to that of calcium prominences except that the activity in the zones 20°—25° in the northern hemisphere and 15°—20° in the southern

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hemisphere is more pronounced in the case of the $H\alpha$ absorption markings.

Forest Research Institute Dehra Dun

An account of research work which is being carried out in the Utilisation Branch of the Institute under different Sections is described below.

Wood Technology Section:—The Wood Technology Section deals with various types of problems in connection with timber identification and utilisation. Investigations are being carried out on the formation of growth rings in chir (*Pinus longifolia*), champ (*Michelia champaca*), cutch (*Acacia catechu*), jaman (*Eugenia jambolana*), kokko (*Albizia lebbek*), sal (*Shorea robusta*), semul (*Bombax malabaricum*) sissoo (*Dalbergia sissoo*), laurel (*Terminalia tomentosa*), teak (*Tectona grandis*) and toon (*Cedrela toona*). Interesting data have been collected regarding the time of active growth season, the rate at which various types of cells are formed in any particular season and finally whether these trees actually have some structural marks in the wood indicating the annual increments. Other important items of investigation are resin tapping in chir pine (*Pinus longifolia*) and gum tapping in karar (*Sterculia urens*). An anatomical and physiological study of the present method of tapping is being made with a view to making some improvements. Researches are also being carried out on the anatomical structure and technical properties of some commercial timbers.

Timber Testing Section:—More than 10,000 tests were done for the determination of the fundamental strength properties of Indian timbers in addition to a large number of tests made during the year for special investigations connected with plywood, tea chests, poles, hammer handles etc. A most important investigation for finding out suitable Indian timber species for aircraft construction has been undertaken. A publication entitled "Charts for the Design of Timber Beams by Limaye" was issued for the use of engineers and timber users in general.

Wood Seasoning Section:—Air seasoning characteristics of various woods were investigated and the information has been written up for publication. An investigation into the kiln drying of light hard woods for packing cases was carried out. The drying time for $\frac{1}{2}$ " thick tula (*Tetrameles nudiflora*) shooks was found to be as low as 30-36 hours. Trials with the soaking of green wood in a solution of common salt prior to the kiln drying were carried out. Only in case of one species of wood, viz., axlewood, did the salt soaked planks show slightly less cracking than the untreated material.

Various investigations connected with the shrinkage, swelling and hygroscopic behaviour of wood, impregnation of wood with various chemicals to retard the swelling and shrinkage, the effect of various coatings to make wood moisture proof, and to prevent the end-cracking of timber etc., have been carried out. Experiments were started on the suitability of indigenous wood for the manufacture of shuttles, bobbins, tool handles, battery separators etc.

Paper Pulp Section:—In this section the following were the more important investigations in progress during 1938-39:

- (i) Production of wrapping and packing papers from *Anthistiria gigantea* (ulla grass) and *Pinus longifolia* (chir), both found in the United Provinces.
- (ii) Studies on the grinding of *Pinus longifolia* (chir) from U.P. and *Kydia calycina* (bendi) from Mysore, with a view to prepare mechanical pulp for the production of cheap printing papers.
- (iii) Studies on the discolouration of bleached pulps and papers, and on the two-stage system of bleaching pulps.
- (iv) Investigations of grasses from Rewa State, Cuddapah and Kurnool as to their suitability for paper making.
- (v) Testing of Sar grass from Sind and dab and gander grasses from Jeypore.
- (vi) Preparation of insulation and pressed boards from bagasse.

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- (vii) Investigations on the possibilities of improving the current indigenous method of making paper by hand on a cottage industry scale.

Wood Preservation Section:—A few experiments were carried out on the treatment of green posts by the sap displacement process using old inner motor tubes. Complete penetration in the case of *Pinus longifolia* and penetration of the sapwood in the case of *Shorea robusta* and *Tectona grandis* was obtained.

Poles of *Terminalia tomentosa* and *Shorea robusta* were treated with Aseu and Creosote-fuel oil mixture and service tests on these poles started in order to compare the relative efficiency of the two preservatives for pole work. Poles of *Casuarina* and *Brugiera* spp. were also tested for their amenability to treatment. Interest has been revived in the treatment of Indian timbers by the open tank process with creosote and tests with specific species were carried out as required. Investigations were also initiated into the causes of failure of treated poles and railway sleepers. Equipment for the measurement of thermal conductivity and sound absorption were installed and some work done. An investigation on the variation of the thermal conductivity of

wood with species, moisture content etc., with particular reference to Indian timbers was initiated.

Wood Workshop Section:—The undermentioned research work was carried out in this section during the year:—

- (i) Testing of Indian timbers for veneers and plywood.
- (ii) Testing of the working qualities of Indian timbers to ascertain their suitability or otherwise for use in furniture work, cabinet making, constructional work, agricultural implements, tool handles, sports goods, toys, wagon and coach building and for many other purposes in which wood is embodied.
- (iii) Testing of cements and glues for use in the manufacture of plywood and laminboards.

Minor Forest Products Section:—Experimental cultivation of various medicinal plants like *Digitalis* spp., *Belladonna* etc. was continued. Very soft charcoal like that of *Cryptomeria Japonica* from Bengal has no demand and experiments on the briquetting of this charcoal with cheap binders like powdered rice and tamarind seeds have been carried out and appear promising.

BOOK REVIEW

The author's review of the growth of the police in India is interesting and refreshingly frank. The police in India is definitely backward in the matter of scientific equipment and detection—and there must be widespread endorsement of Sir John Woodburn's opinion that the investigating staff was "dishonest and tyrannical." His treatment of the interaction of heredity and environment in relation to criminality is intriguing and his remarks apropos of the *Harijans* and Brahmins are bound to be appreciated. The discussion of the correlation of race and crime, religion and crime, science and crime and their metaphysical aspects have been intelligently analysed and collated with reference to standard works. But the author's classification of types of criminals does not appear to be complete and exhaustive. His treatment of juvenile criminality would have been much appreciated if the author could have suggested how the important problem can be tackled and adjusted, with special reference to the culture and genius of the Indian people. Again in his delineation of such topics as forms of punishment and the institution of imprisonment, he might have been more informative regarding the theory of capital punishment. His review of penal methods is interesting and we think the methods followed in Soviet Russia and in other countries may be incorporated in the next edition of the book for the benefit of the readers.

We do not, however, agree with the author in his recommendation of the system of public defence. It is theoretical and sentimental. Parmelu speaks of the innocent victims of public prosecution. Who is to determine this and when? We do not also approve of the way in which the author has tackled the topic of lawyers in the legal hierarchy of India. We are surprised at the author's remark that the better class of lawyers practise on the civil side—the criminal side being mostly done by the Muktears. In the first place, it is wrong as a fact secondly it connotes an undeserved slur upon the latter body.

The chapter on 'The principles of evidence' might well have been omitted, without doing violence to the general scheme of the work. We are afraid, the author has not fully comprehended the significance and implications of the basic principle

viz., that it is better that many guilty persons should escape than that one innocent man should suffer.

The author is more at home in the realm of criminal investigation. He has negotiated this problem adroitly and his suggestions deserve the attention of the authorities.

The book concludes with some appendices which are not without value. We cordially endorse the author's suggestions for a revision of the Indian Penal Code. It is out of date in important particulars. The *Zei tgeist* is swimming fast. We must begin to approach penal problems from a new angle of vision. The law of sedition is very unsatisfactory and some of the sections are mere anachronisms. New types of crimes have also been ushered into existence. Not unoften, criminals seek a loophole for retreat, by the inelastic character of the old sections.

In the author's treatment of the subjects, the topics sometimes consciously, and sometimes automatically have coalesced and overlapped. With a little more thought however, the author will be able to reduce the book to convenient proportions. There is sometimes no proper setting and no systematic evolution of thought.

The book however, displays considerable industry and thought and the author should be congratulated.

S. C. T.

USES OF LAC—by H. K. Sen and S. Ranganathan, (Lac Research Institute, Namkum, Ranchi). Pp. 78. Price Re. 1/4/-

This booklet from the facile pen of the director of the Indian Lac Research Institute and his able assistant is an excellent handbook of general information on the various possible commercial utilities of lac.

After tracing the history of the early uses of lac the authors begin the book by briefly discussing the present position of the trade in lac and gives the different centres where the lac-producing insect is cultivated in India. Though lac is used less in certain industries due to the discovery of aniline and alizarine colours and of synthetic resins, it occupies an important position in several industries.

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220,000 cwts. of shellac are annually consumed in the manufacture of gramophone records and, in fact, this industry provides the largest single outlet for the consumption of shellac. The several processes of the manufacture of the gramophone records have been exhaustively described and there are several illustrations. Further researches to produce better gramophone records are being carried on at present at the Indian Lac Research Institute.

Synthetic resins are nowadays finding increasing applications in the manufacture of moulded electric insulators by virtue of their cheapness, superior mechanical and thermal properties and economy in moulding operation. But if the price of shellac is kept at its present low level and a spirit of intensive research is maintained, whose results up to date are very encouraging, the authors hope to revive the use of shellac in this industry. Next in importance comes the manufacture of shellac bounded mica and paper products. Shellac is also used as protective and decorative finishes on wood, metals, paper, leather and cloth. Several formulae for the preparation of bobbin enamel, anti-corrosive paint, anti-fouling paint and shoe-dressings are given in the book. The subject of nitro-cellulose lacquers has also been briefly discussed.

There are some minor industries like the manufacture of felt, silk and straw hats, of sealing wax and of grinding wheels in which shellac is required. Useful formulae for the preparation of various types of cements and inks using shellac as a constituent are given. These preparations may open some possible sources of income for the unemployed educated youths.

In concluding the book the authors have reviewed the technical investigations undertaken at the Lac Research Institute in England and India for improving the properties of shellac in order to improve its qualities, for the existing industries and to secure new uses. There is a brief but comprehensive summary, with references to original bulletins published by the Institutes in England and India, of the other techniques developed at the research stations for the recovery of lac from *kiri*, for the manufacture of bleached lac, hard and soft lacs and of polishes, paints and varnishes. The

appendix dealing with the accepted standards, adopted by the U.S. Shellac Importers Association, for the different varieties of lac exported from India will be useful to those engaged in the trade. A bibliography of publications on the subject is also added.

The booklet which is neatly printed, well got-up and amply illustrated is sure to be appreciated by persons interested in this particular industry.

B. K. M.

PRINCIPLES AND PROBLEMS OF LABOUR LEGISLATION—by Dr Rajani Kanta Das (University of Calcutta, 1938). Pp. XIV+276, with an index.

Dr R. K. Das has for over two decades interested himself in the study of the various aspects of India's labour problems, and his association with the International Labour Office as senior member and research economist gave him the rare facility of a thorough comparative study of labour laws in various countries.

The Readership lecture contained in the book under review form part of a planned objective study leading to a consideration of labour legislation as an engine of social uplift. It should not therefore be classed either with journalistic or descriptive books on Indian labour, often meant for enlisting sympathy to the labour cause, or with the analytical investigation. The first chapter gives the historical background of labour legislation in British India and the Indian States, and is followed by a lucid chapter on legislative procedure. In the third chapter on "Fundamental Principles" an attempt is made to evaluate labour legislation from the point of view of social justice, social welfare, national economy and international solidarity. This and the fifth chapter on the social significance of labour legislation would certainly add to the author's reputation as a scholar with sound judgement and originality of approach.

More than a year ago the Working Committee of the Indian National Congress decided upon collecting information with a view to the inauguration of a uniform policy "to secure to the workers a decent standard of living, of hours of work, and conditions of work as far as economic conditions permit with international standards, suitable

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machinery for the settlement of disputes between employers and workmen, protection against the economic consequences of old age, sickness and unemployment and the right of workers to form unions and to strike for the protection of their interests." Every item of the above programme presents sociological and economic issues on which Dr Das is both illuminating and constructive. In the wake of provincial autonomy the pace and policy of the

Princes are becoming unequal and confused. Further a look at the latest Annual Report of the Administration of the Factories Act in Bengal, for instance, would reveal a lukewarm enforcement of labour legislation in the province. Except in Bombay and possibly Madras things are not much better in other parts. Dr Das's treatise comes at an opportune moment to rouse public conscience and guide public policy in matters concerning labour at a critical stage of her industrial development.

B. N. B.

Dante not Nordic, but Mediterranean

The iconography of Dante, author of the *Divina Comedia*, and according to some authorities the greatest Italian of medieval times, is reported to be very uncertain and disputed. To identify his face, recourse is to be taken to anthropological evidence directly obtainable from the skeleton itself. In 1921, on the occasion of the 600th anniversary of the great Italian, the Mayor of Ravenna with government permission exhumed the body and then followed a morphological analysis and the metrical analysis of the skull and face. The skull has been found to be oval, and it, taken along with traditions of the presumably brown skin and dark hair transmitted to us by Boccaccio and other contemporaries of Dante, confirms the belief that the great Italian belonged to the Mediterranean race. Special features of his skull and face indicate his Roman origin, but his writings suggest Etruscan stock, which seem almost a corroboration of the historical intuition of Carducci, who called him a "reincarnated Etruscan Pontiff."

His bust has been reconstructed and this is the description given by Prof. Fabio Frassetto as to how he would have looked if he were living.

"In the reserved strength of this gaunt and severe face one feels the pallor of tense flesh, which must have been characteristic of Dante as a result of the never-ending unrest of his spirit. His personality is very clearly embodied in the great thoughtful eyes, made heavier by the weight of the lids, in the unparted sensual lips expressing that knowledge of superiority that dominated him, in his haggard cheeks and also the haggard texture of the skin, the

rugged nose and the prominent Adam's apple (signs of his strongly marked masculinity), and in each other decided and grave feature of his countenance. The whole thus constitutes a complex of composed and collected parts which, in spite of their disharmony, together with the real character features of the face, create in my mind an impression of determination and spiritual strength."

The technical method in reconstruction of the bust consisted above all in the superimposing of the skull profile to a portrait in hand, so that it should assume the same orientation as the picture, provided of course that both pictures have already been reduced to the same size. The second phase of the method consisted in passing one over the other certain points of the face and skull, which were chosen out of pictures especially suited to the purpose, and indeed in such a way as the points of likeness themselves are placed one on the other. The examples of painting and sculpture which are of significance as historical and artistic documents were used for this verification.

Regarding the work of restoration, a noted critic says:—

"By his efforts he has enabled us to behold, beyond the threshold of the grave, Dante's real countenance." But the countenance is Mediterranean, not Nordic!

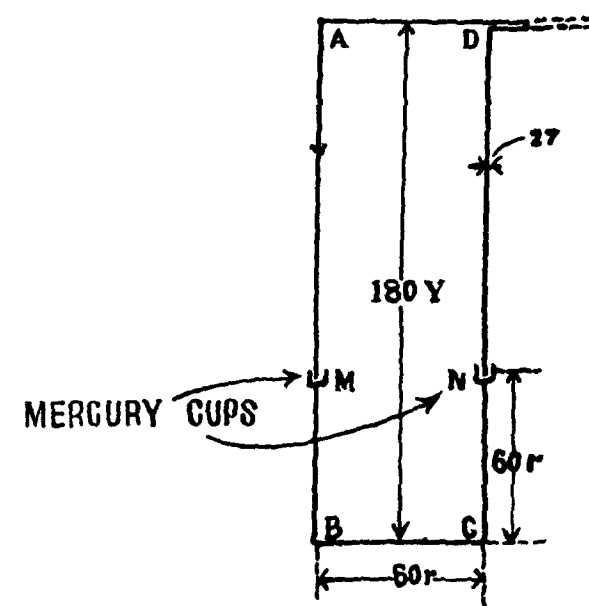
(From an article by Prof. Fabio Frassetto, of the University of Bologna, in the *Research and Progress*, 1939, p. 169. Prof. Frassetto carried out the restoration and has published a book, *Dantis Ossa, Scheletro, Ritratti, Maschere, e Busti* (Bologna Tip. Parma, 1933).

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

The laws of electrodynamics and Newton's third law of motion.

Recently Dr Dunton¹ has referred to the invalidity of the laws of electrodynamics under certain circumstances, but as was shown by Dr. Drysdale², this failure is due simply to an error in the application of these laws. It may, however, be of interest to point out in this connection that (except in the case of parallel current elements) the real source of error lies in assuming the validity* of Newton's law of action and reaction in calculating the mutual forces between two current elements.



DUNTON'S CIRCUIT BREAKER

*The reason for the invalidity of Newton's third Law lies in the exchange of momentum between the current elements and the field.

This inapplicability of Newton's law is not explicitly stated in the usual text-books on Electrodynamics. Biggs³ has, however, discussed this point in dealing with the case of two moving charges.

In the light of the above ideas it will be interesting to consider the example of the circuit breaker discussed by Drs. Dunton and Drysdale.^{1,2}

In calculating the force on the conductor BC, Dunton assumes that it is only the magnetic field of the upper field portion MADN which produces the force on BC. He neglects the mutual forces amongst the elements of the moveable portion MBCN, which would be correct only if Newton's third law were valid in such cases.

The conductor BC exerts on BM an outward force perpendicular to BM in accordance with the usual laws of electrodynamics. Similarly, BM exerts on BC an outward force perpendicular to BC. These two forces are neither equal in magnitude nor opposite in direction, and Newton's third law is, therefore, not applicable. We must thus take into account the effects of the portions MB and CN also in calculating the force on the conductor BC. Hence, the force on BC, as has been pointed out by Dr Drysdale, is due to the rest of the entire circuit, viz., DA, AB and CD.

Physics Laboratory,
University of Delhi,
Delhi, 29-5-39.

S. B. L. Mathur

¹ *Nature* 140, 245-246, 1937.

² *Nature* 143, 601, 1939.

³ Biggs—*The Electromagnetic Field*, (Oxford Press) p. 26.

On the K-Statistic.

In an earlier paper¹ worked out by the author jointly with Mr R. C. Bose the problem of discrimination between and classification of different multi-variate normal populations (with the same sets of variances and covariances but with different sets of means) was sought to be tackled, by defining the Studentised D²-statistic and obtaining its sampling distribution. But the problem yet remained to be tackled when the populations differ in the sets of variances and covariances and when it

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is sought to discriminate between and classify them in the light of their variances and covariances. In a paper which is to appear in *Sankhyā*, the Indian Journal of Statistics, a first step is taken towards answering the following question. Can the two multivariate normal populations from which two samples have been drawn be reasonably (i.e. on a given probability level) assumed to have the same set of variances and covariances? The problem of analysis of variance is, of course, intimately connected with the above and the two are really solved together. For the univariate case the problem is completely solved by the sampling distribution of s_1/s_2 and Fisher's χ .

In the earlier paper¹ by the author already quoted it was noted that if following Fisher² one started from a linear compound, with arbitrary coefficients of the variates and so chose the compounding coefficients as to make a maximum the ratio between the square of the difference of the sample means (for the compound character) and the within variance of the samples for the same character, one could easily see after maximisation that the ratio spoken of above is proportional to the Studentised D^2 -statistic of that paper. In the coming paper, starting from a similar linear compound of the variates and so choosing the compounding coefficients as to make a maximum the ratio of variances of the 1st and 2nd samples (for the compound character), one finds that the quest for the maximised value of the ratio leads one, in the case of p -variate populations, to as many as p statistics instead of to merely one as in the previous case. These p statistics are given by the roots of the following p th degree determinantal equation in K ³

$$|a_{ij} - K^2 a'_{ij}| = 0 \quad (1)$$

where a_{ij} is the co-variance of the i -th and j -th characters and a'_{ij} is the covariance of the 2nd sample for the same characters. Of these p roots ($K^1, K^2, \dots, K^p$) one, say, K^1 , is a true maximum, another, say, K^2 , is a true minimum, while the rest are stationary values. In the case when the populations sampled are identical in sets of variances and covariances (which is the hypothesis to be tested) and when we go on drawing two samples of sizes n and n' respectively from the two populations, the joint sampling distribution of the p functions ($K^1, K^2, \dots, K^p$) has come out in the form

$$\text{Const. II} \frac{K_1^{n-p-1}}{(1+c^2K)^{\frac{n+n'-2}{2}}} (K^1-K^2) \dots (K^{p-1}-K^p)^2 \times \prod_{i=1}^p dK_i \quad (2)$$

where the symbol II stands for the product of a certain number of terms, and $c^2 = n/n'$.

The K 's vary each from 0 to ∞ ; suppose that in any particular case K_1 is the maximum and K_p the minimum. Then

if $K_1 \geq K_p$ and also $\geq 1/K_p$, then in such a case K_1 is the statistic which serves best for purposes of discrimination and whose sampling distribution we should seek. If on the other hand $K_1 \leq 1/K_p$ then K_p is the statistic best suited for discrimination and one whose sampling distribution should be obtained. In the first case integrating out (2) successively over $K_2, K_3, \dots, K_p$, each from 0 to K_1 , we have the distribution of K_1 (the maximum statistic) in the form, say,

$$\text{Const. } F(K_1) dK_1 \quad (3)$$

In the latter case integrating out (2) successively over $K_1, K_2, \dots, K_{p-1}$, each from K_p to ∞ , the distribution of K_p (the minimum statistic) is obtained, say, in the form

$$\text{Const. } f(K_p) dK_p \quad (4)$$

It should be noted from (2) that both $F(K_1)$ and $f(K_p)$ of (3) and (4) are the sums of a certain number of terms each of which is the product of incomplete Γ functions

In a paper which is to appear in *Sankhyā* very shortly after the next it is proposed to obtain (3) and (4) in a form suitable for purposes of statistical application, i.e. for numerical computations. Once we have prepared tables for the incomplete probability integrals of (3) and (4) we can immediately use K_1 or K_p for purposes of discrimination. In any given problem K_1 and K_p can, of course, be obtained numerically to any desired degree of approximation from the sample readings by solving the determinantal equation (1) by, say, Horner's method.

Statistical Laboratory,
Presidency College,
Calcutta, 18-7-39.

Sumarendra Nath Ray.

¹Bose, R. C. and Ray, S. N.: The Distribution of the Studentised D^2 -Statistic. *Sankhyā*, Vol. 4 (1), pp. 19-38.

²Fisher, R. A.: The use of Multiple Measurements in Taxonomic Problems. *Annals of Eugenics*, Vol. 7 (2), pp. 179-188, 1936.

Notes on the General Theory of Impact of an Elastic Hammer on a finite Pianoforte string

The elastic hammer of mass m , strikes the string of length l , at $x=a$, the string under tension T , and of linear density ρ , is fixed at $x=0$ and $x=l$.

If y_a, y_1, y_2 are the displacements at $x=a, x<a, x>a$, respectively, then, we have in the usual manner,

$$y_1 = y_a \frac{\sinh \frac{Dx}{c}}{\sinh \frac{Da}{c}}, \quad y_2 = y_a \frac{\sinh \frac{D(l-x)}{c}}{\sinh \frac{D(l-a)}{c}}; \quad (1)$$

where $b=l-a$.

The pressure P exerted by the load is given by

$$P = m \frac{d^2 z}{dt^2} = T \Delta \left(\frac{dy}{dx} \right)_{x=a} = -E u, \quad (2)$$

LETTERS TO THE EDITOR

where the displacement z of the hammer is given by,

$$z = y_a + \text{the compression } u, \quad (3)$$

From eqs. (1) and (3), eq. (2) gives

$$\left[mD^2 + \frac{T}{c} D \left(\coth \frac{Da}{c} + \coth \frac{Db}{c} \right) \right] y_a + mD^2 u = JD, \quad (4)$$

$$mD^2 y_a + (mD^2 + E)u = JD, \quad (4')$$

where $J = mv_0$, v_0 being the velocity of impact.

From eqs. (4), we have

$$y_a = \frac{1}{F(D)} \cdot v_0 = \frac{T}{Ec} \left(\coth \frac{Da}{c} + \coth \frac{Db}{c} \right) D y_a, \quad (5)$$

$$\text{where } F(D) = D + \frac{T}{Ec} \left(D^2 + \frac{E}{m} \right) \left(\coth \frac{Da}{c} + \coth \frac{Db}{c} \right) \quad (6)$$

Now substituting the exponential values of $\coth \frac{Da}{c}$, and

$\coth \frac{Db}{c}$ in eq. (6), we have,

$$y_a = \frac{(q+p)}{D_1 D_2} \left(\frac{-D\theta_1}{1-e^{-D\theta_1}} - \frac{-D\theta_2}{e^{-D\theta_2} + 1} - D\theta \right) \times \left[1 - \frac{D(q+p)}{D_1 D_2} e^{-D\theta_1} - \frac{D(q+p)}{D_1 D_2} e^{-D\theta_2} - \left\{ \frac{2D(q+p)}{D_1 D_2} e^{-D\theta} \right\} \right] \quad (7)$$

where $D_1 = D + q$, $D_2 = D + p$, $\theta_1 = \frac{2a}{c}$, $\theta_2 = \frac{2b}{c}$, $\theta = \frac{2l}{c}$, and, $-q$ and $-p$, are the roots of the eq., $D^2 + (Ec/2T)D + E/m = 0$.

The general term, (i.e. r th term) of the multinomial expansion of the expression within third bracket of eq. (7) is,

$$\frac{\Gamma(\alpha+\beta+\gamma)}{\Gamma(\alpha+1)\Gamma(\beta+1)\Gamma(\gamma+1)} \left\{ \frac{(q+p)D}{D_1 D_2} \right\}^{\alpha+\beta} \times \left\{ 1 - \left\{ \frac{2D(q+p)}{D_1 D_2} \right\} e^{-D(\alpha\theta_1 + \beta\theta_2 + \gamma\theta)} \right\} \quad (8)$$

where $r = \alpha + \beta + \gamma$.

Substituting the values of the multinomial from (8) in (7), and putting different values of α, β, γ , from zero to any positive integer, and collecting the useful terms which will occur within the time $t=0$ and $t=2\theta$, as hammer always leaves the string long before $t=2\theta$, we get, with the help of appendix² of part II

$$y_a = f_1(t) + \sum_{n=1}^{\infty} [f_{n+1}(t-n\theta_1) - f_n(t-n\theta_1)] + \sum_{n=1}^{\infty} [f_{n+1}(t-n\theta_2) - f_n(t-n\theta_2)] + [2f_2 - 4f_1 + 2f_1](t-\theta) \quad (9)$$

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$$+ \sum_{n=1}^{\infty} [(n+2)f_{n+3} - (3n+4)f_{n+2} + (3n+2)f_{n+1} - n f_n](t-\theta-n\theta_1) + \sum_{n=1}^{\infty} [(n+2)f_{n+3} - (3n+4)f_{n+2} + (3n+2)f_{n+1} - n f_n](t-\theta-n\theta_2) + [6f_3 - 18f_2 + 20f_1 - 10f_0 + 2f_1](t-2\theta) \quad (9)$$

Eq. (9) is the general expression for the displacement of the struck point during impact. Here $\sum$ does not represent an infinite series but is used as an abbreviation in working out a finite number of terms that will occur during different intervals, so long the hammer is in contact with the string. It is evident that, any function in the above general expression, will appear, only from the time obtained, by equating the corresponding argument to zero.

In the similar way the general expression for the pressure exerted by the hammer, can very easily be worked out by the help of eqs. (2) and (6).

Thus the exact problem relating to the acoustics of the Pianoforte string of finite length is successfully worked out, which hitherto remained unsolved.

Department of Physics,

Burdwan Raj College,

Burdwan, 3-7-39. Mohinimohan Ghosh.

¹M. Ghosh, *SCIENCE AND CULTURE*, 4, 252, 1938.

²M. Ghosh, *Ind. Jour. Phys.*, 12, 437, 1938.

Symmetrical Incomplete Block Arrangements with Blocks of Unequal Size.

In agronomic tests involving a large number of varieties, of non-interacting treatments, where there are no interactions available for being confounded with block differences, specialized types of designs have been obtained by Yates¹ and, recently, by Bose and Nair², which, whilst effecting the desired reduction in the size of the block leading to an efficient control of soil heterogeneity, enable all the comparisons between the treatments to be made with equal or unequal precision. I have since been able to work out a new type of such designs in which, although the blocks are unequal in size, each pair of varieties or treatments occurs within a block an equal number of times, as in the case of Yates's symmetrical incomplete randomized block arrangements.

Let v be the member of varieties, b the number of blocks, r the number of times a variety is replicated within a block, λ , the number of times a pair occurs within a block, $k_1, k_2, \dots, k_p$ the p different sizes of the blocks ($k_1 < k_2 < \dots < k_p$), $n_1, n_2, \dots, n_p$ being respectively their number. If N be the total number of plots, it follows that

$$n_1 + n_2 + \dots + n_p = b \quad (1)$$

$$n_1 k_1 + n_2 k_2 + \dots + n_p k_p = vr, \quad (2)$$

$$\text{or } n_1 k_1 + n_2 k_2 + \dots + n_p k_p = vr$$

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$$\lambda = \frac{n_1 k_1 (k_1 - 1) + n_2 k_2 (k_2 - 1) + \dots + n_p k_p (k_p - 1)}{v(v-1)} \quad \dots (3)$$

All the symmetrical unequal block arrangements may conveniently be considered under the two main heads: (i) Designs for which $\lambda=1$, and (ii) Designs for which $\lambda \geq 2$. In the case of designs of the first type, we define as the i th block associates of a variety those varieties which occur with the given variety in blocks of the i th type, i.e., those of size k_i . Thus all varieties other than a given variety split up in respect to that variety into p classes, viz., its first, second, p th block associates. In designs of the second type, we work in terms of *intrinsic* block associates of a given variety as contradistinguished from its ordinary block associates, among which there is clearly intermixture.

Let, now, $\mu_1, \mu_2, \dots, \mu_p$ be the number of ordinary (or *intrinsic*) block associates of a variety, and let a_{jk} denote the number of varieties which are common to the j th and k th (ordinary or *intrinsic*) block associates of two varieties which are mutually i th (ordinary or *intrinsic*) block associates. It follows that

$$v = 1 + \mu_1 + \mu_2 + \dots + \mu_p \quad \dots (4)$$

Then, for the existence of my symmetrical unequal block arrangements, the following conditions must be satisfied:—

(i) Each of $\frac{n_1 k_1}{v}, \frac{n_2 k_2}{v}, \dots, \frac{n_p k_p}{v}$ is integral.

(ii) $\sum_{k=1}^p a_{jk} = n_j - 1$ (for $i=j$),

$$= n_j \quad (\text{for } i, \text{ when not equal to } j) \quad \dots (5)$$

$$\text{and } n_i a_{jk} = n_j a_{ik} = n_k a_{ij} \quad \dots (6)$$

Condition (ii) is analogous to that for Bose and Nair's¹ partially balanced arrangements of the $(p-1)$ th order.

Only designs for which $p=2$, i.e., those with two unequal block sizes, have so far been considered. Among these we first deal with the first type of designs for which $\lambda=1$. If Q_i denotes $k_i k_i$ times the total yield of variety i minus k_i times the sum of the totals for blocks of the first type containing variety i and k_i times the sum of the total for blocks of the second type containing variety i ; and $\sum Q_i (\mu_1, i)$ the sum of the Q_i 's, μ_1 in number, corresponding to the first block associates for variety i , etc., we have for the estimate of the effect of variety i , assuming $\mu_1 < \mu_2$,

$$v_i = \frac{AQ - (k_1 - k_2) \sum Q_i (\mu_1, i)}{A \left[k_1 k_2 r - \frac{k_1 k_2 b}{v} + k_1 + (k_1 - k_2) a_{11} \right] - (k_1 - k_2)^2 a_{11}} \quad (7)$$

where

$$A = k_1 k_2 r - \frac{k_1 k_2 b}{v} + k_1 + (k_1 - k_2) (a_{11} - a_{12})$$

with an analogous expression for the varietal estimate when

$$\mu_1 > \mu_2$$

The sum of squares due to varieties comes out to be

$$\frac{1}{k_1 k_2} \sum_{i=1}^v v_i Q_i \quad \dots (8)$$

Again, the variance of the difference between two first block associates, σ^2 denoting the error variance per plot, comes out to be

$$2 \sigma^2 k_1 k_2 \left[k_1 k_2 r - \frac{k_1 k_2 b}{v} + k_1 + (a_{11} - a_{12} + 1) (k_1 - k_2) \right] D \quad (9)$$

D standing for the denominator of the expression on the right-hand side of equation (7). A similar expression is obtained for the variance of the difference between two second block associates.

Also the efficiency factor of the design comes out to be

$$I = \frac{D}{k_1 k_2 r \left[A + \frac{\mu_1 (k_1 - k_2)}{v-1} \right]} \quad \dots (10)$$

where A denotes the same expression as in equation (7) above.

Similar expressions have been worked out for $\lambda=2$ and $\lambda \geq 2$, $n_i k_i/v=1$, reference now being to *intrinsic* block associates. For full details about the analysis and methods of construction of these designs, the interested reader is referred to the author's paper on the subject appearing in a coming issue of *Sankhya: The Indian Journal of Statistics*.

Statistical Laboratory,
Presidency College,
Calcutta, 14-7-39.

K. Kishen

¹Bose, R. C. and Nair, K. R.: Partially Incomplete Block Designs, *Sankhya: The Indian Journal of Statistics*, Vol. IV, Part 3.

²Yates, F.: A new method of arranging variety trials involving a large number of varieties, *J. Agric. Sci.*, Vol. XXVI, Part II, pp. 301-315.

³Yates, F.: Incomplete Randomized Blocks, *Annals of Eugenics*, Vol. VII, Part II, pp. 121-140.

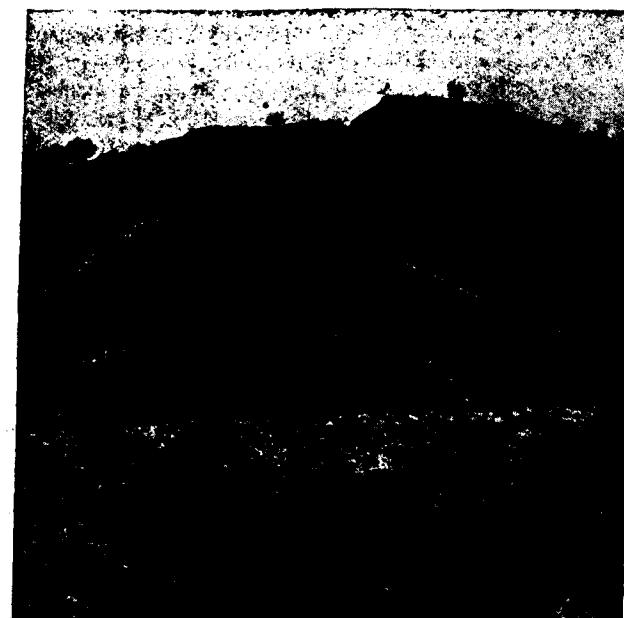
On the possibility of the existence of an oil field in Mandi State.

The Mandi State is situated in the Kangra district of the Punjab. That oil occurs in this region of the Punjab in the Pre-Himalayas of Kangra district was known, long ago. The eternal fire at Jwalamukhi is due to spontaneous combustion of petroleum gases escaping through a fault at the crest of an anticline which is the store of petroleum. The source of oil at this place is supposed to be the Subathu limestone beds which correspond to the Chharat series of the

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Rawalpindi area in Western Punjab. But the Subathu rocks are nowhere exposed near about Jwalamukhi. In fact, it is usually believed that the Nummulitic Subathu limestone is nowhere exposed in the Simla Himalayas. The Jwalaji temple is situated on Dagehai clay beds.

However, recently I was fortunate to discover the Subathu limestone beds in the Simla Himalayas in the Lowakhari area of Mandi State. I made a reference to this in a short paper contributed in the Science Congress, 1928, but as I was engaged at that time in a hurried preliminary survey of the State I could neither devote much time, nor pay sufficient attention to a detailed study of the Nummulitic limestone beds as well as to the rocks and minerals associated with them, at that time.



Anticlinical structure in the Tertiaries of Mandi State seen near Dhanpur in the Sun Khad whose pebble-covered bed is auriferous.

Through the kindness of my old master, His Highness the Maharaja Major Sir Jogendra Sen, K.C.S.I., I had an opportunity to visit Mandi again during last April as His Highness' guest when, among various kindness showered on me and my wife, facilities were afforded also to pay another visit to this Subathu limestone beds in Lowakhari area of the Mandi State. On foot and on horseback my wife and myself followed this limestone band for about 4 miles from the Mandi-Suket boundary at the Sekendara Road, Thankot, to near about Galma R.H. Along this region the limestone occurs in a band 20 to 50 feet in thickness being sometimes nodular, sometimes massive and sometimes thin bedded and contain abundant Nummulites as well as certain species of

gastropods. Microscopic sections of this rock as well as hand specimens have been sent to the Geological Survey of India for identification.

I reported the presence of a deposit of nodular coal full of pyrites occurring in close association with the limestone bed at Thankot in Suket State during my stay in the Mandi State in 1927. But being situated in another State I did not care to devote much attention to this coal. In the interval that followed between my departure from Mandi in 1927 and this re-visit in 1939, Mr. Bhup Singh, Assistant Engineer of Mandi State, discovered deposits of coal in the same locality within the limits of Mandi State. During our excursion to Lowakhari area Mr. Bhup Singh was specially deputed by the State to show me these coal areas. Mr. Bhup Singh reported to me about certain peculiarities of this coal. He said that the coal though of shining black colour gives out a tarry smell when mining it and profuse smoke and characteristic smell of asphaltic road tar when burnt. The coal was analysed and showed a very high ash content.

Mr. Bhup Singh showed me the first outcrop of coal in a gully near Talika haraon. Here the coal occurs in a vertical bed, in intrusive form, within a band of crushed quartzite which possesses all the signs of fault quartzite. When we were approaching the second and important place of occurrence of coal below Kaleri, my wife drew our attention to something like oil floating on Dhabani nala. I subjected it to the usual tests to distinguish between oil scum and ferruginous-scum floating on water and came to the conclusion that it is oil scum. Within a few feet of this we came to the outcrop of a 2 ft. thick coal seam occurring below Kaleri village sandwiched between two layers of nodular Nummulitic limestone dipping at an angle of about 40° to the west. It has already been dug by the Engineer but the surface, though recently exposed, showed development of sulphur and alum. When we started digging the coal it gave out a characteristic tarry smell. The same smell and also that of sulphuretted hydrogen continued throughout the adit which was driven by Mr. T. Anand, A.I.S.M., Mining Engineer of the State along the strike of this coal for 22 feet from the outcrop. The coaly stuff was found to thin out gradually, towards the depth as well as in the strike direction when the overburden increased.

The powder of this shining black, coal-like, substance imparts quickly a brown colour to chloroform which on keeping becomes deep brown and shows phosphorescent bluish-green colour in reflected light. A drop of the chloroform solution leaves a brown oily stain on the paper and gives out a faint smell of kerosene. If specimens of this shining black stuff is crushed between finger tips we get the characteristic smell of kerosene.

The coaly layer was followed further northwards for about a mile from Kaleri to Mansai. At Mansai also the coal occurs as above and gives out tarry smell when dug.

These outcrops of the coal like substance seem to occur in Mandi State in close proximity to a long N-S strike fault

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which is responsible for bringing the deep-seated Nummulitic limestone beds of this area to the surface. The distance of this place from Jwalamukhi on the west, the nearest known petroliferous area in this part of the Punjab, is about 40 miles as the crow flies. Although I have not yet subjected the above mentioned shining black, intrusive, coal-like substance of Mandi State to a detailed chemical analysis but from the geological, physical and chemical characteristics noted above, I am inclined to think that the stuff is residual pitch, it is a show of 'inspissated oil' which became so shining and flaky due to tectonic movements; or it may be a deposit of poor grade crushed coal which has been impregnated by petroleum migrated from the Subathu series of this region. West of Lowakhari during a hurried motor trip to Rawlsar and Bhamla I made some observations about the structure of the Tertiaries in this area and it seems to me that we have most probably an anticlinorium structure of the Tertiaries in this region. Minor folds belonging to the western flank of this anticlinorium are distinctly visible in the Sun Khad near Dhanpur (see photo) close to which there is also a salt spring among the Tertiaries at Luni nal. However, the structure requires to be yet confirmed by a thorough geological study for the area. It is therefore apparent from the foregoing that conditions suitable for the presence of oil occur in Mandi State.

Indian School of Mines,
Dhanbad, 7-7-39.

S. K. Roy

A Note on Partially Balanced Youden's Squares.

It has been demonstrated by Yates¹ that Latin Squares with several rows or columns or treatments, or one row and one column, or either and a treatment missing are valid experimental arrangements amenable to elegant statistical analysis which can be easily worked out by the classical method of fitting constants by least squares. In the case of Latin Squares with several rows (or columns) missing, Youden² has, by further subjecting the columns (or rows) to restrictions derivable from known solutions of Yates's symmetrical incomplete block arrangements for cases in which the number of blocks equals the number of treatments, obtained some elegant experimental arrangements useful in various types of biological and agronomic experimentation.

Bose and Nair's³ partially balanced incomplete block arrangements of the $(p-1)$ th order provide a basis for the generalization of Youden's Squares, the columns (or rows) now being subject to the restrictions similar to those of the partially balanced incomplete block designs for solved cases in which the number of blocks equals the number of treatments. It will be seen that the existence of a partially balanced Youden's Square is tantamount to the existence and knowledge of the solution of the corresponding partially balanced incomplete block design.

As an illustration, we give below a partially balanced Youden's Squares of the first order which has been derived

from the partially balanced incomplete block design of the first order for which $b=v=9$, $k=r=3$, $n_1=6$, $n_2=2$, $\lambda_1=1$, $\lambda_2=0$.

$$p_{11} = \begin{pmatrix} 3 & 2 \\ 2 & 0 \end{pmatrix} \text{ and } p_{21} = \begin{pmatrix} 6 & 0 \\ 0 & 1 \end{pmatrix},$$

the symbols having their usual meaning.

		Columns								
		1	2	3	4	5	6	7	8	9
Rows	1	1	5	8	2	9	3	6	4	7
	2	2	9	1	4	6	7	3	5	8
	3	3	1	4	7	2	5	8	6	9

Higher order partially balanced Youden's Squares are easily obtained in a similar manner.

Coming now to the general case of the Youden's Square of the $(p-1)$ th order, let $b, k, r, v (b=v, k=r), n_1, n_2, \dots, n_p, \lambda_1, \lambda_2, \dots, \lambda_p (\lambda_1 > \lambda_2 > \lambda_3 > \dots > \lambda_p)$ have the usual meaning (vide Bose and Nair³) for the partially balanced incomplete block arrangement of the $(p-1)$ th order, and let $p_{jk} (j=1, 2, \dots, p; k=1, 2, \dots, p)$ denote the number of varieties which are mutually j th associates. Then, for the corresponding Youden's Squares, the number of rows equals to varieties which are mutually j th associates. Then, for the number of varieties per block (or the number of replications), and the number of columns equals the number of varieties or treatments (or the number of blocks) in the partially balanced incomplete block arrangement.

Let $m, r_1, r_2, \dots, r_k (\sum_{i=1}^k r_i = 0), c_1, c_2, \dots, c_b (\sum_{i=1}^b c_i = 0)$, and $v_1, v_2, \dots, v_b (\sum_{i=1}^b v_i = 0)$ denote constants for the mean, rows, columns and treatments respectively for the Youden's Square and let $G, R_1, R_2, \dots, R_b, C_1, C_2, \dots, C_b, V_1, V_2, \dots, V_b$ denote the corresponding yield totals. Then, denoting the sum of the constants for varieties occurring in the first column by $\sum_1(v)$ etc., and the sum of the constants for the columns in which the first treatment occurs by $\sum_1(c)$, etc., we obtain the following normal equations worked out by the method of least squares:

$$\begin{aligned} bkm &= G, \\ b(m+r_i) &= R_i \quad (i=1, 2, \dots, k), \\ k(m+c_i) + \sum_1(v) &= C_i \quad (i=1, 2, \dots, b), \\ k(m+v_i) + \sum_1(c) &= V_i \quad (i=1, 2, \dots, b). \end{aligned}$$

It is, therefore, evident that the rows are orthogonal with columns and varieties (or treatments), and the sum of squares due to them is easily worked out ordinarily from the row totals. Now the sum of squares due to columns and varieties comes out to be $c_1 C_1 + c_2 C_2 + \dots + c_b C_b + v_1 V_1 + v_2 V_2 + \dots + v_b V_b$. Fitting for columns alone, the sum of squares due to columns comes out to be that obtained ordinarily from the column totals (which, evidently, will be the same as the block sum of squares in the corresponding partially balanced

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incomplete block design). Subtracting this from the joint sum of squares due to columns and varieties, the appropriate sum of squares for testing the significance of the difference between varieties is obtained. Both the estimates for varietal (or treatment) effects as well as the sum of squares due to varieties work out to be the same as in the case of the corresponding partially balanced incomplete block design, and are, therefore, not given here, having been already worked out by Bose and Nair.¹

As pointed out by Yates² in the case of the completely balanced Youden's square, the partially balanced Youden's square will be a more or less efficient arrangement than the corresponding incomplete block design according as the elimination of row variation diminishes or increases the error variance, as the efficiency factor in the latter case remains unaltered by the imposition of Youden's restrictions.

It is proposed to consider these designs in detail in a

subsequent paper to be published in a coming issue of *Sankhya: The Indian Journal of Statistics*.

Statistical Laboratory,
Presidency College,
Calcutta, 6-7-39.

R. C. Bose,
K. Kishen,

¹Bose, R. C. and Nair, K. R.: Partially Balanced Incomplete Block Designs. *Sankhya: The Indian Journal of Statistics*, Vol. IV, Part 3.

²Fisher, R. A.: The Mathematics of Experimentation. *Nature*, 142, 442, 1938.

³Yates, F.: Incomplete Latin Squares. *J. Agric. Sci.*, Vol. XXVI, Part II, pp. 301-315.

⁴Yates, F. and Hale, R. W.: The Analysis of Latin Squares when two or more rows, columns, or treatments are missing. *Suppl. J. Roy. Stat. Soc.*, Vol. VI, No. 1, 1939.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

OCTOBER 1939

VOL. V NO. 4

Rural Medical Relief in India

IN a country which has seven hundred thousand villages within its boundaries, where owing to hot and moist climate virulent tropical diseases, many of which are preventible, take a heavy toll of millions of lives annually and where the life span of the people has come round to twentythree and half years (only half of what it is in most advanced countries) the question of rural medical relief and sanitation is of paramount importance to the life and health of the people. On the scale of western countries, India requires two hundred thousand qualified doctors to take care of her village population. But a hundred years' efforts in training people in Western medicine have produced so far only 35 thousand qualified doctors of whom about 15 thousand reside in the villages. This number is utterly inadequate to the needs of the people, and if qualified medical men are turned out at this rate, it will take six centuries to supply India's rural population with an adequate number of qualified doctors.

In matters of sanitation, the condition is worse still. In England and Wales, the expenditure on

public health is £1-0-9d per capita per annum, but the figures in India speak for themselves. From the public budget, we understand that Delhi spends Rs. 1/2/3 per capita, *i.e.*, 1/12 that of England, and figures for the other provinces are: the Punjab, Rs -/5/7; Bombay, Rs -/4/9; Madras, Rs -/2/7; Bengal, Rs -/2/1; Bihar, Rs -/1/3 and United Provinces, Rs -/1/-, this last figure is 1/210 part of the average of England. With such small provision for expenditure, no well considered scheme of medical relief and public health reform can be undertaken by any government. The present top heavy system of administration renders it unlikely that more funds will be diverted to measures of sanitation and public health, unless the national income is substantially increased.

Turning out qualified medical men in large numbers would do little benefit to the country unless the vast rural areas are in a position to utilize their services. Even the small number of medical men who live in the villages fail to earn a decent income. The villagers in general are too poor to consult the doctor and to buy medicines. The same

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cause makes it almost impossible for any adequate measures of sanitation to be adopted throughout the countryside. Timely medical treatment is further rendered difficult on account of difficult means of communication.

On account of the dearth of supply of properly qualified medical men it has been proposed of late to give State recognition to the *Ayurvedic*, *Unani*, and *Homoeopathic* systems of medicine. It is regrettable that some provincial governments have hastily yielded, to a certain extent, to interested clamour. A main objection against the State recognition of such medical men is that a majority of them have not received adequate training in the basic sciences of chemistry, physics, physiology, anatomy, not to speak of biology, including bacteriology. Without training in these basic sciences, we believe that it is not possible to get an insight into the working of the complicated mechanism of the human body and of its occasional failures in the form of diseases. The way in which medicine works on the human system was, up to the beginning of the present century, largely conjectural, and hence imperfect. It was only after the discovery of the science of bacteriology by Pasteur, that the etiology of the various communicable diseases could be logically pursued; the development of chemotherapy in the hands of Ehrlich, Metchnikoff and others led to the invention, for the first time in many cases, of suitable remedies for diseases which were regarded as incurable. These developments were possible through the application of the microscope, and of the advancing knowledge of chemistry. However lynx-eyed might have been a great physician of antiquity, he could not certainly locate a bullet inside the human body, but thanks to the discovery of X-rays, such feats are performed in thousands even by the most ordinary medical men of to-day. The transmission of the malaria parasite, through the agency of the mosquito, from a malaria stricken person to a healthy one, could not be visualised by an ancient sage however superhuman might have been his intellect or inner vision, but even the average modern doctor does it every day of his life with the aid of the microscope. The ancient systems of medicine which are still practised in this country were evolved nearly 2000 years ago either in India

(*Ayurveda*) or in Greece (*Unani*); it is true that medical men of those times made the best available use of the knowledge of the human system and of the action of drugs on it, as far as they could understand them, but compared with the modern medical man they were handicapped because they had little knowledge of many of the basic sciences at their disposal. Most of their methods were empirical.

To be fair to the authors of these ancient system of treatment, it must be said that they appear to have been quite conscious of the empirical and hence imperfect nature of the knowledge which they imparted to posterity. But some of their modern followers in this country ascribe to them and to the treatises they left, a kind of infallibility; criticism of which is considered almost sinful, or for those who are too modern to believe in sin, unpatriotic. But had these ancient seers, who were really seekers after knowledge, been living at the present times, they would have protested against such behaviour on the part of their modern blind followers.

Here is an example of recorded protest against blind adoration of the past. Vagbhata, one of the greatest medical authorities of ancient India who probably lived before the seventh century A.D. writes in his *Astangahridaya*:—

अग्निप्रणीते प्रतीक्षेत् सुक्ता चरकमुश्रुतौ ।

भेलाद्याः किं न पश्यन्ते तस्माद् ग्राह्यं सुभाषितम् ॥

"If a work is to pass current as authoritative simply because it is the production of a sage of old, why are the treatises of Charaka and Susruta alone studied and not those of the Rishi Vela and others. It then follows that whatever is reasonable (methodical and scientific) is to be preferred." —From Sir P. C. Ray's *History of Hindu Chemistry*. (The translation is that of Sir P. C. Ray).

A little commentary is needed for the elucidation of the above passage. At the present time, the standard *Ayurvedic* treatises are those of the Charak school, which deals with the system of medicine, and of the Susrut school, which deals with surgery, but these systems were evolved during Buddhist times, by two different sets of medicine men and they had superseded the ancient crude medical treatises by Vela, Agnivesha and others who were regarded as Rishis (Seers of Truth). The writer of the

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couplet had written a learned summary of the two systems in which he had incorporated inventions and observations of his own. But he did not appear to have received the right recognition from his contemporaries on the *hackneyed argument* that his innovations were new. He protested against this attitude and said, "If my system stands the test of reason, it should be accepted, because Charak and Susrut which are now universally accepted have not been handed from hoary antiquity by some divine Rishi, but had gradually been evolved as a result of the experience of centuries, and they have rightly displaced ancient treatises by Vela and others, who are regarded as 'Rishis.'"

The whole keynote of the above passage is one of progress. It clearly shows that when the national life of India was creative, people believed in the idea of progress and did not attach much importance to any knowledge simply because it was handed down from hoary antiquity and had some honoured name behind it. The country will benefit much if the present followers of ancient systems of medicine are inspired by the same spirit.

We have of course to admit that our knowledge of the human system and of the way in which the medicines work are still far from perfect, and that sometimes cures are effected by medicines of the ancient systems, where modern systems fail. But that is no reason why the enthusiasts for ancient systems should fail to give due credit to the enormous progress which has been made in the system of treatment and in the diagnosis of diseases due to development of the basic sciences of chemistry, physics, bacteriology, pathology and others. To give one example: surgical operations have been revolutionised by the discovery of X-rays and the antiseptic methods, and to-day who would think of going to a *Kaviraj* or *Hakim* instead of to a modern surgeon equipped with an X-ray apparatus, when a bullet is lodged in his body? Even in medicine, bacteriology and chemotherapy have completely revolutionised the methods of treatment. With their aid, many diseases which were formerly considered to be incurable like syphilis, diphtheria have been rendered innocuous. Even in this country, just about two decades ago, the prevalence of Kala-azar had converted parts of Assam and Bengal into valleys of death and no system of medicine was

able to cope with it. But the researches of Sir U. N. Brahmachari and others on modern lines have led to a new system of treatment and above all to the discovery of Urea Stibamine which had stamped out the disease and has saved millions of lives. In Cholera, the treatment by saline injections saves thousands of lives. In the years to come, increasing use will be made of the basic sciences and we may confidently look to times when most of the diseases which now afflict mankind will come under complete control. But if this goal is to be achieved, the teaching of Western system of medicine is to be vigorously continued and adequate finance must be provided for further researches on tropical diseases. The keynote of Western medicine is progress, and it is always ready to give up an old system of treatment in preference to a new one which has been evolved as a result of scientific researches and which has been found to be more efficacious than the existing systems. But the present day votaries of ancient systems of medicines are not actuated by this idea of progress. Excepting a few, they usually do not care to receive any training in the basic sciences and the idea of progress is foreign to them. They look upon certain treatises, which are human productions, as infallible scriptures but never subject their contents to scientific analysis.

We would strongly urge upon the Government that they should not come to a hasty decision regarding the State recognition of ancient and not thoroughly scientific systems of medicine; but should insist that before recognition is accorded, the followers of such systems must possess an adequate knowledge of the basic sciences of chemistry, physics, biology including bacteriology, and anatomy. Further the medicines supplied by such persons should have satisfied certain scientific tests with regard to their action and efficiency.

In pre-Revolution Russia, epidemics sometimes used to carry off peasant populations by thousands and the villagers, who were just as poor and ignorant as the village population of India, in despair used to have resort to black magic. One of the methods frequently pursued was to tie four widows to the plough, and make them run around the village a number of times. The furrow made in this way could not be crossed by witches and evil spirits who were supposed to cause disease. But to-day, thanks to Soviet rule, Russia abounds in

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polyclinics, maternity homes, nursing homes and hospitals the excellence of which excites the admiration of the Americans. Medical men are State officers, and public health and medical aid are State concerns. The example of Russia shows how a scientific approach to a problem, followed by the right kind of activity, can repair most of the ills from which mankind suffers, and for which we look in vain for remedies elsewhere. But India cannot expect to have any improvement in medical aid to the rural population and in public sanitation until the problem of poverty is solved, a task which is now engaging the attention of the National Planning

Committee. But the proposed State recognition of indigenous systems of medicine, without insistence on an adequate knowledge of the basic sciences, will only set the hands of the clock of progress backwards.

Space prevents us from dealing, in this issue, with several important inter-related problems connected with the physical well-being of 400 million people, *e.g.* training and co-ordination of personnel in medical public health, social welfare, medical relief and public health planning, manufacture and supply of medicines, national health insurance, industrial hygiene etc. We hope to deal with some of them later on.

Handicap to Health Services

One of the chief things that hinders the efficient working of public health services in India is the absence of reliable registration of births and deaths and especially the correct diagnosis of the cause of death. This deficiency is referred to in practically every public health report in India that one picks up, and in the immediate future it seems that there is not much prospect of much general improvement, although efforts are being made in certain restricted areas to acquire correct statistics of infant mortality and morbidity. The few reliable figures available show the infant mortality to be appallingly high compared with many other countries, but on account of the high birth rate this great wastage of child life is not obvious to the casual observer.

Although the people will be able to do a great deal for themselves if they are taught how to feed

their children properly and how to prevent them acquiring diseases, the difficulty will be to find a sufficient number of teachers for the innumerable village communities throughout India. It is looking a long way ahead but it seems possible that in time the State might be able to introduce some form of national health insurance such as is working now in many other countries, and that even minute annual contributions from the enormous rural population of India might provide sufficiently lucrative posts to induce more medical men to settle in the country districts. It is only by getting medical practitioners distributed throughout the land and all deaths correctly certified that the chief causes of death can be definitely ascertained, particularly among infants, and following this information the correct preventive measures can be instituted.

—*Indian Medical Gazette.*

Buried Empires

THE plains and steppes of south-western Asia that stretch from the Euphrates to the Indus have been seats of civilization since immemorial antiquity. This vast expanse of territory, known to European writers and diplomatists as the Middle East, falls into three natural divisions. These are marked off from one another by a horseshoe-shaped mountain wall that runs from the tableland of Armenia to the coast off Oman and then, turning north, merges itself in the Sulaiman and Hindukush ranges. Within the curve of the rocky barrier lies the central division—a highland—which embraces the dry plateau of Iran and the arid uplands of Afghanistan. To its west are situated the low-lying swamps and alluvial plains of el-Iraq (ancient Babylonia) or Mesopotamia laved by the twin streams of the Euphrates and the Tigris. To the east of the central highland stretches the valley of the Indus, the southern part of which constitutes the province of Sind.

The volume* before us seeks, in the main, to provide an easy introduction, for the general reader, into the history of the development of civilization in the lands we have defined above. The period selected by the author extends from the earliest times for which archaeological evidence is available to the age of Hammurabi, the famous conqueror and law-giver of Babylon of the twentieth or (as the Mari documents seem to suggest) nineteenth century B.C. An epilogue is however added to the text which gives a brief survey of the succeeding age that witnessed the bursting of Indo-Germanic peoples into the ancient land of Sumerians and Semites.

Though he devotes an interesting chapter to the prehistoric cities of the Indus and gives occasional glimpses of the dry uplands of Persia and also of the country beyond the Euphrates, the author deals

mainly with the historic lands of Sumer and Akkad in el-Iraq and Susa and Ansan in Elam. To him, as to nearly all Western writers, el-Iraq is “by far the most interesting region” as it “has exercised a greater influence on the early history of mankind (Western mankind?) than any other country except Egypt.”

The history of el-Iraq is known to early literary tradition. The scripture of the Hebrews—the Old Testament of the Christians—has references to the city of Ur and the land of the Chaldees. But gone are the days when tales of patriarchs in Holy Writ and of burly knights written by courtly rhapsodes could satisfy the eager minds anxious to delve deep into the past of civilised humanity. The general reader, no less than the student-specialist, now wants more solid materials to bring them into a living communion with those ancient cultures which lie at the root of the civilization which they claim as their own. The writer of the volume before us emphasises the continuity of history. No one doubts the truth of the dictum that “our present is bound up with the past” of every cultured race.

At the very outset we have the fascinating story how the precipices of Persia, the ruin-mounds of Mesopotamia and “the Place of the Dead” (Mohenjo-daro) in Sind yielded to the explorer and the excavator memorials of entombed princes, forgotten peoples, ruined cities and buried empires that once flourished in the plains of el-Iraq, the highlands of Iran and the valley of the Indus. The scholars and investigators to whom we owe our knowledge of the prehistory and early annals of the Middle East include soldiers and consular agents, linguists and travellers, professors and archaeologists belonging to many nationalities. It is to the spade of an Indian archaeologist that the “Mound of the Dead” in Sind yielded relics that bear testimony to a civilization that had its palmy days in the land of the Indus in the third millennium before Christ.

*BURIED EMPIRES. The Earliest Civilizations of the Middle East,—by Patrick Carleton, M.A. (Edward Arnold & Co., London, 1939). Price 10s. 6d.

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be later than 2900 B.C. An Indus seal of the "late" Mohenjo-daro level has been found at Eshnunna. It appears in a context which dates it not later than the twenty-fifth century B.C. On the other hand a seal entombed at Ur cannot possibly be earlier than 2150 B.C. Other seals found at Kish belong to a period later than the Dynasty of Agade (c. B.C. 2568—2426) but earlier than 1900 B.C.

As the Indus script has not yet revealed its secrets to the linguist and the epigraphist, a connected relation of the political events in Sind and the Punjab in the third millennium B.C. is not possible. The material remains that have been discovered so far suffice however to give us interesting glimpses of the life led by the people. Their religion was iconic and laid stress on the worship of gods and goddesses whose peculiar attributes and physical characteristics mark them off from the most prominent deities of the early Rig-Vedic pantheon. The peculiar trait of Hindu and Buddhist sacred statuary to which the name *yoga* is applied, is a feature of some primitive Indus figures. Men, particularly of the upper classes, wore rich robes embroidered with a trefoil design and a light fillet with an ornament in the centre bound round the short hair (p. 154). Dice and board games provided amusement. Women had long skirts and elaborate hooped head-gear. They wore bangles from wrist to shoulder like some of their sisters at the present day. Great as is the indebtedness of modern Hindus to the Vedic Aryans, the heritage that the primitive "Indus People" has bequeathed to them is also not inconsiderable.

Connoisseurs of art testify to the achievements of the ancient peoples of Harappa and Mohenjo-daro in the domain of glyptic art. The breadth of treatment, the feeling for line and plastic form that distinguish some of the seal-designs, and the modelling of some of the statuettes are truly remarkable. Our author refers to a Harappa statuette as the finest ancient work of art in the Middle East, rivalled only by Assyrian bas-reliefs that are two thousands years later in date.

Perhaps the most remarkable achievement of the prehistoric Indus people is the construction of the city that lay buried below the *Mound of the Dead* at Mohenjo-daro. The planning of the city

with its straight streets cutting one another at right angles at fairly regular intervals, its residential quarters that were not allowed to encroach upon public highways, its courtyards, lavatories and baths, its splendid system of drainage, is not equalled by anything in Sumer or Akkad till we come to the days of the great Hammurabi. The absence of temples of the Sumerian type and of inscribed monuments coupled with the special system of town-planning and sanitary arrangements mark, according to our author, the essential difference between the Indian and the Sumerian mind. The ancient Indus citizen was more democratic, less vainglorious and endowed with better ideas of cleanliness than their contemporaries in Mesopotamia. The find of human skeletons with limbs twisted in attitudes of despair and pain, two of which are headless, suggests to the author that the great city perished in a cataclysm occasioned, perhaps, by barbarian inroads.

Valuable as are the material remains of Indus culture unearthed at Mohenjo-daro and Harappa, Chanhu-daro and Jhukar, Rupar and Alor and several other places, they do not as yet enable the historian to reconstruct the early annals of the land of the Indus with due regard for the sequence of events. Far different is the result of archaeological discoveries in the land of the Euphrates and the Tigris. With the help of contemporary inscriptions, the interpretation of which has been made possible by the devoted labour of a distinguished band of scholars since the days of Sir Henry Rawlinson, the student of history is able to present a narrative of events not less intelligible than the early chronicles of Greece or Rome.

Like the prehistoric Age of Painted Pottery, the Dynastic Epoch treated in the volume is divisible into a number of smaller periods. The earliest extends from the time of the first recorded Sumerian kings (*Lugal*) and chiefs (*Isag*, misread *Patesi*) of Ur, Kish, Lagash, Uruk and Umma, to the rise of the empire of Agade (c. B. C. 2568). The Mari documents suggest that the date accepted by our author for the ancient dynasties is perhaps a century too early. The second period covers the age of Semite ascendancy under the Sargonids of Agade. The third opened with a Gutian conquest sometime after 2426 B.C. It witnessed a Sumerian revival with centres at Lagash and Ur. This renaissance

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was ultimately ended by an Amorite invasion in or about 2187 B.C. The fourth starts with a period of struggle (c. 2187-1925 B.C.) when Amorites, Sumerians and Elamites made el-Iraq "a simmering hot-pot" of contending states. Towards its close a new power was driving root in a hitherto obscure place named Bab-Ilum, "the Gate of God"—the Babylon of the Greeks—and soon "gathered all the jangling city-states" beneath its spreading shadow.

In the early dynastic period (c. 3200 to 2568 B.C.) the Babylonian plain was known as Shumir or Sumer, perhaps "reedy land." In the north lay Shubartu, i.e., the plain of Assyria and the steppe of upper Mesopotamia. In the west was Martu, identified with Syria and part of Arabia. In the east stretched Elam, in south-west Persia. When the Akkadians made their way into Babylonia, not later than 2600 B.C., they gave their name to the northern part of the plain from Baghdad to the city of Babylon. The Sumerians proper, who were now practically confined to the south, called themselves "Sakuga or black-headed folk" (p. 87). The earth as conceived by them was a circular island surrounded by the ocean. The idea occurs also in the Vedic and Puranic texts of the Indians.

The Sumerians had a number of nature gods. In this they resembled the Aryans of the Vedic age. The most eminent among them were An (the Sky), Enlil (the Wind, cf. *Anila*), Enki (the Earth and Waters), Dumuzi (the Dying and Resurrected God of Vegetation), Utu or Babbar (the Sun), and Nannar or Zuen (the Moon). Some of these deities were known by other names when they were identified with Semitic gods such as Bel (Wind), Shamash (the Sun), and Sin (the Moon). The god named Ninurtu (the Dragon-slayer) had features in common with Marduk of Babylon. There were two other interesting divinities styled Ningirsu and Nergal. Ningirsu was accompanied by a lion-headed eagle and provided with a sacred club, attributes that remind one of Vishnu (*Garuda-dhva* and *Gadādhara*). An el-Ubeid frieze of very early date shows the lion-headed eagle grappling two stags in its claws. This is paralleled by the *Sauparna* episode of the *Mahābhārata* (Bk I, Chap. 29, where an elephant and a tortoise take the place of the stags). Nergal as described in a hymn on

p. 204 of the present volume, recalls the deity of the *Satarudriya* litany of the *Yajurveda*. The Sumerians and the Semites had a Mother Goddess known in her different aspects by various names such as Innina, Nina, Ishtar etc. The god of each city was looked upon as its real king—the *Isag* (chief) or the *Lugal* (king) being normally only his agent and high priest. With this one may compare the position of Eklingaji in Mewar and of Padmanābha svāmin in Travancore. The worship of kings as gods incarnate was known as early as the time of Aannipadda of the first dynasty of Ur. It became more conspicuous in the days of Narām-Sin, Dungi and Gimil-Sin who flourished in later ages. The Sumerians had also a demi-god in Gilgamesh, the hero of a Babylonian *Mahābhārata*.

Among noticeable features of the early dynastic age may be mentioned the prevalence of human sacrifice as evidenced by the royal tombs or death pits of Ur, the use of the dome in architecture (p. 94), knowledge of the military formation known in the Hellenistic period as the Phalanx, in the days of Eannatum of Lagash. Among the interesting personalities of the age were Ku-Bau, the wine-seller, who became a queen, and the mother of the earliest important ruler with a Semitic name, and Urkagina who reformed burial usages and emancipated serfs.

The second period, namely that of Sargonid ascendancy, witnessed considerable maritime activity. The rulers of Agade "caused the ships of Meluhha, the ships of Magan, the ships of Dilmun to anchor at the quay in front of" their city. Magan which had a king named Manium has been variously identified with places in Arabia, in Egypt and on the west coast of India (pp. 125, 130, 181).

In the third period—the Age of the Empire of Ur—the Sumerians made considerable progress in astrology, medicine and surgery. A common system of law was now applied to the whole of Babylonia. An echo of these laws is found in the story of Hagar and Ishmael in the Bible.

In the domain of religion the older notion of god as an unmoral force persists. But the cylinders of Gudea, prince of Lagash (24th century B.C.) bear testimony to the emergence of more exalted conceptions of the righteousness and loving kindness of god. The Sun-god is spoken of as the country's

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judge and righteous guide. "No mother have I" says Gudea referring to one of the gods. "Thou art my Mother." "No father have I; Thou art my Father." With these sentiments regarding divinity one may compare the invocation of Vishnu in the *Mahābhārata*

Pitā mātā cha sarvasya
Jagatah śāśvato guruḥ

The fourth period, which witnessed the struggle for supremacy between Larsam and Babylon, possibly saw new developments in the ideas of kingship. The king is "shepherd of righteousness" and "shepherd of mankind." The greatest of these "shepherds of righteousness" was Hammurabi, a veritable *Dharma-Mahārājādhirāja*, who "made righteousness to shine forth in the land, destroyed the wrong-doer so that the strong should not oppress the weak." Did the conception of a "shepherd of mankind" produce important results in the domain

of religion? Did the "shepherd of mankind" herald the birth of world-redeemers as the "shepherd of righteousness" presaged the coming of the greatest of Babylonian lawgivers?

We have now come to the end of our survey of the volume before us. It is not free from defects. The chapter dealing with India requires revision in some respects. The chronological scheme, as the author admits, will also have to be modified in the light of a more incisive study of the Mari documents. The index, too, is capable of improvement. A map giving more detailed information about the prehistoric sites of the Indus would have been a fitting companion to the excellent map of ancient Mesopotamia. A few genealogical tables would also have added to the usefulness of the work. While offering these comments, the reviewer is conscious that the author has done a distinct service to the cause of historical studies and prehistoric research by the publication of his interesting volume.

H. C. Raychaudhuri

Factory Town in Palestine

A factory town has been uncovered in Palestine where it is believed to have been laid out and constructed by King Solomon. A new campaign of excavation has just been completed by Nelson Glueck, director of the American School of Oriental Research, Jerusalem, whose report was made public by Prof. Millar Burrows of Yale University. The city, Ezion-Geber in the Bible, which was also Palestine's most important seaport, was built in the tenth century before Christ, Dr Glueck says. Until last year the exact location of Solomon's seaport had long been unknown, but explorations near Akabah had laid bare the site, now known to the Arabs as Tell el-Kheleifeh, Akabah is located on the northern end of the Gulf of Akabah, which is the eastern arm of the Red Sea, the Gulf of Suez being the western arm.

"King Solomon alone in his day had the ability, the vision and the power to build a great factory

town and sea-port a comparatively long distance from the capital city of Jerusalem," the report says. In Solomon's time, Ezion-Geber was a strongly fortified factory site and many of its buildings were heated.

"The city had an extensive system of smelting and refining plants, whose walls were likewise pierced with a more intricate arrangement of flues and air channels, than had been previously suspected. The excavations are by no means concluded as yet, but it seems safe to assume that much of the town was occupied by an elaborate complex of smelters and refineries with the necessary air blasts for the furnaces furnished by the strong winds blowing almost continuously from the north. The entire town was, considering the country and the period, a great factory site of a nature unparalleled in the history of the ancient Orient."

—Science Digest

Chemical Investigation of Artificial Radio-Elements

Priyadarajan Ray
Khaira Professor of Chemistry, Calcutta University.

In two previous articles published in this journal* a general account of the artificial radio-elements and the formation of trans-uranic elements was given. It might, however, be of interest to know how these elements of comparatively short-life-period, produced in almost unweighable and extremely minute quantities, have been chemically separated and identified. It is intended to describe here briefly the technique of the chemical methods which have recently led to some remarkable results of great significance to the nuclear physics.

Since the first synthesis of radioactive isotopes by Curie and Joliot in 1934 (*Compt. Rend.*, 198, 254, 1934), a very large number of radioactive isotopes of various chemical elements have been reported. Besides the forty naturally active elements, some two hundred radioactive isotopes of eightyfive of the chemical elements have now been added to the list.

The methods of their synthesis can be arranged under five different heads according to the nature of the projectile employed for the reaction. These can again be subdivided according to the character of the emitted product. The resulting active element shows either a positron or an electron activity. All these facts are summarized in the following table.

TABLE

(I)	(a) $\alpha:p$ Process	^+e or ^-e activity
	(b) $\alpha:n$..	^+e ..
(II)	(a) $p:n$ Process	^+e or ^-e activity
	(b) $p:\gamma$..	^+e ..

* Entitled NUCLEAR CHEMISTRY. (I, 79, 1935) and EXTENSION OF THE PERIODIC TABLE AND THE ELEMENTS BEYOND URANIUM. (4, 167, 1938).

(III)	(a) $d:\alpha$ Process	^+e or ^-e activity
	(b) $d:p$..	^+e or ^-e ..
	(c) $d:n$..	^+e ..
(IV)	(a) $n:\alpha$ Process	^-e activity
	(b) $n:p$..	^-e ..
	(c) $n:\gamma$..	^-e ..
	(d) $n:2n$..	^+e or ^-e ..
(V)	$\gamma:n$..	^+e or ^-e activity

The symbols are α =alpha particle; p =proton; d =deuteron; n =neutron; γ =gama ray; ^+e =positron; ^-e =electron.

The general method of identification consists in setting up of a nuclear reaction equation. Knowing Z (atomic number) and A (mass number) of the bombarding particle, Z of the target, as well as A and Z of the lighter reaction or disintegration product, Z of the residual nucleus is calculated. For instance, the element boron by means of $\alpha:n$ process gives a product X , whose Z value follows directly from the equation:

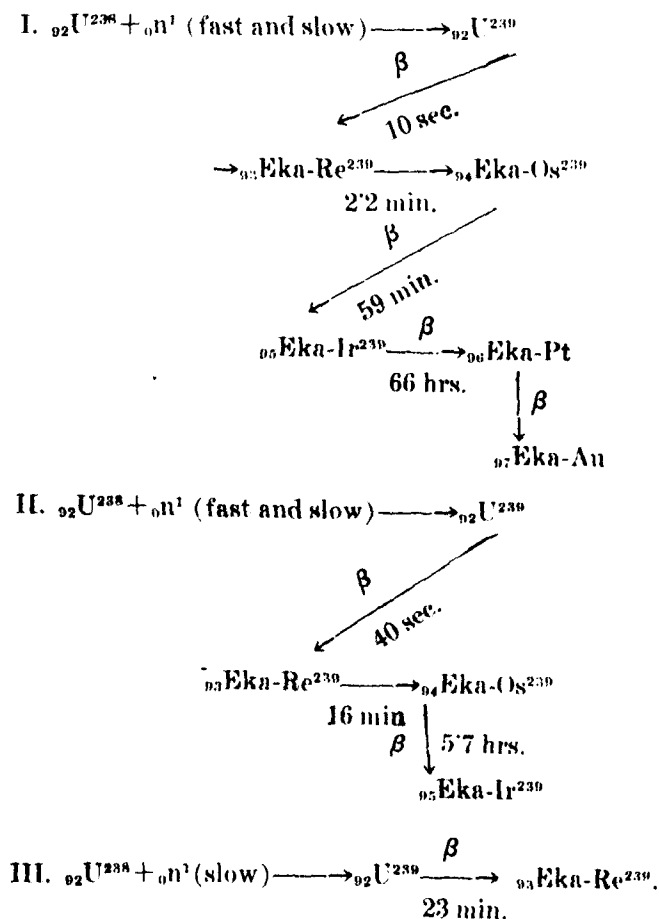
${}_5B + {}_2He^4 = {}_7N^1 + X.$

The value of Z for X being 7, it shows that the product is nitrogen. If X be active, the value of Z is checked by chemical separations. A of the target and the product has to be determined now. This is effected by a consideration of the isotopes of the target.

In this particular case boric acid was used as target. It was heated in a current of air; the

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number of the 13-minute body is 93, which was confirmed by its co-precipitation with rhenium sulphide, Re_2S_7 , in HCl . It would, however, be noted that during bombardment of uranium a Szilard-Chalmer's separation might occur, so that a part of uranium would be reduced to U^{IV} and activated, giving impression of the formation of a Th-isotope. Hence irradiated uranium should be previously oxidized before proceeding with the chemical separation. The above conclusion of Fermi was confirmed by the brilliant work of the German investigators Hahn, Meitner and Strassmann, (*Ber.*, 69B,905, 1936; *Ibid.*, 70B, 1374, 1937). As a result of their work, three different transmutation series, produced by the irradiation of uranium, were distinguished.



Uranium was first freed from its usual active products Ux_1 (Th-isotope) and Uz (Pa-isotope) by precipitation with ammonia in presence of a little

ferric chloride. The precipitate was dissolved in ammonium carbonate and the filtrate was irradiated with neutron after evaporation. The irradiated product was dissolved in hydrochloric acid, oxidized with nitric acid, and the solution was precipitated by hydrogen sulphide with Re and Pt as carriers. The transuranates 93, 94, 95 and 96 were removed leaving ${}_{92}\text{U}$, ${}_{90}\text{Ux}$ and ${}_{91}\text{Uz}$. From the filtrate U-isotopes were precipitated as sodium uranyl acetate. A 23-minute active body was detected in the precipitate. The formation of the 40-second body was also similarly proved.

Separation of eka-rhenium (93) from platinum homologues 94, 95 and 96 was carried out by several methods.

(a) By preferential deposition of nobler platinum homologues on silver, gold or platinum foils saturated with hydrogen.

(b) After the addition of a little bismuth salt to the irradiated uranium solution, the bismuth was precipitated from the solution by reduction with alkaline stannous chloride. The precipitated bismuth carried down all the noble metals along with it, leaving eka-rhenium in solution.

(c) By means of nitron, as it behaves like rhenium which forms an insoluble nitron perrhenate. Some perrhenic acid was added to the irradiated solution as carrier and then precipitated as Re_2S_7 by H_2S . The sulphide precipitate was dissolved in alkaline hydrogen peroxide, the solution acidified with acetic acid and then treated with nitron acetate. The nitron precipitate was associated with the 16-minute body eka-rhenium (93).

(d) By treating the irradiated solution containing minute quantities of sodium perrhenate, platinum and osmium salts with excess of caustic soda ${}_{92}\text{U}$, ${}_{90}\text{Ux}$, ${}_{91}\text{Uz}$ and eka-osmium were precipitated leaving most of the eka-rhenium in solution.

(e) Difference in volatility also served to separate eka-rhenium from eka-osmium. The H_2S -precipitate with platinum as carrier from the irradiated uranium solution was ignited; the residue showed the activity of eka-rhenium.

Or, the sulphide precipitate was dissolved in aqua regia, evaporated and ignited. The sublimate gave the eka-rhenium activity and the residue that of eka-osmium.

(f) From a 10 N.HCl solution eka-osmium was preferentially precipitated by H_2S .

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A partial separation of eka-osmium with metallic bismuth by means of alkaline stannous chloride was effected from the uranium solution irradiated for 10 hours after mixing with little bismuth salt. Eka-osmium was also partially separated from the eka-iridium by precipitation with caustic soda. Eka-osmium was further preferentially precipitated by H_2S in 10 N.HCl .

Eka-platinum can be easily distinguished from its parent, weakly active eka-iridium. The uranium salt was bombarded for several days. The solution of the salt was precipitated by H_2S with platinum as carrier. The precipitate was allowed to stand for two days when only eka-iridium (half-life 66 hrs.) and its disintegration product eka-platinum (half-life 2.5 hrs.) remained. These were then separated by the German workers by various methods.

(a) Preferential precipitation of eka-iridium by H_2S from 10 N.HCl .

(b) Partial precipitation of eka-iridium with metallic bismuth with the use of alkaline stannous chloride as the reducing agent.

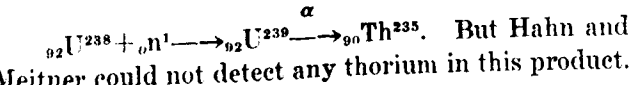
(c) Greater volatility of eka-platinum on ignition of the sulphide precipitate.

(d) Preferential precipitation of eka-platinum with ammonium platnichloride.

(e) Preferential deposition of eka-platinum on platinum foils.

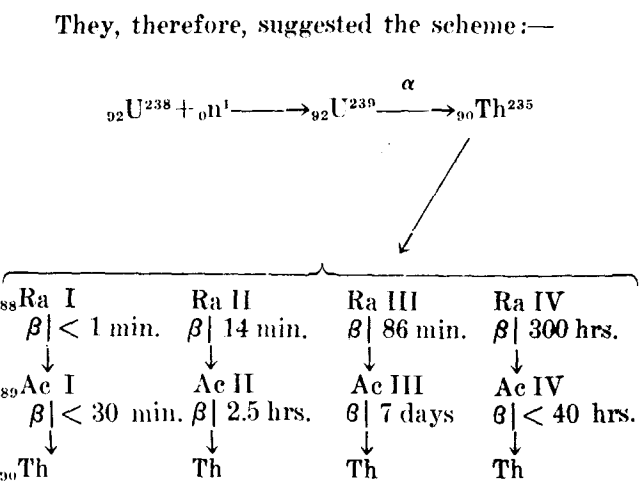
In addition to the above described active substances, a sixty-day body was discovered by German workers but its position in the above series has not yet been settled. Though the transuranates resemble rhenium and platinum metals very closely, still they are not identical in all respects. Slight differences have been observed in certain chemical and electro-chemical properties as well as in their degree of volatility.

Curie and Savitch (*J. Phys. Radium*, 8, 385, 1937) detected an active body of 3.5 hrs. in irradiated uranium. As it was not precipitated by H_2S , they concluded that it must be an isotope of thorium. The nuclear reaction was represented as:



This led the French workers (*Compt. Rend.*, 206, 906, 1938) to repeat their work with greater care. They then reported that the active body (a) is not precipitated by H_2S from 2 N.HCl , (b) is precipitated by ammonium carbonate, (c) is not precipitated by potassium iodate in concentrated nitric acid solution (difference from Th or Ux), (d) is not precipitated by phosphoric acid in presence of zirconium in acid solution (difference from Pt), and (e) is precipitated by oxalic acid from weak nitric acid solution in presence of lanthanum (resembling rare earths and Ac). This suggested that the new body is either an isotope of actinium or a new trans-uranic element differing from those previously described. But it was difficult for them to support either of these hypotheses.

Hahn and Strassmann (*Naturwiss*, 26, 756, 1938; *Ibid.*, 27, 11, 1939) have made a thorough investigation of this active substance. They subjected the irradiated uranium solution to analytical group separation with suitable carriers. Beside the trans-uranic group, activity was found associated with the alkaline earth group precipitate (carrier Ba), rare earth group precipitate (carrier La) and the zirconium group element (carrier Zr). They found that the active body, associated with Ba, has got four different life-periods, according to the period of irradiation, and each of them disintegrates further into successive active bodies precipitable with La, which again disintegrate further with emission of β -rays.



They also showed that the trans-uranates, U, Pa, Ac and Th can be completely separated from the

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barium-active body. This was proved by performing the following experiments.

The solution of irradiated uranium was precipitated by H_2S with platinum as carrier. The precipitate was dissolved in aqua regia, and from the solution barium chloride was crystallized with concentrated hydrochloric acid. The barium chloride precipitate was found to be inactive. The filtrate from barium chloride was precipitated by H_2S . Activity was detected in the sulphide precipitate.

Non-irradiated uranium containing Ux_1 and Ux_2 (Th and Pa isotopes) was dissolved and from the solution barium chloride was crystallized and the crystals were found to be inactive. From a solution containing Ms-Th_2 (Ac-isotope) barium chloride was precipitated with concentrated hydrochloric acid. The precipitate was inactive.

Similarly, active barium chloride precipitate from irradiated uranium was also tested. The sulphide precipitate from the neutral or weakly acid solution of active barium was practically inactive; while lanthanum and zirconium precipitates from the same active solution showed activities whose origin could be traced to that of the barium precipitate.

Attempts were then made to concentrate the active product (Ba-carrier). For this purpose, the barium chloride precipitate was fractionated. The fractions showed neither increase nor decrease of activity. On the other hand fractionation of barium chloride mixed with Thx or MsTh_1 (Ra-isotopes) showed increased activity in the earlier fractions. Further examination was made by an indicator method. MsTh_1 was mixed with the purified RaIV isotope with barium bromide as carrier. The latter was then fractionally crystallized. The earlier fractions were enriched with MsTh_1 , but no enrichment of RaIV could be detected. Hence the German workers came to the irresistible conclusion that this active body is isotopic with barium. Similar indicator method was also applied to AcII. This was mixed with MsTh_2 and fractionated with lanthanum oxalate in nitric acid solution. MsTh_2 was enriched in the end fraction but not AcII. Hence it is identical with lanthanum.

This shows that, by bombardment with neutron, the uranium nucleus (92) may suffer a fission into a barium nucleus (56) and possibly a krypton nucleus (36) as $92-56=36$. Frisch (*Nature*, 143, 276, 1939) also obtained evidence by physical method of the liberation of heavy particles of atomic mass of at least 70 from uranium under neutron bombardment. If it be $_{36}\text{Kr}^{88}$, then $_{56}\text{Ba}^{139} + _{36}\text{Kr}^{88}$ would involve a loss of 12 mass units or neutrons from $_{92}\text{U}^{239}$.

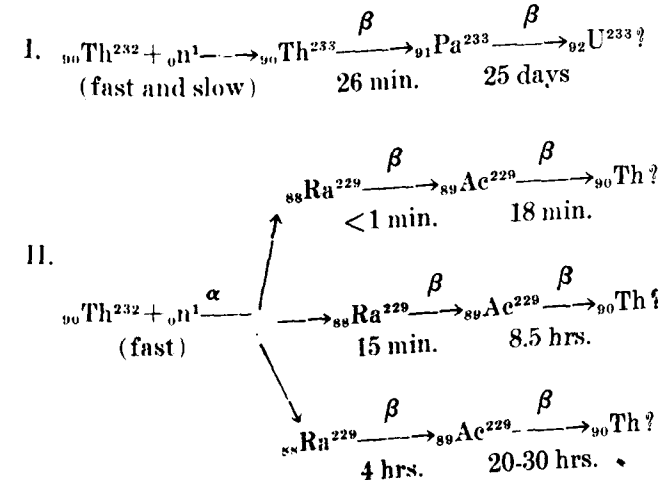
The formation of barium isotopes from uranium by bombardment with slow neutrons was further established beyond all doubt by a number of indicator experiments as well as by means of a cyclic process. The indicator methods were carried out with previously termed RaIII (86 min.) and RaIV (300 hrs.) which should now be written as BaIII and BaIV. In one case BaIII was mixed with the radium isotope MsTh_1 , and then fractionated with barium bromide; in another case it was mixed with Thx, also a radium isotope, and then fractionated with barium chromate. In the third case BaIV was mixed with Thx and also fractionated with barium chromate. In all these cases it was found that the relative amount of active barium isotope, or in other words its activity, remained unchanged in different fractions, whereas that of radium isotopes gradually diminished in successive fractions.

In the cyclic process the active barium isotope BaIV was separated from the irradiated uranium solution by crystallization with barium chloride as usual. After the decay of BaII and BaIII, the active product containing BaIV was recrystallized. One-fourth of the total quantity of the crystals separated was set apart, and with the rest the following cyclic process was carried out.

(1) Barium chloride $\rightarrow$ (2) Barium succinate $\rightarrow$ (3) Barium nitrate $\rightarrow$ (4) Barium carbonate $\rightarrow$ (5) Barium chloride $\rightarrow$ (6) Barium ferri-mannite $\rightarrow$ (7) Barium chloride. After this, the final barium chloride crystals were again recrystallized for purification. The quantity of barium chloride set apart in the beginning, which did not pass through this cyclic process, was also subjected for the same length of time to recrystallization. Activity of the equal amounts of the product from the cyclic as well as the control preparations were compared and found identical. From this it can be concluded that BaIV remained associated with its inactive isotope barium through all these processes.

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The same workers also examined the so-called radium isotopes resulting from thorium by bombardment with neutron. In extension of their previous work already mentioned, Hahn, Meitner and Strassmann in 1938 showed (*Z. Physik*, 109, 538) that by irradiation of purified thorium (freed from its natural disintegration products) with fast neutrons three different radium isotopes could be chemically separated, which further disintegrated into three different actinium isotopes. The entire transformation process was then represented by the following scheme.



Since it is definitely established by experiments that the so-called radium isotopes from uranium are identical with barium and are really isotopes of thorium, the latter element, Hahn and Strassmann (*Naturwiss*, 27, 89, 163, 1939) now examined the above mentioned radium isotopes produced from thorium by bombardment with neutron. The results of their experiment in these cases as well left no doubt about their identity with barium. 15-min Ra and 4-hrs Ra from Th were tested for this purpose. As an indicator for radium Thx, which is spontaneously generated in Th, was employed and the fractionation was effected with chromate. Thx was found to be concentrated in the first fractions whereas the activity due to the 15-min or 4-hrs body remained unaltered in different fractions. So, like the case of uranium, a fission of thorium nucleus occurs on irradiation with

neutron giving rise to active barium isotopes. There is, however, one difference in the two cases. Whereas the uranium nucleus explodes by the action of slow neutrons, the thorium nucleus requires fast neutrons for the same process.

From the facts thus established, it follows that the further disintegration of the above described barium isotopes both in the case of uranium and of thorium leads to lanthanum and cerium isotopes and not to those of actinium and thorium as previously assumed. The question that now naturally arises is—what is the other fragment of the fission of uranium nucleus? Is it krypton as already suggested from a consideration of atomic numbers? Or, is it masurium since its mass number 101 (approx) with that of barium equals the mass number for $_{92}\text{U}^{239}$? But this would involve a loss of seven electrons as the sum of the atom numbers for barium and masurium is $56+43=99$. This would seem to suggest that the transuranates, which closely resemble rhenium and platinum metals, but are not identical with them, might be identical with their still lower homologues, masurium, ruthenium, rhodium and palladium.

Hahn and Strassmann have actually succeeded this year in proving chemically the existence of strontium in irradiated uranium. For this purpose the irradiated uranium solution was mixed with 150 mg. of strontium. This was carefully freed from transuranates by precipitation with H_2S . The filtrate was next treated with ammonia. The uranium precipitate containing strontium was dissolved in 65% nitric acid and from the solution strontium was precipitated by fuming nitric acid. The strontium nitrate was dissolved in water and the solution after mixing with 60-70 mg. barium was treated with ammonium chromate in presence of acetic acid. From the filtrate of barium chromate strontium was precipitated as strontium carbonate and then dissolved in hydrochloric acid. The resulting solution was treated with 10 mg. of yttrium and the latter precipitated by carbonate-free ammonia. In the filtrate strontium was finally precipitated as carbonate. The precipitate showed distinct and well-defined activity. By this process of chemical separation the strontium was freed from transuranates, uranium, Ux, Uz, barium, any lanthanum or cerium etc., resulting from the

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in the process of nuclear fission of uranium. This has to be accounted for. Halban, Joliot and Kowarski (*Nature*, 143, 470, 1939) have proved that neutrons are actually liberated during the nuclear explosion of uranium. This has been confirmed by Michiels, Parry and Thomson (*Nature*, 143, 760, 1939).

As a result of the application of chemical methods to the study of nuclear processes, discoveries of remarkable facts of far reaching importance have been made, and new promising fields of investigation have been opened up, for the full exploitation of which the co-operation of workers in the two sister branches of science—physics and chemistry—seems indispensable.*

* Based on a lecture delivered at the Bose Institute, Calcutta.

Utilities of Radio

Numerous are the contributions of radio to our knowledge and civilisation. The potential control of human relations through entirely new possibilities of mass psychology is one of the portents of our times. Related to this are the amplifier and the loud speaker. The elimination of the problems of auditorium acoustics is remaking the arts of oratory and of singing. To the finest of the arts, music, new vistas are opening through new types of musical instruments and extensions of ranges and control, all provided by radio techniques. Time measurement has been made so precise by radio devices as to reveal an effect of the motion of the moon on the rate of accurate pendulum clocks and even to discover variations in the rate of rotation of the earth on its axis. The art of the physician is notably advanced by radio-frequency devices which permit treatment in the very interior of the tissues of the human body. Television has become a reality through the development of photo-electric and cathode-ray tubes. A single radio device, the electron tube, has grown so great that politicians squabble over it. In recent patent litigation, the

Attorney General of the United States said this 'is the key device which is essential to the operation of modern telephone and telegraph wire networks; to radio transmission and reception; to sound motion pictures, to the transmission and reception of images by television or wire photography; to public address systems; to diathermic medical treatment; and to electric power transmission. There is no substitute for it, and without it the modern electronics industry could not function.' Radio is also directly aiding the advance in certain sciences. They are the large-scale sciences, of the general category of geophysics and astronomy. For radio waves operate outside the laboratory, along and above the surface of the earth, in and over the earth's atmosphere. Specially, the sciences in which the use of radio itself is contributing to progress are: the electrical properties and composition of the atmosphere, meteorology (i.e., the sciences of weather), terrestrial magnetism, solar physics, and astronomy.

—*Journal of the Franklin Institute*

Foreshore Fishing in the Eastern Part of the Bay of Bengal

Chinta Haran Mojumdar

THE coastal area of Bengal which lies along the eastern shore of the Bay of Bengal presents special features in its physical conditions. In some places the coast is open, in others islands with ranges of hills or plains lying close by have resulted in numerous channels of muddy or clear saline water. The mainland again forms, in places, true estuarine areas interwoven with numerous *khals* (small streams) and is covered with forest trees somewhat similar to those of the Sunderbans. On account of these peculiarities, the fishes and the methods of fishing on this coastal line combine all the varieties seen along the rest of the sea board.

The seasonal and daily tidal changes, "Jos" and "Dalas" etc., all have their direct effect on the fishes, their life history and the methods of fishing. A *Jo* is the period of 8 days lying on either side of full or new moon day when the tides maintain high water levels and the rest of the fortnight is called a *Dala*. For example, *Jo* is the suitable time for general fishing in the foreshore areas, whereas *hilsa* fishing takes place during the *Dalas*. Fishes move at a greater depth by day than by night and the estuarine fishes liberate their eggs mostly in the months of *Falgun-Chaitra* (March-April) irrespective of the early rains which are essential for the spawning of the freshwater fishes in Bengal.

The Coastal Hilsas

Amongst the sea fishes, the *hilsa* holds an important position even in the fisheries of the coastal region. During the winter season from November to February large shoals of this fish appear in the coastal waters of the Bay. This is definitely six months ahead of the period when they migrate into the rivers from the month of May onwards. The reason assigned by the native fishermen for this early appearance is that there in the coastal region they liberate eggs in the months stated above just

before the rains set in, whereas they spawn at a much later period in the inland rivers.

The *hilsas* are classified into three types by the fishermen:—

- (i) The *Fotyas*, the smallest of the three types.
- (ii) The *Chandanas*, the largest of the three types, and
- (iii) The true *hilsas*, which grow as big as those obtained during the rainy season in the inland rivers.

The *Chandanas* never move in shoals, while the *Fotyas* get disbanded if disturbed while moving in shoals. But the true *hilsas* very often remain near the surface of the water. Even if they go under water, they soon rise up, the reason as adduced by the local fishermen being that they are invariably followed by sharks (*Carcharias spp.*) and saw fishes (*Pristis spp.*) in the lower regions. The *hilsas* move near the surface of the clear saline water in large shoals till the early summer. The fishermen go out with two boats and a net in a batch every morning in search of shoals, and when found they spread their net along the probable way and wait with one boat at each end of the net. The net is about 150 cubits in length and 50 cubits in breadth with floats attached on one side. As soon as the shoal comes near the net the other end of it is pulled up and the fishes are trapped. The other way of catching the *hilsas* in this part of the country is to drive the shoals into the branch rivers opening in the sea by the beating of tins or drums. When they are up in such a *khal*, their way to the sea is obstructed with nets and they are caught for days together. The *hilsas* are also caught by *char jal*, a net of any length and 10 to 12 cubits in breadth. During the flood tide *char* areas are enclosed with these nets, and *hilsas*, which sometimes go there along with other fishes, are stranded on the sand when the water recedes at the next ebb tide.

FORESHORE FISHING IN THE EASTERN PART OF THE BAY OF BENGAL

The *hilsa* season, of 1937-38 was very disappointing. This year (1938-39) too, fishing boats searched in vain for shoals of *hilsas*. It is reported that they were moving down the Burmah coast, some 20 miles off the Bengal shore. It is abnormal that *hilsas* should move into fixed nets at such a great distance from the shore, as was the case this year when some 1500 *hilsas* were trapped in the third week of December, 1938, to the west of Cox's Bazar in the Chittagong district.

There are centres where Rs 10,000 to Rs 12,000 worth of *hilsas* are caught and disposed off annually, also there are people who live on *hilsa* fishing alone in this part of the country. But this scarcity of fish has brought in a dislocation of their business. The rivers there, as stated above, have generally short courses and the *hilsas* cannot go far up for breeding. And it is likely that an early flood, after the liberation of the eggs, washes the eggs to the sea where they are destroyed.

Fishing by Floating Nets

From time immemorial the fishermen of certain localities on the coastal region go to some particular portion of the Bay, namely, Kalidhar to fish the highly prized fishes of the area. The place is well known to the fishermen though it has no geographical location on the map. The depth of water is 10 to 12 cubits, and the nets they use are something like 200 cubits in length and 10 to 12 cubits in breadth. These are spread at suitable places and the fishes in their course of movement get so much entangled with their fins and parts of head that they become exhausted after struggling for a while. The catches are the Lawka (*Polynemus indicus*), Churi (*Trichiurus savala*), Sharks, Chanda (*Stromateus sinensis*) and others. The fishermen have to go from the port of Chittagong southwards, a journey of 6 to 7 days with their supplies of rice, fuel, water etc., which would last for a month for a dozen or so men on board. The result is that their primitive boats do not allow them to fish more than 15 days at a stretch and for the same reason they cannot either dispose of or preserve their catches when far away in the sea. Consequently they have to come back within one month of their start and

in doing so they lose the best part of the fishing time in repeating their journeys over the same track.

A definite improvement has been effected in this type of fishing by the use of floating nets as has been done by a Chinese gentleman who started a shark fishing firm some ten years back on Moheshkhali island in the Bay. He began his business with 2 fishing boats and now he has 11 such boats of the Junk pattern. These are driven by sails. They can withstand hurricanes which would capsize the country boats. With these improved boats he does his fishing for a period of six months while the native fishermen cannot do so even for a period of 4 months in a year. Out of the 11 boats he has fitted two with motor engines. He only fishes for sharks and saw-fishes, which after a special treatment are exported to foreign countries. The other fishes caught in his nets are sold locally. He has some 80 to 90 trained employees and his income allows free rations, a handsome pay and some bonus to each of them at the end of the season. In this type of fishing the nets are comparatively much shorter in length and can be operated by two or three men. A boat with a crew of three, 30 to 35 nets and necessary food-stuffs goes out to sea for fishing for 3 to 4 days at a stretch. The motor boats collect the catches and bring them to shore at intervals. The gentleman has a jetty, ware-house and a Chinese mechanic to help him in his construction work. Powerful lamps fixed on the jetty are used as signals for the fish-collecting boats at night.

The Bay of Bengal abounds in fishes, and the Chinese gentleman has fully justified the views of Col. A. Alcock, I. M. S. that a shark fishery alone would amply repay the outlay of a large capital. Fishing by floating nets has become very popular at places by the sea-side but no capitalist has so far organised a business on the lines followed by the Chinese gentleman. The old system of fishing with slow and frail boats, which cannot withstand the rough weather of the early summer in the sea, must be replaced by better types of vessels and better nets also should be introduced for the purpose.

Fishing by Fixed Nets

The foreshore fishing goes on more or less throughout the whole year but the large-scale commercial fishing is done during the *Jo* period of

FORESHORE FISHING IN THE EASTERN PART OF THE BAY OF BENGAL

the winter months with the help of funnel shaped nets called the *Birindhi* nets. There are certain currents in the Bay at special depths which are called the "*Dhars*". There are 18, 25 and 35 cubit deep *dhars* within 5 miles from the island of Shonadia, an important foreshore fishing centre, but the prospective and well-to-do fishermen try to select out their areas at a distance of 15 to 20 miles off the shore. Sets of 14 nets are generally kept operating simultaneously and these are replaced as required with extra nets in stock. They require two big boats with a crew of twenty on each. To fix the nets in the distant sea they first of all drive in long poles into the bed at, say, a depth of 45 cubits or more with their ingenious implements. The nets are fixed to those poles with the help of cables and sunnhemp ropes. The currents of the sea make the nets work, by keeping the mouth of the nets always facing it, both during the ebb and the flood tides. The force of the tide brings the nets to the depth where the current is the strongest, and maximum numbers of fish are forced in.

The catches are collected after several hours, and are sent to the shore every 12 hours, as soon as the relieving boat reaches there. One boat with full crew remains always by the net-side to attend to emergent cases, for repairing of the nets or for making them work if they do not operate automatically for some reason. Sometimes giant fishes get into those nets. These fishes which they cannot control are let out by making openings in the nets. Porpoises, which are caught, are used for extracting oil in a most crude way by hanging them by the tails in the sun with an empty tin placed underneath.

Scientists are of opinion that oil from the livers of some of the Indian fishes e.g., sharks, has as much as 5 times the vitamin potency of that of the European Cod liver oil. But who ever cares to extract even an ounce of the oil from the livers of fishes which are now only thrown away or at best utilised as baits by the anglers near the fishing centres where sharks are more or less abundant almost every day during the fishing season.

During the season the fishermen get 8 *Jos* and 8 *Dalas* for fishing, a period approximately of 2

months in each case. At times, the catches are so great that a single day brings them Rs 500/- to Rs 600/- worth of fish. Sometimes during the *Dalas* an under-current from the west moves on to the netted areas thus forcing a huge quantity of fish into the nest. For this type of fishing, the fishermen invest near about Rs 12,000 to organise the fishing and generally reap a good profit unless the season becomes abnormally adverse. The catches, which contain such valuable fish as the Pomfrets, Talia, Bhetki, (*Lates calcarifer*) etc., present no charm for them as they have no facilities for marketing them. Transport difficulties force the fishermen at places to barter their catches for fried paddy or betel leaves or such articles. They perform their business under many disadvantages. They suffer from scarcity of good water to drink. Their sanitary arrangements require improvement. Foul smell comes from heaps of drying fishes and multitudes of flies always hover over the food and bodies of the fishermen in their villages.

The fishermen should be enlightened regarding the use of improved nets, scientific methods of fishing and preserving the fishes. Transport by fast-running motor boats and improved methods of preservation of fishes would give them a better return for their labour. At present they are unable to send the quality fish to suitable markets and most of their catches are, therefore, either sold at a very low price or only dried. The methods of fishing so far in vogue in the coastal regions and the Bay are fundamentally defective in the sense that the catches are dependent on the movements of the fishes and on the currents, unlike the modern practices in Europe, America and the Far East where the trawlers force the fishes, irrespective of currents, into their big and strong drag nets.

The coastal region and the Bay itself offers immense possibilities for the development of an extensive fishing industry. In these days when the need for increasing national wealth is being keenly felt, it is hoped that the information contained in the preceding pages will show the scope for a flourishing fishing industry in and along the Bay, provided scientific experts and the capitalists are prepared to explore the available resources, and set to work along right lines for improving the crude, indigenous methods followed by the poor, illiterate and disorganised fishermen at present.

A Bratachari Map of the Ganges-Brahmaputra Basin

G. S. Dutt

Founder, Bratachari Movement.

IN recent years, great interest is being taken in the Ganges-Brahmaputra river system and a number of eminent people have written on the subject from different points of view. It has been now recognised that the health as well as the prosperity of the entire area of India east of the Punjab (classical Aryavarta) and particularly of the deltaic area of Bengal are intimately connected with and dependent on the condition and the operation of the Ganges-Brahmaputra river system. Some of the writers have dealt with this river system from a historical angle and have written learned articles on the changes which this river system has undergone during historic times. A great number of interesting maps and sketches of this river system has also been published from time to time.

In a field where eminent scientists, engineers and sociologists have been working for a number of years, a layman like the present writer feels considerable diffidence in entering. My only apology is that there appears to be a fresh point of view from which the subject may be approached, viz.: a synthetic point of view combining the various aspects of public health, economic development and physical formation and growth and decline of population, with the cultural point of view superadded to them; and this is how the question unfolded itself before me. In fact when acting as District Officer of Bankura between 1921-23 I became conscious of the great havoc caused to the productive power of the district by unchecked deforestation of the countryside, which appeared to me to have had a very baneful effect on soil fertility and capacity of the soil for holding water; and I started a movement for the afforestation of the uplands in the Bankura district and for the conservation of private forests in the district. I also intended to start an afforestation society with a view to checking the evils attendant

on the present unscientific system of management of private forests and making them economically profitable to the population. This is mentioned only to show that even a layman like myself was impressed as early as 1921 with the relation between afforestation and soil conservancy and its effect on the rainfall and prosperity of the land and with the need for careful planning for the conservation of the land as well as of the rivers.

Since 1929, I have been interested in the problem also from a cultural point of view in connection with the Bratachari movement. This movement is founded on the deep belief, shared by human societies from time immemorial to Hitler's Nazi Germany, that there exists a profound connection between the nature of the soil and the culture of the region; in other words, between Nature and Man in every ecological area. The Bratachari movement, which was preceded by my researches in the field of folk-arts and folk-culture of Bengal, led me to investigate more closely into this underlying connection. Now Bengal is a land of rivers. It is, in fact, the gift of the Ganges and the Brahmaputra. Civilisation here has always grown on the banks of the main rivers and of their tributaries, and hence it became clear to me that a preliminary requisite to this investigation would be to obtain a complete idea of the river system of Bengal.

But when I looked for a map suited for the purpose, I was very much disappointed. All the available maps referred only to the administrative area of Bengal. They showed only the lower course of the rivers. Even the Irrigation Department of Bengal, when approached, could not give me a map that gave all the information that I sought. It is clear even to a layman that the problems of flood, irrigation and navigation in Bengal cannot be treated in a piecemeal way, because the rivers which

A BRATACHARI MAP OF THE GANGES-BRAHMAPUTRA BASIN

carry the water form an organic whole and they have their sources and upper courses far away from the present administrative area of Bengal. At my request my friend, Mr T. A. Curry, then Chief Engineer of the Irrigation Department, Bengal, undertook to prepare a map which would give a complete and synthetic picture of the rivers, and the result of his labours was a map which is reproduced here and which surprised him as well as myself with its wonderful significance and the mass of detailed information which it carries even to a layman regarding the main rivers, the Ganges and the Brahmaputra and their feeders. The original was drawn to a scale of 1"=32 miles and was entirely based on data available in the maps of the Survey of India Department. In this will be found all the main rivers, the Brahmaputra, the Ganges, the Jamuna, the Gogra, the Gandak, the Sone, the Bhagirathi, the Damodar and the Meghna and all their tributaries from their very sources. The principal river courses are drawn deliberately with thick and prominent lines as forming the trunk lines of this most extraordinary river system and constituting the main artery of human life in the heart of Hindusthan. The only obscure part of the system is the actual source of the Brahmaputra and its course from Tibet to India. I believe that there has been a lot of research about the actual source of the Brahmaputra, but controversy still exists as to whether it actually originates at the Manasa Sarovar or at some distance to the east of it. For the purpose of this map the Brahmaputra has been shown as originating from the Manasa Sarovar and this is a controversial item. The course of the Tsan-po river of Tibet and the course by which it debouches into the plains of Assam as the Brahmaputra is yet largely unknown, as the area is densely covered with forests and populated by wild animals and savage human tribes. But it has been known that the river falls through a series of gorges known locally as the Lion's Mouth.

It is clear from this map that this river system collects a huge amount of water brought by the monsoon winds and precipitated over the country and principally over the great Himalyan range and farther to the north over the Kailas mountains which run parallel to the main Himalayan system. The

monsoons lose their force after crossing the watershed between the Indus and the Ganges and the head waters of the rivers are therefore formed by the elevated region round the Manasa Sarovar lake and the group of peaks in the north-west, of which the most prominent are the Badrinath, the Kedarnath and the Gangotri. A large number of rivers is also drained from the Vindhyan range to the south and carried to the main system by the Betwa and the Sone and their tributaries.

I am informed that though the total length of this river system, and the area drained by them is smaller than in the case of certain other similar river systems in the world, *e.g.*, the Amazon, the Missouri-Mississippi, and the Yang-tse-kiang, yet in point of discharge of total amount of water, the Ganges Brahmaputra system far exceeds them. The maximum discharge of the Ganges before it joins the Brahmaputra has been found to be nearly two million cusecs (cubic feet per second); that of the Brahmaputra has not been yet accurately measured, but is supposed to be one and half times higher. The discharge of the Ganges alone is nearly seven times that of the Nile, and nearly 500 times larger than that of the Thames. Such a huge volume of water, flowing through the soft soil of a comparatively small area, gives rise to physiographical changes of a far-reaching character leading to periodic and catastrophic floods, erosions, submersions, and decay of cities and population centres. It will be an interesting study to investigate how many famous cities of antiquity like Pataliputra and Gaur have been destroyed by the action of the rivers, and how far the topographical changes caused by the action of the rivers have influenced history.

Although a great many maps have been published by various authorities showing the Gangetic and Brahmaputra river system at various periods of history, none of these, perhaps, gives information with the same degree of completeness as this map affords to students of the physical geography of northern India, whatever may be the motive with which they approach the subject, *viz.*, economic, public health, commercial, industrial, administrative or cultural, as to the actual sources and the entire courses of the river system at the present day. The map will reveal its many-sided significance, but certain salient features may be mentioned here.

A BRATACHARI MAP OF THE GANGES-BRAHMAPUTRA BASIN

This map indicates at a glance the close mutual interdependence of all the regions and provinces which form the Ganges and the Brahmaputra basin. Broadly speaking, the entire region of the Ganges and Brahmaputra basin (excluding the Tibetan portion of the Brahmaputra basin) falls into two main cultural regions, namely, the Hindi or Hindusthani region on the west and the Bengali region on the east. The Bengali region, besides being fed by the entire system of the Ganges and Brahmaputra rivers has, in addition, its own separate systems of rivers rising in the Chhotanagpur Hills on the west, in the Himalayas on the north and in the Garo, Khasi, Manipur, Cachar and Chittagong Hills on the east. The economic prosperity as well as public health improvement of Bengal, including a proper solution for malaria, thus depend on the operations which can be performed on, and the treatment which can be accorded to, not merely the rivers, uplands and hills within the boundaries of Bengal, but also their numerous tributaries as well as the hills and uplands from which they rise, spread over a region as wide as the entire area of northern India (excluding the Punjab) and in addition, the region of southern Tibet. The question of afforestation and deforestation in the Himalaya, Aravalli, Mandar, Chhotanagpur, Garo, Khasi, Manipur and western Burma hills affects intimately not only the regions relating to their immediate vicinity but Bengal as well. It is also evident that every irrigation work for exploitation of the water of any of the rivers of the combined river system at any particular point of their course vitally affects the regions which lie lower down in regard to health, economic prosperity and culture. The implications of this map from the cultural point of view are of considerable interest. From the point of view of Bengal, it would seem that Bengal constitutes the region of the physical synthesis of this great river system and this corresponds to a cultural synthesis of the streams of culture which find expression in Tibet, Nepal, Bhutan and Chhotanagpur on the one hand and the Gangetic area bordered by the Himalaya, Aravalli, Vindhya and Chhotanagpur regions on the other. The highly complex civilisation and culture of Bengal cannot be explained without reference to these physical facts

and particularly to the hills and river systems shown in this map.

It is certain, in any case, that the future cultural integrity and prosperity of Bengal depends vitally on the restoration and maintenance of the regime of the rivers which cover the entire Gangetic and Brahmaputra region and which have their origin in the deepest and highest regions of the Himalayas, in the heights of Tibet and the wild unexplored areas on the eastern borders of India as well as in the Aravalli, Vindhya, Chhotanagpur, Garo, Khasi, Manipur and western Burma Hills.

A glance at the map shows how artificial are the divisions into which the area has been divided for administrative purposes. These divisions have admittedly no rational basis. As every student of history knows, the boundaries are neither natural nor linguistic, and have been due sometimes to administrative expediency and sometimes to the exigencies of the political situation. But the soil on which the vast population of Hindusthan lives has been built up by the action of these rivers which have gone on performing their natural functions without paying the least heed to human shortsightedness or inconsistencies. The plants and vegetables on which human life depends are entirely dependent on the nature of the soil and on the amount of water which they receive either from natural methods or by irrigation. Since as yet the vast population of Hindusthan is mainly dependent on agriculture and on industries based on agricultural produce, it is clear that for the future we have to plan the land for maximum production. This is possible only if the rivers are studied scientifically and from the point of view of the whole country; for sometimes it happens that when one plan is pushed for satisfying the demands of some immediate objective, a great amount of harm is done by the neglect of other factors. For example, it is admitted on all hands that the system of irrigation canals in the Punjab, by which millions of acres of desert land were brought under cultivation, has been of immense benefit to the inhabitants of the Punjab. But at the time when the canals were planned, it was not realised that were irrigation without arrangements for a thorough washing of the land would gradually lead to the surcharging of the soil by alkalis and render it useless. This is what happened in those parts of the Punjab, and the reclamation of alkaline soils

A BRATACHARI MAP OF THE GANGES-BRAHMAPUTRA BASIN

has become one of the most pressing necessities. Canalisation has also given rise to malaria in these areas; but these consequences could have been foreseen by the irrigation engineers if they had acquainted themselves with the consequences of irrigation in other countries like Iraq (Mesopotamia) where canal irrigation rendered whole areas alkaline. Sometimes, as in Bengal, the opening of railroads and ordinary roads has admittedly interfered with the natural drainage of the country and has converted fertile and healthy areas into malaria-ridden swamps, rendering them unfit for human habitation. It may also happen that the measures taken by one province for the amelioration of its own condition, entail serious consequences on the neighbouring province, and in such cases the neighbouring province has a right to demand that its interests should be properly safeguarded. The enormous extent of the evils which have followed in the train of indiscriminate deforestation of the areas at or near the head waters of the rivers are only now beginning to be realised. In the United States of America, which has to deal with similar problems, the rivers are all regarded as federal subjects, and the power of the States to interfere with them is limited. I, therefore, warmly welcome the formation of a Ganges River Commission which will deal with all river problems from a unitary point of view and which will include the representatives not only of the provinces which are comprised within the Ganges basin, but also of those which are included within the Brahmaputra basin. The Commission will no doubt include among its members not only well-trained river engineers, but also physicists, soil scientists, forest officers, and others connected with the ecology of the rivers.

In one sense the map is not quite complete. At the present time no country can merely depend upon agriculture. It must develop its industries. Now the first step towards development of industries is to find out cheap sources of power. It is well known that India contains only a limited supply of coal situated in the Chhotanagpur and C. P. area which are far away from the main centres of population which is collected in the river-basins. Major parts of India will, therefore, have to depend largely

upon the development of water power. Now both the Ganges and the Brahmaputra and their tributaries rise in very high mountainous regions and after courses of some hundreds of miles debouch into the plains. Any head of water which is more than 10 ft. in height can be utilised to give us electrical power, provided the supply is uniform and reliable. A survey of the Ganges-Brahmaputra river system from this point of view has, so far as I know, not been undertaken seriously, except in a preliminary and incomplete fashion about twenty years ago by Mr Meares; and even these reports have not, I believe, been utilised for the abovementioned purpose. But even without entering into details, it is safe to hold the opinion that there exist in these uplands, and sometimes also in the plains, huge untapped resources of water-power. The first step towards the development of power should obviously be a proper survey, by a competent staff, of the discharge of the rivers throughout the year and of the possibility of cheap power production and a careful verification of the existing official figures so as to obviate all possibility of mistakes before any planned action on a large scale is undertaken. When Russia, after the Revolution, adopted the resolution that as the first step towards the consolidation of Soviet Power the power resources of the country should be developed, she found from the then existing data collected during the Czarist regime that the total water power resources of Soviet Russia was only 14 million kilowatts. But the Russian Government were not satisfied with these estimates as they thought that there was a risk that these figures, being produced with the help of engineers not sufficiently acquainted with the land and acting on the advice of untrained local staff, were neither thorough nor entirely reliable. They proceeded to attack the problem in a systematic manner. They first opened a number of central hydro-dynamical laboratories in central cities like Moscow, Leningrad and Tashkend and educated a large scientific staff for the survey of rivers. After their education was complete, a large number of first class, second class and third class river stations were opened, their total number being about 5,200. Survey from the river stations revealed the very interesting fact that the previous estimate of total potential water-power was nearly 20 times too small, and the total power available was nearly 280 million kilowatts, which is nearly 2000 times the amount of power used now at Calcutta. Of course,

A • BRATACHARI MAP OF THE GANGES-BRAHMAPUTRA BASIN

all these were not economically profitable, but a large number was; and the Russian Government, on this basis, mobilised the whole power of the State for the construction of a large number of hydro-electrical stations. The most famous is the station on the Dnieper river, opened in 1932, which produces a total power of half-million kilowatt i.e., nearly four times the power now used at Calcutta and has given rise to large scale non-ferrous metal industries in the surrounding region. The total production of power in Russia from hydro-electric sources amounts to nearly 45000 million units, which is about 20 times larger than that of pre-War Russia.

It is obvious that the Ganges and the Brahmaputra river system holds out equal possibilities and a number of hydro-electric stations have been opened as a result of the energy and initiative of Sir William Stampe in the Upper Ganges Basin. The extremely high cost of this undertaking has, however, acted as a deterrent to further enterprise in this line, but 'errors' are unavoidable in a new venture and there seems to be a very strong case in favour of a systematic, scientific and comprehensive campaign of river-surveys. It is hoped that this aspect of the matter will receive due consideration from the River Commission alluded to above. When this is done, we can give a new meaning to the map which is printed here. The possible hydro-electric stations would be specially marked with the amount of power which may be developed there and would be indicated by proper markings and this should be followed by a survey of the possible industries which can be started round the stations. An economic survey seems essential, because there can

be no point in developing power unless it is utilised. An example will make it clear. A promising site in North Bengal was surveyed some years ago at the initiative of the Government of Bengal and it was estimated that about 50,000 kW. of power could be very easily developed by damming the Tista river above Darjeeling and that in course of time, the power developed might be several times multiplied. After the survey, it was discovered that there would be no use for the power, because no industries could be started in that region unless the railways undertook to utilise the major part of the energy produced. The electrification of railways being a complicated affair, the railways naturally refused to give any previous undertaking. It is well known, however, that the Himalayan regions are well-stocked with pine forests of great economic use which, with the help of water-power, can be converted into wood pulp which is the raw material for manufacture of paper and artificial silk. Whatever may have been the position in the past, it is hoped that it will be possible to effect a successful exploitation of these natural resources in the near future in the light of the data obtained as the result of the survey.

The future cultural development of the Gangetic and Brahmaputra basin generally, and of Bengal in particular, depends not only on the development of agriculture and industry but on the maintenance of friendly relations between the provinces into which this region has been artificially divided. It is only by concerted development of agriculture, industry and human relationship that we can look forward to the realisation of that inner harmony between Man and Soil which is necessary for the development of the highest form of culture. This would be the natural fulfilment of the Bratachhari ideal.

Symposium on Coal in India

A SYMPOSIUM on 'Coal in India' was organised by the National Institute of Sciences, India and was held in Calcutta in the Royal Asiatic Society's Hall on the 25th and 26th August 1939, under the chairmanship of Col. R. N. Chopra, the President. About 50 papers were communicated and these covered all the important aspects of coal, such as history of the development of coal industry and coal mining, coal reserve of India, different scientific uses of coal with relation to power and metallurgical operations, physical and chemical studies of Indian coal, high and low temperature carbonisation, domestic coke industry, gasification of coal, methods of analysis of coal, coal cleaning and preparation for the market, microscopic and X-ray studies, conservation and State control and marketing of coal in India and outside:

Fuel Research Board

The necessity of having a Fuel Research Board in India was stressed upon in their papers by Messrs. C. S. Fox, N. N. Chatterjee and C. Forrester. Mr N. N. Chatterjee gave a detailed account as to how well-planned fuel research in India could be immediately started by maintaining co-operation and co-ordination between the various technical and research departments of the Government and of the different well-equipped laboratories of the universities and the industrial concerns. The papers evoked interesting discussion and the National Institute of Sciences of India has adopted a resolution urging the India Government to take early steps to establish a Fuel Research Board in India on the lines of His Majesty's Fuel Research Board in the United Kingdom.

History of Coal Industry

Mr E. R. Gee gave a historical account of the development of coal industry and coal mining in India. It was during the time of Warren Hastings in 1774 that Messrs Heatly and Summer applied for grant of lands to raise coal in the Ranigunj coal

field at Aytoora near the present site of Sitarampur. Mining operations were started in 1815 by Rupert Jones who opened coal mines near Ranigunj and within a few years Ranigunj coalfield was brought to the notice of the public interested in mining. The work in the Jharia coalfield was next started in 1893 and it rapidly outstripped the Ranigunj coalfield in production within a short period and it is holding the supreme position even now.

Coal Reserve

About India's coal reserve Dr M. S. Krishnan read a paper in which he stated that, according to the estimate of Dr Fox, the total reserve of Gondwana coal is 60,000 million tons of which 20,000 million tons may be taken as occurring in workable seams. Of this good quality coal (with ash not exceeding 16% on a moisture-free basis) amounts only to about 5000 million tons, while good quality caking coal amounts to 15,000 million tons. These caking coals are mainly to be obtained from Jharia, Giridih, Ranigunj and Bokaro fields. The tertiary coalfields contain about 2000 million tons in Assam and 300 million tons in other areas. It was mentioned in the paper that except for a few fields such as Jharia, Ranigunj, Giridih, and Bokaro the data are as yet meagre and that a maximum depth of 2000 ft. has been taken into account during calculation in case of Jharia and Ranigunj coalfields. The total world reserves are now probably of the order of 7,000,000 million tons and India's total reserve, being 70,000 million tons is only of the order of one per cent of the world total. From the account given in the paper it is quite clear that we have at present very little knowledge regarding the actual amount of coal reserves in the various coalfields of India and that more intensive and thorough survey work is needed to get the correct figure of the extent of India's total coal reserve. During the discussion of this paper it was brought out in a very clear manner that according to the existing method of extraction and mining only 50%

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of coal could be raised, and that unless improved methods of mining were introduced the important reserve of high grade coal of Bengal and Bihar coalfields would be depleted very soon and their life would be very much shortened. This matter is now in the hands of the India Government and it is hoped by introducing sand-stowing methods in coal mines maximum extraction of coal would be possible and the life of these coalfields will be increased.

Coal in Metallurgy

Regarding the use and importance of coal in metallurgical operations Dr Fox mentioned in his paper that the amount of coal used as reducing agent in iron ore smelting is small, compared with that used for fusion, and that the actual smelting may be performed by using solid fuel (coal), liquid fuel (tar oils), or gases (obtained from coal), or by electric smelting (in a resistance furnace). Dr Fox discussed the possibilities of smelting iron ores electrically and showed how this would completely dispel the illusion which persists regarding the fundamental necessity of good quality caking coals for the preparation of metallurgical coke. But the discussion of the paper clearly showed that the conditions in India have not yet become favourable for the smelting of iron ores electrically and therefore the iron industry cannot do without the high grade metallurgical coke.

Coal in Relation to Power

Dr Fox in another paper on coal in relation to power pointed out that in India coal is *par excellence* the fuel for power purposes, especially in the supply of electricity for towns, for factories and for metallurgical works. He also discussed the reasons which have led to the belief that really cheap electrical power could only be procured from hydro-electric projects, and showed that this idea does not appear to hold good in India for many reasons such as (i) inaccessibility of sites and difficulty in railway communication, (ii) heavy cost of building storage dam (iii) cost of transmission of power, (iv) difficulty in selling the power and (v) heavy cost to prevent silting up of reservoir. In contrast to this a coal-fired generating station erected in a coalfield has

the following advantages: (i) railway communication, (ii) the cost of the power station would be generally less than that of a storage dam and hydro-electric plant, (iii) the power, if cheap, would be easily sold if industries spring up (iv) transmission cost need not be large if the industries centres are located in the neighbouring places. The difficulties of water supply need not be serious in a well-chosen site. Dr Fox discussed the possibility of starting electricity generating stations in the Bengal and Bihar coalfields and described how the different industrial centres in the surrounding places might be supplied with cheap electrical power.

Low Temperature and High Temperature Carbonisation

An interesting work by Prof. S. K. Roy and Mr S. S. Ghosh on low temperature carbonisation of inferior Jharia coals, (seam VI to XII) shows that on an average the tar yield is 10 gallons per ton of coal. The tar oils when fractionated give the light and heavy oils, phenols and tar residues. The authors mention that annually 3 million tons of inferior coal are used for soft coke manufacture, by a crude and wasteful process. About 30 million gallons of tar suitable for fuel oil are thus being lost and it is estimated that this loss would represent one crore of rupees annually. Mr B. W. Haigh in his paper on high temperature carbonisation gave details of the by-product recovery units with special reference to India and discussed the possibilities of developing a medium temperature carbonisation industry in India for production of free burning coke for domestic use.

Physical and Chemical Studies

Mr A. K. Shaha gave an interesting talk on the scientific utilisation of coal in various ways. Mr Kirby enumerated several physical conditions which affect spontaneous heating in coal mines and Mr Park mentioned in his paper that on account of bad ventilation the heat generated during oxidation would be stored up and might lead to spontaneous combustion. Messrs Gee and Forrester in their papers mentioned that during storage of coal also there would be certain conditions favouring spontaneous combustion and that free ventilation

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would be needed to prevent such disasters. Mr N. N. Chatterjee in his paper discussed the cellulosic and resinic contents of coal and their bearing on the caking and swelling properties. Mr Chatterjee in another paper gave an account of the different forms (pyritic, sulphate, organic) in which sulphur occurs in the tertiary coals of India. According to him, an appreciable amount of sulphur is present in organic state of combination and that any mechanical means of washing or panning would not eliminate that organic sulphur. Dr Forrester read a paper on the calorific value of volatiles of coals obtained from the different seams of Jharia and Ranigunj. Some Indian coal ashes were analysed by Dr Dutt Roy in an attempt to find out a relation between the chemical composition and the fusibility of ash.

Microscopic and X'ray Studies

A paper on micro-structure of Indian fusains by Mr N. N. Chatterjee has shown that Gondwana fusains contain plenty of tracheids with bordered pits showing gymnosperms and that places of tertiary fusain reveal structures of angiospermous wood. X'ray study of coal by diffraction method was done by Dr Mahadevan who has shown in his paper that vitrain gives patterns due to particles of colloidal dimensions, the durain pattern is found to be made up by superposing 'ash' and 'graphitic carbon' spacings on the vitrain pattern. The fusain gives haloes ascribable to ash and free carbon.

Methods of Analysis

Regarding methods of analysis of coal Messrs Forrester and N. N. Chatterjee contributed interesting papers in which they drew the attention of the scientists as well as of coal-producers and coal-consumers to the fact that no standard and accurate method of analysis was being adopted in the Alipore Test House and Indian Coal Grading Board.

Mr N. N. Chatterjee discussed this subject thoroughly in his paper and suggested a method of proximate analysis of coal which might be adopted as a standard method for use in Indian Laboratories. Mr Chatterjee also suggested that the National Institute of Sciences of India should take up the important work of standardisation for the benefit of the coal industry.

Coal Cleaning and Briquetting

Messrs Forrester and Gee contributed papers on the coal cleaning and beneficiation. According to them, on account of a very fine state of division in which mineral matter occurs in the coal substance a large majority of coal is difficult to clean by any known wet or dry process. Messrs C. Forrester and A. N. Mukherjee read papers on the possibility of coal briquetting industry in India and the latter suggested that in India there is a great opening for utilisation of inferior coal, coal slack and coke dust in the manufacture of briquettes at a cost of about Rs 4/- per ton.

Safety in Mines and Stowing

Subject of safety in coal mines was discussed by Messrs H. K. Nag, E. B. Park and R. P. Sinha who laid much stress on the necessity of imparting proper education to the labourers in respect of various regulations for safety and suggested that mine owners should co-operate with the Government in this direction. Regarding the improved method of mining and extraction by packing Mr Barraclough contributed a paper in which he has shown that mechanical stowing by means of throwing belt conveyor would be suitable in virgin workings and that hydraulic stowing seemed to have the greatest possibilities in India.

Domestic Coke

The subject of domestic coke industry was discussed by Messrs N. N. Chatterjee and C. Forrester who urged for the immediate improvement in the method of manufacture. Mr Chatterjee mentioned that Soft Coke Cess Committee has been realising the cess on soft coke for the last ten years for popularising soft coke and improving its method of manufacture. But as there has been no improvement at all he thought there was no reason why this cess should not be stopped.

Marketing

Finally the subject of marketing of coal in India and export trade was discussed by Messrs C. A. Innes, A. L. Ojha and J. K. Dholakia. All of them were unanimous in saying that railway collieries were a source of trouble to the coal industry. The railways as the biggest consumers (nearly $\frac{1}{3}$ of

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the total production) and the biggest purchasers in the market exercise control on the prices. Being themselves producers, they are able to keep the market price at a low level and their tender policy has but tended to depress the price. Messrs Dholakia and Ojha laid much stress on this point and suggested that railway collieries should be closed particularly in periods when the price would be low. The question of both external and internal competition in the coal trade was thoroughly discussed by Messrs Ojha and Dholakia who think that the underlying causes are due to the absence of any effective co-ordinating organisation among the producers and differential conditions prevailing in the mines. They urged for the establishment of a strong central marketing organisation under Government patronage. For domestic trade they suggested

that railway freights should be lowered and made uniform and the surcharge substantially reduced. They also stressed on the rational utilisation of the different grades of coal.

In drawing the proceedings of this symposium to a close Prof. Meghnad Saha said that the large amount of useful research work that has been done on Indian coal as laid before the National Institute of Sciences would of great help to the All-India National Planning Committee in connection with the deliberations of the mineral and fuel sub-committees. He also expressed the urgent necessity of starting a Fuel Research Board for conducting well-planned and systematic research work on the various important aspects of coal in India. This would help in the general industrialisation of the country and ultimately in raising the standard of living in India.

N. N. Chatterjee.

Deep Seas

The broadest ocean surfaces are in the southern hemisphere, but north of the Equator occur the greatest submarine upheavals, deforming the bottoms of the Caribbean sea, and the Atlantic and Pacific Oceans, in a broad expanse from the latitude of the Panama Canal to that of Philadelphia. In these regions, especially in the Pacific, vast plains and plateaus, tall peaks and deep canyons form another world. In the shallower portions ocean currents are the breezes that sway submarine trees, and fish are the variegated birds flitting among the branches, while varied coral formations look like flowering shrubs.

Down the middle of the Atlantic, extending 8,000 miles south from Iceland, runs a mountainous ridge almost 10,000 feet above the adjoining basins. Soundings already recorded indicate that three-

fourths of the Atlantic is at least 6,500 feet deep, and over half is 13,000 feet.

The Pacific has more great depths than any other ocean, according to the records of the Hydrographic Office of the U. S. Navy Department, which show eight in excess of 30,000 feet. The deepest hole in the Pacific is 35,400 feet, just north-east of Mindanao of the Philippine Islands. This is the greatest recorded ocean depth in the world. The record in the South Pacific Ocean is 30,930 feet; North Atlantic, the new Milwaukee Deep, 28,680 feet; Southern Atlantic, 26,575 feet; Indian Ocean, 22,968 feet. A sounding of 17,850 feet is recorded in the Arctic Ocean, and one of 14,274 feet near the Antarctic Continent, in the South Pacific.

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OBITUARY

COM. FRANK WILD

THE death of Commander Frank Wild, the famous Antarctic explorer, is reported in a recent *Reuter* message from Transvaal. Frank Wild was born at Skelton, Yorkshire, in 1874 and was a descendant of Captain Cook, the famous navigator. He went to Australia at the age of 15. In 1901 he was selected by Scott as a member of his expedition to the Antarctic in the *Discovery*, and for the next 21 years his life was chiefly devoted to Antarctic exploration. He was in five expeditions and spent more than 10 years in frozen seas—a record unequalled even by Scott, Evans, Shackleton or Amundsen. The *Discovery* remained in the Polar regions till February, 1904, and Wild took part in much of the exploration work. By 1907 he was back on the Antarctic ice as a member of the Shackleton-Nimrod expedition, which in the next two years reached a point about 100 miles from the South Pole. In 1911, Wild joined the Australian party under Dr Mawson in the *Aurora*, in which he spent two years in investigating the coastal areas of Gaussberg and Cape Adare, and in 1914 he was a member of the Imperial Trans-Antarctic Expedition.

After serving in the World War, Wild went to Central Africa. There he heard that Shackleton was going south again and at once started to join him. Shackleton made him second in command of the *Quest*, the expedition's vessel. After the death of his leader in January, 1922, Wild took the *Quest* back to England where the Patron's Medal of the Royal Geographical Society was presented to him. In 1923 he wrote *Shackleton's Last Voyage*.

Public Health in India

IN his annual report for 1937 published recently, Sir Alexander Russel, Public Health Commissioner with the Government of India, has reviewed public health activities in this country. The rather unusual delay which has become the usual practice with the Government in publishing annual reports on matters of considerable public interest often takes away much of its importance and fails to arouse the right amount of enthusiasm even in those who are interested in such matters. A rather too optimistic note runs through the Public Health Commissioners's report. "There has begun to arise," says Sir Alexander Russel, "a new determination to combat ill-health and suffering by organised effort, and this national awakening to realities is one of the most hopeful developments any public health officer could desire to witness. The greatly increased public interest evinced in health matters, the efforts both official and voluntary, being made to promote the health of the people, and the wider powers possessed by popularly elected Governments—some of which have already organized Health Ministries and are engaged in providing themselves with up-to-date legislation—all warrant the belief that more rapid progress will be made in the future than in the past towards an improved standard of living and higher level of health through the length and breadth of this great land."

Judging from what has been and is at present being done in India by the Government in the domain of public health, we regret we cannot fully appreciate the wishful thinking of the writer of the Report. During the first 150 years of British rule no progressive government policy in regard to public health was followed in India. During the last twenty years, however,

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part in the Committee's deliberations and the problems of the training of an elite, the synthesis of human knowledge and the unity and universality of higher education engaged the attention of the Committee. The development of intellectual collaboration in the sciences was also continued. In addition to the work previously undertaken, *viz.*, co-ordination of scientific terminology, international collaboration between science museums, scientific bibliographies, etc., several meetings of scientific experts were held during the past year at Zurich (on the bases and method of mathematical science), at Strasbourg (on magnetism), at Groningen (on ionising radiation measures) and at Geneva (on science and its social relations, and the application of calculations of probabilities).

Journal of the Indian Anthropological Institute

THE Indian Anthropological Institute was started in 1936 with the object of promoting anthropological studies in India. We have received a copy of the first issue of the Journal of the Institute which has been published recently under the editorship of Dr B. S. Guha assisted by a strong board of associate editors. The volume contains several learned articles from the pen of eminent Indian and European anthropologists on problems concerning Indian anthropology and archaeology. Articles on 'Future of Anthropology in India' by Prof. J. H. Hutton, 'Pre- and Proto-Historic Archaeology in India' by Lt.-Col. D. H. Gordon, 'A Lhota Naga 'Apotia' Death' by J. P. Mills, 'Anthropology in India and enthrical position of Indians' by Col. Germano da Silva Correia, 'Indian Oil Presses and Oil Extraction' by Prof. K. P. Chattopadhyay and several others appear in this issue. We wish the journal continued progress and hope it will continue to fulfil the purpose for which it has been started.

Excavation at Maski

AN excavation was recently conducted at Maski in Raichur district, Hyderabad State, by the State Archaeological Department. Terracotta figurines of men and animals have been found along with *chank* and glass bangles, heads of various kinds, painted pottery, burial urns, wheels of toy-carts, crucibles and furnaces for smelting gold and iron. "A small baked disc with the impression of a seal is among the terracotta finds. The characters appear to be of the first or second century B.C., but the seal has not been

properly deciphered as yet." Human remains have also been discovered, and they are now under expert examination. Near by are dolmens, menhirs and also, apparently, some alignments, with surface-occurrence of neolithic celts, chisels, crushers and hammers 'in considerable numbers.' Some paintings have also been discovered in rock-shelters in the neighbourhood which are supposed to be of prehistoric age.

Development of India's Mineral Resources

THE importance of geology, metallurgy and mining, particularly coal mining, in relation to any scheme of national planning was emphasised by Mr Jhaverilal K. Dholakia in his speech as president of the annual meeting of the Geological, Mining and Metallurgical Society of India, held recently in Calcutta. India, said Mr Dholakia, had only made a beginning in producing raw materials. If India was to improve industrially efforts should be made for the development of her mineral resources. The Geological Department of the Government of India had done very useful work in producing maps and memoirs, but this was not enough. It was advisable to equip the Geological Department with sufficient men and materials to enable geologists to carry on surveys, investigations and explorations. Groups of geologists or mining men and chemists should be allotted certain areas in which they would carry out full investigations so that correct information on finds, the possibility of their economical exploitation and the manner of turning them to commercially sound propositions would be made known to the public. Research work in all directions was a necessity and a start on a large scale should be made.

India, as is well-known, has deposits of coal, rich iron ores, other raw materials and the best mica in the world and what has been discovered is a mere drop in the ocean of what there is to discover. With proper co-operation, information, guidance and control, India would be able to manufacture every article she requires, including machinery and plant, for her industrial and economic development. A beginning has to be made and it should start from correct, accurate and exact geological surveys. We have in India, quite a large number of graduates in geology, chemistry and engineering and mining experts and technicians whose services can be profitably utilised in the work of the development of Indian national industries. In view of the present international situation, the Government of India should take the lead and support the development

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of the national resources of the country. India can play a very important part in supplying the requirements needed in present day warfare. The Government should come forward with financial, technical and practical support of all descriptions to the basic industries and make India a strong and effective member of the British Commonwealth.

Buddhist and Muslim Finds at Sopara

EXCAVATIONS carried out at Sopara, Bombay, early this year by the Archaeological Survey of India, have brought to light the remains of a complete brick built Buddhist *stupa* of the second century A.D. Although from the base of the drum, the apex of the surviving dome stands to a height of 23 feet, there is no doubt that originally the *stupa* must have stood about 100 feet high. The drum of the *stupa*, however, survives in its entirety and from its circumference of 275 feet, it appears to be among the largest of its kind yet discovered in Western India. Excavation of the open area directly to the south and south-west of the base of the *stupa* drum has revealed several brick platforms roughly square in plan, side by side with circular brick basements. It is not improbable that these structures attributable to the fourth and fifth centuries A.D., represent the remains of smaller votive *stupas*, usually dedicated by devotees visiting the main *stupa*. A coin of Ahmed Shah, the first Sultan of Gujarat (1411-1441 A.D.) discovered in the remains of later structures indicates some temporary settlements of the Muslim period, but on the whole the site was never re-occupied. Excavations have revealed a 12 feet thick enclosure wall round the site, also of the late period, surrounded by a ditch. A significant fact about this 12 feet wide wall built of stones from earlier buildings of the Hindu period is that while the stones used in its outer casing are severely plain, the infilling is made up of damaged and broken decorative stones and sculptures. A large number of basalt balls varying in diameter from 3" to 10" some of which are shaped like miniature *stupas*, apparently of a votive character have also been discovered.

The earliest relic recovered is part of a stone edict of Asoka, now kept in the Bombay Branch of the Royal Asiatic Society. Fifty-seven years ago, Dr Bhagwanlal Indraji, a prominent Indian archaeologist, dug out from the centre of the *stupa* a 2' 9" square masonry

pillar in which he discovered the original relics enshrined in a nest of a number of caskets such as of stone, silver, copper, gold and crystal along with over 50 stone beads, 13 gold bespangled earthenware pieces, supposed to be of a begging or drinking bowl, and other precious objects.

Though now a small hamlet, Sopara was a historical city, famous through the ages. It was the main emporium of the trade that flowed from the Deccan tableland through the Nana Pass in the Western Ghats and along the Ulhas river now flowing by Kalyan and Bassein. The shifting of the channel and the silting up of the harbour must have put an end to the activities of the port. There is a reference to the place in the Epics as well as in the early Buddhist and Jain legends and also by Greek, Egyptian and Arab geographers. The name, Surparaka, is undoubtedly derived from its situation near an estuary with mountain ranges on either side, giving it the appearance of a *surpa* or winnowing basket.

Distribution of Standard Biological Products

THE Biochemical Standardization Laboratory, All-India Institute of Hygiene and Public Health, Calcutta, has been constituted a "National Centre" for the distribution of Standard preparations of biological products. If laboratories intimate their requirements, the Centre will import and supply the appropriate standards. Standards have been established for many products by the Biological Standardization Committee of the League of Nations, and the actual "standard preparation" of each kind is maintained and issued to research and manufacturing laboratories by specified Institutes, such as the National Institute for Medical Research, Hampstead (under the Medical Research Council) and the State Serum Institute, Copenhagen. For convenience of distribution of the "standards" to those that require them, it has been found advisable to form "National Centres" in countries where biological products are manufactured. These centres receive duplicates of each standard at intervals and issue them to working laboratories for the control of their preparations. Formerly, laboratories in India had to obtain their "standards" from the Institutes in Europe possessing each individual type.

Some of the standards which will be available at the Laboratory are: Insulin; Pituitary (Posterior lobe) Standard Powder; Oestrus-producing Hormones; Male Hormone (Androsterone); Corpus Luteum Hormone

constructional works. Although it is some years since aluminium found a place in the electrical industries, the extent of its applications, especially in the more recent years, are perhaps not fully appreciated. The results of a survey, which has recently been conducted by the Aluminium Information Bureau, Bush House, Aldwych, London, are therefore, of interest.

One of the principal applications of this metal is for the construction of the overhead transmission lines. It has been estimated that aluminium due to its lightness and high electrical conductivity has already covered some 650,000 miles throughout the world. In the case of high power currents, its thermal properties are also of importance, and the thin oxide film which forms on the surface, either naturally or due to electrolytic treatment, renders it chemically inert and greatly resistant to corrosion. The relative conductivities of aluminium and copper at 0°C are 1.8×10^{-6} ohm. cm. and 3×10^{-6} ohm. cm. respectively. As the density of copper is about three times that of aluminium, it follows that a cable of the former material will weigh about twice as much as that of the latter for the same conductance. Even when a steel core is employed, as is generally the case, the composite cable only weighs about 80% of an equivalent copper and is about 50% stronger. A good deal of investigation and many improvements have been made on the problem of overcoming corrosion at joints and connections in the lines. A problem that has had to be considered now is the prevention of damage due to the natural vibration of the conductors.

The thermal as well as the electrical properties of aluminium make it suitable for the transmission of large currents, such as those carried by bus-bars in electrometallurgy and electroplating. Though the rate of temperature rise in an aluminium conductor is the same as that in the equivalent copper conductor, the former having a larger surface, in normal circumstances, will radiate more heat and, when carrying the same current, will attain a lower temperature. This property, together with the fact that aluminium from the heating point of view has a higher overload capacity than copper, accounts for the large use made of aluminium for bus-bars and battery connections. A further interesting application of aluminium in the electrical industries is its use for the rotor bars and end rings on squirrel-cage induction motors. These bars and rings may be cast solid

with the rotor slots, and it is interesting to note that by alloying the aluminium with the right amount of silicon its resistance may be adjusted to give the required starting torque characteristics. The ribbed tanks of oil-cooled transformers are also being made of aluminium on account of its high thermal conductivity, lightness, and chemical inactivity. The breaker arms of switchgears are made of aluminium, as its low inertia enables high speeds of break to be obtained. It is further employed on the trolley poles, boomheads and pole-bases of trolley buses, and for these purposes is now being alloyed with 10% magnesium to improve its strength, ductility and resistance to atmospheric conditions. Aluminium has already found an application in the construction of electrolytic condensers and of reflectors for lighting equipments. These reflectors are produced by an anodising process which can be arranged so as to produce a tinted light of various shades. It is claimed that such reflectors are very durable.

N.K.S.G.

Longest Electric Lift in India

AN electrical winding plant containing many points of interest has recently been constructed at the Gifford's Shaft in Mysore, of the Champion Reef Gold Mines of India, Ltd. This plant will be utilised to raise gold ores from extremely deep and rich lodes, which are now to be exploited. It is usual to perform such an operation in two or more stages. In this case, the recent advances in winding technique will make it possible to hoist in one stage from the deepest levels even. The winding operations will therefore be greatly simplified and the handling and hoisting costs will be considerably reduced. This new plant will be one of the longest single lifts in the world.

The main winder at the Gifford's Shaft is designed for raising a net load of 10,000 lb. in trucks or cages from a depth of 6,556 ft. The loaded cages weigh about 10 short tons and the rope which is of the flattened type, 6 inches in circumference, weighs about 23 short tons for a length of 7,300 ft. The total hoisting load is therefore 61, 200 lb. which is wound from a depth of 6,555 ft. in 160 seconds.

There are two exceptionally large bi-cylindrical drums, each of which is driven at a speed of 27.2 r.p.m. by two motors, through a multiple-tooth clutch and gearing. These motors are supplied from a motor-generator set with two flywheels and slip

regulators of the hydraulic type. The small diameter of each drum is 13 ft. and rises with eight spiral turns of rope to the large diameter of 35 ft. On this diameter there are 52 turns of rope in two layers. Separate brakes, of the suspended parallel motion post type, and 18 ft. in diameter are provided for each drum. These are gravity operated by weights and are controlled by break engines operated by oil supplied at constant pressure from a weight loaded accumulator. The driving motors have a combined rating of 2,550 h.p. to 4,450 h.p. and are of the separately excited, interpolar, open self-ventilated type, with compensating windings.

The converter equaliser set consists of synchronous motor of unity power factor so that it compensates for the lagging current taken by the other plant in the mine. It is supplied by three phase current of 200 V. and 25 cycles. This motor is coupled to two generators with a combined rating of 1,800 kW to 3,600 kW at 500 V., which supply current to the winding motors. Mounted between the two generators are two disc type flywheels, each weighing 25 tons. The flywheels have been designed to have sufficient stored energy to complete a wind, if the power supply fails any time after a wind has been started. In this event, the drop in speed of the wheels and generators may be approximately 50%, and to compensate the generations for the reduced voltage a voltage regulator is supplied for the field of the main exciter and is directly coupled to the converter set. The field strength of the generators and the winder motors is thereby maintained to the end of the wind, but the generator voltage and consequently the winding speed falls in proportion to the flywheel speed.

In order to bring the motor-generator set to a standstill quickly, the alternating current motor can be used as a dynamic brake by exciting its stator with direct current and dissipating the energy of the set in resistance in the motor circuit. Overwinders have been fitted which are designed to give protection against overspeed, overwind, too-rapid acceleration, delayed retardation and starting up in the wrong direction. In order to enforce a very low speed of winding as the cages approach the landing, the overwinder is fitted with a Duplex governor, which is sensitive down to a speed of 1.5 ft. per second on the descending cage. There are various arrangements for braking, etc., for

maximum safety. The difficulty of the task can be imagined from the fact that a rope one and one-fourth mile long stretches several feet when taking up the tension of a loaded cage and this elasticity permits the cage to develop vertical oscillations of considerable amplitude, if the winding drums be braked violently.

N. K. S. G.

Filters in Photography

SOME colours appear brighter to the eye than others; yellow, for example, appears much brighter than blue or red. This is equally true of photographic materials, only the apparent brightness of different colours is not the same for photographic materials as for the eye. Sensitive materials have their greatest sensitivity in the blue, violet and ultra-violet regions, and it is in this respect that they differ markedly from the eye, which has its greatest sensitivity in the yellow-green, and is less sensitive to the ultra-violet. The object of using a filter in photography is to modify the effective colour sensitivity of the photographic materials. The modification is really in the light which falls upon the material and not in its sensitivity, but the effect is the same as if the colour sensitivity were changed. A filter, which changes the colour of the light so that its effect on the film is the same as its original effect on the eye, is known as an ortho-chromatic filter (meaning 'correct colour'). But in recording the colours of the subject in monochrome we are actually compressing two different ranges into one—the colour range and the light and shadow or brightness range. If we are to preserve a lifelike impression of colour we must sometimes make a certain compromise with this orthochromatic reproduction. A colour filter absorbs light of certain wavelengths, and this reduces the total light reaching the film. The ratio by which the exposure must be increased to compensate for this loss is known as the filter factor, and it is dependent on three things:

- (i) The absorption characteristics of the filter.
- (ii) the colour sensitivity of the photographic material.
- (iii) the colour composition of the light by which the subject is illuminated.

An important function of the filter in outdoor photography lies in the elimination of haze. The presence of particles of water and dust suspended in the air gives rise to a mist which tends to obscure distant

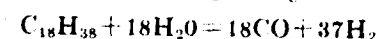
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objects. This effect is greatly increased in photography, since the violet and ultra-violet light to which the film is most sensitive is strongly scattered by these particles of water and dust. The scattering effect of haze is at a maximum in the ultra-violet and decreases generally as the wave length of light increases until it reaches the invisible infra-red wavelengths, where it approaches a minimum. It is for this reason that infra-red photography is able to penetrate distances far outside the range of the human eye.

Nearly all filters are made of a thin sheet of dyed gelatine cemented between two glass plates. The reason for using such a fragile medium as gelatine, instead of coloured glass, is because a much wider and more useful range of filters can be made with the dyes that are available. The *Kodak Magazine* in its June issue has discussed about these filters and the quality of illumination required in each case. This will serve as a close guide to photographers.

Water Gas from Oil

THE Polytechnique Institute of Milan has formulated a new process for the production of water gas, called 'Catagas'. In this process steam reacts on gas oil instead of on coal, corresponding to the formula



In practice this new process gives a gas containing a remarkable quality of methane; this gas has therefore a higher calorific capacity of about 2800 calories per cubic meter. The reaction takes place between 850° and 950°C in the presence of catalysts. The yield per kilogram of gas oil amounts to 2.7 cubic meters of gas, suitable for cutting sheet iron, and 1.7 cubic meters of gas for lighting purposes, corresponding to a calorific yield of 70 to 75 %. The oil required must be of a good grade, rich in saturated hydrocarbons, having a density of 0.850 to 0.880, and containing less

than 0.2% sulphur. The first plant for the production of 'Catagas' with capacity of 30 cubic meters per hour, is under construction at Milan.

N. K. S. G.

New Fertiliser in Soviet Union

A new fertiliser combination is reported to have been invented by the Soviet chemists. The mixture is said to contain air-dried ground peat, ammonium sulphate, and ground phosphate rock. Advantages claimed for the new product are the ease and cheapness of its preparation, its tendency not to cake while in storage, and increased efficiency because of slow escape of the active ingredients into the soil. Experiments have so far been conducted with grains, potatoes, flax, and hemp, and other crops with favourable results in all cases. There appears to be no obstacle to large scale production of this new fertiliser compound, as the Soviet Union has an abundant deposit of peat and phosphate rocks in many parts of the country. The European part of the Union alone is said to have known resources of 27,000,000 metric tons of phosphate rocks.

N. K. S. G.

Fibre Plant Exhibits

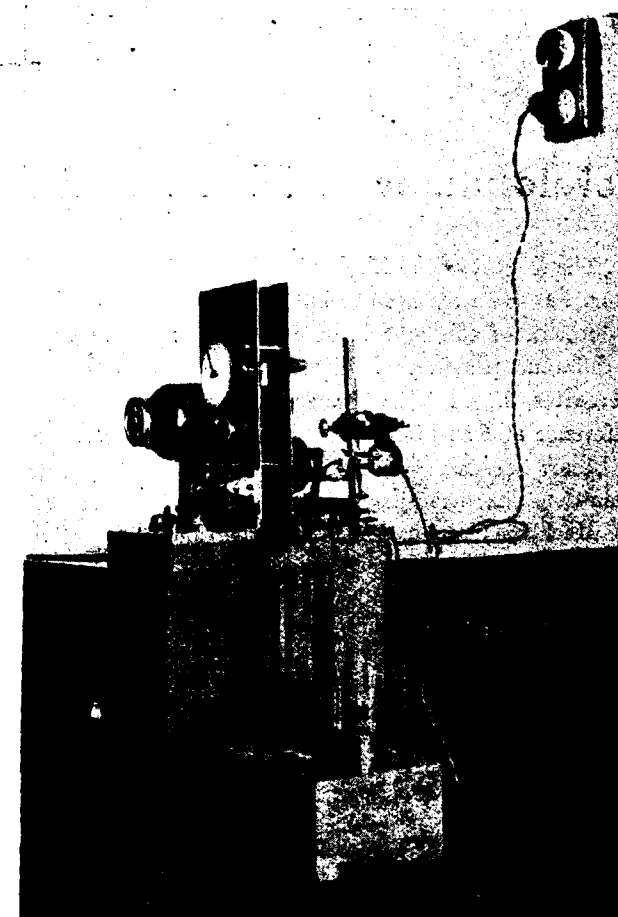
RECENTLY additions have been made to the catalogue of fibre plant exhibits in the Industrial Section of the Indian Museum. A Catalogue of Fibre Plant Exhibits at the Industrial Section of the Indian Museum, brought out by the Botanical Survey of India, contains descriptions of 152 plants grown and found in India. Details are given in the Catalogue of the habits and distribution in India of the plants described and remarks have been added about their industrial uses together with indications of the parts which could be so used. Both the scientific names and those in common use have been incorporated in the Catalogue and it will prove valuable for reference work.

A Dial-Reading Strength Tester Designed at the Technological Laboratory, Matunga, Bombay.

The tensile strength is one of the important properties of a tensile fibre, and hence a knowledge of it is useful both to the breeder and the spinner. On account of its importance numerous instruments have been designed for determining the breaking strength of cotton and other textile fibres. Three of these strength testers, belonging to different types, were tested at the Technological Laboratory of the Indian Central Cotton Committee at Matunga, Bombay, and it was found that they were either costly or suffered from a number of limitations and defects. In view of these findings, it appeared possible that, retaining the hydrostatic principle of applying tension, an apparatus could be designed in which many of the defects and limitations of the earlier instruments could be avoided. The attempt has proved successful and a brief description of this instrument is given below.

The principle on which this instrument works may be understood from the photograph which shows its front view at an angle of 45°. A fibre is suspended from one end of a hook fixed to a lever arrangement which completes an electric circuit as soon as the fibre is straightened out. The other end of the fibre is attached to a float suspended in a solution of calcium chloride contained in one arm of a U-tube. The tension on the fibre is applied by raising a counterpoise suspended from a string in the second arm of the U-tube. As this counterpoise is gradually raised at a uniform speed the level of the liquid surrounding the float falls and the pull on the fibre increases until it snaps. The counterpoise is raised by winding the string on a pulley which is driven by a gear arrangement from a small electric motor. The gear records the tension applied to the fibre on two dials. The apparatus is so constructed that the arrangement for applying and recording the tension applied to the fibre works only so long as the fibre is under tension. As soon as the fibre breaks, an electrical circuit connected to the lever is interrupted and the pointer comes to rest automatically.

The mean strength values obtained with this apparatus for a large number of samples are found to



agree well with those obtained by using another well known fibre strength tester. Further analysis has shown that there is no appreciable difference between various other statistics (coefficient of variation etc.) derived from the data obtained with the two instruments. The instrument may, therefore, be used with confidence, for determining the strength of textile fibres.

Besides being accurate, the instrument has several good points in its favour. It is extremely simple in design, and, therefore, its costs of manufacture and maintainance are quite small. Once constructed, it needs very little looking after and practically no repairs. It

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can be driven by a small electric motor (220, 110 or even 6 volts) which consumes very little energy. It is estimated that the daily consumption of energy is less than half a unit. The testing is done at a fairly good rate, while the tension is applied to the fibre at a constant rate and without any jerks. With a little adjustment the rate of loading can be varied over a

fairly wide range. The calibration of the instrument is quite easy and can be carried out in a short time. Though primarily intended for cotton, it may be used to measure the strength of any other fibre which is not very elastic. For the last three years it has been used at a number of places where tests of fibre strength are made. At all these places its performance has been quite satisfactory.

Development of Mechanical Industries*

The Report of the Mechanical Industries Committee, Bihar, has recently been published. The Committee is an outcome of the conference of Ministers of Industry of different provinces held at Delhi in October last whereafter the Hon'ble Dr Syed Mahmud, called a conference at Ranchi to consider the industrial planning of Bihar. As an outcome of that conference, three committees, viz., (a) the Chemical Industries Committee, (b) Mechanical Industries Committee and (c) Cottage Industries Committee were formed.

The members of the Mechanical Industries Committee are: Mr P. N. Mathur, (Convener), Superintendent, Duplex Plant, Messrs. Tata Iron & Steel Co. Ltd., Mr N. N. Rakshit, Director, The Tatanagar Foundry Co. Ltd., Jamshedpur; Mr J. Tullis, Principal, Bihar College of Engineering; Mr B. K. Rohatgi, India Electric Works Ltd., Calcutta; Mr G. N. Maity, Managing Director, Vishwakarma Limited, Calcutta; Mr Gur Saran Lal, Proprietor, Gaya Cotton Mill, Gaya; Mr B. L. Roy, Secretary, Bengal Industries Association, Calcutta and Mr T. N. Das, (Co-opted Member); M.Sc., (Pat) B.Sc., Tech. (Manchester); A.M.C.T., Bihar College of Engineering, Patna. The committee formed a sub-committee consisting of Messrs P. N. Mathur, N. N. Rakshit and B. K. Rohatgi to decide about the terms of reference and guiding principles.

Terms of Reference

The sub-committee decided upon the following terms of reference for the preparation of the Report:

1. To examine and ascertain the natural advantages of the Province of Bihar for all kinds of mechanical industries.

*Being a review of the Report of the Bihar Mechanical Industries Committee. This Report is possibly the first collective attempt to suggest ways and means for a planned industrialisation and hence it has been thought advisable to discuss the report in greater detail.

2. To enquire into the present position of the existing mechanical industries in Bihar, and find out which of them has still scope for further development.
3. To investigate in which directions there are possibilities for the establishment of new industries with a fair prospect of success.
4. To draw a comprehensive list of possible mechanical industries grouped according to manufacturing units, with full information as to their geographical distribution, approximate cost of establishment and production, labour, water, power, transport facilities, availability of raw materials, etc.
5. To consider the problem of financing the industries, and advise how the proposed scheme of industrial expansion may be placed on a sound financial basis.
6. To advise what small and cottage industries may grow together with and as subsidiaries to the large-scale mechanical industries, and suggest ways and means for the rehabilitation of existing cottage industries that are in moribund state.
7. To recommend such changes in the State policy as are likely to prove essentially necessary for industrial development in this province.

Besides the terms of reference, there were certain guiding principles to direct the members of the Committee

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to formulate the scheme of industrial planning. It will be worthwhile to quote the first paragraph of the guiding principles. "For a long time to come, India must remain a nation of imitators rather than originators. Today, we are in the same boat as other nations were when they were struggling through the initial stages of their industrial development."

One can easily note here the general outlook with which the committee members started their work. It is indeed difficult for a large number of properly qualified Indians to be unanimous regarding the method of approach to solve our industrial needs. But anyone who has carefully gone into the industrial history of nations, which have been late in the field in working out problems of industrialisation, will find that the above outlook has never been the case, excepting for very short periods. In fact, even in highly industrially developed countries the feeling is growing apace that the methods by which their industries have been developed as also the present state of the development are not sound. In America, for example, in the mechanical industries connected with textiles, Dr Maurice Holland, Director, Division of Industrial and Engineering Research, National Research Council, in October 1936 called together a conference of the Textile Industries Association and there poignantly remarked that within the last half a century there had not been any fundamental development in the textile industries in America. The nations which had lately struggled through the initial stages of their industrial development have evolved types of machinery, novel in principle and economically more sound in operation, simply because they did not imitate on all matters. It is regrettable that the principle of imitation has been the foundation on which the Committee made their Report.

The Industrial Scheme

The Committee has submitted a scheme whose main feature is an investment of 6½ crores of rupees paying an annual wage bill of 180 lakhs. They have detailed the different advantages to the provincial as well as to the central government that will result from the operation of the scheme. The scheme primarily consists of a National Engineering Workshop and allied units consuming 3 crores of rupees. The other industries which are eleven in number, are more or less small compared to the Engineering Workshop.

They are as follows:

1. Structural Workshop	..	36.0 lakhs.
2. Sheet Metal Product Company	..	69.0 "
3. Tool Steel Product Company	..	61.0 "
4. Bolts and Nuts Factory	..	19.5 "
5. Metal Product Company	..	63.0 "
6. Watch and Clock Manufacturing Company	..	14.5 "
7. Metallic Lamp Manufacturing Co.	..	15.0 "
8. Umbrella Fitting and Manufacturing Company	..	14.5 "
9. Electric Product Manufacturing Company	..	14.5 "
10. Wire and Cable Company	..	20.0 "
11. Electric Communication Apparatus Manufacturing Company	..	30.0 "

The details of the proposed factories are given in some length along with the type of labour required.

The Committee has a special note on automobile industry and it is probably the idea that the National Engineering Workshop will turn out automobiles though that is not specifically mentioned in the general scheme. In this special note, it is however suggested that the same type of machinery and equipment would be capable of turning out motor cars, and there is also an estimate based on Sir M. Visvesvaraya's pamphlet. But one is led to enquire how the proposed National Engineering Workshop can do this work until it has a subsidiary establishment for the purpose.

The Report deals also with industries which are to be kept in abeyance at present, e.g., metallic alloys, agricultural implements, tin buckets, enamelled iron wares, typewriters, sewing and knitting machines, clocks and time-pieces, fencing materials, wires and wire ropes, steel pipes, batteries, electric lamps, glow lamps, etc.

Regarding the method of administration and sales organisation it has been suggested that methods followed by Burmah Oil Company and Messrs. Bata Shoe Co., should be adopted. In the training of labour it has been suggested that the National Workshop should be utilised as a training ground and in the matter of selection of apprentices general intelligence and technical aptitude should be thoroughly considered as well as psychological tests will be applied for the purpose.

There is a brief note on small and cottage industries which may be encouraged with a capital of Rs. 5000/-

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or less and a list is also supplied for 32 small and cottage industries, as follows:

1. Dry cell batteries and electric torches.
2. Stove making.
3. Small electric switches, regulators.
4. Spectacles' frames.
5. Safety razor and blades.
6. Pin, gem clips, nibs, clips.
7. Electric casing, blocks, picture frames.
8. Lacquering.
9. Brass fittings for doors and furniture.
10. Jewellery works.
11. Watch and clock repairs.
12. Spring hinges.
13. Electroplating.
14. Brass and aluminium utensils.
15. Utensils of alloys.
16. Brass and bell-metal ornamental works.
17. Small tin cases of sizes and shapes for various domestic purposes.
18. Metallic sticks.
19. Musical instruments.
20. Radio and gramophone repairing.
21. Balances.
22. Fountain pen and stylo pen assembly.
23. Electric fans, etc., repairs.
24. Motor car and cycle repairs.
25. Small cast iron foundry.
26. Small brass foundry.
27. Adjustable pencils and metallic tapes.
28. Surveying instruments repairing.
29. Type-writing machine repairs.
30. Electric iron and heater.
31. Metallic buckets and jugs.
32. Heat treatment of tools.

If one goes through the list, there is one important feature that attracts the attention, namely, a definite lack of classification. Then again taking one example it is difficult to understand how "heat treatment of tools" can be a cottage industry unless there be large users of tools.

Capital and Organization

Regarding the financial aspect of the situation the Committee proposes that the State should guarantee 4% interest for 10 to 15 years on the invested capital of 6½ crores of rupees. There are 15 items which form the Committee's recommendations which are as follows:

(a) The Government of Bihar must press before the National Planning Committee for the immediate

start of recommended industries in Bihar on national basis.

(b) The State should guarantee interest on the capital invested in the industries, the administration of which should be on the same lines as the State-controlled Company-managed Railways.

(c) All units should preferably be located near one another to be able to use water, current steam, compressed air, and even oxygen from common sources, as far as possible. This will also simplify purchases, sales and supervision.

(d) Central Government, Railways, Provincial Governments and leading industrial concerns must be made to buy major part of their requirements from the National Workshop and units.

(e) Before establishing any unit, a delegation consisting of a suitable number of industrialists and experts must be sent abroad (say U. S. A., England and Germany) to collect first-hand knowledge and information regarding the manufacturing unit under consideration.

(f) In the beginning, covenanted hands (specialists) have got to be recruited from abroad. They should be called on contract basis, on a reasonable monthly salary plus a bonus at the termination of the contract, provided they train up in their profession the Indian assistants under them.

(g) All covenanted hands to be engaged as consultants and not as superintendents or supervisors.

(h) From the point of view of the proximity of raw materials, water-supply, availability of trained labour, transportation facilities and availability of pig iron and steel, Chota Nagpur Division seems to be the most ideal location for the establishment of the industrial units.

(i) The manufacture of motor cars and trucks ought to be the most paying industry in India at present. Due to insufficient import of the above, it is suggested that the manufacture of engine and other major assemblies should take place at the National Workshop while the building of boilers and final assembly and testing should be done at the Sheet Metal Products Company. This same company should also undertake the assembly of bicycles.

(j) The manufacture of such products, as porcelain insulators, copper wire and cables and motors which

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are to be extensively used in the transmission lines and tube-wells is desired first.

(k) Building should be designed to suit the equipment and machinery and not the vice-versa. In order to tie up the minimum amount of capital in industry, as far as possible all the equipment, machinery, conveyers and cranes should be of the same size, make and design.

(l) In order to avoid cut-throat competition and over-production, no new manufacturing plant should be allowed to be started in India without the consultation of and coming to a mutual agreement with the owner of the present industries, large or small.

(m) The National Workshop and other industrial units should be utilized by engineering graduates from Indian universities for getting practical experience.

(n) The Control Laboratory and its staff connected with the National Engineering Workshop shall assist all the prospective small independent manufacturers with necessary technical information and selection of proper machinery and equipment.

(o) The members are strongly of opinion that due consideration should be given to the scheme submitted by Sir Visvesvaraya regarding the manufacture of motor cars and trucks in India.

It is interesting to note in conclusion that Mr Rohatgi, the proprietor and managing director of India Electric Works, Calcutta, who has himself organised his own factory, could be present only in one meeting and Mr J. Tullis, Principal, Bihar College of Engineering, Patna, who is responsible for the engineering education of the province could only attend two meetings. Mr Gur Saran Lal who is the proprietor of Gaya Cotton Mills could not attend a single meeting. It seems therefore that the members of the Committee who have experience of organising industries, did not lend their whole-hearted support and co-operation to this Committee. This may explain why one finds more of the theoretical aspects regarding the mechanical industries than the practical suggestions which the country at the present moment is justly in need of.

P. N. G.

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Physical Fitness with Advancing Years

KEEPING fit is an individual problem and depends on maintaining balance between the energies conserved and spent. The physical fitness of an adult is the result of natural endowments modified by habits, training and environment. To be as good at 40 as at 21, it is essential to find out, through a thorough medical and structural examination, what physical assets and liabilities are present. A structural examination checks up the body alignment and a medical examination judges the individual needs. In planning for physical fitness such details as the following should be taken into consideration: age, height, weight, type (thin or fat), occupation, routine of daily life, amount of activity, hours of sleep, rest, play and outside demands on strength as well as the habits of eating and drinking. An intelligent budget to have a reserve of as great value at 40 as at 21 will include exercise for relaxing, for improving circulation and for muscle building, rest for recuperation, repose for thought, and recreation for re-creation.

Hygiea gives the following brief suggestions which may form a working basis of such a plan.

Take the individual's own daily dozen after rising in the morning.

Watch the pace and find out by trial the natural stride to be adopted by the individual.

See that the dress does not tire out strength and muscle for the sake of style and fashion. Develop a healthy sense of proportion of balanced values and not to have a burdensome concentration on monotonous routine.

After 40 an individual, having passed his youth, has a different proposition to face. During the forties certain structural changes often appear which, if disregarded, are likely to become well-established at 50. Heads, necks and shoulder droop, abdomen protrudes, backs round over above, fat pads appear in definite areas etc. As a result of these changes, circulation,

digestion and elimination become sluggish and faulty. In addition to this, there is often a sluggishness in activity, a change in the temper and a feeling of inferiority. To correct this, after doing the daily dozen one should see that the exertion is normal; there should not be total relaxation nor over-exertion. To preserve the bodily fitness there are times and conditions when relaxation should be substituted for activity.

For every woman over 40, this is a period of physical and emotional disturbance as during adolescence and is therefore dreaded. Disturbance in blood pressure is often an aggravating factor. But a sane mental condition plus adequate physical activity by prescribed exercises to maintain properly the bodily function will be quite sufficient.

Good health should be an unconscious possession and should be consciously controlled. Relaxation and bodily control will go far towards the development of a healthy, normal attitude which is of utmost importance in attaining smooth and happy life at this period.

Health of Forty Million People

THERE has been some 4,000 surveys in U. S. A. during the last 35 years to determine the extent and efficiency of public health activities, the costs of medical care and the methods of supplying medical services. It is reported that the failure to secure medical services is in most instance not due to a lack of facilities but to one or more of the following causes:

(i) A break in the chain of communications failing to bring the patients where services can be supplied. (ii) A lack of desire for the services available, and (iii) An inability to pay for such services. Experimentation in the distribution of medical services has also been taking place for many years throughout the United States, and a large number of different types of medical plans are operating under various organisations. The medical profession is now represented by 110,000

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physicians who constitute the American Medical Association.

But still, *Hygiea* reports that a study of 15,000 persons with chronic diseases by the Massachusetts Department of Public Health revealed that 71% had the services of a physician and the remaining 29% had no physician for the following reasons: in 23% due to lack of health education, in 3% due to economic reasons, in 2% owing to their having irregular practitioners and 1% for unknown reasons. Educational barrier appears therefore to be more important than economic barrier for the denial of public health relief. As a solution to this problem, the medical practitioners of the United States are unwilling to foster a system of compulsory sickness insurance or State-managed medicine, as adopted in various foreign countries. They fear that such a system would undoubtedly set up a far stretching tax system, the burden of which will fall heavily over the low-income class; that diagnosis and treatment under such a system would be mechanical and superficial; and that in such a system medical care for the indigent is omitted. They are also apprehensive that the control of medical service may thus be placed in the hands of unqualified non-medical individuals and organisations and ultimately medical care would lead itself to political control and manipulation.

The medical profession of course, approves the principle of hospital service insurance as a community project. It is thought to be practicable to develop cash indemnity insurance plans to cover, in whole or in part, the costs of emergency or prolonged illness. But it must be seen that the indigent and the "medically indigent" (i.e., those unable to provide for medical service without being deprived of the necessary food and other necessities of life) get special consideration for their health needs. These people now constitute a large group of about 20 million indigent and 20 million medically indigent. The question of determining the nature of medical requirements for these 40 million persons out of a total of 130 millions and of developing procedures

to supply their needs has become a national health problem.

The annual expenditure for medical care according to the percentage of population (as worked out by the Committee on the Costs of Medical Care, 1929) was as follows: 28%—\$10 or less; 25%—\$10-\$100 and 5%—\$100-\$500 or more. There are today medical services available in all but 19 of the 3072 counties of the United States and the residents of these 19 counties have access to services of physicians in adjoining counties. There are, at the same time, individual human factors such as accidents, ignorance, superstitions and personal preferences which make it difficult to guarantee good medical care to every one even when medical services are available.

The American Medical Association, which does not deny the existence of medical needs for these 40 million underprivileged persons, is opposed to any scheme that would give the poor an inferior quality of medical care. The Association has consistently maintained that the primary mission of the medical profession is the service to humanity. In addition to the provision of free services at an annual cost of \$300,000,00, the medical profession has organised several hundred county plans for the care of the indigent, medically indigent and the group with low incomes, thus making good medical care readily available for the millions of underprivileged persons. The Association lays more stress on the relief of the economic and material needs of the underprivileged, and has been repeatedly urging since 1874 for the establishment of a Federal Department of Health with a secretary who shall be a doctor of medicine and a member of the President's cabinet. The department shall be responsible for the development of efficient and economic ways and means of expanding public health services as well as maternal and child health services. It is strongly felt that a high quality of medical care should not be provided for the well-to-do only when only an inferior quality of medical services can be arranged for the lower in the strata. There must be one type of medical service to all.

S. R. G.

Certain Aspects of Present-day Biochemical and Nutritional Research in America and Europe

B. Ahmad

Department of Biochemistry and Nutrition, All India Institute of Hygiene and Public Health, Calcutta.

Of the many lines of investigation in the fields of pure and applied biochemistry carried on in some outstanding American and European laboratories a few topics are selected here¹ for discussion. There are undoubtedly many others, of equal or even greater importance which have necessarily to be omitted on account of the limited space available for this article. The subjects selected are:

- (i) The use of isotopes as biological indicators in the study of intermediary metabolism.
- (ii) Visual purple, its relation to vitamin A, and the assessment of vitamin A deficiency.
- (iii) Increasing the span of life.
- (iv) The role of trace element cobalt in animal nutrition.
- (v) The guidance of instinct in the selection of food.

Isotopes as Biological Indicators

The discovery of induced radioactivity, and the production of radioactive isotopes of phosphorus, potassium, iron, sulphur etc., has opened up an entirely new field in biological research. It has now become possible to follow the course of a substance in the body, and to study its interactions, changes and interchanges, by tagging on a radioactive atom to the substance. The production of radioactive isotopes has been made possible by the invention and the development of the cyclotron by Professor E. O. Lawrence at the University of California.² The cyclotron emits a beam of particles of very high energy, such as deuterons, which when allowed to impinge on an atom, completely disrupt it and a new atom is formed. Some 500 new atoms have been created

by this means, all of which are unstable, and radioactive, and are continuously disintegrating into more stable forms. In the United States, after the University of California, cyclotron has been built at the Franklin Institute, Philadelphia, and several others are in course of construction at the universities of Chicago, Princeton, Rochester and Harvard.

The use of isotopes as indicators in biological investigations was first demonstrated by Hevesy³ as early as 1923, and he was the first to use phosphorus with atomic weight 32 (P_{32}) in phosphorus metabolism studies.⁴ Since the development of the cyclotron at the University of California, and the ready availability of radioactive isotopes of phosphorus and other elements, very interesting investigations in mineral metabolism are being undertaken at the biochemistry department of the University Medical School at Berkely.⁵ While it is not possible to discuss, in detail in this article, the findings of those investigations, it might be stated that this technique, has for the first time made it possible to determine in a precise and unprecedented manner the course of a mineral substance in the body: its absorption, distribution and excretion. The distribution of the ingested radioactive phosphorus in the bones and teeth after ingestion, has indicated that even these tissues are continuously and actively involved in mineral metabolism. In rachitic rats, it is found that the administration of vitamin D, increases the net absorption of phosphate administered by stomach tube, only by 10-15%. The lipid phosphorus in the bones was unchanged, but inorganic 'labelled' phosphorus was raised 40%. The $P_{32}:P_{31}$ ratio of the organic phosphorus (protein and ester phosphorus) of the bones increased and was about

¹ Hevesy, G., *Biochem. J.*, 17, 439, 1923; *Biochem. Z.*, 173, 175, 1926.

² Chievitz, O., and Hevesy, G., *Nature*, 136, 754, 1935.

³ Cohn, W. E., Greenberg, D. M., *J. Biol. Chem.*, 123, 185, 1938. Joseph, M., Cohn, W. E., Greenberg, D. M., *ibid.*, 128, 673, 1939.

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the same as that of the blood. This indicated that organic phosphorus of the bones is rapidly formed from the blood phosphorus. There appears to be a specific effect of vitamin D on organic bone phosphorus and a specific role in bone formation, other than the mere deposition of inorganic phosphorus resulting from increased absorption.⁶

Studies on phosphorus metabolism by this technique are also being followed at the Rochester University School of Medicine and Dentistry.⁷ Their most striking observation is in connection with iron metabolism, made by the use of Fe_{59} . It is found that iron is absorbed only in traces by the un-anaemic dog, while in abundance by the anaemic animals, indicating that iron absorption is according to the needs of the body. The earlier accepted view has been that iron is absorbed in the upper intestinal tract depending upon its concentration in the food, its state (ferrous or ferric) and the acidity of the gastric juice.⁸

Investigations of still greater importance into the intermediary metabolism of fats and proteins, involving the use of isotopes of hydrogen and nitrogen, are being actively pursued by Dr Rudolph Schoenheimer and his colleagues at the biochemistry department of the University of Columbia, College of Physicians and Surgeons, New York. Since no radioactive isotopes of hydrogen and nitrogen are known, with a half-life long enough to permit their use for organic synthesis and metabolism experiments, only stable isotopes concentrated from natural mixtures can be used. The methods of fractionation developed by Professor H. C. Urey have made possible to obtain mixture with increased amounts of heavy hydrogen and heavy nitrogen (N_{15}).

The building up of fatty acids with deuterium in the molecule, or amino acids with N_{15} has involved lot of skilful technique, and credit for this is due to Dr Schoenheimer and his associates. The combination of the atom of the isotope in the molecule had to be in a stable enough position so that the tag is not easily

⁶ Cohn, W. E., Greenberg, D. M., *J. Biol. Chem.*, 128, xvi, *Proc.*, 1939.

⁷ Haven, F. L., Bale, W. F., Le Fevre, M. L., *J. Biol. Chem.*, 123 lii, *Proc.*, 1938. Le Fevre, M. L., Bale, W. F., *J. Dent. Res.*, 17, 312, 1938.

⁸ Hahn, P. F., Bale, W. F., Lawrence, E. O., and Wipple, G. M., *J. Amer. Med. Assoc.*, 111, 2285, 1938.

knocked off. For example, a deuterium atom in hydroxyl, carboxyl, and amino groups is labile and interchangeable with the hydrogen atom of water. A stable combination is found to be with carbon such as in methyl or methylene groups. A number of deuterio-fatty acids and deuterio-amino acids have been synthesized by these workers for their projected investigations.

While the estimation of radioactive isotopes has been a relatively simple matter by means of Geiger counters and electrosopes, it is not so in the case of deuterium and heavy nitrogen. Methods had to be developed for the estimation of both of these in micro quantities. This has now been made possible. Organic matter when burnt yields its hydrogen in the form of water and deuterium will form heavy water. The methods of heavy water analysis have been developed to a sensitivity of detecting a concentration as low as 0.02%. The estimation of heavy nitrogen could only be possible by the complicated technique of a mass spectrometer.⁹ By means of this instrument Schoenheimer and his colleagues are able to estimate N_{15} to a concentration of 0.003%, and only 1 mg. of nitrogen is required for the analysis.

The studies of Dr Schoenheimer's school have brought to light many interesting facts regarding the metabolism of fats and proteins. After feeding saturated deuterio-fatty acids to mice, they isolated the unsaturated fatty acids formed. To another group of animals these unsaturated fatty acids were fed, and the saturated fatty acids formed were isolated. The deuterium content of these fractions indicated that the saturation and desaturation of fatty acids in the animal is a physiologically reversible process.¹⁰ Another important fact demonstrated by these investigators is the conversion of stearic acid into palmitic acid in the organism, a change which involves the shortening of the carbon chain.¹¹ In the field of nitrogen metabolism they have demonstrated that the animal organism can utilize to a small extent dietary ammonia for the formation of amino acids. The feeding of an isotopic *dl*-tyrosine, revealed an extensive deposition of the dietary tyrosine in the body proteins. Further more, other amino acids isolated: arginine, histidine, lysine, glutamic and aspartic acids, all contained the isotopic

⁹ Rittenberg, Keston, Rosebury, and Schoenheimer, *J. Biol. Chem.*, 127, 291, 1939.

¹⁰ Rittenberg and Schoenheimer, *ibid.*, 117, 485, 1937.

¹¹ Schoenheimer and Rittenberg, *J. Biol. Chem.*, 120, 155, 1937.

¹ This article is a continuation of an earlier one: 'Impressions of an educational tour of the universities of America and Europe'; published in the September '39 issue of *SCIENCE AND CULTURE*.

² Lawrence, E. O., *Phys. Rev.*, 50, 1131, 1936.

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nitrogen with the exception of lysine.¹² This indicated that the nitrogen of dietary amino acids is only partly excreted in the urine, while the rest is retained in the proteins of the body with the corresponding excretion of tissue nitrogen. Only a fraction of the nitrogen ingested remains attached to the original carbon chain, the bulk being utilized in the formation of other amino acids.

In Europe investigations by this technique, are being continued by Professor G. Hevesy in the Institute of Theoretical Physics at Copenhagen in collaboration with different physiological laboratories and in the laboratory of Professor B. C. P. Jansen at the University of Amsterdam. Reports have come of the preparation of radioactive glutathione at the Biochemical Foundation of the Franklin Institute, Philadelphia, by growing yeast in a medium containing a radioactive sulphate.

Visual Purple and its Relation to Vitamin A

Visual purple, the photo-sensitive pigment of the retina has long been known to occur in the retinal rods of the eyes of human beings and nearly all vertebrate animals.¹³ During recent years intensive investigations have been undertaken in different laboratories into the properties of this substance, particularly the changes that it undergoes in light and darkness.¹⁴ The most striking investigations in this field are those of Wald.¹⁵ It has been found that visual purple in the retinae forms on exposure to light a yellow bleached product, the visual yellow, which in the dark partly breaks down into colourless products, and is partly transformed into visual purple again. Wald has been able to establish the presence of a carotinoid pigment, "retinene," in the yellow bleached retinae, and vitamin A in the final colourless breakdown product. On the basis of this, Wald considers that vitamin A is both the precursor and

the final product of the decomposition of visual purple and the visual process forms a cycle:

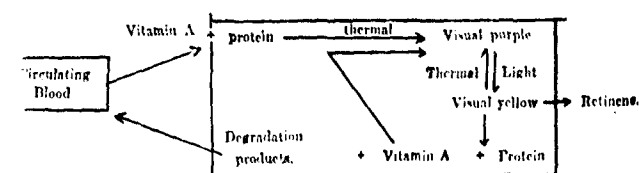


Diagram of the visual cycle in the frog.
(after Wald)

This important discovery of Wald had a very important practical application in the field of nutrition. The relation of vitamin A to night blindness has been recognised from the earliest days of vitamin research. Now a direct proof was available that vitamin A was essential for the formation of the pigment of the retinal rods, the visual purple, which was responsible for vision under faint illumination. This was indeed an important discovery and soon overwhelming evidence showed that essential hemeralopia was the earliest and the most constant manifestation of vitamin A deficiency in both adults and children. The degree of hemeralopia, which could be detected by suitable means, could therefore, be used as a means of assessing vitamin A deficiency.

In the wake of this discovery rapid developments followed in the technique of estimation of the rate of dark adaptation and the final threshold of the dark adapted human eye. Still more striking were the results of surveys in this field undertaken in different parts of America and Europe on different groups of the population. While it is not possible to discuss in any detail in this article, the newer techniques developed for the ready detection of mild hemeralopia, the old Birch-Herschfeld visual photometer,¹⁶ has proved quite satisfactory. The newer instruments are the biophotometer,¹⁷ and Hecht's visual adaptometer,¹⁸ which is more refined.

One of the earliest studies with this technique was that of Jeans and Zentmire¹⁹ at Iowa city. The study showed that a wide variety of percentage from 20-79% of the population in different economic groups in this

¹⁶ Birch-Herschfeld, *Z. Ophth. Optik.*, 5, 44, 1917; *Z. Augenheilkunde*, 37, 289, 1917.

¹⁷ Jeans, Blanchard and Zentmire, *J. Amer. Med. Assoc.*, 108, 451, 1937.

¹⁸ Hecht and Shluer, *J. Opt. Soc. Amer.*, 28, 269, 1938.

¹⁹ Jeans and Zentmire, *J. Amer. Med. Assoc.*, 102, 892, 1934; *ibid.*, 106, 906, 1936.

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area are in a state of vitamin A subnutrition. This aroused a host of criticism in America against the reliability of the technique, the results and the principle on which the conclusions were based. A number of critical investigations were undertaken in different American and European laboratories, and the discussions which followed at the meetings of the American Federation of Biological Sciences in April at Baltimore, and of the International Physiological Congress later in August at Zurich, abundantly proved the reliability of the principles involved and the techniques employed for the measurement of the rate of dark adaptation as a means of assessing vitamin A deficiency.²⁰ The results of these investigations indicate that 25-35% subnormal vitamin A nutrition is not uncommon in parts of the western countries. The results of similar studies in India would be awaited with interest.

Increasing the Span of Life

Interest in the span of life is probably as ancient as the human race itself. In every age, the philosophers, the monks, and the scientists have approached the subject in their own characteristic ways. Some spent the best part of their lives in a vain search for the 'potion of eternal life,' others subjected their own bodies to rigorous experimentation. The descriptions of those experiments fall generally in the domain of legend. Even when fuller accounts are available, it is impossible to assess their true value in terms of modern science. Modern biologists, Raymond Pearl and J. R. Miner summarize the factors affecting the duration of life in the following terms:

- (i) Endogenous: wear and tear due to internal functioning.
- (ii) Exogenous: wear due to environment and diseases.
- (iii) Genetic constitution.
- (iv) Rate of living: growth, metabolism, reproduction, and other functions.
- (v) Immediately lethal accidents.

Any attempt to increase the span of life must be made along one of these lines. In America attacks along two

²⁰ Jeghers, H., *J. Amer. Med. Assoc.*, 109, 756, 1937; *Annals of Inter. Med.*, 10, 1304, 1937; Maitra and Harris, *Lancet*, ii, 1009, 1937; Getz, H. R., et al., *J. Amer. Med. Assoc.*, 112, 1308, 1939.

lines are proceeding, (i) changing environment through improvements in nutrition, (ii) reducing the rate of living.

Of the environmental factors, food is evidently very important and it has a profound influence upon the length of life. Professor Henry C. Sherman of the Columbia University is devoting himself to this study with the co-operation of the Carnegie Corporation of New York and the Carnegie Institution of Washington. Within the zone of normal nutrition there is a large area between the merely adequate and the optimal. It is the exploration of this area towards which the investigation is being directed. In their first study the addition of more milk to an already adequate diet showed expedited growth, a higher level of adult vitality and increased longevity.²¹ Later it was sought to study the effect of nutritional improvements through four individual food factors, calcium, protein, vitamin A and lactoflavine, at different stages of the life cycle, on the health and the longevity of the rat.²² The recognition by Professor Sherman, of differences in requirement of different stages of the life cycle is important. The requirements of old age are likely to be quite different to those of adult life or active growth. So far this point has received little attention at the hands of modern scientific workers in this field. Professor Sherman has obtained positive results from these later experiments, and an increase of the order of about 10% has been achieved in the average normal span of life.²³

The experiments of Dr C. M. McCay at the Cornell University, Ithaca, are more extraordinary. It would be appropriate to quote his own words.

"Today both children and animals are being fed to attain maximum growth rate. Research has narrowed into a channel of primary interest in the young growing animal. After it becomes an adult, it is no longer an apple of the eye of the nutritionist but primarily a carcass which provides dissecting material for the pathologist. The nutrition student is too busy pouring in vitamins, minerals, proteins into the young and the growing to be much concerned with the grown.

²¹ Sherman, H. C. & Campbell, H. L., *Proc. Nat. Acad. Sci.*, 14, 852, 1928; *J. Nutr.*, 2, 415, 1930.

²² Sherman, H. C. and Campbell, H. L., *Proc. Nat. Acad. Sci.*, 20, 413, 1934; *ibid.*, 21, 235, 1935; *J. Nutr.*, 10, 363, 1935.

²³ Sherman, H. C., *Bull. New York Aca. Med.*, 13, 311, 1937.

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"This philosophy belongs properly to the butcher. Every producer of meat wants to rear animals quickly.... These animals are killed as soon as they mature.... There is a flood of advertising of fortified foods for children, chiefly for defenceless babies that are more or less easily coerced into engulfing various vitamin concentrates.... Technical journals are cluttered today with thousands of reports concerning the growth of the white rat.... But who knows what is the effect of this rapid growth upon the life span of the animal. What agricultural expert can tell the effect of feeding in the growth period upon the milk producing capacity of a cow during her entire life. What chicken specialist can tell the effect of the rate of growth of the chicken upon the egg production of the laying hen. And who can give assurance that a child that matures rapidly will not die after a short span of life."

The entomologist has long been aware that the entire life period of an insect is increased if one of the stages of development is slowed.²⁴ Relying on similar considerations and his earlier observations on the brook trout McCay postulated that *something was consumed in growth which was essential for the maintenance of life*. Following the work of Osborne and Mendel,²⁵ Dr McCay, Prof. Maynard and their colleagues started experiments to prolong the life of rats by retarding their growth through inadequate feeding during early life. A diet was devised adequate in every way and containing every recognisable constituent. The animals were allowed to eat limited amounts of this diet so that it was inadequate only in calories. The results were extraordinary. The retarded animals appeared youthful when the others eating unrestricted amounts of the same diet had become senescent. The average normal life span of the control animals was 809 days for males and 801 days for females. At the age of 1000 days when the control animals had long been dead, 18 out of 73 retarded animals were still alive. At the age of 1200 days, among the retarded animals, 18 out of 70 were alive in one

experiment, while 3 out of 73 in another.²⁶ These very old animals were susceptible to lung infections and this was the immediate cause of death in most cases. They had also grown blind. It was also found that the aorta, heart and the kidneys of these retarded animals tended to calcify earlier. In spite of these they attained longer life spans. These very interesting experiments are being continued.

Trace Element Cobalt in Animal Nutrition

While the nutritional significance of zinc and fluorine still remains in the domain of uncertainty, the work of Professor McCollum's school in Baltimore has definitely established the essential character of manganese in animal nutrition. They showed that this element was essential for growth, reproductive processes and the development of the foetus both during gestation and lactation. Their most striking observation was that the development of normal mother instinct required an adequate supply of manganese in the diet. Further interest was focussed on this element by the reports of Dr Norris and his colleagues²⁷ who established that a deficiency of manganese caused perosis²⁸ or 'slipped tendon' in chicks.

During the last two years, on the other hand, a large volume of definite evidence points that cobalt is another element essential for animal nutrition. In western Australia, where sheep farming is done on a large scale, a widely prevalent condition 'Coast disease' has been a source of great economic loss to the farmers. It was characterised by enzootic marasmus, or progressive wasting and emaciation, endemic in certain areas. In the South Island of New Zealand a similar condition called 'bush sickness' has been known and affected the Glenhope district and the Mortan Mains. It was recognised that these conditions were due to a dietary deficiency, and among various things empirically tried it was found that 'limonite', an iron ore, was

²⁴ Maynard, L. A., McCay, C. M. and Sperling, G., *Proc. International Physiol. Cong.*, Zurich, II, 230, 1938; McCay, Maynard, Sperling and Barnes, *Anat. Rec.* 74, No. 4, Suppl. 90, *Proc.*, 1938.

²⁵ Sedgwick, W. H., Norris, L. C., Heuser, G. F., *J. Nutr.* 14, 155, 1937; Gallup, W. D., Norris, L. C., *Science*, 87, 18, 1938.

²⁶ Perosis is an anatomical deformity characterised by gross enlargement of the tibial-metatarsal joint, twisting and bending of the distal end of the tibia and of the proximal end of the metatarsus, and slipping of the gastrocnemius tendon from its condyles. Calcification is quite normal.

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effective in curing and preventing this condition. While attempting to discover the active agent in limonite, Underwood and Filmer²⁹ prepared an iron free filtrate which was effective in curing and preventing enzootic marasmus, and the further fractionation of which showed that cobalt was the active agent. Askew and Dixon³⁰ who had been studying the problem in New Zealand also found that the effectiveness of different iron ores in curing bush sickness was proportional to their cobalt content. Further evidence for the essential character of cobalt in the nutrition of sheep was furnished by the fact that the soils of the area where the disease occurred were very low in cobalt content and consequently also the grasses and the vegetation that grew on those soils. The tissues of animals reared on those soils were also low in cobalt.

Following these observations in the Southern Hemisphere, came the news from Florida³¹ that nutritional anaemia in cattle known as 'salt lick' which occurs there, is only sometimes overcome by feeding ferric ammonium citrate, commercial red oxide of iron, and copper sulphate, but not always. The ineffectiveness in other cases is due to an overlapping cobalt deficiency. By feeding young calves on cobalt low diets, an experimental deficiency condition was produced which was apparently aggravated by iron salts and corrected only by a cobalt supplement. The deficient animals showed a rough hair coat, scalliness of the skin, listlessness, retarded development of sexual characteristics, gauntness due to loss of appetite, and muscular atrophy. The spleen was shrivelled and fibrous, and the heart flabby. The blood picture showed microcytic hypochromic anaemia. The addition of 5-10 mg cobalt in the daily ration corrected the condition rapidly.

The action of cobalt in producing polycythemia in the rat has been known for a long time³². The effect of cobalt-deficient or cobalt-low diets on the rat are being actively investigated in various laboratories. The cobalt status of soils, plants, foods, and animal tissues

²⁹ Filmer and Underwood, *Aust. Vet. J.* 10, 83, 1934; Underwood and Filmer, *ibid.* 11, 89, 1935.

³⁰ Askew and Dixon *N. Z. J. Sci. Tech.* 18, 73, 688, 1936. *ibid.* 19, 317, 1937; Askew, *ibid.* 18, 707, 1937; Dixon *ibid.* 18, 710, 892, 1937; Kindson, *ibid.* 18, 694, 1937.

³¹ Neal and Ahmann, *Science*, 86, 227, 1937; *J. Dairying Sci.*, 20, 741, 1937.

³² Stare and Elvehjem, *J. Biol. Chem.*, 99, 473, 1933.

reared in different parts of the United States are also being studied³³.

Guidance in the Selection of Food

Sometimes one meets with instances of peculiar animal and human behaviour which appear to suggest the guidance of instinct in the selection of food. Some women during the months of pregnancy have been observed with a strong craving for eating earthen matter. One finds them eating chalk stone (*Kharya matti*) and soft baked clay. In areas where the soil and consequently the vegetation on it is deficient in phosphorus, the cattle develop the peculiar habit of chewing bones. Can all these perverted appetites for uncommon substances be regarded as an instinctive selection of things for making up the dietary deficiency?

This question was taken up by Dr L. J. Harris³⁴, who quite clearly showed that instinct was a poor guide in the matter of selection of proper food. He proved this point not only by arguments and examples from the history and habits of human communities from the primitive man downwards but also by a series of experiments on animals. Dr Harris pointed out that instinct was no help to the people of the Far East who for ages suffered from the plague of beri-beri. In the prevention of goitre, or rickets or scurvy also instinct could not come to the help of man. There are many instances of the tribes of primitive man almost decimated by disease due to dietary deficiencies. Whenever any help came, it was either from the long accumulated experience of the ages or from knowledge gained through active research. It sometimes happened that an important discovery or remedy was hit upon by a simple empirical trial, and there intuition played its part. This phenomenon also repeats in modern scientific research.

In the case of animals there appeared to be little food instinct. In Dr Harris' experiments, normal and deficient rats were offered a choice of different foods. It was found that they chose the food according as it made an immediate appreciable effect in making them feel better and not otherwise. The animals generally selected such a food by taste or smell. If these were altered, the animals were confused. In the case of

³³ Ahmad, B. and McCollum, E. V., *Amer. J. Hyg.* 29, 24, 1939.

³⁴ L. J. Harris: *Vitamins in theory and practice*. London, (1935).

²⁷ J. Northrup, *J. Biol. Chem.*, 32, 123, 1917.

²⁸ Osborne, T. B., Mendel, L. B., and Ferry, E. L., *Science*, 45, 294, 1917.

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foods where no immediate wholesome effect could be thus felt by the animals, they had no other sense of selecting a particular food even if they died from a deficiency which could be made up by that.

The study of the nutritional requirement of animals by self selection or appetite method has recently been taken up by Dr C. P. Richter,²² who has been carrying on a series of interesting experiments at the Henry Phipps Psychiatric Clinic of the Johns Hopkins Hospital, Baltimore. Normal animals and animals in various states of dietary deficiencies, glandular deficiencies, and during pregnancy and lactation were offered a selection of pure carbohydrates, fats, proteins, vitamins, and minerals. The animals were able to make advantageous and economical selections. For example, normal animals given access to eleven substances, olive oil, casein, sucrose, 3% solution of sodium chloride, 4% sodium phosphate, 1% potassium chloride, 2.4% calcium lactate, cod liver oil, dried bakers' yeast, and wheat germ

²² Richter, *et al.*, *Amer. J. Physiol.*, 119, 388, 1937; *ibid.*, 115, 161, 1933; *Endocrinology*, 21, 50, 1938; *ibid.*, 22, 214, 1938; *Science*, 86, 354, 1937; *Proc. Inter. Physiol. Cong.*, Zurich, II, 233, 1938.

oil, made selections which resulted in excellent growth and normal reproduction. They ate nearly 25% less calories than on the standard McCollum diet. Pregnant and lactating mothers showed increased appetite for protein, fat, calcium and phosphorus. Vitamin-A-deficient animals when given access to cod liver oil, or vitamin-B-deficient animals when given access to dried yeast or crystalline vitamin B₁ or riboflavin, ate such quantities that their deficiencies were quickly corrected. Adrenalectomized rats showed great appetite for salt and ingested large amounts of 3% sodium chloride and remained free from symptoms of insufficiency. Adrenal implants in the eyes caused the salt appetite to decrease. Similarly parathyroidectomized rats showed an increased appetite for calcium. These animals therefore were able to choose what they needed economically. Dr Richter considers that appetite may serve as a reliable guide to nutritional needs in both man and animals. It is evident, however, that instinct played no part in the advantageous selections made by the animals in these experiments. When an abundant supply of the right thing is available, experience accumulated will soon show what is needed. Unfortunately such conditions of plentiful supplies of the right foods are so rare in nature.

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Electro-encephalograms of Mental Patients

A recent investigation by Davis and Davis of the Harvard Medical School (*Amer. J. Psychiatr.*, 95, No. 5, March, 1939) entitled "The Electro-encephalograms of Psychotic Patients" throws considerable light on the still unsettled question: "Do the brain waves of psychotic patients, especially of manic-depressive and schizophrenic types, fundamentally differ from those of normal persons?" In his earlier studies, Berger found schizophrenic patients' brain potentials falling within the range of normal variation. That was in substance the conclusion of Travis and Malamud (1937), Lemere (1936), Jasper and Solomon, and Hoagland (1937). These workers, however, noted especial changes in the electro-encephalogram (EEG) of mental patients such as the following: high frequency potentials, slowing and grouping of the alpha rhythm, low amplitude potentials, a high value of the "disintegration factor" as indicated by swings of the base line, slow waves and other irregularities. But such changes were not consistent nor were they different from those found sometimes in normal individuals. Gibbs, Gibbs and Lennox (1938) found abnormal patterns (square topped, slow waves) in a brilliant college student, mentally normal but having convulsions, and in a graduate student with paranoia but no seizures. So in spite of the desire on the part of workers to find the electrical identification symbol or symbols of different types of mental patients the answer has not been clear-cut. And yet if EEG is an indication of the functional organization of the brain cells and if mental patients are assumed to have dysfunction of the brain, one would expect to find consistent abnormal EEG signs in such patients.

The problem was attacked quantitatively in the study of Davis and Davis in the following way.

They took the brain rhythm of 500 normals, 180 unselected mental hospital patients and 52 chronic schizophrenics, by means of standard low frequency, high amplification EEG machines, and figured out the "alpha index" of these patients. The "alpha index" is the percentage of time that the alpha rhythm (having a frequency from 8.5 to 13 per second and amplitude over 7 microvolts) appears on the record when taken under standard conditions off the skull overlying the visual part of the brain of a patient. It is revealed that the mental cases as a group have a much lower alpha index than the normals. In fact there is an inverse trend in respect of this index between these two groups, with some overlapping. Is this overlapping due to (i) what has been called the "waste basket" classification of mental cases by hospitals, or (ii) the failure of the discovery of a still deeper distinguishing electrical criterion, or (iii) both, or (iv) the presence of a certain degree of normality in mental patients? No definite answer can be given at present. Davis' study pointed out that the mental patients often showed brain wave patterns totally different from those found in the normal series, *e.g.*, greater irregularity of frequency and voltage, spasmodic slow waves, sudden "spikes" occurring singly or in groups, a burst of waves of an unusual frequency etc. It was further found that sometimes one particular brain area of a mental patient like the frontal or temporal area gives abnormal wave pattern while other areas do not. A mentally alert lady of 92 with generalized arteriosclerosis showed no abnormal brain wave pattern, but when she developed mental retardation a year and a half later such a pattern appeared. The conclusion of the authors is that "abnormalities which break into the brain wave pattern, rather than the type of the pattern itself, constitute the significant difference

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between the EEG of these patients and normal individuals." Studies like this indicate the existence of a wide field for exploration and research.

B. K. B.

Cromerian Tools

Mr J. Reid Moir contributes a short note to the *Nature* (July 29, 1939, No. 3639) on the Cromer Forest Bed Implements. The characteristic ochreous artefacts of the Cromer Forest Beds are extremely rare on the coast of Norfolk, being confined only to one particular point. The flint is of a special variety, not found on the foreshore; and they are also being rapidly reduced in number, which would not have happened if the objects were being turned out by wave-action every day. Thus they are in all probability the handiwork of man.

Mr Reid Moir has been able to distinguish six periods altogether inside the tool-bed. The implements are distinguished from one another by their different degrees of patination, as well as their form and method of flaking.

T. C. D.

Applied Anthropology in China

Intensive study of typical villages or similar small units, providing economic, social, religious and political problems of modern China, has been undertaken by a band of young Chinese anthropologists, trained and inspired by prof. Wu Wen-Tsao of Yenching University. Some of these problems have already been tackled with and the results are published, mostly in Chinese. The names of a few of these monographs (Litigation in a Village Community of Hopei—by Y. S. Hsu; Chinese Rural Education in Shangtung, in Change—by T. C. Liao; A Clan-Village in Fukien—by Y. H. Lin, etc.) indicate the nature of the subject-matter and scope of study. *Peasant Life in China* by Dr Hsiao-Tung Fei, published recently in English, introduces to us a fascinating "account of the system of consumption, production, distribution and exchange of wealth among Chinese peasants as observed in a village, Kaihsienkung, south of Lake Tai, in Eastern China." The inhabitants of this village are mainly agriculturists with sericulture as the only supplementary

occupation. Recent depression in silk trade throughout China has intimately affected these villages and has led to complicated adjustments in the socio-economic life of the villagers. The present work shows how the inhabitants of a typical village are trying to adjust themselves to the changed conditions of life brought about by this economic depression and the new measures introduced by the present government to break through the traditions of the oldest living civilization of the world. "By becoming acquainted with the life of a small village, we study, under a microscope as it were, the epitome of China at large." Though this monograph by Dr Fei and similar others by his fellow-workers give intensive pictures of particular segments of Chinese life, yet when assembled together they show us the mosaic of Chinese culture as a whole and that in a better perspective than what we get from the pen of ethnographers who only work out the averages of manners and customs of human groups. Similar intensive study of particular villages were undertaken in the United States of America, before this, with success, but only in relation to tribal population. In fact, anthropology has so long been confined to the study of savagery and the Chinese scholars are making a combined and conscious effort to divert its attention to the problems of civilized life. It is perhaps the first attempt to apply anthropological methods to the study of a culture with an unbroken tradition of over four millenniums. That is, perhaps, why Prof. Malinowski characterises Dr Fei's book as a "landmark in the development of anthropological field-work and theory" and perhaps the same remark may be applied in respect of the works of the other Chinese scholars. What has been found suitable and useful in China may be equally so in India. Here are materials enough for the Indian anthropologists and sociologists to think about.

T. C. D.

Ultramicro-Determination of Vitamin B₁

Schultz, Atkin and Frey (*J. Amer. Chem. Soc.*, 59, 2457, 1937, *Ibid.*, 60, 1514, 1938) reported that thiamine under appropriate conditions, cause a pronounced stimulation in the rate of alcoholic fermentation. Based on this stimulation a method was devised which permitted the estimation of thiamine content of various substances. By this method it was

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possible to estimate thiamine in the amounts of 0.5 to 4.0 micrograms.

Naw Atkin, Schultz and Frey, (*J. Biol. Chem.*, 129, 471, 1939) describe a method which permits the determination of 5×10^{-9} gram of thiamine. The usual Warburg apparatus with a flask of special design is used and the experiment performed at 30°C in an atmosphere of nitrogen. The apparatus and the method of procedure have been described in detail. The authors find that 5 mg. of baker's yeast produce at 30°C about 400 c.c. of gas per hr. under the conditions specified by them. The addition of 80 millimicrograms of thiamine increases the rate to

about 950 c.c. per hour. The difference, 550 c.c., is the stimulation due to thiamine. The relation between stimulation and quantity of thiamine is approximately linear up to 30 millimicrograms. The gas production due to 10 and 20 millimicrograms is measured and aliquots of the unknown, containing intermediate quantities of thiamine, are estimated on the basis of the linear relationship. Thiamine content of human blood in a 0.1 c.c. sample and of milk in a 0.035 c.c. sample could be easily estimated by this method. The very small quantity of a substance required for estimation suggests many valuable applications of this ultramicro-method.

H. N. B.

Climatic Cycles Reflected in Geological Data

Geological formations appear to abound in evidences of climatic cycles of different lengths. Alternate beds of shales and limestones, for example, seem to show the wet and dry periods for a climatic cycle. Frequently fifteen, or more, pairs of such beds occur in sequence and are so uniform in thickness as to leave but little doubt that the cycle was very regular in length. Seams of coal of about the same thickness are often spaced so uniformly in the geological column as to tell the same sort of a cyclic tale. Recessional moraines left by the last great ice-sheet occur occasionally in a long series of a score or more, so regularly spaced as to indicate cyclic retardations in the retreat of the glacier. The same is true of smaller ridges that sometimes occur on wide recessional moraines. Raised beaches around existing lakes frequently form a series of eight, or more, so regularly spaced as to leave no doubt that a climatic cycle of considerable length and of great amplitude caused them. The same is true of terraces along river-valleys.

Following this, theory may be developed of terrestrial and solar emission of electrons and of rotating electron-shells as a cause of weather and climatic cycles as well as cyclic changes in the earth's oblateness and in regional disturbances of

the crust. This electron theory of weather and climate cycles results in a cycle whose length is the gyration period of the earth's axis. That period is about 26,000 years, and, according to the electron theory, a maximum number of spiralling solar electrons would enter the earth around its magnetic poles when opposite poles of sun and earth are most inclined towards one another. The last time that this occurred was at the winter and summer solstices between 17,000 and 16,000 B.C. About 13,000 years later a minimum number of solar electrons entered the earth because like magnetic poles of earth and sun were most inclined towards one another at the solstices, causing magnetic repulsion. It should be remembered that electrons moving in a magnetic field tend to move spirally around a magnetic axis, and therefore have magnetic polarity, which, in the case of the sun, would be the polarity of the pole around which they escape.

This theory gives us two critical epochs for the 26,000-year cycle, namely a maximum terrestrial inflow of solar electrons between 17,000 and 16,000 B.C. and a minimum between 4,000 and 3,000 B.C.

—Bulletin of the American Meteorological Society.

UNIVERSITY AND ACADEMY NEWS

National Institute of Sciences of India

(Calcutta, August, 1939, *Proc Nat. Inst. Sc. Ind.* 5, 167-305, 1939)

K. B. MATHUR: Reflection and absorption of electromagnetic waves in the ionosphere.

B. D. PANT AND R. R. BAJPAI: Studies on the ionosphere at Allahabad.

J. N. RAY: Some recent developments in the study of the constitution of natural products.

P. C. MITTER: Researches on organic chemistry in India (1896-1923).

P. C. GUHA: Synthetic investigations in bicyclic terpenes.

D. CHAKRAVARTY: Synthesis of coumarins and chromones.

R. C. SHAI: New synthetical methods in coumarin chemistry.

K. S. NARANG, J. N. RAY AND B. S. ROY: The structure of rottlerin. Part III.

K. VENKATARAMAN: Synthetical experiments in the flavone and isoflavone groups.

R. D. DESAI AND Z. AHMAD: The colouring matter of the yellow flowers of *Theceta nerifolia* (Apocynaceae).

R. C. SAHA, C. R. MEHTA AND T. S. WHEELER: The constitution of oroxylin-A. Part II. Attempted synthesis of oroxylin-A and the synthesis of wagonin.

T. S. WHEELER: Synthesis of some naturally-occurring flavones from chalkones.

H. S. RAO: On the burrowing habits of a gobioid fish of the genus *Toenioides* in the Andamans.

S. L. HORA: Physiology of respiration and evolution of air-breathing fishes.

A. C. JOSHI: Structure and development of the embryo-sac of *Iphigenia indica* Kunth.

Symposium on recent work on the synthesis of naturally-occurring substances.

Royal Asiatic Society of Bengal

(Calcutta, 4th September, 1939)

L. S. DUGIN: The Songs of the Elder of Herat (translated from the Russian of V. Zhukovsky).

CAPT. L. MUNN: A sword dance and skewer-piercing ceremony at Tintini.

H. S. RAO: The King Crab.

Indian Chemical Society

(Calcutta, June, 1939, *J.I.C.S.*, 16, 261-309, 1939)

S. S. BHATNAGAR, A. N. KAPUR AND MAHENDRA SARUP BHATNAGAR: Adsorptive properties of synthetic resins. Part III.

R. K. BAHL AND SURJIT SINGH: A study of the periodates of copper.

A. MUKHERJI: The estimation of ancurin by the thiochrome reaction with Pulfrich photometer.

N. W. HIRWE, G. V. JADHAV AND D. R. SUKHANKAR: Interaction of sulphuryl chloride with arylamides of aromatic acids. Part II. Orienting influences of groups in substitution reaction in aromatic compounds.

N. M. SHAI: Chloralides. The condensation of butylchloral with α -hydroxy carboxylic acids.

MUHAMMAD QUDRAT-U-KHUDA AND SUBASH KUMAR GHOSH: Chemistry of substituted ring compounds. Part I. Synthesis of α -trimethylcyclopentanone.

JAGRAJ BEHARI LAL: Studies in chalkones. Part I. Chalkones derived from resacetophenone and its dimethyl ether.

UNIVERSITY AND ACADEMY NEWS

U. P. BASU AND P. K. DAS GUPTA: On 2-phenyl-4-aminoquinoline derivatives.

M. K. SRINIVASAN: Viscosity of non-ideal binary liquid systems.

EDWARD BARNES: A note on the action of strong solutions of alkalis on potassium ferriocyanide.

Indian Chemical Society

(Calcutta, July, 1939, 16, 313-368, 1939)

S. S. BHATNAGAR, BRAHM PRAKASH AND JARNAIL SING: Colour and magnetic properties of manganous sulphide.

BIJAN BIHARI LAL: Decomposition of hydrogen peroxide by potassium ferrocynide. Part I.

A. MOKTADER AND S. S. GUHA SIRCAR: On the bitter principle from *Andrographis paniculata*. Nees Part I.

R. K. BAHL AND SURJIT SINGH: The action of hydrogen sulphide on an aqueous solution of paraperiodic acid.

BALWANT SINGH AND SOHAN SINGH: Potentiometric studies in oxidation-reduction reactions. Part VI. Iodometric determination of organic acids.

BALWANT SINGH AND SOHAN SINGH: Potentiometric studies in oxidation-reduction reactions Part VII. Determination of aromatic compounds with potassium chlorate.

SURESH CHANDRA SEN GUPTA: Studies in genyurogenation. Part IV.

MATA PRASAD, JAGDISH SHANKAR AND PRABHAKAR N. BALJEKAR: Space-group determination of the crystals of *p*-nitrophenol (metastable), phenacetin and tribenzylamine.

S. J. DAS GUPTA: Acridine derivatives as anti-malarials. Part IV.

Anthropological Society, Calcutta University

(Annual Report, 1938-39)

J. K. BOSE: Effect of culture contact among the Garos.

M. N. BASU: The Negrito element in Bengal.

T. C. BAGCHI: A method of cooking observed in Asansol.

D. C. SEN: Distribution of palaeolithic hand-axes in India.

T. C. DAS: Fish-gorges.

K. P. CHATTOPADHYAY: Determination of nasion in the living.

MISS C. H. LAWRENCE (LOND. UNIV.): Anthropological work among the Khasis.

M. N. BASU: Fishing method employed in Jessore district.

T. C. RAYCHAUDHURY: Santal physical anthropology.

K. P. CHATTOPADHYAY: A fish lure in Meerut district.

Errata

In the last September issue on p. 190, 1st col. in line 17 from the bottom, *read* identitaten, *for* indentitation, in line 2 from the bottom *read* Raman *for* Ramon.

On the same page, 2nd col. in line 14 from the bottom, *read* Chelone mydas *for* chelonmydas, and in line 9 from the bottom, *read* Mangifera *for* mangifera.

BOOK REVIEW

POLITICAL HISTORY OF ANCIENT INDIA—by Hem Chandra Raychaudhuri, M.A., Ph.D., Carmichael Professor and Head of the Department of Ancient Indian History, Calcutta University. (Calcutta University, 1938). Fourth edition, revised and enlarged Pp. xxiii+574.

The value and popularity of the work have called for its fourth edition which has made it more up-to-date. There are many singular features of the work of which the more important ones may be pointed out. Pre-Buddhist India has been given a chronological history for the first time on the basis of Vedic evidence critically handled for the purpose, and certain synchronisms worked out between Vedic teachers (from Vamsa's Lists) and the Buddha's contemporaries. Next, there are studies of early Indian geography from different sources, Brahminical, Buddhist, and Jain, and of kingship in the Brāhmana—Jātaka period. There are several new points introduced in pre-Maurya history, e.g., the Sanskrit equivalent of the Greek name Agrammes. The treatment of Maurya History is marked by a complete collation of the evidence furnished by Megasthenes and Kautilya, together with interpretation of Asokan administrative and other terms of his inscriptions in new references, and dates of his coronation and conversion, and the like. There are also new views advanced with great cogency on (i) chronological relations between Pushyamitra and Khūravelu (ii) time of Menandar (iii) early Sātavāhanas and Sakas (iv) Seytho-Parthian History, and (v) 'Mitra' group of coins. Some new facts have also been brought to light on topics of Gupta History, e.g., (1) Naga rule preceding the Guptas (or which the late Dr Jayaswal has given an elaborate treatment), (2) King Chandra, (3) Rāmagupta, (4) Vākātakas, (5) evidence of Manjusri Mūlakalpa and (6) identification of Bālāditya, Surya-

varman, and Susthitavarman and of the Sulikas. Throughout, the treatment has been based on literary, epigraphic and numismatic evidence, and its up-to-date interpretation. The work is a study in documentation and is indispensable for post-graduate students of Ancient Indian History who will get in it conveniently assembled all available sources and references upon which they have to draw in following the reconstruction of that ancient history. The work thus serves at once as a primary source-book and a useful historical compilation in which have been utilised the latest discoveries of scholarship. It is a credit to the University and the exalted chair of the History which its author holds.

R. K. M.

HEAT—by R. G. Metton. (J. M. Dent & Sons, Ltd. London). Pp. 338. Price 6 shillings.

The book is intended as a text book for students going up for medicine or the intermediate examinations in science but the book may be recommended to those who are preparing for a pass degree of an Indian University.

It presents an outline of heat as it is at the present day in a very simple and lucid manner. There is an appendix at the end of the book which gives a list of dates and original papers dealing with more important investigations in the subject and the student will find it highly useful. A special feature of the book is that it contains a large number of useful problems with answers most of which are collected from past examination papers. The treatment of the kinetic theory of gases and some of its applications, as for example, in connection with mean free path, viscosity of liquids and gases, Brownian movements etc., is very simple and will be interesting to young learners of the subject.

S. K. A.

BOOK REVIEW

WHERE THEOSOPHY AND SCIENCE MEET: A Stimulus to Modern Thought. Parts I and II.—Edited by D. D. Kanga, I.E.S. (Retired). (The Adyar Library Association, Adyar, Madras). Price Re 1/14 each.

These two volumes contain a series of monographs on various scientific and philosophical topics, and cover a wide range of subjects. The monographs which were contributed by a number of writers of repute, though written mainly for laymen, will also be found interesting by specialists and experts. The writers have made praiseworthy efforts to describe briefly the latest developments of scientific principles and theories in the domains of such branches of knowledge, as geology, archaeology, biology, physics and chemistry, and then to establish the identity of fundamental conceptions underlying these sciences with those propounded in treatises on theosophy. In many cases, the writers are of the opinion that the truths discovered by the scientists were already known to eminent theosophists, and the method of clairvoyant research is quite as effective as the orthodox scientific method. On this point there are bound to be considerable differences of opinion, and it is not the intention of the reviewer to introduce a controversy on this matter in this very brief review.

The mental outlook of a twentieth century scientist is quite different from that of his confrere of the 19th century. No scientist of repute will assert nowadays that the last word on any scientific topic has already been said. All scientific theories are more or less provisional and are liable to be altered, as soon as they do not fit in with observed facts. This view will not possibly be accepted by the theosophists with respect to clairvoyant research practised by them. Be that as it

may, there is no doubt that all true scientists must keep their minds absolutely open to receive light from whatever source it may arrive. The 19th century scientists were so overwhelmed when the flood gates of nature's secrets were partially opened, and new and startling discoveries made from day to day, that they in their hour of triumph thought that theirs was the only method of knowing what was worth knowing, and that knowledge could only be gathered by the method of observations of and experimentations on material objects. Their successors of the 20th century soon discovered that nature yielded only a little of her secrets and that there were unexplored domains into which scientists with their existing equipments were not as yet able to find a pathway. Scientists of the status of Sir James Jeans and Sir Arthur Eddington have expressed the opinion that in the twentieth century metaphysics and physical science had joined hands in certain spheres. One ought not to be unduly surprised to learn that theosophy contains in its teachings statements of theories and principles which run parallel to and may have a bearing on the theories and principles propounded by the so-called positive sciences which follow the orthodox methods of scientific investigation. The difficulty with the occult method is that it cannot be studied as an open book and it is very difficult to accept all that is claimed for it.

To the reviewer who is not a theosophist, and therefore not conversant with the *modus operandi* of clairvoyant research, the book proved to be very interesting from the layman's point of view. The speculative conception of theosophical field and planes is rather fascinating. There are other interesting matters in these volumes which are worth a study even though one may not see eye to eye with authors in all that they have tried to establish.

H.P.B.

ERRATUM

In the last September issue, p. 193, 2nd col. line 23 from top, read Upper Cretaceous horizon for Upper Eocene horizon.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

Spectra of the salts of the first transition group of elements

A very well-known property of the salts of the first transition group of elements is that they are strongly coloured. These colours are so very characteristic of these elements that they are very often considered as a sure sign of the presence of these elements. Such an important property hardly goes without explanation in the domain of natural science, and we see quite a number of attempts towards an understanding of this phenomenon.

Two important properties of these salts that have connection with the phenomenon of colouration are that the salts are mostly crystalline and that they require a number of water molecules to form the crystals.

The attempts for an explanation of the colouration can be grouped under two general heads depending on the factors held responsible for it. These attribute the origin of the colour to (i) a primary product of the crystalline field and (ii) a transition in the metal atom itself while it is in a state of ionisation to form a molecule of ionic type.

Taking individually, these interpretations explain the origin of colour of most of the salts of the first transition group of elements. As has been pointed above, many of the salts are coloured only when they are crystalline with their required number of water of crystallisation. When the water molecules are removed, the salts lose their crystalline property as well as their colours. But some of these amorphous dry salts are found to give out radiations under suitable excitation. An attempt to account for this colour on the basis of metastable transition of the metal ions was also not a success.

An explanation is suggested here. The transition group of elements are Sc, Ti, V, Mn, Cr, Fe, Co, Ni. Their electronic structure is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^n 4s^2$ where $n=1$ for Sc, $n=2$ for Ti, and $n=8$ for Ni. Normal or the deepest state of the atom is given by such an electronic configuration. If we consider the chlorides of these elements, we see that the chlorides, when excited by high frequency discharge or otherwise, become in most cases monochlorides. The emission band

obtained from such an excitation corresponds in many cases to the atomic transition amongst the different, more or less forbidden, states of the ground term $3d^n 4s^2$ or a transition between the states of the type $3d^n 4s^2-3d^{n+1} 4s$, or $3d^n 4s^2-3d^{n+2}$. These transitions in many cases lie in the near or far infra-red part of the spectrum but in some cases they lie in visible but rarely in the ultra violet.

In the following table will be found a summary of results and the attempted explanation.

Molecule.	Transitions suggested.	Energy of the transition.	Observed position of the band.
TiCl.	$3d^2 4s^2 \leftarrow 3d^3 4s$	20000	23820
MnCl.	$3d^5 4s^2 \leftarrow 3d^6 4s$	23300	26800
FeCl.	$3d^6 4s^2 \leftarrow 3d^7 4s$	12000—24000	16600—22000
CoCl.	$3d^7 4s^2 \leftarrow 3d^8 4s$	18500—25000	22000
NiCl.	$3d^8 4s^2 [^3F-^1G]$	22108	23000

Indian Association
for the Cultivation of Science,
210, Bowbazar Street,
Calcutta, 15-8-39.

S. C. Deb.
B. Guha.

Losses of protein and minerals in cooked rice

In the ordinary process of cooking rice, the rice is boiled with water and the excess water is thrown away as waste. It is known that this procedure of cooking rice is wasteful and involves the loss of some nutritive elements of rice. As, however, no quantitative data on the subject have come to our notice, we considered it desirable to estimate this loss.

100 g. milled parboiled rice were boiled with 2000 c.c. of water for half an hour in the usual way and the fluid decanted. The volume of the fluid was 50 c.c. The fluid was dried in an electric oven and the dried mass incinerated in a silica crucible. The ash was extracted with N/2 HCl, and calcium, phosphorus and iron were estimated according to the method of Pal and Guha¹. Nitrogen of the cooked rice was estimated by the usual Kjeldahl method and the value of protein obtained

LETTERS TO THE EDITOR

by multiplying the figure by 6.25. 100 g. of same rice as was used for the cooking were incinerated and the calcium, phosphorus and iron contents of ash estimated. Protein was also estimated in the fresh rice. The results are given in the following table.

	100 g. rice contain	Rice water obtained after cooking 100 g. of rice contains	Cooked rice from 100 g. of rice contains.	Percentage losses on cooking.
Calcium	0.0067 g.	0.0047 g.	..	70
Phosphorus	0.15 g.	0.027 g.	..	18.4
Iron	0.68 mg.	0.32 mg.	..	47
Protein	6.83 g.	..	6.58 g.	3.7

Thus we find that considerable amounts of calcium, phosphorus and iron are lost with the rice-water which is discarded. The loss of protein, however, is not considerable. It is obvious that cooking of rice with minimum quantity of water (so that all the water is absorbed in the rice) would prevent these losses. Considering that the ordinary middle-class diet in Bengal does not provide a sufficiency of these nutritive elements and that rice forms by far the largest proportion of the daily diet, the conservation of the nutritive elements by a rational process of cooking would naturally be of great significance from the standpoint of nutrition.

Department of Applied Chemistry, Sachchidananda Banerjee,
University College of Science,
Calcutta, 11-9-39.

¹ Pal, J. C., and Guha, B. C., *Indian Med. Gaz.*, 72, 24, 1937.

The Western Isles through the mists of Ages

Sir Albert C. Seward

Prof. A. C. Seward's illuminating presidential address garbed in popular language on the ancient plants of the earth, gives us a hint how the "Nature's infinite book of secrecy" has been unfolded during his life-long investigation. Prof. A. C. Seward stated that by an excursion into the past "we shall try to reconstruct a small part of an ancient land, a remnant of which is now called Scotland, and envisage a scene at a stage in the history of the earth separated from the present by at least sixty million years, a stretch of time difficult for us who have been called 'the afterthoughts of creation' fully to appreciate. When we substitute geological standards for the modest time-scale of the human period and remember that the earliest chapters of the world's history are recorded in rocks at least two thousand million years old, sixty million years dwindle to comparative insignificance. All that it is possible to do is to lift a corner of the veil separating us from the world as it was and view through dimly illuminated vistas the forests and undergrowth on an ancient continent that is now represented by a few widely scattered, dismembered pieces."

A resume of the history of plant life then follows. "The history of plant life in the sea and on land is a branch of natural knowledge not unworthy of consideration by us human beings who owe our existence to the vegetable kingdom. Green plants in one vital sense are our superiors: from air and water they build up the complex organic substances necessary to our life, a feat beyond man's power. As members of a subject race we should be interested in endeavouring to unravel the history of the plant kingdom—in trying to trace the origin and relations of the several classes and groups as defined by botanists. The documents that are the sources of the botanical historian are contained in the earth's crust: as a preliminary it is worth while to ask ourselves of what these documents consist; how they came to be preserved in the rocks. In order to bring to life the past we must take the present for our guide: 'speak to the earth, and it

shall teach thee.' There is no reason to think of Nature's methods as other than continuous. If we stand by the bank of a river flowing past tree-covered slopes we see on the sand and mud by the edge of the channel or floating on the stream leaves, twigs, and seeds that are random samples of vegetation scattered by wind or shed from overhanging boughs, debris swept along with off-scourings from the rocks to be carried eventually to a delta or an estuary where the water-borne material comes to rest. Beds of old sands and mud, with included fragments of contemporary trees and other plants, exposed on the faces of cliffs and ravines, are layers of sediment that have been raised to a higher level. In addition to leaves, twigs and other scraps easy to see on the split surface of sandstone or shale, sediments of former ages, especially such as are peaty, occasionally furnish another valuable source of information invisible to the unaided eye. Minute grains of pollen may be carried by wind to places where conditions are favourable for their preservation: fortunately the grains, or at least most of them are protected by highly resistant coats and retain almost for all time their characteristic form and surface-sculpturing. With hardly any exception it is possible for a specialist, by comparative microscopical examination of fresh material, to assign fossil pollen-grains to their generic and occasionally their specific position in the plant kingdom.

There is another natural agency to which students of extinct plants are not infrequently indebted: the formation of rocks by volcanic action. From time to time volcanoes that have long been dormant eject clouds of ash: these with streams of lava poured over the rim of a crater spread havoc among trees and shrubs that had colonised precarious sites during a peaceful interlude. Vulcanicity is not only destructive: paradoxical as it may seem, forces inimical to life have contributed to the reconstruction of life which they destroyed."

While dealing briefly with the reconstruction of a forest scene on the geological background he

touched upon the prolonged and intermittent volcanic activity. "With the uplifting of the chalky ooze from the ocean bed and the gradual recession of the waters a new land was born; a new chapter was inaugurated in the history of the earth. Following the great upheaval, as a consequential phenomenon, subterranean forces that had long been quiescent gained the upper hand: floods of semi-molten rock from deeply hidden reservoirs surged as a fiery deluge over the chalk downs, and over other and older rocks, converting thousands of square miles into barren lava-fields, extending over an area, not less than 2,000 miles from south to north, which reached far beyond the Arctic Circle. This unprecedented manifestation of volcanic energy, by no means confined to Europe and the Arctic regions, but recorded on an equally titanic scale in the peninsula of India and elsewhere, is one of the wonders of geology; it is convincing evidence that the earth after the lapse of many hundred million years had not lost her youth; there was no sign of senescence."

The world to our limited vision appears to be almost static; the mountains we have been accustomed to think of as symbols of eternity, seen through geological spectacles, take their place as episodes in a series of events which have moulded the changing features of the earth's face. The rocky covering of the world viewed by geologists, 'foreshortened in the tract of time' reveals itself as a dynamic, mobile crust responding from age to age to constructive and destructive forces which have operated since the earth's early youth following a still earlier stage when, in the imagery of the poet, 'this world was once a fluid haze of light'.

"It was not until the middle of the nineteenth century that Mr McQuarrie of Bunessan discovered the fossil plants, which were very briefly described by Prof. Edward Forbes in an appendix to an important paper by the Duke of Argyll published by the Geological Society of London in 1851. The Duke spoke of the leaves as having been shed 'autumn after autumn into the smooth still waters of some shallow lake, on whose muddy bottom they were accumulated, one above the other fully expanded and at perfect rest'. By far the richest collection for fossils was made by Mr Starkie Gardner rather more than fifty years ago, and partially described by him in a paper read to the Geological Society of London in 1887. Descriptions of several

fossil plants from the Mull beds have also been published by Mr T. Johnson. The main collection is now in the British Museum. Additional specimens have been obtained by other collectors in more recent years. The work of deciphering the botanical records from Mull, Skye, and a few of the other islands is rendered mildly exciting by the danger of misinterpretation: fossil leaves, we are often reminded, are very uncertain guides—records left by Nature in a mischievous mood to mislead the unwary and over-confident student. Sir Joseph Hooker in an address to the British Association at Norwich in 1868 spoke of Fossil Botany as 'most unreliable of sciences'; but he added by way of consolation—'the science has of late made sure and steady progress, and developed really grand results'. One may cheerfully take the risk of being called an unscientific optimist by colleagues whose chief concern is with living plants. Botanists who confine their attention to recent plants have ample sources of information, not merely detached leaves but twigs bearing leaves, flowers, and fruits; it is natural, therefore, that they should tend to underestimate the value of leaf-form and venation, characters that are often the only criteria available to the palaeobotanist."

In discussing the ancient flora of the Inner Hebrides Prof. Seward reviewed the different grades of vegetation from the liverworts bearing close resemblance to *Pellia epiphylla*, to fern—the sensitive *Onoclea sensibilis*, to *Equisetum*, the horsetails to further higher up—the Conifers to Phanerogams. *Abies pectinata*, *Cephalotaxus*, and *Cryptomeria japonica* of Japan and China so common in the hill stations of India and *Ginkgo biloba*—the Maidenhair tree, whose fossilised pollen grains were discovered by Dr Simpson, were recorded. "*Ginkgo* of all trees furnishes the most thrilling example of a link with the past: its history compiled from fossils of many geological ages and in many parts of the world is an enthralling romance." Higher up fossil form of leaves of *Quercus* and remains of other genera such as *Platanus*, *Corylus*, *Vitis*, *Cercidiphyllum*, have been discovered. Pollen grains believed to belong to the species of *Nelumbium* have also been discovered. "This genus is one of the most attractive water plants, a plant held sacred in ancient Egypt and venerated in the Far East. One of the living species is the sacred lotus, native in China and Japan and established as far west as the Caspian Sea: the other species has an extended range in North America,

spreading as far south as the West Indies and Brazil. *Nelumbium* no longer grows in the Nile: long years ago it had a wide distribution in Europe, both in the Cretaceous period and in later ages. Looking backwards we see its great circular leaves spread over the still waters of a Thulean lake. It is important to note that Dr Simpson's comparative investigation of fossil and recent pollen shows a preponderance of eastern Asiatic species in the Hebridean flora.

In discussing evolution Prof. Seward says, "The facts do not substantially help us to trace the unfolding of life in the long interval separating the older part of the Tertiary era from the present time. There is little difference between the past and the present vegetation of the world as a whole in the nature of trees, shrubs, and ferns: our knowledge of the earlier history of herbaceous plants is very meagre. The fossil flora of Mull represents an early phase of what may be called the modern type of vegetation, which overspread the world in the later stages of the Cretaceous period and has persisted with few major modifications until now. Evolution seems to have been characterised by bursts of production when new and successful types exercised a transforming influence and these periods of exceptional creative activity were separated by periods of relative stability. The early Tertiary floras belong to a stage when a new order had become well established and an older order had passed its prime. The one great difference that emerges from comparison of the Mull flora and the existing European floras is not the difference in the components of the world forces, but a contrast in the geographical positions occupied by the various genera in the northern hemisphere; for the most part a western home has been exchanged for a home in the Far East.

It is difficult, it is probably impossible, to explain the facts without calling to our aid the hypothesis of drifting continents usually associated with the late Prof. Wegener and recently discussed in an able book by Prof. Du Toit of South Africa..... I can do little more than reaffirm adherence to the view that plant records from rocks of many ages raise problems which seem to be insoluble unless we postulate movement and sliding of the earth's crust, Proof or disproof of the Wegener

hypothesis will be forthcoming in the more distant future when the precision of modern methods of measurement has been available long enough to provide trustworthy data. Meanwhile we must be content to wait in sanguine expectation that an interpretation of the overwhelming evidence furnished by fossil plants will be provided by research workers in the geophysical field. The geological historian needs the co-operation of astronomers and physicists in his endeavour to reconstruct the world at the successive stage of its development; he looks to them to prevent him from making assumptions inconsistent with conclusions reached by workers in other fields. On the other hand, geologists and palaeontologists contribute facts that are incontrovertible however much they seem to be in opposition to the views of students whose primary interest is in geophysical problems..... the main conclusion forced upon us by our retrospect cannot fail to convince us that it is impossible to understand the present distribution of plants over the earth's surface unless we extend our survey into the past. Darwin spoke of geographical distribution as a noble science, 'almost the keystone of the laws of creation.' The living world cannot be fully appreciated as an expression of creative energy unless we free ourselves from the cramping influence of the environment in which we live."

In connection with this address it will be interesting to know that the secret of evolution of plants and animals was revealed to the ancient sages of India. A manuscript in a canister appeared after a portion of the great Chinese wall built by Shitruang-ti was bombed. In this manuscript there is a direct reference to the laws of Manu, which were first written in Vedic language 10,000 years ago. In this book it says "From the plants life passed into fantastic creatures which were born of the slimes of water, then through a series of different shapes and animals it came to man." The Darwinian theory of 1859 was thus known and accepted seven thousand years ago. But the theory remained to be proved in the light of modern scientific discovery. Researches on palaeobotany, palaeontology, movement of the earth's crust and also the study of the distribution of present day flora and fauna throw considerable flood of light on this great problem.

K. B.

Mathematical and Physical Sciences

Instruments in Science and Industry

—R. S. Whipple

Dr Whipple gives us a historical perspective of the growth of scientific instruments from the early ages. He begins with the microscope, which Leeuwenhoek, the Dutch naturalist, in the later part of the 17th century, used to discover protozoa and bacteria. The names of Hooke, John Marshall, Chevalier, Tulley are closely associated with the improvement of microscope regarding its different components, namely, the objective and the eyepiece. Abbe undertook the theoretical aspect of microscope design for correcting the aberrations of lenses, and at his suggestion Schott improved the quality of glass for optical purposes. The use of ultra-violet rays, and fused quartz as the optical material helped J. E. Barnard successfully to photograph living bacteria. This success of shortwave radiations in revealing the structure of finer bodies has been followed up and in 1939 Von Borries and Ruska developed the high voltage electron microscope in which magnification as high as 20,000 diameters and with clearest resolution has been obtained in the case of bacteria and bacilli. The microscope is also an important aid to the metallurgists and it played not an unimportant part in the development of alloys of ferrous and non-ferrous metals.

The discovery of telescope is much earlier than that of the microscope. Some of the honoured names in science are associated with this instrument namely Galileo, Newton, Herschel. The study of heavens with the help of telescopes of higher and higher light-gathering power culminated in the perfection of the technique of polishing mirrors for telescopes. If the mirror of the Mount Wilson observatory is enlarged 250,000 times, its radius of curvature would be about that of the earth, i.e., 4000 miles and then the divergence of its surface from a true paraboloid would be only $\frac{1}{4}$ inch.

Distinction between the telescope suitably mounted to survey the heavens and that used to measure distances upon the earth's surface is a faint one. The first mention of the word "theodolite" is

in a book, *Pantometria* (1857) by an English man, Thomas Digges. With the advancement of telescopes and its eyepieces fitted with micrometers, the accurate dividing of circles has always been one of the more difficult task of the instrument maker. The names of George Graham (1673-1751) and John Birel (1700-1776) may be mentioned as masters of the art. Ramsden was the pioneer in the construction of modern dividing engine and his machine constructed in 1775 is now in the National Museum at Washington. In 1921 Heinrich Wild, a Swiss engineer designed an ingenious optical system in which the vertical and azimuthal circles could be read simultaneously in the eyepiece of a microscope and one can now read accurately up to 0.1 sec. The Greenwich Observatory has recently mounted the reversible transit circle and the Astronomer Royal states that no where one could find errors exceeding fraction of a second. In aerial survey, the advance is to be attributed to the perfection of photographic lenses and the recent seven lens camera introduced by Major-General McLeod enables one to have a fairly accurate survey of an area covering 1000 sq. miles from a height of 15,000 ft. in one flight of an aeroplane. The plotting machines designed by E. H. Thomson enables one to assemble the photos into a complete map in about a week's time.

Perhaps there is no instrument which in recent times has aided pure science so much and which is now beginning to help industry as the spectroscope. Fraunhofer first constructed the spectroscope in 1817. The solar spectrum was first photographed in 1842 by Becquerel and Draper. In 1859 Kirchhoff showed the law of absorption. Hartley (1882) introduced the quantitative method of analysis with the help of the spectroscope. Our knowledge of minute constituents of soil, the effect of the minute impurities in materials of constructions, such as cement is possible only with the aid of this instrument. In theoretical physics, the value of a spectroscopic work cannot be exaggerated. The new development of X-ray spectroscopy has been utilised for the study not only of the minerals but also of vegetable fibres, animal tissues and other bodies in which the minute orderly arrangement of the constituent parts would not be otherwise discernible.

The measurement of time dates as far back as the observation of Galileo in 1581, namely that the oscillations of a pendulum are executed in equal intervals of time. The first pendulum clock was however constructed by Huyghens. Graham and Harrison introduced the compensated pendulums to keep the length of pendulum invariable. Guillaume discovered the alloy of nickel and iron having a negligible co-efficient of expansion and pendulum rods made of "invar" form an essential component of time keeping clocks. By the use of a newer non-magnetic alloy, 'elinvar' in balance wheels of watches, it is possible now to have a mean daily variation even up to .06 sec.

The accurate control of the length of wireless waves radiated by the broadcasting stations had been a difficult problem. The discovery of the Curie brothers in 1880, namely the property of quartz crystals capable of maintaining oscillations at a definite frequency led to the adoption of quartz crystal controlled oscillators. In this, the accuracy of frequency can be maintained one part in one hundred million.

Thermometer is the most another scientific tool invented by Galileo in about 1592. In 1693 mercury-in-glass thermometers were fairly known. Lord Kelvin propounded the thermodynamic scale of temperature as a final standard of reference and to this absolute scale of temperature all measurements of temperature are now referred. The standardising laboratories of the world have developed a procedure by which it is possible to measure temperatures with such thermometers within 0.001°C. The mercury-in-steel thermometers, vapour pressure thermometers are to a very large extent used in the industries and it is interesting to note that the National Physical Laboratory alone certifies more than half a million clinical mercury-in-glass thermometers annually. The electrical method of measuring temperatures was suggested first by Sir William Siemens in 1871, but the platinum-resistance thermometer for accurate measurement of temperature within a range -100° to 600°C has been developed mainly through the efforts of Prof. Callendar. The thermo-electric pyrometers consisting of platinum and an alloy of platinum with 10% rhodium as couple was introduced by Le Chatelier in 1886. The base metal couple consisting of nickel and nickel-chromium are due to Hoskins. The radiation pyrometry for measurement of high temperatures was also due to Le Chatelier and the different

types of instruments have now been so far perfected that temperatures upto 2700 C can be judged within $\pm 10^\circ\text{C}$.

The last instrument dealt in the address is the Galvanometer. In 1802 Bischoff first introduced this name to an instrument for measuring electric current to commemorate the discovery of Galvani. In 1858 Lord Kelvin invented the Mirror galvanometer which rendered submarine signalling possible. In 1881 Deprez-d'Arsonval invented the moving-coil galvanometer. It has been studied theoretically and practically by Ayroton, Mather, Zernick and Moll. Paschen, Nichols, Downing and Hill have done much to increase the sensitivity of the moving-magnet galvanometer. The form of galvanometer which has proved of great service in industry in connection with alternating currents is the electro-magnetic oscillograph, an instrument invented by Blondel in 1893 but largely developed by Duddel. The problems connected with telegraphy and wireless have also invoked the aid of the oscillograph. Many of the phenomena to be studied take place in such short intervals of time, namely, one millionth to one hundred millionth part of a second that no form of mechanical instrument would be capable of responding to it. This has brought in general use the cathode ray oscillograph, a form of which is now so familiar in television sets.

An address regarding instruments would be incomplete without the mention of the thermionic valve. Its advent has led to the birth of wide range of new instruments, otherwise impracticable. Its rectifying action combined with amplification enables alternating currents as small as 10^{-4} amp. to be ascertained. During the last 40 years there has been steadily growing demands for higher and higher accuracy. The development of the high speed steam engine, the motor car, the aircraft machines brought about an insistent demand for accurate tools and gauges. The manufacture of interchangeable components in large quantities has further increased the demand for accuracy. The introduction of new alloys requiring special heat treatment created demand for precision thermometry and accurate estimation of feeble currents. Instrument manufacture and instrument design have two-fold aspects. More time is now spent in the actual drawing and designing than in the technique of experts and manufacturers.

P. N. G.

Engineering

The Future of Flying

—H. E. Wimperis

Mr Wimperis began with the early achievement of the Wright brothers in 1903, when they experimented on a queer sort of machine, weighing 180 lb., with a speed of 31 m.p.h. and with an engine of 12 h.p. The success of this experiment opened the door to further improvement as regards speed and design. Greater speed was attained by putting in extra engine power, but there came a limit to the extent of progress by this means. It was soon discovered that without increasing the engine power a considerable speeding up could be effected by the "cleaning up of the aerodynamic structure," which was first pointed out by Prof. B. M. Jones of Cambridge. Since then the overall increase in aeroplane performance is very convincing. The speed has increased from 31 m.p.h. to 469 m.p.h., the engine power has increased from 12 h.p. to 3,000 h.p.; and the loading of 1½ lb. per square foot has increased to 20, 30, 40, lb. per square foot in modern times. Besides the change in external characteristics, there have been internal changes, *viz.*, improvements in the materials of construction, and discoveries of new materials. As a matter of fact, this factor of "material" goes a great way towards the "growth in altitude" and "range of flight". Now a days dural is the best material, but, if some improved reinforced plastic could replace it, the manufacturer who is skilful in the art would have to face an easy job.

As regards maximum speed, speeds of 500 m.p.h. may be attained, a speed of 600 m.p.h., which is some 80 per cent of the speed of sound, cannot be exceeded, inasmuch as the drag rises to a "level far ahead of any prospective engine improvements. Although nothing in the physiology of man forbids even higher speeds, as witness the high orbital speed of the earth* on which we all live with some measure of tempered comfort, there is soon imposed a physiological limit if high speed is combined with

rapid manoeuvre. If the latter is required then the speed must be controlled to suit the conditions."

Progress also depends not only on the skill of the engine designer and the metallurgist, but on the industrial chemist, for much depends upon fuels—for their ability to resist detonation when they are used in engines of very high compression ratio. Since engines of today run safely at very higher speeds than of yore, the pusher airscrews, when they will become common, will afford a means of substantially diminishing the wing drag.

Referring to the great advance in quality of the flying boats, Mr Wimperis observed that the fine fleet of Empire flying-boats is made up of 20-ton units; the new Short 'Golden Hind' class for the Atlantic weigh 33 tons apiece; the Boeing 'Yankee Clipper' has a total weight of nearly 40 tons; the Dornier Dox has a weightage of 50 tons. There has also been remarkable improvement in carrying capacity, *e.g.*, the Boeing Boat has a total load of 40,000 lb., including 4,000 gallons of fuel and the 'Golden Hind' has an equal amount of load. It is designed for a big range of 3400 miles without refuelling!

But the science of aeronautics has to tackle many things as yet. A quite fascinating problem for investigation is the change in the air flow over a wing surface from the laminar to the turbulent state. If the flow could be kept laminar the drag would be reduced. A step in the right direction has been taken at the Langley Field Laboratories by means of some wind tunnel tests in which a special form of aerofoil gave a drag co-efficient of about one-third than usual. Other problems relate to (i) adjustable wing areas during flight by telescopic or other means, (ii) increase in the control forces required of the pilot in large machines of high speed capacity, (iii) variable pitch airscrews, in relation to the landing run, (iv) advantages at high air speeds of two-speed gear boxes, (v) pressure cabins, (vi) rotating wings which are advantageous in "take-off" and "landing".

The lecturer then drew attention to the future of flying in respect of speed, range and size. Since

military craft will be ever in progress, it seems that speeds between 500 and 600 m.p.h. will become usual; but for the Civil Air Services, there is good economic reason for speeds to settle down in the 200-300 range; as, in the latter case, "quiet, comfort and cost" will count much. For civil work the advantage of long-range flying and ability to fly by night cannot be over-estimated, and such work is rapidly progressing. Radio-services are improving and the "vagaries of the ionosphere" are becoming more and more intelligible. Size depends mainly on engine power. With tractor and pusher airscrews in tandem, six such pairs may be the practical limit and 12 engines will be necessary, so that the total power will be 36,000 if 3,000 h.p. is needed for each engine. It is estimated that a total flying weight of 250 tons will be available, and the craft, in that case, can carry 200 passengers or more.

The discovery of the art of flight has raised terrible problems, but it does seem that mankind

is beginning to see way out of the morass. The universal growth of armament is one of the most outstanding pre-occupations of our times. When a politically-minded person talks about 'parity in the air,' he probably means equality in offensive force. The right way to arrive at a proper balance of air armaments is to seek reasonable parity in respect of bombing aircraft, and leaves every one free to build as many defensive aircraft as they care to afford. Mr Wimperis however finds no reason why there should not be an agreed limitation in respect of numbers or tonnage of bombing aircraft—leaving the interceptor fighters entirely aside. Civil types would by reason of their low speed (high speeds will not pay: dangerous for passengers, more noisy and need wasteful forms of air ports) be incapable of acting as fighters and would be speedily shot down if they tried to act as bombers.

D. B.

Educational Science

Education for Industry

—A. P. M. Fleming.

The amenities of modern life have mostly been rendered possible through the utilisation of scientific knowledge. The various natural resources have been turned into forms suitable for use by the community. This transformation process which is termed industry usually includes many stages. The fundamental need of industry is that each of this chain of processes should be put through with the minimum possible wastage. Scientific discoveries have generally an important bearing on technical development, and industrial units undergo in size as well as in type of organisation as a consequence of evolution of industrial processes. The personnel of industry must therefore be always alert to apply new knowledge and should be able to adapt itself to the changes in the processes of manufacture and organisation. This is essential for continued efficiency of production; and if the articles can be manufactured at home efficiently *i.e.*, more cheaply, it is evident that there will be more employment and more money at home for further circulation and use.

The effective training of industrial personnel is therefore a problem of national importance as affecting the welfare of the nation and not only the people engaged in industries.

There are at present in Great Britain four main classes of entrants into industry:—

- (a) those who come from the post primary schools of various kinds including central schools and junior technical schools, at school leaving age,
- (b) those from secondary schools who have attained the school certificate (roughly corresponding to the standard of matriculation or admission to universities)
- (c) those who have had university training, and
- (d) adults at various ages and educational levels.

(a) Industrial workers of this group show best results when they have had some training for industry, as in the courses giving industrial bias

* It is to be noted that the earth's orbital speed is roughly 19 miles/sec., or, 68,400 m. p. h.

in the final years of Junior Technical Schools. Very few entrants from Junior Technical Schools lag behind as mere artisans as is the case with other entrants at school leaving age. For those who wish to enter industry as artisans, there should therefore be facilities for training in craft and a planned course leading to a national certificate. Sufficient technical training should be provided for those who aspire to higher jobs later on.

(b) The entrants of this group have the advantage of a preliminary science preparation and this helps them in acquiring the necessary technical knowledge of industrial processes. The higher level of general education also is of use to them in maturing their powers of judgement and thereby fitting them better for staff positions.

(c) There are very few mis-fits in this group. The entrants already possess a considerable amount of the necessary knowledge of the technological and fundamental principles. A high degree of specialisation is not however desirable at this stage. It may more advantageously be provided by the concern itself a year or two after entry.

The problem of finding suitable personnel for management is more serious. It is essential for such recruitment that the selected men should be given preliminary and widely applied responsibility before imparting formal training in such work. Recruitment for research work in industry is another difficult matter. In both cases opportunities must be offered to selected persons to bring out their latent capacity.

New scientific knowledge with its technical application tends to reduce the amount of labour required for production. But the resulting unemployment tends to be counter-balanced by the opening up of new lines of production and consumption. An example in point is the recent phenomenal growth of the film and radio industries. Mechanisation and standardisation of the processes enables the securing of necessary production with shorter hours of work. Hence it should be possible to provide better educational facilities of a cultural type for the industrial worker than is now available in part-time day or evening schools. In the authoritarian countries, education for industry is planned and organised more efficiently than in Great Britain. This inferiority is undesirable and should be removed. Under present condi-

tions this weakness can be remedied only by more complete voluntary co-operation within industry. An effective way of stimulating this might be by the remission of income-tax on the money spent on such training. One method of such training which has been widely used in Germany and to a less extent in other countries, with success, is the establishment of separate "nursery" workshops in industrial firms. Such workshops are now in existence in a few industrial organisations in Great Britain.

A problem of a different type has arisen in education for industry owing to the establishment of largescale research stations by industrial concerns. Many scientists, who previously went to universities to teach in those faculties which have a technological bearing, now join the technical staff of industrial concerns. The result is a shortage of personnel available for teaching in those faculties. This difficulty again can be surmounted by co-operation between industries and the teaching bodies. The technical knowledge and experience of eminent technologists in industry might be utilised with advantage by co-opting such men to the teaching staff of universities and technical colleges for special courses on specific technical subjects. The success of the post-advanced courses in Lancashire by experts in industry on the lines noted above indicate that this type of arrangement will prove to be the correct solution to the problem.

Greater co-operation than at present exists between education and industry is also essential to ensure that the completion of industrial training will lead to a start in the chosen career. This is at present a matter of chance to some extent and entails waste. In order to eliminate this weakness in organisation, changes will be necessary in the syllabuses of workshops and technical studies appropriate to the different educational levels of entrance to industry.

It should not however be overlooked that any attempts to improve methods of education in general will be helpful to industrial training. Men and women who have been trained to think for themselves and not merely to assimilate technical facts, are bound to develop valuable habits of constructive criticism and be the more ready to utilise and develop new ideas. It cannot therefore be emphasised too strongly that the education of those engaged in industry should be characterised by broad aims and linked up with the world outside. K. P. C.

SCIENCE AND CULTURE

 NOVEMBER 1939

 VOL. V NO. 5

A Monthly Journal of Natural and Cultural Sciences

The War Comes

AFTER 25 years war has broken out again in Europe. It is true that there have been within this period many minor wars and incidents, but the present one is of a quite different magnitude because it tends to develop into a world conflagration threatening to consume many of the achievements of civilisation, which are results of hundreds of years of patient and co-operative work.

At this juncture, the foremost question which crops up before every country is that of defence and security. These subjects are in the keeping of the Governments; outsiders have very little chance of prying into their secrets; the public, like Plato's cavemen, have to satisfy themselves with whatever inferences they can draw from the shadows and murmurs of passing events.

But no less important than the problems of security and defence is the task of continuance of the tenor of human life for millions of civil population who are not engaged in actual warfare in this country and in every other country. In ancient times, wars did not affect much the life of the peasants and the village dwellers. It is said that they used to carry on their peaceful occupations, while the rival armies might be exterminating each other close by. After the war, the civil population used to transfer their allegiance from the vanquished to the victor. But the wars of modern times, particularly those which tend to develop into world wars, do not spare even the remotest villages of the least advanced countries.

City life in the advanced countries is, of course, the first to be affected, but gradually everywhere the whole machinery of civil life tends to come to a standstill.

The Lessons of the Last Great War

The lessons of the last War provide a pointer to what may be in store for us, the people of India, in course of the present struggle; specially if the expectation that the present war will continue for three years comes unfortunately to be true. It may be recalled that during the last War, prices of all commodities gradually soared up and the supply of many essentials of life, for which India depended on foreign countries, was very much disturbed. The price of textiles, one of the fundamental necessities of human life, soared up so high that many people in the villages could not buy new pieces of *Dhoti* for years. If the present war also continues for three years, as is expected, cloth supply may not be affected, because within the last 25 years India has forged ahead in this line but even of this we are not quite sure, if Japan swells the rank of belligerents. Textiles, however, are but one of the essentials. The war threatens to cut off the supply of other commodities no less essential *e.g.*, machineries, chemicals and metals necessary for many manufacturing processes, for locomotives and other transport materials, for telegraphic and telephonic and radio goods, for papers, scientific instruments, glass apparatus etc. Many of the manufacturing concerns of the country may have to close down on account of lack of supply of essential materials and apparatus.

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The Government of India takes a Resolution

During the Great War, this situation became so acute that the Government of India was forced to address the Secretary of State as follows:

'After the War India will consider herself entitled to demand the utmost help which our Government can afford, to enable her to take her place, as far as circumstances permit, as a manufacturing country.'

The motive behind the resolution was clearly to secure for India autarchy in all essential industrial commodities and on paper it was accepted by the Secretary of State for India. Though nearly 20 years have passed, the amount of autarchy achieved has been negligible. For details the reader may be referred to an article 'Technical Assistance to Indian Industries by the Government of India' in *SCIENCE AND CULTURE*,* which describes in detail how in spite of successive Commissions, Committees, Advisory Councils and new Departments of Governments practically nothing has been done to substantially establish industrial autarchy for India.

Lessons of the Great War on other Countries

But how different was the reaction of other countries to the last War, the effect of which was felt not only by India, but by all the belligerent as well as non-belligerent countries. It revealed for the first time the extreme amount of dependence of different countries upon each other for even the most essential commodities of life. This condition was the result of the Industrial Revolution and the principle of Free Trade, which was its necessary corollary. It is admitted that Germany was forced to her knees not so much by allied victories on the field, as by the naval blockade which deprived her of many of the essential materials required for the manufacture of armaments and cut down her food supply. On account of the unrestricted submarine warfare, England too was at one stage in danger of being starved to submission. Even neutral countries did not escape the effects of general chaos. Countries like Switzerland, and Sweden prior to the War depended for their fuel and power supply mostly on imported coal either from England or from Germany. During the War both these supplies were either totally cut off or seriously interrupted, and the people had to bear great hardships. In Sweden the interference with the import of food-stuffs and green vegetables was very keenly felt.

*See page 147 of the September, 1938 issue.

Attempt at Industrial Autarchy in other Countries

Almost all the countries without exception after the War began to think of autarchy or self-sufficiency in the production and supply of materials essential for human life, as well as for those commodities necessary for defence and offence. In other words, the tendency was to return to pre-Industrial Revolution system of economics. But this was rendered extremely difficult as the requirements of modern civilisation were much more multifarious than in any previous century. Planning for a new economic system became the order of the day. The amount of success achieved by different countries has been variable, but in most European countries so much progress has been made towards autarchy that it is expected that the present war, even if it develops into a world conflagration, will not affect many countries as disastrously as it did on the last occasion. We may review in brief the result of all this progress, taking a few typical cases.

Development of Power Supply

One of the foremost requisites for the industries of a country is cheap and abundant supply of power. Now, most of the countries, as a result of the lessons of the last Great War, made a great effort to develop all their power resources and make themselves independent of all foreign supply or at least reducing the dependence on foreign imported materials to the minimum. This movement gave a great impetus to hydro-electric developments in Europe, particularly in those countries which have no supply of coal. To take few examples: the Swedish Government organised a Royal Water Power Board which has developed within the last 25 years the hydro-electric power resources to such an extent that the country is now entirely independent of supplies of foreign coal, and every Swedish citizen gets on an average nearly 1500 units of energy, which is nearly 20 times the yield per person, for countries like India which are dependent mainly upon human and animal labour. Similar efforts at power autarchy have been made by Switzerland and Italy with conspicuous success. Even countries which were already well developed, did not lag behind. Electricity production in England by means of persistent effort has been raised by 13,000 million units of power in course of last twelve years since 1926 and in Germany it has been raised by 15,000 million units (the figures are in round numbers). It is only in the countries which were too much distracted by civil war or threatened from outside that the development has not been so striking. Poland is an example.

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But the greatest effort was made by Russia which, as a result of successive Five Year Plans developed its electrical power from about 1,500 million units to about 45,000 millions i.e., nearly 30 times the pre-War amount.

These examples are being cited because the production of power is an index to the whole industrial and agricultural production of a country. If a country today consumes ten times more power, it may be taken as a sure index that her industrial output is about ten times larger. In Sweden, for example, the development of power led to the electrification of half of her railways, opening of tramway services, the development of her forest and metallurgical industries and widespread application of electrical power to agricultural and other rural purposes.

Problems of Food Supply

Most of the countries concentrated their efforts on the materials which they lacked. For example, Sweden, which was hard hit on account of lack of foodstuff, particularly wheat, began to devise methods of more intensive production of this staple foodstuff. As we mentioned on a previous occasion,* she mobilised her scientific men and developed new varieties of wheat which can be acclimatized and grown on Swedish soil. As a result of these efforts, Sweden has made herself very nearly independent of imported wheat.

The food problem was also very keenly felt in England, but here the activities of the Government took a different direction. It was recognised after some vain efforts that it was not possible to interest a larger number of Englishmen in agricultural pursuits. So the British Government directed all its attention to the perfection of methods of good conveyance and food storage. As a result of these efforts, a method of refrigerated gas storage has been developed by British scientists which enables fruits, vegetables and cereals to be stored for over a year in fresh condition. Huge stores of food have been created and it is expected that as a result of these efforts, England has stored sufficient food to last for over a year, even if her food supply is entirely cut off.

Development of 'Ersatz' or Substitution Industries in Germany

Germany, which was brought to her knees on account of cutting off of the supply of many of the

*SCIENCE AND CULTURE, 4, 669, 1939.

essential materials for industry, as for example, rubber, petroleum and metals like copper, nickel and tungsten, has turned her attention to the manufacture of synthetic substitution products. The result has been the production of artificial rubbers of many types, the development of the Bergius and Fischer-Tropsch processes of conversion of coal into petrol and perfection of many substitution industries.

Russia becomes a Leading Industrial Country

But the largest amount of development has been witnessed in Russia which before the War was more Asiatic than European. It was like the present-day India, a country of villages and farmers ruled by landlords, princes and officials. But the country had vast possibilities both agricultural and industrial. In spite of these, the Czarist Government, instead of devoting its attention to the development of the country's resources, used to get itself involved in imperialistic ambitions abroad. One of the main achievements of the new Government of Russia has been a thoroughgoing industrialisation of the country leading to the development of her land and mines and production of all essential materials in the country by its own experts.

Industrial Research Precedes all Industrial Policies

The above short review is made just to demonstrate how the lessons of the last War were taken seriously by all governments. They mobilised fully their available scientific and industrial talents to devise plans for development and to give effect to them. The effort of the State in forcing up production was preceded by industrial research, liberally backed up by the State. The *Encyclopaedia Britannica* for 1938 gives under the heading Industrial Research, a summary of the activities of different countries, and we choose only two examples, Germany and England for the year 1937.

GERMANY.

All industrial research positions under the German Ministry of Education are unified; the Reich Research Council, which plans all investigations, now has jurisdiction over about 1,000 research organisations. Plastics, rubber, textiles, fats, cellulose, and metals are receiving main attention. German research was especially active during 1937 in the fields of alloys, synthetic resins and rubber, tanning materials, and art goods. Calcium chloride and sodium silicate were tried for reinforcing shifting sands and other loose formations under building foundations. German engineers were energetic in promoting unworked iron ores. Word came of a new process for rapid saponification; the 'Igepals' are new

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detergents of German origin; a German factory is making soap from fat derived from coal; the solution of problems of producing fatty acids economically from petroleum is being zealously sought. German technologists introduced more refined processes in the coking industry of the Ruhr, increasing yields particularly of benzene. By one process, we are informed, about 80 per cent. of the sulphur produced in coking can be recovered. Lately Germany has turned to anthracene as a raw material for making carbon black. German chemists demonstrated that coal-tar oils can be used as fuel for diesel engines, if there are added small amounts of 'Kogasin' an intermediate product of the Fischer synthetic petrol process. A new process for the manufacture of triacetylcellulose was announced. Germany is engaged in building up a large synthetic rubber industry, based on a product termed 'Buna.' Leatherlike products from plastics were developed. A new German raw material for varnishes and plastics is cellulose acetobutyrate, and a novel German plastic is 'Astralon,' a cousin of American 'Vinylite.' A new chemical filter material and fibre ('Zellwolle') appeared, as did new developers of the pyrogallol series.

GREAT BRITAIN.

The Department of Scientific and Industrial Research through the organizations working productively under its aegis, added bountifully to scientific and technological progress. The British Non-ferrous Metals Research Association reported work on the properties of lead and lead alloys in relation to important uses, published research on the effects of impurities in copper, and described the mechanical properties of magnesium alloys at elevated temperatures. The Building Research Board, active for 11 years, made substantial progress towards the solution of problems involved in the use of such constructional materials as cement, stones, plaster, and mortars. Wood preservatives were investigated broadly by the Forest Products Research Board. Advances in lubrication were considered thoroughly by the Institution of Mechanical Engineers in a symposium of 140 papers. A new liquefied petroleum gas was introduced, and the search for petroleum in Great Britain was continued. Further progress in low-temperature carbonization of coal and in oxidizing ethylene with air was reported. The Rothampstead Experimental Station paid much attention to insecticides and weed killers and to liming of soils. The Medical Research Council investigated the health effects of industrial solvents. The Food Investigation Board has been studying problems in the transport and storage of food, and has under

development the shipment of tropical fruits, especially conveyance under gas storage. The growth of plastics revived the manufacture of synthetic phenol, dormant since the World War. The Water Pollution Research Board worked on the use of synthetic resins for water softening. A firm announced a process whereby a woollike character can be given to rayon staple fibres, and 'Velan PF,' a new water-repellent material for textiles, was exhibited. All the varied interests of the dye consumer are covered by British specialists.

Position of India vis-a-vis the War

The above short survey shows that the outbreak of the war has found India totally unprepared not only for defence and offence, but also for the maintenance of the smooth tenor of civil life, should the war be unfortunately prolonged for three years. Already the prices have soared up and if the complications further increase, some of the essential commodities for which India depends on foreign countries may be entirely stopped. It should be borne in mind that in spite of the pious intention contained in the resolution of the Government of India, quoted on page 266 we have not developed our power resources; no steps have been taken for the manufacture of essential chemicals, metals and alloys, and commodities required for the maintenance of transport and communication services. The industries for the manufacture of scientific apparatus, glass and many other essentials are either in a backward condition or do not exist at all. It was the experience of the last War, that as it went on, the frightfulness increased, and on the present occasion as well it may not be quite a false alarm that after sometime the supply of foreign goods may be very seriously hampered.

The Government of India has shown some enthusiasm for pushing up the yield of agricultural products and they have set up an Agricultural Research Council for carrying on researches in this line. But no steps have been taken for exploiting the resource of the country for planned industrial development and for mobilising the scientific and industrial talent of the country for industrial research, which is most needed by the country. At last the country has been roused to the gravity of the problem and a non-official National Planning Committee has been formed, but without sufficient financial backing and responsible reaction of the State to its recommendations, the future may be considered very gloomy indeed.

Indian Rock Paintings-II

The Rock Painting of Kabra Pahar, Raigarh State

Lieut. Colonel D. H. Gordon

To continue my observations on the rock paintings of Raigarh State; besides the well known shelter at Singhanpur,* four new sites have been brought to light in the State, these are Kabra Pahar, Khairpur, Karmagar and Nawagarh, and of these Kabra Pahar is by far the most important. In this article I shall deal with the balance of the material from Singhanpur and Kabra Pahar which is of any importance, and which is not included in *Memoir* No. 24 of the Archaeological Survey of India.

The newly found shelter of Kabra Pahar, by reason of its proximity and of the similarity of a number of the paintings, is to be associated quite definitely with Singhanpur. This shelter is situated about ten miles south-east from Raigarh city in a ridge south of and at right angles to the B. & N. Railway. It is at the foot of a very high white cliff, from which it derives its name. The shelter is formed by the whole cliff face, which is but little weathered, being sloped out at an angle, and in this way, because of its height, forming an overhang.

The paintings in this shelter are difficult to copy, almost all of them being from ten to twenty feet above the shelter floor; this also making photography, except with the aid of a telephoto lens, quite out of the question. In most cases it is possible to see the ledges from which they were painted, but these ledges are difficult of access, for where the approach is not perpendicular, both it and the ledges are so polished as to afford little grip even for bare feet.

All the paintings are in varying shades of red and depict for the most part animals, with a few human beings here and there, and a certain amount of enigmatic designs to which it is impossible to assign any particular meaning. Taking a selection of paintings from this shelter it is possible to draw striking parallels with those of Singhanpur, and of the shelters of the Mahadeo Hills.

*SCIENCE AND CULTURE, 5, 142, 1939.

Parallels have already been drawn in my first article* between the human figures, and now in Pl. I. figures of sambhur are given from Tamia, Adamgarh Quarry Hoshangabad, Pachmarhi, and Kabra Pahar which show many points of resemblance and are all in the same colour, namely dark red. In fact, the Tamia shelter with paintings all in red, all of animals or enigmatic signs, shows the most striking similarity to that of Kabra Pahar.

There are, as is shown in Pl. 3, a number of signs and symbols to which it would be foolish to attempt to assign a meaning. The dangers are well illustrated in the secret symbols of the African Nisibidi Society in which obvious solar symbols of the type illustrated in fig. h, Pl. 3. indicate the Nisibidi house, a comb sign means men on a log, and a barred oblong means a mat. Without definite knowledge, such interpretations could have never been given to these signs. Mr. F. E. Williams in his article on Papuan Petrographs, (*J.R.A.I.*, Vol. LXI, 1931) has some pertinent remarks to make on the subject of "symbolic" abstractions drawn on rocks by primitive peoples, and his suggestion that some of the designs invested by anthropologists with ritual significance are the result of idle scribbles is worthy of very serious consideration.

A design of joined squares was pointed out to me by the Dewan of Raigarh State, who accompanied me, as being one indicated to him by Mr Amar Nath Datta as representing numerals in the Indus script. A more elaborate example, however, shows clearly the true nature of this design which proves to be a row of human figures standing hand to hand and foot to foot, the heads being omitted in the more conventionalised copy. These may be compared with a similar design from the Son Bhadra shelters in the Mahadeo Hills, the above points can be followed more easily from the figures on Pl. 2. As there are many who have a predilection for proclaiming a meaningless

*Published in the September, 1939, issue of our journal.

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scribbles as Proto-Indus scripts, I produce two such groups of symbols, (Pl. 3. figs. *a* and *g*.), these, together with other solitary symbols, some of which are reproduced now, I showed to Dr G. R. Hunter, one of the foremost authorities on the Indus script, who confirmed my suspicions that none of the designs which I had collected in any rock shelter was in any way even remotely connected with the Indus script.

A most curious item in the Kabra Pahar shelter is a design which appears to have been made by spreading paint over netting placed against the rock, thus forming a stencil, this shows as a red ground with an elaborate reticulated pattern where the white surface of the rock has remained untouched. This would have been a most intricate undertaking if produced by any other method.

Local villagers have dug up part of the floor of the shelter in the hope of finding buried treasure. On the surface of the shelter floor, which is an unpleasant powdery dust mixed with lumps of rock debris, I picked up in the very short time left at my disposal after copying a number of the paintings, thirteen flakes of sorts. They can be paralleled from the Mahadeo Hills and are of the familiar microlithic technique. As mentioned in my first article, similar flakes were found by me at Singhanpur.

It was impossible under the circumstances to obtain from Raigarh in the few hours at my disposal a selection of artifacts such as I have been able to collect in and around Pachmarhi in the course of over two years. I had to depend to a large extent on the willing but inexperienced assistance of villagers, even so the material gathered shows quite conclusively that the local stone culture is a typically microlithic one of retouched blades and crescents, small borers and graters, flake blades and points and small cores, these are of chert, chalcedony and quartz. (Pl. 5).

That the paintings from the Raigarh shelters resemble quite strongly the early series from the Mahadeo Hills cannot in view of the evidence be well denied. But on the strength of the microliths, which may themselves quite well date to the 1st century A.D., it is dangerous to attempt to force conclusions which are not borne out by the period requisite for the development of the paintings in the Mahadeo Hills from the early styles. These, as I have said, appear definitely to equate with those of Raigarh, the latest which are provisionally, but with reason, dated to the 10th or possibly the 11th century A.D. I hope in the course of my next article to make quite clear the development of the paintings which are present in such vast numbers in the rock shelters of the Mahadeo Hills.

Prehistoric Cultures and Peoples in the British Isles

At least seven or eight cultures are now recognizable, and are referable to permutations and combinations of at least half as many ethnic elements, while during the thousand years 2500-1500 B.C. these came gradually into a more or less firm pattern of combination with each other which characterizes the Middle Bronze Age. With the Late Bronze Age around 1000 B.C., there was the familiar phenomenon of successive immigrations from the continent, all usually considered Celtic, which ended only on the eve of the Roman conquest. The whole culture sequence of the

1st millennium B.C. is marked by the spread of a system of rural economy, attested not only by the plough-abriculture of the 'Celtic fields' now so well known from air photography, but by the extensive use of ditch-and-bank boundary-strips in connexion with the culture's pastoral side. The extent to which this development of settled life of the land was liable to interruption by invasion and warfare is a question calling for comparison of archaeological evidence between farm village sites and the familiar hill-forts or 'British Camps' of the British Iron Age.— *Man*.

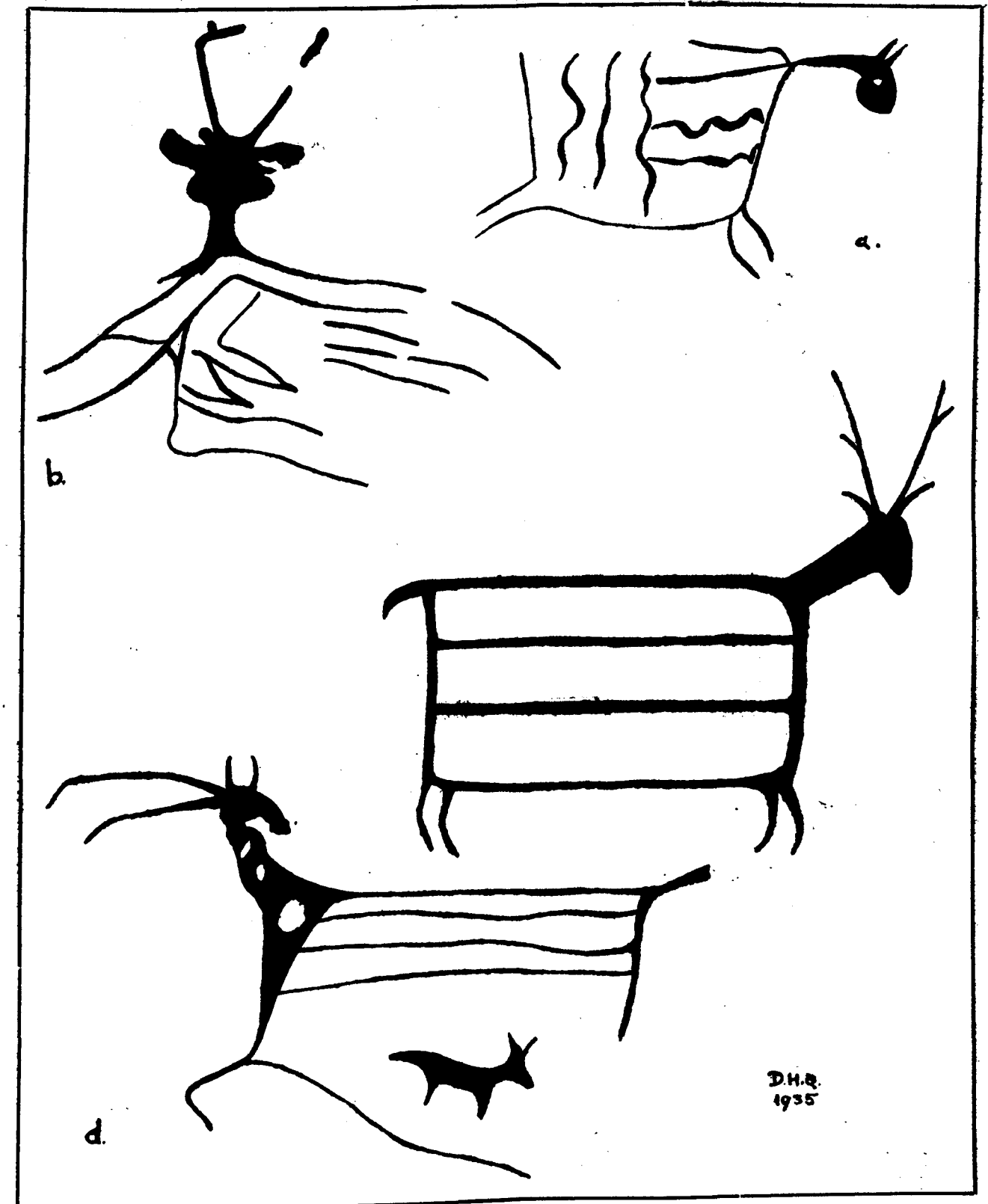


Plate 1
Sambhur figures in Dark Red from (a) Tamia. (b) Pachmarhi. (c) Adamgarh. (d) Kabra Pahar.

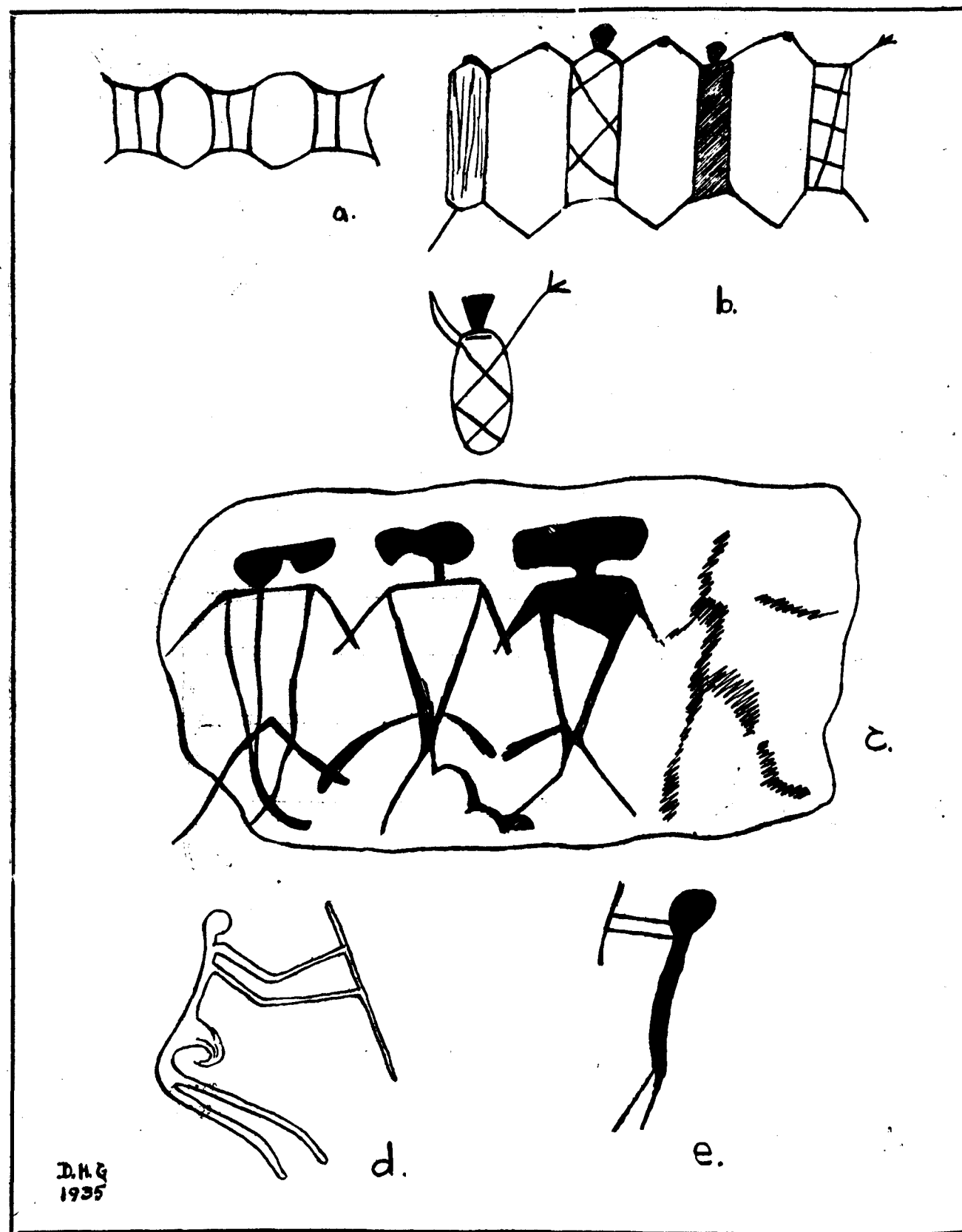


Plate 2.

(a) & (b) Kabra Pahar. (c) Son Bhadra. (d) Jambu-Duip, Pachmarhi. (e) Singhanpur.

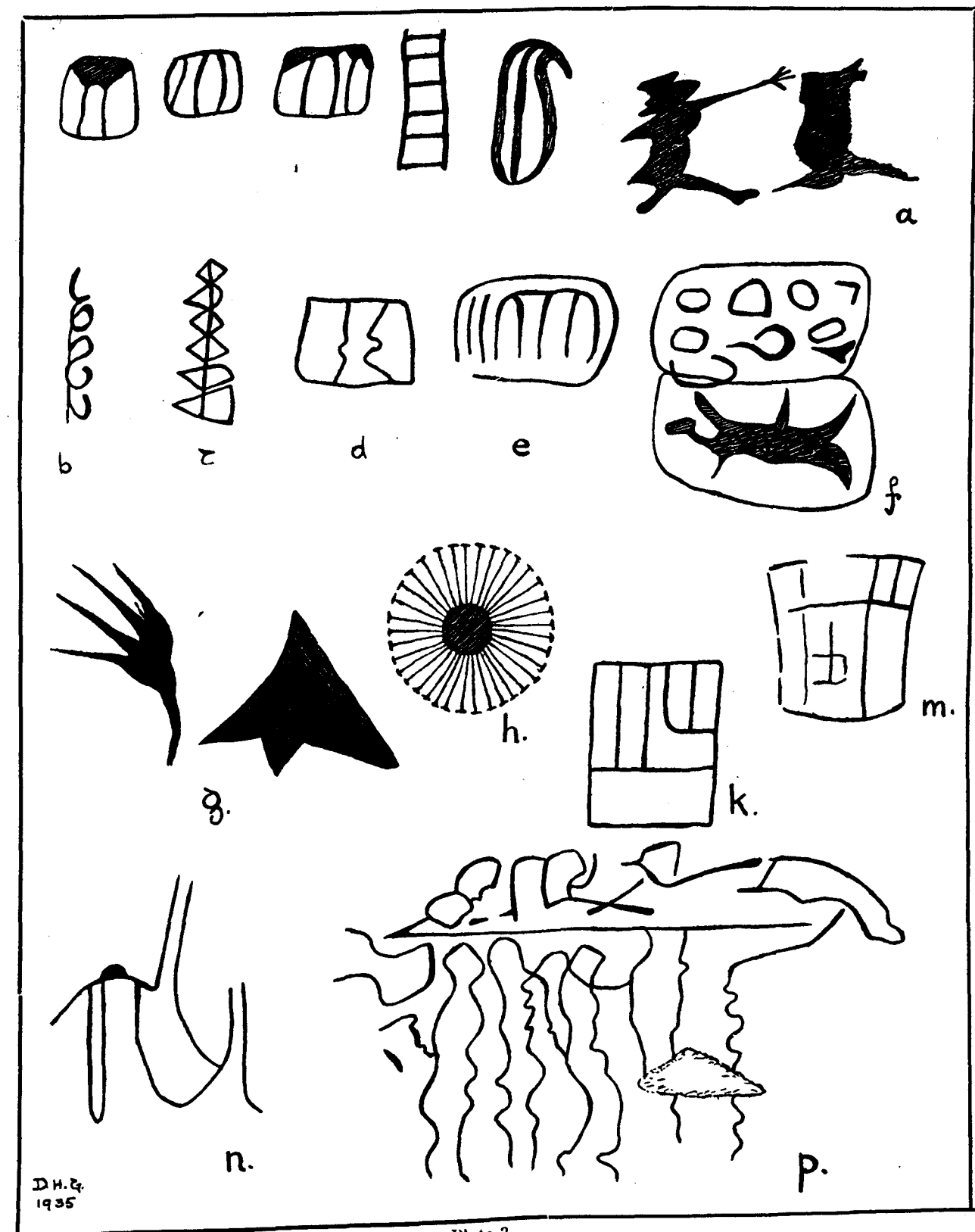


Plate 3.

(a) Adjacent signs of the type that might be used to illustrate a proto-Indus script at Son Bhadra. (b-h) Independent symbols from Kabra Pahar. (k-n) Independent symbols from Singhanpur. (p) Enigmatic pattern at Tamia to be compared with similar patterns from Singhanpur. (*Memoir No. 24. A.S.I. Plate XVI. C.5. & Plate XVII. C.8.*)

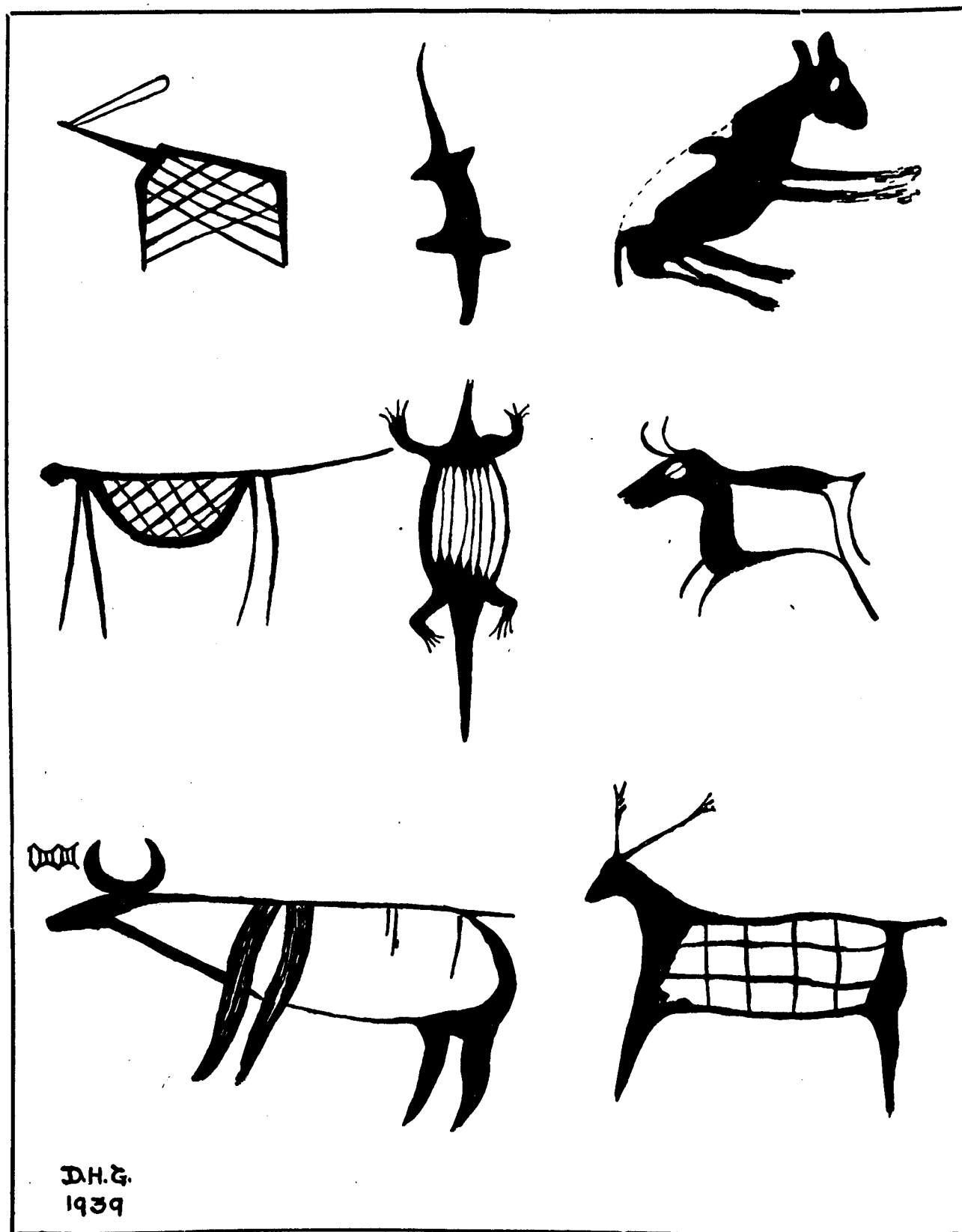


Plate 4

Top right, small horse from Singhanpur; Remainder, animal figures from Kabra Pahar.
Bottom left shows actual position of linked square d sign

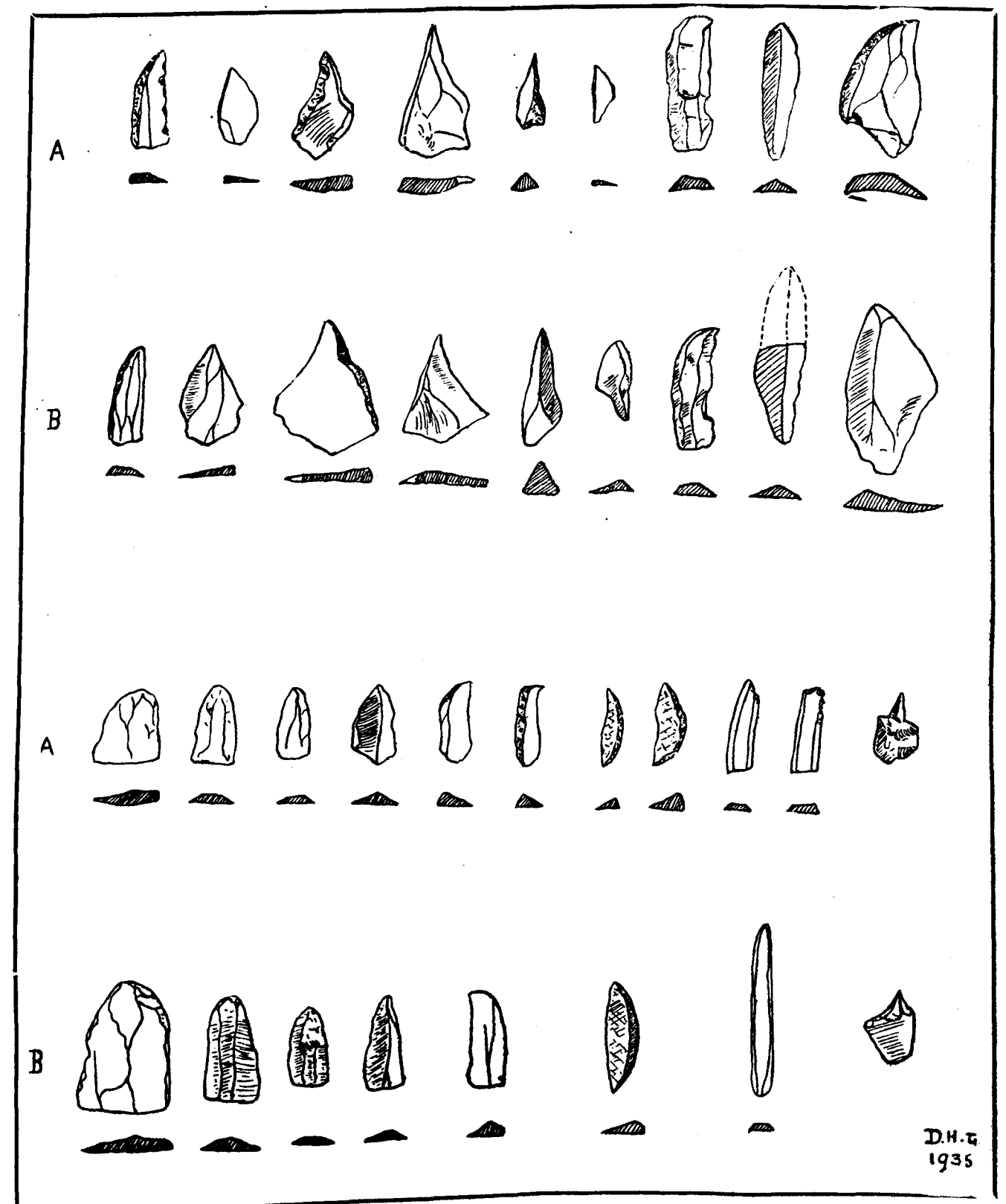


Plate 5.

Showing the similarity of Microliths from (A) Raigarh. (B) The Mahadeo Hills.

Biochemical Aspects of Lactation

Hirendra Nath Banerjee

Department of Biochemistry and Nutrition,
Bose Research Institute, Calcutta

Introduction

THE efficient functioning of the internal secretory organs of the bovine system is responsible for the production of milk, but the external factors like food which contribute to the general make-up of the bovine body are in no way less important. The quantity of milk yielded by an animal in lactation is not a single entity; it is the resultant of complex forces. It is of very great interest to the practical breeder to know what factors affect the yield and how and to what extent they do so. A knowledge of these will enable him to assess the true economic worth of his animals and to control the various factors, as far as it lies in his power, to get the maximum return from his stock. Nutritional science plays an important part in maintaining health, increasing production and decreasing cost in livestock farming. Malnutrition not only causes deficiency disease but also renders an animal more susceptible to the attacks of bacteria, protozoa and parasitic worms. Imported breeds of high fertility, rapid growth and heavy milking type are more liable to mineral deficiency because such functions require more phosphorus than the natural pastures can afford and therefore the improved breeds may die, lose type or revert to scrub. A cow yielding 1500 gallons in a lactating period will excrete 14 lbs. of lime in its milk alone, a 4 lb. hen laying 250 eggs a year will excrete over 3 lbs. of lime in the egg shell alone. Thus the modern high-producing farm animal has unnatural nutritive requirements and the ordinary farm ration is too often a mere compromise between imperfect nutritional knowledge and economic expediency. If the animal is to leave no progeny, then production dairy cows, bacon-pigs and laying hens can be safely forced to its ultimate limit by the aid of concentrated food, but where an animal is to be used for breeding, it should be fed as nearly as possible on its natural food, such as grass and milk.

Protein Requirements of the Dairy Cattle

Among the several factors which have been studied for increasing the milk-yield of cattle, consi-

derable attention has been paid to the question of food intake and its possible effect on the quality and quantity of the milk. The feed as a factor in influencing the composition of milk has also been the subject of much study.

With any mixed ration, such as is commonly given in dietary practice, 0.6 lb digestible crude protein or 0.5 digestible true protein per 1000 lbs live weight (animal) is required for maintenance, the percentage utilisation of protein varying inversely with intake. With low intake the utilisation is high but unthriftiness and malaise occur, while with high intake the percentage utilisation is low, resulting in an unnecessary economic waste. About 70 per cent is considered to be utilised under average practical feeding conditions. If 1.2 to 1.3 times the protein in the milk be supplied as digestible true protein, the maximum level which will permit the highest possible milk yield will be achieved.

For the production of milk it is essential to supply to the food those amino acids found in the milk protein, which cannot be synthesised in the animal body. Proteins in the form of spring grass, silage from summer grass, low temperature dried blood meal and pea-meal resemble milk protein in their content of amino acids more closely than do linseed cake, decorticated earth nut cake, maize or oats. For maximum milk production 0.5 digestible true protein is required per 10 lbs of milk, but with proteins of high biological value, which supply all the essential amino acids in the proper proportions for milk production, the amount does not exceed 0.44 lb digestible crude protein per 10 lbs. of milk. Non-protein nitrogenous food cannot replace any part of the protein in the food.

Mineral Requirements of Cattle

The nature of the feed exerts a good deal of influence on the assimilability of the minerals supplied with the feed. It is not the presence of a mineral in a particular feed but the form in which it is present in that particular feed that is a deciding factor. It has

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also been found that the proportion of the different minerals in the ration (their ratio to each other) is also of great importance for the maintenance of a proper balance within the system.

Orr has proved that the ratio of sodium to potassium affects the assimilation of both calcium and phosphorus. Godden, Richard and Husband have shown that an excess of phosphorus in the ration, while phorus. Godden, Richard and Husband have shown that an excess of phosphorus in the ration, while temporarily depleting the sodium, has its main effect on the nitrogen, calcium and phosphorus balances; a high ratio of potassium to sodium tends to lower the assimilation of these constituents, whereas when the sodium is in excess, the assimilation is raised. This may be the explanation of the beneficial results of feeding sodium chloride (common salt) to stock. Armsby is of opinion that rachitogenic feeds (faulty foods which produce ricket) usually show a misproportion of potassium to sodium.

Results of experiments carried out at Dacca, conforming as far as possible to the type of feeding used in Bengal, show that under the condition of paddy straw feeding the lime requirement is 24 grams, phosphoric acid 10 grams, magnesia 15 grams, potash 70 grams, and sodium chloride 32 grams per 500 lbs live weight. Attention should be concentrated upon the absolute intake of calcium and phosphorus per day except where the imbalance is very wide. In that case preponderance of one over the other becomes so great that the liberal physiological mechanism for preservation of neutrality of the tissues are strained. Although there is a minimum requirement of mineral for the animals, the criterion for this minimum is not always a phase indicated by the absolute minimum need of the animal, but is a condition mostly regulated by the nature of the feed, so that with different feeds this minimum is likely to vary.

Vitamin Requirements

In India the main feed of the dairy cattle consists generally of a roughage and a concentrate generally composed of grains and oil-cakes.

It is from the roughage that the main supply of vitamins are derived. If an animal is given green feed as a major portion of its roughage, the vitamin supply may be fairly assured. But it may not be possible under practical conditions of farming to provide such natural feed throughout the year, so that

they have to depend on preserved fodder for a considerable period. Cow's milk is a rich source of most of the vitamins, so that deficiency of vitamins in the feed is ultimately reflected in the milk and thereby on the health of the future generation. Colonel Sir Arthur Oliver in his presidential address at the Medical and Veterinary Research Section of the Indian Science Congress in 1937 very aptly described in detail how this aspect of the problem is intimately connected with the public health problems in India.

In connection with experiments on animal nutrition carried out in the laboratory of the Bose Institute, nearly 200 samples of milk from various dairies in and out of the city of Calcutta have been examined. A few of the results are tabulated below. These will indicate that the vitamin C content of the Calcutta cows' milks is much below that reported on European cows.

	Calcutta Dairy Average of 20 Buffaloes	Calcutta Dairy Average of 20 Cows	Average of 20 stray cows from village	Average of 20 Goats	Reported by Z. Markuze on Warsaw cows	Reported by Shin- field workers
	No. 1	No. 2				
Milligram of vitamin C. per 100 cc. milk ...	0.56	0.995	1.85	2.56	2.18-2.12	2.38

It is interesting to find that milk of cows living out of Calcutta is richer in respect of vitamin C than that of the city cows, although the city cows look more healthy. The only explanation is that the village cows live on fresh green pasture, whereas the urban animals live practically on dry paddy straw as roughage with rich concentrates.

The plasma content of vitamin C of the city cows has also been found to be definitely lower than that of the village cows. Calcutta goat's milk have been found to be superior to Calcutta cow's milk and Calcutta cow's milk is again superior to Calcutta buffalo's milk in this respect. The defects of the milks can be easily corrected by a liberal use of green fodder as is indicated by the results obtained.

Cross Breeding for Milk Yield

It is well known that crossbreeding and selection can improve a stock. The western breeds have been found to excel the indigenous cattle in milk yield. Numerous attempts have therefore been made in India

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to combine the milk yield of the western dairy cattle with the hardiness and adaptability to local conditions of Indian breeds. Hutchinson and Joshi have recommended a *breeding method* adopted with great success in North America, South America, South Africa and elsewhere. It is the well-known method of back crossing and selection, or what may popularly be called as breeding back to the indigenous type. How far this method conforms to our requirements can only be said after the method has received suitable trial in this country.

Physiology of Mammary Activity

In the foregoing passages a brief account has been given of the factors which indirectly influence the character of milk secretion from the bovine udder. Let us now come to the more direct aspect of lactation. Our knowledge of lactation is rather rudimentary. More is to be known about the functional histology of mammary gland, the functions of its smooth muscles, its lymph drainage, the enzyme mechanism in the secretory cells and the sequence of chemical changes taking place in these cells. Nothing practically is known about the energy requirements of such secretion.

Like all other organs of the animal system, the function of the mammary gland is entirely dependent on its blood supply. All materials out of which the specific milk constituents are to be made must be transported to it by the blood stream. Efficient secretion of milk depends in part on the direct control of the secretory cells by hormones and to a considerable extent on the maintenance of a constant supply to those cells of the specific raw materials from without, both for milk production and for tissue maintenance. Researches of Gomez and Turner prove that the lactogenic hormone exerts a direct influence upon the lobule epithelium of the mammary gland thereby initiating the secretory function, and by continued stimulation maintains the activity of the secretory cells, provided the precursors of milk are sufficient. These two aspects of mammary secretion namely (i) hormonal control of the gland and (ii) supply of raw materials to it, are closely interlinked: progress in our knowledge of the one depends on, and is assisted by, well-established findings as regards the other.

The Endocrine System

We all know that animal activities are regulated by a system of communication, which is centred in

the brain and the spinal cord, analogous to the telephonic net work that helps to correlate and unify the activities of society. This system, the nervous system, transmits an impulse of unknown nature, comparable to the electrical impulse that passes along the telephone wire, arising at a point of stimulation to some organ which it sets in action. The organs known as endocrines, ductless glands or glands of internal secretion (which is another regulatory system in the animal body), transmit definite chemical substances, called hormones, by way of the blood system, arising in these special organs known as endocrine glands and producing marked effects on more or less distant parts of the body. The chief endocrine organs are (i) the epiphysis or pineal gland located in the upper and back part of the brain (ii) the hypo-physis or pituitary gland resting in a small cavity of the skull beneath the brain (iii) the thyroid gland located at the base of the neck in front (iv) the parathyroid glands attached to the back of thyroid (v) the thymus gland lying below the thyroid in front of the heart (vi) the adrenal or suprarenal glands attached to the upper end of each kidney (vii) the island of Langerhans in the pancreas (viii) the placenta (ix) the gonads or sex glands such as the testes in the male and the ovaries in the female. It has long been suspected that hormones of the pituitary gland are concerned with the initiation and control of mammary function. The secretion of the thyroid, the gonads and the suprarenal, which are controlled by the pituitary gland have also been found to be concerned with efficient lactation.

Development of the Mammary Gland

Lactation normally follows parturition, but the young mammary gland, both before and during pregnancy, undergoes a lengthy process of preparation before milk production is possible.

The udder and testes of a female calf slowly increase in size as the calf grows up. This increase in size is very rapid at puberty with the onset of ovarian function, and is influenced by the hormones now secreted by the ovary. In the virgin heifer, each ovarian cycle leads to a small increase in the size of the udder and the repeated ovarian cycles produce a cumulative effect. The duct system, in which milk will be stored after secretion and through which it will eventually be drained towards the teats, gradually increases in size and complexity. This is associated with the secretion of "oestrone" by the ovary. The milk secretory cells however still remain in the quiescent state.

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Recent researches of Gomez and Turner have proved that the effect of oestrone on mammary development takes place as a result not of the direct stimulation of the mammary gland, but indirectly by the production, under the influence of oestrone, of a specific mammary-gland-growth stimulating hormone by the pituitary. Maximum development of the udder takes place during the months of pregnancy. This development is due largely to the joint effect of the oestrogenic hormone of the ovary and the placenta and of the hormone secreted by the corpus luteum.

Onset of Milk Secretion

In the later stage of pregnancy the mammary glands are so well developed that milk secretion could readily take place. But lactation is absent till after parturition, when, after a rapid onset, it becomes firmly established. In order to explain why the beginning of lactation coincides with parturition, Nelson supposes that the ovarian hormones which are known to be present in relatively high concentration in the blood during pregnancy inhibit lactation, (a) by arresting the production of hormone called "prolactin" by the anterior lobe of the pituitary, which is solely responsible for the initiation and maintenance of lactation in developed mammary glands, and (b) by a direct inhibitory influence on the mammary gland. With the fall in the level of the ovarian hormones in the blood which occurs at parturition, the inhibitory influences are removed and milk secretion begins.

Hormones of Lactation

Riddle was the first to show that relatively purified anterior pituitary extracts retain their lactogenic powers when administered to animals suitably prepared beforehand. This lactogenically active material was called "prolactin." It was subsequently shown by Gomez and Turner that the purified lactogenic hormone "prolactin" could not re-establish lactation in animals from which the pituitary gland had been removed during full lactation, whereas the mammary glands of two similar animals which were given daily a dose of ground, aqueous suspension of fresh pituitary gland remained functional. Thus it is well established that purified "prolactin" has no true lactogenic activity and that a fraction from the pituitary is strongly lactogenic. Crude extracts of the anterior pituitary gland possess many hormonal activities, some of which by suitable methods may be separated by fractionating the crude extracts. Probably no single specific lactation hormone is

responsible for the lactogenic activity. The action is probably synergistic.

Influence of the Thyroid Hormone

Thus normal milk secretion depends largely on the presence of an intact pituitary gland. It also depends on the adequate functioning of the thyroid gland. It is known that the thyrotropic hormone secreted by the pituitary gland increases the size of the thyroid gland in immature animals and increased thyroid activity means enhanced metabolic rate of the body. The pituitary glands from actively lactating dairy cows have been found to contain rather more of the thyrotropic hormone than the corresponding glands of dry cows or of beef cows. When a cow in declining lactation was given either desiccated thyroid tissue to eat, or was injected with synthetic thyroxine (thyroid hormone), lactation was raised to a higher plane of efficiency, and the increase in volume and quality of the milk was maintained so long as the thyroxine treatment was continued. The arterial blood sugar level which appears to be correlated, even in the normal animal, with milk yield, is raised by thyroxine treatment. Persistency of milk secretion is due at least in large part, to the maintenance of the secretion of the thyrotropic, or thyrotropic plus lactogenic hormones by the pituitary. Where naturally persistency of secretion is poor, the response to administered pituitary hormone or to thyroxine treatment has been found to be effective.

Action of Oestrogenic Hormones

As mentioned before, it is the oestrogenic hormones which keep in check the onset of milk flow from the mammary gland even when it is fully developed during the later stages of pregnancy. But when oestrone is administered to the actively lactating cow, it is found that oestrone diminishes the volume of milk of the cow. At the same time, however, it improves the compositional quality of the milk. The percentage of fat and also of non-fatty solids increases and there is also an increase in the lactose content. There is also a sudden rise in milk phosphatase, which is an enzyme having an important function in the metabolism of bone formation. This method may be utilised under suitable conditions to improve the nutritional quality of milk secreted by a cow.

Precursors of Milk

Good deal of researches have been done in various European countries to determine the chemical nature of the materials from the blood stream that are used by the mammary gland, and to explain how

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these materials from the blood are converted into specific milk constituents in the secretory cells. In order to establish the identity of the milk precursors from the blood of the cow, the following technique was adopted. The composition of blood entering the mammary gland was first determined and then the composition of the blood leaving the mammary gland. From the deficiency of certain constituents in the outgoing blood we can easily determine which particular substance or substances have been retained by the mammary gland for the purpose of milk production.

From the method described above it has been found that about 20% of the arterial blood sugar is retained by the active mammary gland. This sugar plays a dual function in the gland. A part of it is directly converted into lactose or milk sugar and a part is utilised for supplying the energy requirements of the gland. The level of glucose in the blood has a controlling influence on milk secretion. It has actually been found that the diminution of the blood sugar level by insulin or by starvation is accompanied by a fall both in the total quantity of milk secreted and the quantity and percentage of lactose present in the milk. In order to maintain the actively lactating animal in its peak in respect of milk secretion, a large porportion of the total blood volume must pass through the mammary gland every minute. To maintain this steady level of arterial blood sugar, the liver or other organs responsible for this maintenance will have to suffer a good deal of exertion.

Milk fat or butter fat is a characteristic component of the cow's milk. The fat can be derived from the components of its blood in several ways, either directly from the fatty constituents of blood itself or by chemical interaction of different components contained in blood. It has been shown by Maynard and collaborators that there is a drop in neutral fat in the blood as it traverses the udder of the lactating cow. It is possible therefore that the milk fat is derived directly from the neutral fat contained in the blood.

The mechanism of the synthesis of caseinogen, the characteristic protein (containing large proportion of phosphorus) of milk, is still somewhat uncertain. The most careful analysis of arterial (incoming) and mammary venous (out going from the mammary gland) blood show that inorganic phosphorus fraction

of blood diminishes when the blood traverses the mammary gland. Recent researches by the use of radio-active phosphorus has also confirmed that not only caseinogen phosphorus but also those of the phosphoric esters are derived from the free inorganic phosphate of blood.

Conclusion

The modern dairy cow is a highly specialised animal for milk production. What immense strain the modern high-yielding dairy stock has to undergo can be gauged from what has been detailed above. A very simple calculation can give us a quantitative idea of the whole picture.

Suppose X milligrams of the blood precursors of a milk constituent disappear from one lb of blood in passing through the mammary gland, and Y milligrams of the product are present in one lb of the milk produced. Assuming that all the precursors disappearing from blood are synthesised into the milk constituent without loss, then the amount of blood required to circulate through the mammary gland to produce one lb of milk must be approximately $\frac{Y}{X}$. Calculating in this way, we find that 400 litres of blood circulate through the udder for each litre of milk secreted. The abdominal subcutaneous veins, along which the main venous drainage of the udder is effected in a good cow are characteristically large, and in fact the size of the "milk well" (the aperture in the body wall through which the milk vein goes) is naturally used in the cattle market as a guide to milk producing capacity or potentiality. This indicates that the udder of an average cow in full lactation takes about one quarter of the heart's output of arterial blood. Now imagine the strain of good modern cow producing 2000 gallons of milk over a period of ten or more months, during a large part of which time she will be in calf and will therefore have to provide also for the not inconsiderable demands of the growing foetus.

It is therefore in the fitness of things that animal nutrition has received so much attention from the scientists all over the world. In India also researches along the lines as indicated above, with a view to improving the present Indian domestic cattle, may be forthcoming which will enable us to develop our deficient dairy practice. India is in need of such development more than any other country in the world at the present time.

Fission of Nuclei

P. L. Kapur

Physics Department, Panjab University, Lahore

WHEN an element is bombarded by means of projectiles, such as, neutrons, protons, deuterons or α -particles, the result is invariably a transmutation of the given element, that is to say, we get as a result of such bombardment a new element having atomic and mass numbers slightly different from those of the bombarded element. Neutrons are more efficient transmuting agents, because unlike the charged particles they are not affected by the Coulomb repulsion of the nucleus. The transmutation is sometimes the result of radiative capture of the incident particle and sometimes it is accompanied by ejection of elementary particles. For a proper understanding of such nuclear transmutations brought about by the impact of material particles, we must, according to Bohr, look upon the entire process as taking place in two distinct or independent steps. The first step consists in the formation of an intermediate metastable system consisting of the initial nucleus plus the incident particle. When the incident particle collides with the nucleus, on account of the close coupling, it at once shares its energy with the nuclear particles. The excitation energy should thus be regarded as temporarily stored up in some complicated motion of the constituent particles of the intermediate nucleus. One may say that this excess energy is divided amongst the various degrees of freedom in a way which is analogous to the thermal agitation of a solid or liquid body. The next or the second step consists in the decay of this intermediate compound nucleus, and the relative probabilities of the different possible modes of this decay will depend upon the facility with which the excitation energy of the compound nucleus is either radiated away or concentrated so as to result in the disintegration of the compound nucleus. If a sufficient portion of this energy gets concentrated on some particle near the surface of the nucleus, the particle may break away from the nucleus just as a molecule with a large velocity near the surface of a liquid breaks away from the bulk.

The remainder of the nucleus will be left in the ground or an excited state according as the escaping

particle carries away whole or part of the excitation energy. If the energy left in the remainder is not sufficient to enable any other constituent particle of the remaining nucleus to escape, the nucleus will fall to the ground state by the emission of radiation. If on the other hand, the energy left behind after the escape of one particle is still sufficient to enable another particle (when concentrated on it) to escape, the nucleus may come to a ground level by the emission either of a γ -quantum or of a particle according as which of the two processes has a greater probability.

Till recently the above two were the only recognized modes of decay of the intermediate nucleus, namely, the emission of radiation and the ejection of one or more (in any case few) elementary particles. There is one more possibility and that is, that the excess energy in the compound nucleus, instead of getting concentrated on any one of the constituent particles resulting in its escape, excites some special mode of vibration of the compound nucleus involving a considerable deformation of the nuclear surface resulting in the breakdown of the nucleus into two parts just as a liquid drop breaks up into two droplets when very violently agitated. This phenomenon of an excited nucleus breaking up into two (or more) nuclei with much inferior atomic and mass numbers is called *fission*. It is evident that the phenomenon will occur only when the deformation energy is greater than the energy which tries to keep a nucleus together. Talking in terms of the language applicable to a liquid drop, one would say that the intermediate nucleus will break up into two if the deformation energy tending to break it is greater than the surface tension of nuclear matter. The whole question of nuclear 'fission' is found to bear a close analogy to the stability of a charged liquid drop which becomes less and less stable against any surface deformations, as its charge is increased. As we go to nuclei with large atomic numbers, the mutual repulsion between the charged nuclear constituents will to a large extent

FISSION OF NUCLEI

by checking that the number of pulses depended upon the strength of the neutron source. This experiment thus provided the first physical evidence for the breaking up of the uranium nucleus when it is bombarded with neutrons.

Assuming that the uranium nucleus breaks up into two particles only, its nuclear charge and mass must be shared by the two lighter nuclei. Here it must be emphasised that not the same two lighter nuclei will always be produced as a result of the fission, but in general there will be possibly a number of modes of fission, the relative intensities of which will depend, as already mentioned, upon the finer structural details and the manner of excitation of the initial nucleus. For example, if the excitation is brought about by s-neutrons (for which the orbital angular momentum $l=0$), the fission products will in general be different from those that result when the excitation is brought about by p-neutrons ($l=1$) or by d-neutrons ($l=2$) etc. The light elements thus produced will contain considerably more neutrons than any of the heaviest stable isotopes with the same nuclear charge. For example, a splitting into $^{96}\text{Kr}_{34}$ and $^{140}\text{Ba}_{56}$ would mean an excess of 10 neutrons in the former and 5 neutrons in the latter over the number of neutrons in their heaviest stable isotopes respectively. This excess of neutrons can be got rid of in two ways; either they are liberated directly as neutrons as a part of the 'explosion' or as an 'evaporation' of the resulting nuclei or, a neutron transforms into a proton by the emission of a β -particle. By the emission of one β -ray the excess of neutrons will diminish by two units and therefore this seems to be a more probable process. Actually it has been found that both these modes of getting rid of the excess of neutrons are operative though more information has been obtained on the β -active products.

It has already been mentioned that the fission products will have very large energy (~ 100 million volts), and therefore it should be possible to collect

them on suitable surfaces if placed closed enough to the uranium layer. A most convenient collecting surface is provided either by water which is previously tested to be free from any radioactive contamination or a glass surface placed at a distance of about one millimetre from the uranium layer bombarded by neutrons.

The experimental procedure already outlined is now applied to this collected material and it has been found that it is β -active having a number of life periods which have been chemically identified with elements having atomic numbers far below that of uranium. Some of the life periods detected in the collected products have been found to be the same as were previously ascribed to 'transuranic' elements. Now it is evident that mere capture of a neutron would give so little kinetic energy to the compound nucleus that only a vanishing fraction of these nuclei could reach the collecting surface which is placed at a distance of one millimetre. So the occurrence of 'transuranic' periods on the collecting surface should be taken to be conclusive evidence of the so-called 'transuranium' elements originating from the fission of the uranium nucleus. A number of transuranium periods are now ascribed to elements considerably lighter than uranium.

The importance of these experimental results cannot be over emphasized. A closer examination of the conditions for the occurrence of fission and the nature of the fission products will take us a long way towards a better understanding of the nuclear excitation and throw some light on the structural details. Already we can draw one conclusion and that is, since the effective cross-sections for the fission phenomenon for neutrons of different velocities seem to be of about the same order of magnitude as the cross-sections for ordinary nuclear reactions, the deformation energy sufficient for the fission of heaviest nuclei is of the same order of magnitude as the binding energy of a particle in a nucleus. It would be further interesting to know whether it is the energy of excitation alone which leads to the fission phenomenon or there is also an important role of the angular momentum.

Enzymes and Catalysis

N. B. Das

Department of Biochemistry and Nutrition,
Bose Research Institute, Calcutta

It is a well-known fact that the velocity of certain chemical reactions can be enormously accelerated by the presence of small amounts of foreign substances. For example, ethyl acetate in the presence of water is decomposed into ethyl alcohol and acetic acid, but addition of a small quantity of hydrochloric acid increases the reaction considerably and hydrochloric acid is found unchanged at the end of the reaction; MnO_2 accelerates the decomposition of potassium chlorate with the evolution of oxygen, the MnO_2 itself being left unchanged. Similarly finely divided platinum decomposes hydrogen peroxide with much greater rapidity. These substances which have the property of accelerating chemical reactions without forming part of the systems in their final equilibrium are known as "Catalysts."

In the living organism, i.e., *in vivo* the chemical reactions in connection with metabolism take place with great ease and rapidity even at low temperature while *in vitro*, i.e., under artificial conditions outside living organism, much longer time, higher temperature and acidity are necessary. Observations showed long ago that the hydrolysis of substances like starch, sugar, fats etc., takes place with considerable rapidity in the presence of certain substances which can be extracted from vegetable and animal tissues. These substances behave like catalysts and are known as enzymes, and the substances acted on by enzymes are called substrates. The enzymes accelerate reactions which, in their absence, proceed very slowly. Enzymes can thus be called organic catalysts or bio-catalysts. They are colloidal in nature and do not undergo any chemical change or inactivation unless the product formed in the course of the reaction interferes with them.

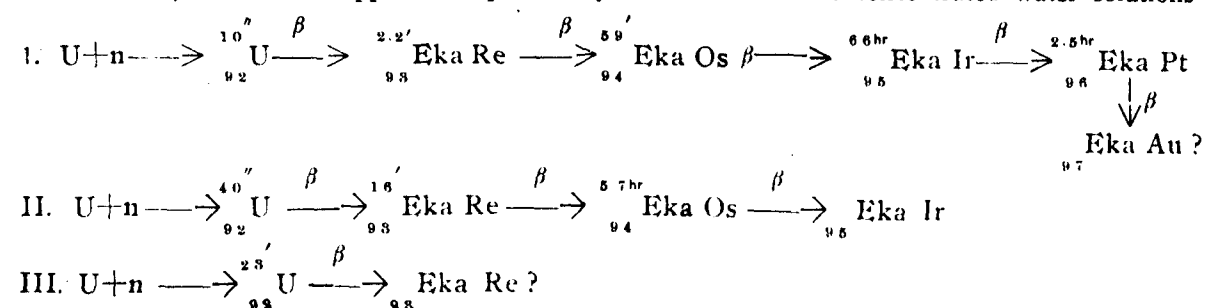
Study of enzymes began as early as the end of the eighteenth century. But definite evidence of the existence of enzymes was obtained only in 1833, when Payen and Persoz discovered that germinating seeds contain a substance which converts starch into sugar.

They named this substance diastase which term was later changed into amylase. Outside the living organism, hydrolysis of starch by ordinary chemical means takes place only at high temperature or at higher acidity. Within the living organism or in the presence of enzymes, hydrolysis takes place at ordinary temperatures and with considerable rapidity. Following this, many other enzymes were discovered in rapid succession.

It was observed long ago that alcohol and carbon dioxide were produced from sugar by yeast fermentation. This mysterious reaction attracted the interest of many philosophers and scientists. In 1837 Berrelius thought that fermentation was a catalytic process. Liebig in a series of papers developed a pure chemical theory of enzyme action. In 1857 commenced the classical researches of Pasteur, who showed that living yeast was necessary for fermentation. A great controversy continued between Pasteur and Leibig. This controversy terminated only when Buchner discovered that alcoholic fermentation could be caused by a cell-free extract of yeast, proving definitely that living organism is not essential for fermentation. The cell-free extract was in reality a mixture of enzymes. Buchner's discovery of the cell-free enzyme, termed zymase, which can cause alcoholic fermentation, introduced new experimental methods by which the problem of alcoholic fermentation has been attacked. As a result considerable advance has been made in the knowledge of the nature and conditions of yeast enzymes and the mechanism of fermentation has been found to be much complicated. In 1905 Harden and Young showed that the cell-free enzyme preparation of yeast, which can cause alcoholic fermentation, can be divided into two components—apozymase, and co-zymase or co-enzyme. Any one of these components alone cannot bring about alcoholic fermentation of sugar, but a mixture of both produces almost as active a fermentation as the original enzyme. As co-zymase was found to withstand the temperature of boiling water and was dialysable, it was considered to be more

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counteract the effect of the short range forces in keeping the nuclear constituents together, *i.e.*, will decrease the nuclear surface tension. A rough calculation shows that the surface tension of nuclei decreases with increasing nuclear charge, becomes zero for atomic numbers of the order of 100. So that we see that the uranium nucleus, the heaviest element ($Z = 92$) occurring in nature, has a very little stability of form and if we could agitate it sufficiently violently, say by bombarding it with some suitable projectile, it may explode into two (or more) lighter nuclei of approximately equal charge and mass (the exact ratio of sizes as regards charge and mass will depend upon the finer structural details *e.g.*, the mode of vibration of the nucleus leading to its fission and the angular momentum associated with it) rather than disintegrate in the ordinary way by the expulsion of one or more neutrons, protons or α -particles etc. Projectiles having an electric charge are not suitable agents to bring about the disintegration of the uranium nucleus. For, to have an appreciable probability of



penetration through the repulsive Coulomb potential barrier of the nucleus they will need to be provided with a kinetic energy which at present is beyond what we can attain in the laboratory. Neutrons, because they have no charge, are very suitable and experiments with neutron bombardment have shown quite conclusively the occurrence of the fission of the uranium ($Z = 92$) and thorium ($Z = 90$) nuclei.

The experiments on the bombardment of uranium (and thorium) by neutrons were done as early as 1934 by Fermi and collaborators, but the results were then interpreted not as demonstrating the occurrence of 'fission' of nuclei but as evidence for the existence of the so-called 'transuranic' elements *i.e.*, elements with atomic numbers beyond 92. They found that as a result of the above reaction radioactive substances are produced with half-value periods of 10 sec., 40 sec., 13 min. and 90 min., and ascribed two of them to 'transuranic' elements. Later, Meitner and others demonstrated the existence of nine radioactive periods

and put forward the following scheme of reactions to explain them. The upper indices give the half-value periods and the lower ones the atomic numbers.

In other words, they postulated the artificial production of 'transuranic' elements up to atomic number $Z=97$. It is now believed and has been experimentally demonstrated to be true that the radioactive periods which had previously been assigned to 'transuranic' elements are due to lighter nuclei which are produced as a result of the fission of the uranium nucleus. For a clear understanding of the reasons which formerly led to the assignment of these radioactive periods to elements beyond uranium, it is essential to know in broad outline the procedure adopted in all transmutation experiments.

As the radioactive substances produced by the neutron bombardment are usually β -active, the substance to be investigated is usually put in the form of a cylinder which can be fitted round the Geiger-Muller (G.M.) counter used for their detection. This is done in order to minimize the loss in intensity through geometrical factors. The substances are also irradiated as concentrated water solutions in suitable

test tubes. After irradiation for a convenient period of time, the activity of the substance is studied by means of a G. M. counter, the impulse from which after amplification are counted by mechanical devices worked by thyratrons, and the decay curves (number of counts per second against time) are plotted. Such decay curves are sometimes simple exponentials showing the existence of just one radioactive life period and sometimes can be analysed into two or more exponentials. When this is the case, it is convenient to irradiate the substance for different lengths of time in order to activate the various components with different intensities. The existence of different life periods is attributable to the different isotopes of the substance which is irradiated or, when only one isotope is present, to different modes of disintegration.

This part of the experiment only demonstrates the existence of one or more radioactive substances in the irradiated product. To be able, however, to

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discuss the nuclear reaction giving rise to the active element (or elements), it is essential to identify this (or these) chemically. As the amount of active substance produced during irradiation is extremely small, ordinary methods of chemical analysis cannot be expected to be applicable. The usual procedure adopted in all such cases is to make a solution in some suitable solvent of the irradiated product and to add to it small amounts of the inactive substances of which the active elements in the irradiated product are suspected to be isotopes. These added elements are then chemically separated and examined for activity. If an added element after separation is found to possess an activity of a life period found in the irradiated product, and if this life period is absent from the remainder of the solution after separation of this one added element, and if in addition this life period cannot be separated from the element by any chemical means, this radioactive period can be considered to be due to an isotope of the added element. A slight variation of this procedure is to add to the irradiated substance an ordinary β -active element. If it be then possible to show that the induced activity (which can always be recognised by its characteristic life period), can be chemically separated from the added activity, it is reasonable to assume that the two activities are not due to isotopes.

This is the experimental procedure in outline and it will be found that one is guided by his own intuition derived from experience in establishing the chemical identity of the active product.

Experience had indicated that in almost all nuclear reactions the escaping particle had zero, one or two electric charge units so that the atomic number of the final nucleus differed from that of the parent nucleus by only a few units. This was the guiding principle in establishing the chemical identity of the products of disintegration. One always assumed that the atomic number of the product nucleus was near that of the parent nucleus. All the substances near about the bombarded nucleus were therefore tried as added elements and thus excluding them or establishing some one as being isotopic with the active element in the irradiated substance.

The same ideas were applied when uranium was bombarded with neutrons. Trying to establish the chemical identity of the active products, Fermi and collaborators found that one life period (13 min.) could not be due to an isotope of any of the elements between $Z = 86$ and $Z = 92$ or with $Z = 82$ and

$Z=83$. So naturally, since the atomic number of the final nucleus should be close to that of the parent nucleus, they were led to postulate the occurrence of elements beyond uranium. When a body with properties similar to those of osmium ($Z=76$) was found, it was assumed to be eka-osmium ($Z=94$) rather than osmium. The conclusions arrived at by Meitner and collaborators already quoted are an embodiment of the above point of view.

The table, however, turned out with some observations made by Hahn and Strassmann in 1938. They found that when uranium is bombarded with neutrons, at least three radioactive bodies are formed which are chemically similar to barium and later on they were able to establish that these could not be separated from barium by any chemical means. The conclusion then is that *isotopes of barium ($Z = 56$) are formed when uranium is bombarded with neutrons*. This is a case of *fission* of uranium nucleus. When one of the products is barium, the other, assuming that the uranium nucleus breaks up into two lighter nuclei, should be the rare gas krypton ($Z = 36$) which decays through rubidium to strontium.

The two nuclei into which uranium nucleus breaks up will repel each other and thus gain quite large kinetic energy (~ 200 million volts). Thus when a layer of uranium is bombarded by neutrons, we should expect, if the phenomenon of fission is taking place, lighter nuclei with atomic numbers about 50 coming out with energies as large as 100 million volts. These nuclei in spite of their large energy will have a very small range (a few millimetres only) in air on account of the large ionization they will produce. Each such particle may produce as many as a total of about three million pairs in their path. So that if we take an ionization chamber lined with uranium and connect the amplifier to a thyatron (which works the mechanical counting meter) which is so biased as to record only those pulses which correspond to 10^5 ion pairs or more, and if we place a neutron source at some suitable distance from it, we should get an appreciable number of counts if the process of fission takes place. Such an experiment has actually been performed by Frisch who counted 15 particles per minute when the neutron source, 300 mg. of radium mixed with beryllium, was placed at a distance of one centimetre from the uranium lining. No pulses at all were recorded when either the uranium lining or the neutron source was removed. The possibility that these pulses are produced by accidental summation of smaller pulses was excluded

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by checking that the number of pulses depended upon the strength of the neutron source. This experiment thus provided the first physical evidence for the breaking up of the uranium nucleus when it is bombarded with neutrons.

Assuming that the uranium nucleus breaks up into two particles only, its nuclear charge and mass must be shared by the two lighter nuclei. Here it must be emphasised that not the same two lighter nuclei will always be produced as a result of the fission, but in general there will be possibly a number of modes of fission, the relative intensities of which will depend, as already mentioned, upon the finer structural details and the manner of excitation of the initial nucleus. For example, if the excitation is brought about by s-neutrons (for which the orbital angular momentum $l=0$), the fission products will in general be different from those that result when the excitation is brought about by p-neutrons ($l=1$) or by d-neutrons ($l=2$) etc. The light elements thus produced will contain considerably more neutrons than any of the heaviest stable isotopes with the same nuclear charge. For example, a splitting into $^{96}\text{Kr}_{36}$ and $^{140}\text{Ba}_{56}$ would mean an excess of 10 neutrons in the former and 5 neutrons in the latter over the number of neutrons in their heaviest stable isotopes respectively. This excess of neutrons can be got rid of in two ways; either they are liberated directly as neutrons as a part of the 'explosion' or as an 'evaporation' of the resulting nuclei or, a neutron transforms into a proton by the emission of a β -particle. By the emission of one β -ray the excess of neutrons will diminish by two units and therefore this seems to be a more probable process. Actually it has been found that both these modes of getting rid of the excess of neutrons are operative though more information has been obtained on the β -active products.

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ENZYMES AND CATALYSIS

simple in constitution than the enzyme. Phosphate was also found to be indispensable for the breakdown of sugar into alcohol and carbon dioxide. This decomposition of sugar occurs in stages with the formation of intermediary complex hexose phosphates and a series of enzymes are responsible for the various intermediary stages. It has been found that similar processes as the alcoholic fermentation by yeast cells are involved both in the conversion of carbohydrate into lactic acid in animal muscles and in the decomposition of carbohydrates by plants, moulds and bacteria. Nothing definite was known as to the function and nature of co-enzyme (co-dehydrase I) until recently when Euler and Warburg with their collaborators isolated it from various sources, chiefly from yeast and red blood-corpuscles. They studied the functions and the chemical constitution of this co-enzyme. This work in this direction has made a landmark in the progress of biochemical researches.

Up till now we are acquainted with three co-enzymes which belong to the group of the very interesting chemical compounds—'dinucleotides.' These are co-dehydrase I (co-enzyme; diphosphopyridine nucleotide), co-dehydrase II (Warburg and Christian's co-ferment of hexose monophosphate system; triphosphopyridine nucleotide) and flavin-adenine-dinucleotide (co-enzyme of *d*-amino acid dehydrogenase). Some mononucleotides also act as co-enzymes, as for example, adenylic acid (co-enzyme of glycolysis; co-phosphorylase), alloxazine nucleotide (riboflavin phosphoric acid; prosthetic group of Warburg's yellow enzyme). All these co-enzymes are reversibly dissociable from the enzyme (the protein carrier) i.e., the co-enzymes can be separated from the enzyme by mechanical means and can be made to reunite in proper portions. Recent researches have revealed that co-enzymes is low molecular prosthetic group of a high molecular protein carrier. This is in accordance with "Trager" theory of Willstatter, who as early as 1922 suggested that enzymes contain a special reactive group which either combines with or possesses some particular affinity for definite groupings in the substrate molecule. The special reactive group is attached to a colloidal carrier. Willstatter suggested this theory before there was any definite evidence as to the chemical nature of the prosthetic groups. More recently it has also been found that the prosthetic group of carboxylase (an enzyme decarboxylating keto acids) is vitamin B₁-pyrophosphate and that of each

of catalase, peroxidase and cytochrome C is an iron porphyrin residue. But the prosthetic group in the latter three cases have not yet been proved to be dissociable.

The activity of these enzymes is due to both the components, namely the prosthetic group and the specific protein carrier. According to Willstatter, the special reactive group which is the prosthetic group, determined the specificity of enzyme action. But modern researches point out that the specificity of an enzyme is not only determined by the nature of the prosthetic group but also by that of the colloidal carrier. As for example, co-enzyme when united with the specific protein apozymase causes alcoholic fermentation but the same prosthetic group when united with other specific proteins, causes dehydrogenation of malic acid, lactic acid, citric acid, glucose, glutaminic acid etc. These enzymes are known as dehydrogenases which take out two hydrogen atoms from the substrate molecule and cause them to unite with molecular oxygen through the agency of respiratory carriers. Study of this class of enzymes has contributed greatly to the knowledge of the mechanism of hydrogen and oxygen activation. Researches of Warburg, Wieland, Keilin, Szent-Gyorgyi, Euler and Thunberg are worthy of mention in this connection.

It is not possible to deal in a short article with all the functions and constitutions of the various co-enzymes and respiratory carriers, though they constitute the most interesting chapter of modern biochemistry. For the sake of its great importance, the case of co-enzyme may be discussed briefly. Its chemical constitution has been determined by Euler and Warburg. According to Euler and Schlenk its constitution is as follows:

Phosphate — ribose — Adenine

Phosphate — ribose — Nicotinic acid amide

This dinucleotide occurs widely in nature both in vegetable and animal tissues. It forms the prosthetic group of greatest number of apo-enzymes or apo-dehydrogenases.*

Investigations of Euler and his collaborators have shown co-enzyme to be a hydrogen carrying co-enzyme. It takes up two hydrogen atoms forming dihydrocozyme and transfers them to respiratory carriers forming co-enzyme again but not to molecular oxygen. In this way it functions as hydrogen carrier

*Apo-enzyme + Co-enzyme $\rightleftharpoons$ Holo-enzyme.

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between the donor and the acceptor by virtue of its property of reversible oxidation and reduction.

The question whether it acts as a phosphate carrier has led to confusing results. Purified co-enzyme, free from trace of adenylic acid, has been found to have lost all its co-phosphorylase activity. Mention should be made that co-dehydrase I can be phosphorylated to co-dehydrase II by an enzymic process. This might suggest some important physiological complications.

Some of the vitamins like B₁ (thiamine), B₂ (riboflavin), and nicotinic acid amide (p-p factor and a component of vitamin B complex) are linked with enzymes. Vitamin B₁-pyrophosphate is the co-enzyme of carboxylase. Vitamin B₂-phosphoric acid is prosthetic group of yellow enzyme and a component of the co-enzyme of *d*-amino acid dehydrogenase and many other yellow enzymes. Nicotinic acid amide is also a component of co-enzyme. In view of these facts it has been assumed that co-enzyme function represents the main tissue activity of the vitamins. The function of respiratory carrier has also been ascribed to vitamin C (ascorbic acid).

The enzymes are very widely distributed and form the constituent of all living cells. Majority of enzymes are intra-cellular and non-diffusible through cell wall. Such enzymes naturally act inside the cell. In some cases enzymes are not inactivated even when the protoplasm is destroyed. Zymase (the enzyme of alcoholic fermentation) belongs to this class of enzymes. Again a few of the enzymes occur in the secretion of living organisms and are called extra-cellular enzymes. They are diffusible through cell wall and naturally act outside the cell. Gastric juices and milk are examples of such enzymes.

An excellent illustration of a single cell containing all the different enzymes necessary for the process of metabolism is the unicellular fungus yeast. The vital reactions like digestion, respiration and fermentation etc., are caused by different enzymes, both extra-cellular and intra-cellular.

Some of the intra-cellular enzymes have afforded much difficulty in their preparation. Buchner in the preparation of zymase crushed the yeast cells by grinding with sand and kieselguhr and pressing the ex-tract out by pressure of 300 atmospheres. Many other methods have been developed for breaking the cell membrane, such as, by plasmolysis, autolysis, sudden freezing followed by crushing the cells and so

on. Some of the enzymes are easily extracted with water, buffer or saline; the degree of solubility depending on hydrogen ion concentration. Others are purified by methods depending on solubility, such as, precipitating with cold alcohol or acetone at a suitable pH; by absorption on the surface of kaolin, alumina gel, charcoal, kieselguhr, frankonite etc., electrophoresis and ultracentrifugal sedimentation. The latter two methods have been developed at Prof. Svedberg's laboratory at Upsala (Sweden) and have afforded a successful method by means of which the problems of high molecular substances like proteins and higher carbohydrates can be tackled.

Much of the earlier works on the enzymes were carried out with extra-cellular enzymes which are comparatively easy to prepare. Though some of the intra-cellular enzymes are not destroyed even after destruction of natural protoplasm, some enzymes have not yet been separated from the cell structure. These are believed to be intimately connected with the structure of the living cell. Perhaps some day biochemists with more efficient technique at their disposal will be able to solve this mystery of nature.

According to the theories of enzyme action, an intermediate enzyme-substrate complex is formed which ultimately breaks down with the regeneration of enzyme and substrate decomposition product. Many of the processes that are accelerated by enzymes are reversible, that is, enzyme is capable of accelerating the reaction in both directions. Many biological syntheses are made by enzymes. Glucosides, proteins and amino acids are synthesised by enzymes both *in vitro* and *in vivo*. Enzyme actions are profoundly influenced by hydrogen ion concentration, temperature, and substrate and co-enzyme concentrations. In general, they show an optimum of hydrogen ion concentration, temperature, and substrate and co-enzyme concentrations. The enzymic reactions which are reversible are inhibited by the reaction product and the extent of inhibition with different reaction products is not the same.

Most of the enzymes exhibit great specificity. For example, zymase breaks down glucose into alcohol and CO₂ but it cannot break a starch molecule. There are instances where different substrates are attacked by the same enzyme, e.g., lactic and malic acids are attacked by the same dehydrogenase. Also there are instances where enzyme attacks a particular optical isomer of the substrate. Zymase which ferment *d*-glucose, is quite inactive with *l*-glucose. Cell-free

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d-amino acid dehydrogenases attack only *d*-amino acids (α) but not *l*-amino acids. It is probable that the enzyme, which is at present known as a specific

enzyme, may in reality be composed of many different enzymes. Enzymes have been classified according to their specific functions and a list of the more well-studied enzymes is given below:

Classification of Enzymes

ENZYMES	SUBSTRATES	END PRODUCTS
1. <i>Enzymes hydrolysing nitrogen compounds.</i>		
Pepsin	Natural proteins	Proteoses and Peptone
Trypsin	Natural proteins, Proteoses and Peptones	Polypeptides and dipeptides
Erypsin (Perhaps mixture of polypeptidase and dipeptidase)	Polypeptides and dipeptides	Amino acids
Papains	Natural proteins	Polypeptides and dipeptides
Rennin	Casein	Paracasein
Urease	Urea	CO ₂ + NH ₃
Arginase	Arginine	Urea Ornithine
Asparaginase	Asparagine	Aspartic acid + NH ₃
Glutaminase	Glutamine	Glutaminic acid + NH ₃
Guanase	Guanine	Xanthine + NH ₃
Adenase	Adenine	Hypoxanthin + NH ₃
2. <i>Enzymes hydrolysing Esters</i>		
Lipase	Fatty acid esters	Fatty acids + alcohol
Choline esterase	Choline ester	Choline + acetic acid
Chlorophyllase	Chlorophyll-a	Chlorophyllide-a + phytol
Pectase	Pectin	Pectic acid + methyl alcohol.
Tannase	Tannins	Glucose + gallic acid
Phosphatase	Phosphoric esters	Phosphoric acid + alcohol
3. <i>Enzymes hydrolysing Carbohydrates.</i>		
Amylase	Insoluble starch	Soluble starch
Amylase (α + β)	Soluble starch	(α + β) Maltose
Maltase	Maltose	Glucose
Invertase	Sucrose	Fructose and Glucose
Trehalase	Trehalose	Glucose
Pectinase	Pectic acid	Galactose + galacturonic acid
Emulsin	β-glucosides	Sugar + non-sugar residue.
Nucleosidase	Nucleosides	Sugar + non-sugar residue.
4. <i>Oxidases</i>		
<i>d</i> -Amino acid oxidase	<i>d</i> -α-amino acids	Ketoacids + NH ₃
Hypoxanthine oxidase	Hypoxanthine	Xanthine
Xanthine oxidase	Xanthine	Uric acid
Uric acid oxidase	Uric acid	Allantoin + CO ₂
Polyphenol oxidase	Polyphenols	Quinones
Tyraminase	Tyramine	p-oxyphenylacetic acid + NH ₃
Tyrosinase	Tyrosine	Melanine
Dopa oxidase	Dihydroxyphenylalanine	Melanine
Glucose oxide	Glucose	—
Ascorbic acid oxidase	Ascorbic acid	Dehydroascorbic acid.

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ENZYMES	SUBSTRATES	END PRODUCTS
5. <i>Enzymes activating H₂O₂</i>		
Catalase	H ₂ O ₂	H ₂ O + O ₂
Peroxidase	H ₂ O ₂	Activated O ₂
6. <i>Enzymes inserting H₂O without hydrolysis</i>		
Fumarase	Fumaric acid	Malic acid
7. <i>Enzymes attacking the C-C Bond</i>		
Zymase	Hexose	Ethyl alcohol + CO ₂
Carboxylase	Ketoacids	Aldehyde + CO ₂
8. <i>Dehydrogenases and Oxidation-reduction Enzymes.</i>		
Alcohol dehydrogenase	Alcohol	Aldehyde
Succinic	Succinic acid	Fumaric acid
Malic	Malic	Oxaloacetic acid
Lactic	Lactic	Pyruvic acid
Isocitric	Iso citric	α-Ketoglutaric acid
Formic	Formic	CO ₂ + H ₂ O
Glutaminic	Glutaminic acid	α-Ketoglutaric acid
β-hydroxy-butyric	β-hydroxybutyric acid	Acetoacetic acid
Hexosemonophosphate dehydrogenase	Hexosemonophosphate	—
Glucose dehydrogenase	Glucose	Gluconic acid
Glycerophosphate dehydrogenase	Glycerophosphoric acid	—
Aldehyde mutase	R. CHO	R.CH ₂ OH + R.COOH.
Diaphorase	Reduced co-enzyme + dyestuff	Co-enzyme + lenco dye
Yellow enzyme	Reduced co-enzymemolecular	Co-enzyme + H ₂ O
	Reduced co-enzyme + molecular O ₂	Coenzyme + H ₂ O
Glyoxalase	Methyl glyoxal	Lactic acid.

Enzymes are now extensively used for many industrial purposes. Organic compounds prepared by enzymic processes often cost much less than when prepared synthetically. Wine, vinegar, lactic acid and butyric acid are manufactured by fermentation. Citric, pyruvic and fumaric acids are also manufactured by similar biochemical processes. Another interesting example is the preparation of glycerine for manufacture of explosives by fermentation of sugar which method was adopted in Germany during the Great War.

Recently several enzymes have been prepared in the crystalline state. The first crystalline enzyme was urease prepared by Summer in 1926. The enzymic activity is reported to remain constant through repeated recrystallisation. The other crystalline enzymes were pepsin and trypsin prepared by Northrop in

1929 and 1931 respectively. Theorell in 1935 crystallised yellow enzyme of Warburg and Christian. Following this, many other enzymes are reported to have been isolated in the crystalline state. No definite statement can be made as to the purity of these crystalline enzyme preparations, unless our present technique of studying high molecular substances is more improved. Some are of opinion that these so-called enzyme crystals contain some impurity, others hold that the actual activity is adsorbed on the surface of the protein molecule. The fact that these enzymes retain their activity on repeated crystallisation indicates the possibility that the crystals may be pure enzymes. Svedberg's ultracentrifuge and Tiselius' electrophoretic apparatus have afforded means by which some of these crystalline enzymes have been proved to be homogeneous proteins.

ENZYMES AND CATALYSIS

Colloids and high molecular substances are the building stones of the cells. Life is not possible without these substances. Accordingly biologists who aim at the elucidation of the processes taking place in living beings are interested in the properties of high molecular substances. Illness and death cannot be successfully combated unless we know the chemical

and physical properties of the high molecular substances of our body. Very great care is necessary in the purification and characterisation of these high molecular substances which are none too sensitive to the methods used for ordinary organic compounds. Study of the chemistry of high molecular substances is now the focus of interest in biochemistry, organic chemistry and chemical technology. Promising developments are foreseen in researches on these substances.

Power as a Key to Social Development

The cause of the recent rapid and enormous change in society is found in the discovery and utilization of the means by which heat energy can be made to do man's work for him. The key to the whole development is found in the use of power machines, and it is a most significant statistical fact that the standard of living in the various countries of the world follows closely the order in which so-called labor-saving devices have been most widely put into use. In other words, the average man has today more of goods and services to consume in about the proportion in which he has been able to produce more of goods and services through the aid of the power machines which have been put into his hands. In the last analysis, this use of power is why our most important social changes have come about. This is why we no longer drive our ships with human slaves chained to the oars as did the Romans and the Greeks. This is why we no longer enslave whole peoples, as did the Pharaohs, for building our public structures and lash them to their tasks. This is why ten times as many boys and girls are in the high school today in the United States as were there in 1890 more than five million now, half a million then. This is why we have now an eight-hour day instead of, as then, a ten, a twelve—or sometimes a fourteen-hour day. This is why we have on the average an automobile for every family in the country. This is why the lowest class of male labor, i.e., unskilled labor, gets nearly twice as much in real wages in the United States as in England, three times as much as Germany or France and thirteen times as much as in Russia, and this is why the most abused class of labor in the world, domestic service, is even better off relatively in this country though completely unorganized, i.e., through the unhampered operation of economic laws, than is any other class of labor, skilled or unskilled.

These facts make it wellnigh certain that we shall increase in economic well-being in the future just as we have in the past in just the proportion in which we continue to apply science and engineering to our industries and thus produce more and more in goods and services per man hour, thus freeing more and more men, more and more time, and more and more brains for education, for research for art and for all the other service industries. There is a saturation point for automobiles and radios, but there is no such thing as saturation in education or the service industries generally.

Civilization consists in the multiplication and refinement of human wants. It is a simple historical fact that these wants have actually developed with great rapidity wherever and whenever labor-saving machines have been rapidly introduced. In 1900, 60 per cent of our population was on, or supported immediately by, the farm; in 1930 not over 44 per cent. Without serious unemployment in that period the millions of displaced farmers found their way into garages, service stations, newly created secretarial jobs, news reporting, a newly created telephone service advertising, insurance, gardening, domestic service and a thousand other service industries, and no serious or prolonged unemployment occurred until the enterprisers who normally create the new jobs began to be suppressed, legislated against and scared by unwise financial and political policies. The faster science and engineering are applied to industry, the faster we ought to progress. There is literally no other way of comparable effectiveness to raise the standard of living, and the chief element in its effectiveness is in getting more power in the hands of the laborer so that he can produce more for himself, for in the last analysis the laborer taken as a whole gets under almost any modern social system practically all that he produces.

—The Scientific Monthly

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CULTURE

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OBITUARY

PROFESSOR SIGMUND FREUD

ON September 25, a Reuter message from London announced the death of Professor Sigmund Freud, the originator of psycho-analysis. A victim of Nazi terror, Professor Freud left Vienna with his family in June last year to take up residence in England. He died at his London residence.

Sigmund Freud, was born of Jewish parents at Freiberg, Moravia, in May, 1856. He studied medicine at Vienna and was for a time a hospital surgeon. Later he taught at Vienna University and in 1886 went to Paris as a pupil of Charcot. Returning to Vienna, he was appointed lecturer on neurology and in 1920 professor of that subject.

Professor Freud was one of the thinkers who have revolutionised whole systems of human knowledge. His probings into the dark and inscrutable realm of the sub-conscious have brought strange, and in some cases terrifying, things to light, revealing us as the unconscious tools of hidden or suppressed appetites, wishes and instincts.

He developed a special technique, the psycho-analytic method, under which a patient in ordinary conversation and by the interpretation of his dreams revealed what was wrong with him. After studying thousands of dreams he came to the conclusion that a dream is the symbolic expression of some hidden wish which would not be admitted by the conscious personality and which usually dates from childhood. He devised a system of interpreting dreams from which, he claimed, he could learn what was in the dreamer's unconscious mind, which is full of forgotten facts and repressed wishes, which nevertheless exercise an influence on his habits and behaviour. Professor Freud's method of treating mental diseases by psycho-analysis was at one time strongly opposed by the bulk of the medical profession on the ground that it was calculated to make people morbid and by others who disliked the idea of everything in life being traced to sexual instincts.

Professor Freud made a great reputation by his writings in which he gradually developed his psycho-analytic system. His long series of books was translated into all the different European languages. Among

his most important works are *Studies on Hysteria* (1895), *On Dream*, *Psychopathology of Everyday life*, *Three Papers on the Sex Theory*, *The Mind and its Relation to the Subconscious*, *On Psycho-analysis*, *An Introduction to Psycho-analysis*, *The Ego and the It*, *Topical Thoughts on War and Death* and *Psycho-analytic Studies on Literature and Art*. His studies yielded interesting results in relation to other subjects and in the possibilities of their adaptation to branches of knowledge such as mythology and the history of religion, civilization and literature. His chief works in the connexion are *Totem and Taboo*, *A Childhood Memory*, *Leonardo da Vinci*, *Beyond the Pleasure-Principle* and *Mass Psychology and the Ego-Analysis*. Freud also edited the *Year-Book of Psycho-analysis*, the *Imago* and the *International Journal of Psycho-analysis*. At the age of 70 he published a book, *The Future of an Illusion*, in which he declared that religious creeds were the result of human illusion. Every educator or doctor aimed at liberating a child from its neurotic tendencies, and it was incumbent on the educator of mankind to free man from fixed religious ideas and illusions. He added that there was no need to regret the impending loss of religion. Mankind's chief aims should be humanitarianism and the limitation of human suffering.

Computation of Total Solar Eclipses

UP till now, Bessel's method has been exclusively used for the computation of total solar eclipses, which is based on the geometry associated with the varying fundamental plane, the normal to which at any instant is parallel to the line joining the centres of the sun and the moon. In the June issue of the *Journal of the British Astronomical Association*, M. Davidson has described a new method of dealing with the same problem. In his method the earth's equator is taken as the plane of reference and rectangular co-ordinates are used throughout, the origin being the apex of the cone formed by the tangents to the sun and the moon. In this way, points on the central line of totality may be readily computed. A comparison of the results obtained by the two methods shows that considering the degree of accuracy with which the spherical co-ordinates of the sun and moon are known, it is not possible to be certain of the position of the central line to an accuracy greater than about a quarter of a mile when the sun's altitude is about 20 degree, the uncertainty in the general case being proportional to the cosecant of the altitude.

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'Science Review' Broadcast

FROM January last the British Broadcasting Corporation included in their programme of broadcasting a special fortnightly feature *viz.* 'Science Review,' which provided a service of firsthand news from the world of science in a form intelligible to the public. The item sometimes included description of scientific research or explanation of some scientific discovery selected from the physical and other natural sciences. This method has the advantage of bringing the man of science in direct contact with a large audience and obviates any fear of false emphasis or misrepresentation in the dissemination of scientific knowledge to the public. There has already been talks on subjects like 'What happens to the rain,' 'Splitting of atoms of uranium,' 'Sponge epidemics in the West Indies,' 'How Eskimos think' and various topical aspects of astronomy. The success of the scheme has largely been dependent on the co-operation of scientific workers and the authorities of the British Broadcasting Corporation and considerable interest has been evinced by the listeners. India lags far behind in propagating and popularising scientific knowledge and the All India Radio may follow the British Broadcasting Corporation in including this useful item as a regular feature in their programmes. If the Broadcasting authorities so desire, co-operation of scientific workers will be readily available and they may be invited to give talks on suitable subjects and offer suggestions for drawing up a programme.

Geographical Expedition to the Pacific Ocean

A NOTABLE expedition has been arranged by the National Geographic Society of America and the University of Virginia, to undertake varied geophysical investigations in the Central and South Pacific Ocean. The expedition will be carried out by a 2,000 ton steel Coast Guard Cutter fitted with sonic depth-finding apparatus and carrying a scout observation seaplane for making aerial photographs and island maps. While the scientific work will proceed, a survey of present and future needs for navigational and radio aids to marine and air-commerce will also be made. The expedition will range over an area of $4\frac{1}{2}$ million square miles, south of Hawaiian Islands, east of Australia and north-east of New Zealand. Most of its work extending over a whole year will be done on the many islands scattered over this area. As its work goes on, the expedition will send out radio broadcasts describing its progress. Gravity determinations and magnetic observations, together with careful observations of latitude and longitude, will be made on the islands and the geology of the islands will be studied. Artificial seismic waves will be set up by explosions on the ocean bed to indicate the types and depths of rocks below; mud 'cores' will be obtained from the top layer of the ocean floor to examine their composition. Observations on marine biology will be made and radio engineers will accompany the expedition to investigate radio phenomena. The expedition is really one of the most important and extensive scientific

exploration surveys undertaken by any country for a long time and it is to be hoped that the plans would be carried through fully and successfully.

Movement of Water in the Soil

IN his presidential address, delivered before the Royal Meteorological Society, B. A. Keen pointed out how the generally accepted view regarding the movement of water in the soil, which provides a ready explanation of certain usual cultivation practices, such as rolling, harrowing and hoeing, has had to be abandoned in recent years. According to this theory, the rain that percolates to some depth into the soil forms a reservoir that can be drawn up by plants during droughts, the water ascending by capillary tubes built up between the soil particles from saturated levels below to supply the roots of plants at higher levels. If this theory is accepted, harrowing and hoeing conserve moisture by destroying the top of the capillary tubes at the earth's surface and so checks surface-evaporation. An entirely new theory has now been developed and experimentally verified by Haines and Schofield. Observations made at Rothamstead on the water level in cylinders closed at the bottom and filled with various soils showed that capillary rise cannot exceed 3 or 4 feet even in extreme droughts. Haines has also showed that pore space in soil is cellular and not capillary in structure and the movement of water takes place through sudden changes caused by abrupt emptying and filling of the cells. A marked hysteresis effect in moisture content according as the soil is being moistened or dried has been observed by Schofield. If this new theory is to be accepted, cultivation would improve by the encouragement of soil crumb formation and control of soil moisture is to be done simply by removing weeds which compete for moisture and nutriment.

Recent advances in Radio Engineering

A JOINT meeting of the Institute of Radio Engineers and the International Scientific Radio Union (American Section) was held at Washington D.C., in April last. A number of papers dealing with the fundamental aspects of radio communication were presented before the meeting, which showed the trend of advances in the different branches of radio engineering. In an interesting paper, D. R. Goddard reported reception at Long Island, N.Y., of British television transmissions on 41.5 and 45.0 mega-cycles from Alexandra Palace, London. The author showed reproductions of images, some of which were clear and others distorted owing probably to multiple path transmission. Usually clear pictures are obtained during winter months but in the past few years the latest date for good reception has been steadily receding from March through February to January. Prof. Leon Brillouin presented a theoretical discussion of the transmission of electromagnetic waves in hollow conductor pipes of elliptical and square cross sections. These investigations are helpful in the design of tuning units of small attenuation for very high frequencies. H. T. Stetson of the Massachusetts Institute of Technology reported corroboration of a lunar effect on radio transmission first published several

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years ago. His observations yield fairly consistent results among themselves and indicate increased field strengths as the moon nears the meridian. J. T. Henderson, J. W. Bell and H. P. Smyth of the National Research Council of Canada, described a 12-inch cathode ray direction finder and its application to determine the direction of atmospherics. While it has not as yet been possible to locate storms simply by these directional observations of atmospherics, early location of storms is an object of the work. S. S. Kirby and F. R. Gracely, of the U. S. National Bureau of Standards reported comparisons of signals received at Washington from Buenos Aires with signals received from European stations. The South American path averages about twenty times as good as the European path as to average field intensity and range of nightly variation of intensity. On comparing the transmitting conditions with co-existing magnetic disturbances, it appears that poor conditions on the northern path usually persists even several days after the magnetic disturbances have ceased. Ralph Stair and W. W. Coblentz described a precision instrument sent aloft with balloons for observing and reporting to the ground the distribution of ozone in the stratosphere. Measurement of change in spectral distribution of ultra-violet solar radiation is made at different heights as the balloons rise with the help of a cadmium photoelectric cell, and these are transmitted to the ground by a small radio-transmitter including a relaxation oscillator. Heights up to 27 km. have been explored and maximum ozone content has been found at heights of about 25 km. N. Smith and A. S. Taylor described a project now under progress to predict monthly average ionospheric characteristics and maximum usable frequencies for undisturbed days for several months in advance. Such predictions are already being published each month in the *Proceedings of the Institute of Radio Engineers*. These predictions are related to sunspot numbers.

The Indian Journal of Entomology

WE have received a copy of the first issue (vol. 1 Parts I & II) of the *Indian Journal of Entomology* recently published by the Entomological Society of India, New Delhi. The Society which was started last year, aims at the encouragement and promotion of entomological study and research in India. It has established branches at important scientific centres in different parts of the country, where its meetings are held. The Journal is meant to be the official organ of the Society and will be published twice a year and will be supplied free to its members. In a country like India where crop pests and timber pests cause huge loss of millions of rupees annually, entomological studies and researches should be further encouraged by all means. Up till now contributions relating to Indian insects have been mainly published in the reports, bulletins, memoirs and departmental publications of the Government or of some of the Indian Universities. Many of these are not easily available even in India not to speak of other foreign countries. We hope in future this Journal will become the medium of publica-

tion of important and valuable entomological papers and will thus remove a long felt inconvenience of both Indian and foreign workers interested in Indian entomology. We wish for the success of the Entomological Society of India and its Journal.

Archaeological finds in Jaipur

ARCHAEOLOGICAL finds dating back to the Kushan and Gupta periods have been found in Jaipur. Long ago a few trial pits dug by Major Handley at a mound situated on the bank of a dried up lake known as Malisar, four miles from the Sambhar lake, led him to believe that the site was a Buddhist one. Recent excavations at the site revealed no traces of Buddhism but disclosed the existence of three principal strata of buildings, the latest dating back to the 8th and 9th century A.D. Antiquities found on this level include stone tablets bearing figures of Vishnu, Durga and other Brahminical deities, and below this were found coins of the Indo-Sassanian period. The intermediate level, is assignable to the Kushan and Gupta periods. Buildings here are constructed on the usual Indian plan of a central open court surrounded by rows of rooms and are built of well baked bricks of dimensions usually to be found in the buildings of this period at other sites. Further evidence of the date of these structures was provided by the discovery of a copper coin of Huvishka and a silver coin, of the Indo-Greek King Hormaios. The finds include a large collection of pottery utensils of various kinds prepared of fine clay and not seen at other ancient sites in India. Among these are oval-shaped bottles with their necks and handles so designed as to represent the descent of the river Ganges from the matted hair of Trimbaka-Lord Shiva. Another find is a tank of burnt clay with a well-shaped figure of an elephant in the centre and lamps on the tops of the sides. Similar tanks have been found at Taxila and Ur and also in Egypt. The earliest stratum is at present represented by only one large house in and around which were found circular copper coins similar to those of the Malava tribe, found by Carleyle at Nagar in the Uniara *thikana* of Jaipur State. Further excavation work at this site is in progress.

Indian Central Jute Committee

A REVIEW of the activities of the Indian Central Jute Committee during 1938-39 is contained in the annual report of the Committee for the year. During the past year the Committee collected facts and figures which enable it to give a much more accurate and up-to-date picture of the production of jute, and the world demand for its products than has so far been available. Along with this an inquiry has been made regarding the marketing and transport of jute and its products. The conditions in certain markets in Bengal, Bihar and Assam have been thoroughly investigated and reports drawn up for the assistance of the provincial governments concerned on complete working schemes for the institution of regulated markets for jute at those centres. Important work has been done on the improvement of the jute forecast by an attempt to get far more

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accurate estimates of the area planted to jute each year and the acre yield of that area. On the technological side there has been scientific research work on jute itself to increase the efficiency of its production and to enable it to be utilized more efficiently and more widely. In the agricultural research section a study of the different varieties of jute was undertaken to find out their relative resistance to diseases and pests under field conditions. *Olitiorious* plants did not show any chlorosis at all, and they were less attacked by the stem-rot disease and apion weevil. The solution of the problem of transferring the resistance from *Olitiorious* type to the *Capsularis* type would depend upon the success that can be achieved in crossing these two types.

Indian Meteorological Department

NEARLY 10,000 messages to shipping at sea and to ports, 7,000 warning messages of high winds, frosts and heavy or untimely rain, 9,000 weather forecasts, 14,000 upper wind reports and 23,000 current weather reports for aircraft,—all these were issued by the Meteorological Department of the Government of India, during the year 1938-39. The annual report published recently shows that during the year funds set free were utilized for establishing from September 1 of this year, the forecasting centre at Delhi, which was closed in 1932 and for providing a short wave wireless station for broadcasting meteorological data from different stations in India and outside. The Royal Air Force Meteorological Offices were given an increase in the staff and more observatories were established in the northwest India. New forecasting centre for both civil and military aviation will be established at Willingdon Air Port.

In 1914 the Aerological Observatory was established at Agra, chosen as being at the boundary of the two main monsoon currents of the Bay of Bengal and the Arabian Sea. The Agra Observatory's work has multiplied, and now a large number of pilot-balloon observatories are run from Bahrein to Chittagong and Peshawar to Trivandrum. The Upper Air Office will be completely shifted in the next two years from Agra to Delhi. Regional and collective broadcasts of the Poona Wireless Station are now exchanged with the meteorological services of Malaya, Siam, Indo-China and other neighbouring countries. To meet the growing needs of aviation, the Karachi Meteorological Office was shifted to the new buildings near Karachi's Air Port, and Gwadur, Allahabad and Alipur (Calcutta) observatories were shifted to Jiwani, Bamrauli and Dum Dum, respectively. Pilot balloon stations making two ascents per day, were started at Rajsamand and Madhosagar. Daily afternoon ascents were added at Bhuj, Malegaon, Hyderabad (Deccan) and Bangalore. Arrangements, similar to the trans-India route were made for reports along the Karachi-Colombo route. Inter-

national codes were adopted for all reports issued from stations on the air routes, to give more detailed information on clouds, visibility, thunderstorms and dust-storms. For the use of the Royal Indian Navy, evening synoptic broadcasts were begun through the Navy Wireless Station, Bombay, from June 1, 1938.

The Agricultural Meteorological Section at Poona made steady investigation of the movement of moisture and of salts through soil layers, of the variation in frosts in Gujerat and of the rainfall of Bijapur and Amraoti. The observatory is also paying particular attention to solar and sky radiation, radiation, minimum temperatures under different conditions of exposure, the effect of surface covers on soil temperature, evaporation from soil and water surfaces, transpiration from plants, the climates of different crops, the exchange of moisture between plant materials and the atmosphere, and finally the seasonal variation of the nitrogen content of the surface layers of the soil.

Industrial Research Bureau

AN account of independent investigations and researches covering widely divergent industrial subjects carried out by the Industrial Research Council and the Industrial Research Bureau, including the Research Branch of the Government Test House has been given in the Annual Report of the Industrial Research Bureau of the Government of India for the year 1938-39. The Bureau acted as a co-ordinating link for industrial research work in provincial laboratories and technical institutions. The Industrial Research Council, which is the advisory body for the Industrial Research Bureau consists of Directors of Industries of provinces and States and a few members nominated by the central and provincial governments.

A feature of special interest to the public is the Industrial Research Council's annual prize competition for research papers on subjects of industrial value. The papers were judged by a Committee nominated by the Council and opinions of scientists and other authorities were sought. In 1938 prizes to the total value of Rs. 1,450 were awarded.

The Bureau published a series of interesting and useful notes and bulletins on various chosen subjects connected with Indian industrial research e.g., on the manufacture of China glass and liquid gold, silk production and weaving in India, workshop training in precision methods, washing and purification of Indian glass making sands, Indian refractory clays, clock-making in India, recovery of titanium oxide as a bye-product in the manufacture of alumina ferric from bauxite, the leather industry, the handloom industry, the manufacture of artificial silk, sulphuric acid from gypsum, phenol-formaldehyde resins for plastic moulding powders, spectacles and spectacle lenses, and on the design, construction and operation of a recuperative glass pot

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furnace. The Report shows that the number of enquiries dealt with, which form a considerably part of the work of the Bureau, has considerably increased.

The work of the Research Branch of the Government Test House, described in detail in the Report, includes the improvement of paints and utilization of indigenous materials for paint manufacture, the development of a technique to guide the manufacture of efficient dry cells, the utilization of Indian vegetable oils as lubricants and fuels in internal combustion engines, investigations of limes, and building materials, investigations to aid the glass industry, investigations and tests to aid the Indian electric lamp industry, road research, and other items of practical industrial value.

Announcements

THE eighteenth session of the International Geological Congress will be held in London in 1940. The sessional meetings will be held during July 31-August 8,

1940, and the following ten subjects have been listed for discussion: (i) Metasomatic processes in metamorphism; (ii) Rhythm in sedimentation; (iii) Geology of iron ore deposits; (iv) Geology of petroleum; (v) Geology of sea and ocean floors; (vi) Pliocene-pleistocene boundary; (vii) Faunal and floral species and zonal correlation; (viii) Earth movements and organic evolution; (ix) Geological results of applied geophysics; (x) Geology and paragenesis of the ores of lead and zinc. A number of pre-congress and post-congress excursions will be arranged. All communications should be addressed to the General Secretaries, Eighteenth Session International Geological Congress, Geological Survey and Museum, Exhibition Road, London, S. W. 7.

ACCORDING to the International Statistics recently published the population of the globe at the end of 1937 was 2,134,000,000. Half of this number belonged to Asia. Europe had 297,000,000 inhabitants, the most thickly populated countries being England, Germany and France.

Industrial Raw Materials for England

Sources of supply of the United Kingdom's requirements of industrial raw materials and foodstuffs are reviewed in the current issue of the *Bulletin of the Royal Institute of International Affairs*, and it is concluded that it should be possible to draw sufficient quantities of all but a very few commodities from the countries bordering on the Atlantic. A summary of the position contains the following remarks regarding the supply of raw materials: France should be able to supply potash, bauxite, some iron ore, and perhaps phosphates (from North Africa). Africa could provide vegetable oils (West Africa), copper (Northern Rhodesia, Belgian Congo), manganese (Gold Coast), chrome ore and asbestos (Southern Rhodesia), and vanadium (South-West Africa or Northern Rhodesia). Brazil and Central America have plentiful bauxite (British and

Dutch Guiana), oil (particularly Venezuela and Mexico), and lead, zinc, and antimony (Mexico). The United States is the United Kingdom's great source of supply for cotton and tobacco, while her oil, sulphur, phosphates, and molybdenum might also be important. Canada's many assets include timber, asbestos, copper, lead, zinc, nickel and aluminium (smelted from imported ore). It would also be important yet perhaps difficult, to acquire iron ore from Sweden or Spain, pyrites from Spain or Norway, and mercury from Spain. The only industrial commodities whose import from beyond the Atlantic appears to be essential are rubber (Malaya, Netherlands, East Indies or Ceylon), and tungsten (Burma, Malaya or China).

—The Chemical Age.

SCIENCE IN INDUSTRY

Fungus Growth on Paints

FUNGUS on paint films exposed to the weather has been found to play an important part in the breakdown of films. The growth has been observed to be particularly extensive on red oxide paints during the monsoon months. The fungus is dark, practically black, and appears to produce fine pin-holes in the paint film. In order to inhibit the growth of fungus, it is necessary to incorporate a suitable toxic substance. A series of paints were prepared containing small quantities of a number of toxic materials at the Industrial Research Branch of the Government Test House, Alipur, and the panels painted with them were exposed outdoors. The results so far obtained indicate that certain of the substances which have proved efficacious in western countries for similar purposes, such as sodium silicofluoride, magnesium borate, and tribromophenol, are of very little value in Bengal, but mercuric oxide and mercuric phthalate appear to retard the growth of fungus perceptibly. The optimum concentration of these materials required to inhibit the growth altogether or to reduce it effectively still remains to be determined. The fungus has been identified as *Ascoidea rubescens* by Dr. S. R. Bose, Professor of Botany, Carmichael Medical College, Calcutta, and with his assistance it has been possible to propagate the particular fungus in the laboratory for the experiments. Further information regarding the life and habits of the fungus requires to be gathered, and also whether this is the only type that grows on paints or there are other fungi also.

Coal as Motor fuel

COAL research division of the Research Foundation of Armour Institute of Technology, Chicago, has developed a new fuel named "liquid coal" for use in automobiles. "Liquid coal" consists of a suspension of powdered coal of about 500 mesh in a very light oil, or a form of range oil with a light fraction of hydrocarbon. The test was made on a 1939 model standard car engine. Excepting the removal of one fine screen filter no further change was made in the carburetion or in the ignition system of the engine. The engine was started with gasoline and after attaining smooth running conditions the gasoline supply was cut off and the liquid coal introduced in the carburettor. The test yielded a very satisfactory result.—
N.K.S.G.

Substitute Fibres

A RECENT *Bulletin of the Indian Central Jute Committee* contains information about manufacture of more substitute fibres. Banana-plant fibres which come from the genus (*Musa*) as Manila hemp (*Abaca*) have been woven into sacks. A sack made of banana fibres (110×68 cm.) weighs 470 gms. while a jute sack of the same size has a weight of 1000 gms. and a henequen sack 1850 gms. But the jute sacks are much more durable than banana fibre sacks. There are at present two plants in Mexico where banana fibres are being extracted but it is reported by the *Jute Review* that a speedy and effective method has not yet been evolved.

The manufacture of yarn and twine from paper is another development. It is progressing in many countries since pre-War days, especially in Germany. Chemically treated 'Kraft' paper is generally used for the purpose. The brown colour of paper twines conforms very nearly to that of usual hemp and jute shop twine. Advantages claimed for them are uniformity of thickness, perfect smoothness, unstretchability, non-contaminating properties, freedom from dust and fluff and power to stand varying climatic conditions. The paper twines and cords have been certified by the British Institute of Hygiene as reported in the *Industrial Fibre Review* and their use is advocated for the purposes such as bacon rolling and for packing meat and foodstuffs. There are now special types of paper twine for incorporating in upholstery work and special insulating and filling yarns for cables, dynamos and electrical motors. Other industrial uses are for bedding and piping cords and ropes. Paper yarns also make good carpet backing and prevent curling when the carpet is moist. Available in a wide range of fast colours these paper yarns are steadily finding other new uses.

Intermetallic Compound for Machine Tools

A NEW intermetallic compound corresponding to the formula $W_{10}Ti_3C_3$, or more correctly $W_{10}Ti_3C_4$, suitable for preparing hard tools which will machine steels, Monel metal and corrosion-resistant chromium and nickel alloys with speed and economy has been prepared. The substance is obtained by heating tungsten, titanium, and carbon in pure graphite crucibles in a bath of nickel to a temperature of 2000° F. for a prolonged period, whereupon crystals of tungsten-titanium-carbide

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are formed. On cooling, the crystalline substance is separated from the nickel by digestion, first with aqua regia and other reagents, and finally with hydrofluoric acid in platinum dishes.

The compound is used for producing a series of hard alloys named "Kennametal", by the process of powder metallurgy, in which the $W_{10}Ti_3C_4$ crystals are pulverized with cobalt, tungsten and carbon under exacting conditions and then pressed into a variety of shapes, such as toolpoints, corrosion and wear-resistant nozzles, valve-seats, balls, and die insets for drawing steel tubings and wires. Alloys containing $W_{10}Ti_3C_4$ as an ingredient are high in price and consequently only articles weighing under 100 grams are generally manufactured. There are prospects of large savings when used at strategic points of apparatus which are subject to failure by corrosion or wear. In deep-well oil pumps, balls and seats of this new hard metal can be used to control alternating valve action. Recently tests were made in which $\frac{3}{8}$ inch Kennametal balls were hammered against seats of Kennametal by a pneumatic hammer, using 600 blows per minute at 25 lb. air pressure with $\frac{1}{2}$ inch stroke. After 105 minutes of hammering, the valves showed no signs of destruction. This test is much more severe than that encountered in months of service of the pumps.—
N.K.S.G.

Uses of Sugar

WHAT a large number of products are derived from sugar and its chemical substitutes is described in a recent issue of *Industrial India*. The commonest use of sugar is in preserving foodstuffs, condensed milk, milk meals or powders, fruits, salt meats, etc. As a reducing agent sugar may be utilised in the manufacture of metallic oxides and in tanning. It is required during deliming of hides and skins and making of Chinese cement. It is an ingredient for polishes, transparent soap, dressing for textile materials, pastes, copying inks and liquid gums. Sugar yields alcohol, and on fermentation with particular organisms, acids, specially citric acid, can be obtained. Ethyl Alcohol and acetaldehyde obtained from saccharine leads by synthesis with butadiene to the formation by polymerisation of synthetic rubber (Buna). After treating sugar and sucrose with chemicals, many of the bye-products of the reactions are used as solvents valuable for making synthetic glass and artificial resins. Another product now manufactured, especially in America, and which has a great sale as a plasticizer in different industries, is sucrose octoacetate. Its utilization in varnishes is due to its solubility in petroleum spirit, in turpentine, in boiled linseed oil, in cotton oil and in the different vegetable oils. Productions of glycerine by fermentation of sugar was carried out in Germany during the last War. And

the systematic investigation of the optimum conditions of fermentation with different yeasts have led recently to a series of patents. Products of the nitration of sucrose have a secondary importance, which is however more than many other explosives.

A present tendency in view of the high price of proteins is to use molasses for the manufacture of yeast for feeding young cattle and milch cows, and horses, pigs and other animals during fattening. As is well-known, yeast is a food rich in nitrogen, specially valuable for its content of vitamins, amino acids and mineral salts. Irradiated yeast added to the ration of milch cows has resulted in a yield of milk, which is richer in butter fat and has antirachitic action due principally to the presence of vitamin D. Nitrogenous yeast is also used in human nutrition. In Germany, especially dishes such as soups, sauces, hashes, etc., are prepared having yeast as their basis, as well as extracts used for the making of concentrated broths. Treated yeast residues are used for the manufacture of ergosterin and after drying, as stock feed.

Sulphur From Fuel Gases

DURING the last fifteen years much progress has been made in the recovery of sulphur as a useful by-product from coke-oven gas, water gas, refinery still gas, natural gas, and other fuel gases. A detailed description of the processes in use throughout Europe and U. S. A. is given in an article in a recent issue of *Industrial and Engineering Chemistry*. The sulphur is recovered as solid elemental sulphur, as gaseous H_2S , or as ammonium sulphate. Under favourable conditions the recovery processes lead to a net profit, the value of the recovered sulphur being greater than the total cost of purifying the gas. The importance of these purifying processes can be gauged from the fact that sulphur recovered in Germany from the coke-oven gas alone amounted to 10,000 metric tons in 1927, which slowly increased to 13,000 metric tons in 1932, and then rapidly increased to 32,000 metric tons in 1937. It is estimated that in 1938 the production was about 50,000 metric tons. In U. S. A. also, on the completion of the new plants that are under construction, the total production of sulphur in all forms recovered from fuel gases will be approximately 50,000 tons per year. And yet this only represents a small percentage of the total potential yield.—
N.K.S.G.

Heating by Vapour

AN eutectic mixture of diphenyl (C_6H_5)₂ and diphenyl oxide (C_6H_5O)₂, called "Dowtherm A" is being used for heating purposes in the process industries, in the range between 400° to 700° F. Its boiling point at atmospheric pressure is 500°F, and it does not solidify until the temperature is lowered to 54°F. It does not break down chemically during long periods of operation while generating vapour within the above range.

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The use of a condensing vapour for the transmission of heat in process work has the advantage of close regulation of temperature in the heated vessel. The high rate of transfer due to latent heat of condensation of the vapour ensures economical use of the heating surface and permits operation with close temperature differences between the heating medium and the product heated. Steam is an excellent medium for such heating services up to temperatures of 350° to 400°F., but for higher temperatures the pressure becomes excessive with the result that serious difficulties and expenses are encountered. A comparison of the properties of Dowtherm vapour and steam shows that under ordinary conditions the latent heat of Dowtherm vapour, which is 123 B.t.u. per lb. at 500°F., is much less than that of steam; on the other hand, the density of Dowtherm vapour is correspondingly greater. The net result is that, volume for volume, the two gases have approximately the same latent heat content at corresponding pressures in the range of normal commercial usage of Dowtherm vapour.

Several units for generation of Dowtherm vapour for use in process industries are in operation in U.S.A. for the last 6 or 7 years. The Dowtherm is tested annually for deterioration; but in 7 years, there has been no trace of decomposition. During the same time there has been no sign of corrosion or scaling of the Dowtherm heating surface, which was made of steel.

The deodorisation of vegetable oil is perhaps one of the most delicate of all chemical heating processes because free fatty acids, which cause odour and rancidity boil at temperatures which is very close to the scorching point of the oil. In the past, the use of batch system was always used for the removal of acids. Recently continuous vegetable oil deodoriser systems, heated by Dowtherm, have been put into successful operation. The method is also finding its applications in petroleum refining.—
N.K.S.G.

Waterproof Paper

A FRENCH patent has been taken recently for a process for manufacture of paper which is impermeable to water or to greases by the addition of artificial resins to the paper pulp. The resins are precipitated on the fibers of the pulp by addition of electrolytes and the pulp is passed over hot calenders

without vulcanising agents. A wide range of plastics can be used, the butadiene polymers being preferred. Vinyl ester polymers, polyvinyl alcohols, and acrylic acid polymers can also be used.

As an example, a mixture of 100, parts of dry cellulose with 5 to 10 parts of artificial rubber in aqueous emulsion, with diethyl phthalate, is prepared and 10 per cent solution of aluminium sulphate is added in sufficient quantity to introduce 5 parts of sulphate to 100 parts of cellulose (dry). This precipitates the rubber on the cellulose fibre. Manufacture of the paper is then carried on in the usual manner, the only special requirement being that the calender should be heated to about 120°C. This softens the rubber sufficiently to permit it to be pressed into the pores between the fibres producing a paper which is impermeable to water, air and greases, as well as being very flexible and elastic.—
N.K.S.G.

Steam in 15 Seconds :

IN recent years steam generating plants have been designed and erected, which can be started up and brought to full steaming capacity within a remarkably short period of time of ten minutes only. Naturally this marks a considerable advance in technique over that in former practice with fire-tube and older water-tube boilers where the time required was in hours generally.

However ten minutes are hopelessly long compared to the time required for the tiny boiler, marketed by Westinghouse Electric Mfg. Co., of U. S. A., to attain full steaming capacity, for it starts to blow superheated steam at 350°F. just 15 seconds after the operation starts. Heating is done by electric coils, directly immersed in water and the thermal efficiency is 90 per cent. There is a superheating coil and the outward shape of the boiler is that of a vacuum tube. It is only 9¼ inches in height and the casing is made of chemical resistant glass able to withstand an internal pressure of 25 lbs. per sq. in., and a shock of transference from hot to cold water and vice versa without cracking. Different sizes of 1000, 1500 and 2000 watts and evaporating capacity of 5.7 lb. of water per hour have been marketed. They will find lots of uses in plants and laboratories for sterilising instruments for doctors, for distilling, and for supplying steam for small scale processes where steam is required quickly.—
N.K.S.G.

Chemical Industries in India

Hira Lal Roy

College of Engineering and Technology, Bengal, Jadavpur.

The total population of India including those of the Indian States and the French settlements according to the last Census (1931) is about 338 millions (Bengal. 51 millions). Of this vast population only about 1,600,000 i.e., 0.48 per cent are engaged in large industrial establishments (i.e., industrial concerns in which on an average not less than twenty persons are engaged in the production side per day). Figures for smaller establishments are not easily available unless they are carefully collected during the Census and equally critically sifted from that vast amount of data. But the figures collected from the latest publications (of 1935) issued by the Department of Commercial Intelligence and Statistics and those stated above show that India is not industrialized unless single-family or sub-family agricultural operations be considered as industries. In that case, agriculture will be by far the biggest industry of the country. Of the different perennial industries with a daily minimum of 20 workers, the following are the most important:—

Industry	Average No. of workers per day	
	India	Bengal
Cotton (spinning, weaving etc.)	514,000	28,000
" ginning and baling	180,000	2,000
Jute Mills	281,000	264,000
" Presses	32,000	32,000
Coal Mining	180,000	.....
Railway & Tramway Works	113,000	28,000
Engineering Workshops	92,000	45,000
Rice Mills	75,000	13,000
Sugar Factories	73,000	3,500
Tea Factories	66,000	19,000
Printing and Book Binding	38,000	9,000
Dockyards, ship-buildings	21,000	15,000
Ordnance factories	19,000	6,000
Match factories	19,000	6,000
Bricks and Tiles	15,000	500
Oil Mills	14,000	2,500
Cement, Lime, Potteries	13,000	2,000
Rope works	13,000	1,000
Tobacco	12,000	1,000
Leather, Shoes and Tanneries	8,000	1,500
Woollen Mills	8,000	200
Dyeing, Bleaching, Indigo	8,000	.....
Silk Mills	7,000	500

Industry	Average No. of workers per day	
Glass Works	7,000	1,500
Paper Mills	7,000	5,000
Coaching, Building & Motor Car Repairing	7,000	2,000
Stone-dressing	6,000	200
Hosiery	6,000	1,600
Flour Mills	6,000	1,500
Kerosene, Tinning and Packing	6,000	2,500
Rubber	6,000	3,600
Saw-Mills	3,000	250
Petroleum Refineries	3,000	.....

Chemical industries themselves do not produce commodities for general consumption but are mostly feeders for other industries; this statement is more applicable to the case of heavy chemicals, i.e., chemicals which are produced in large quantities at a comparatively low cost of manufacture and are not directly consumed as such by the people.

In the Table below is given a list of some of the heavy chemicals used by Indian industries, the amounts of their indigenous production and import of each for the year 1937.

Chemicals	Indigenous Annual Production in Tons	Annual Import in Tons
Sulphuric Acid	28,000	290
Nitric Acid	480	300
Hydrochloric Acid	340	80
Aluminium Sulphate & Alum	8,940	4,150
Sodium Sulphate	1,050	2,530
Sodium Sulphide	Nil	4,110
Magnesium Sulphate	3,060	720
Copper Sulphate	Nil	2,840
Iron Sulphate	480	80
Ammonium Sulphate	12,000	48,100
Magnesium Chloride	?	900
Zinc Chloride	Nil	2,850
Ammonium Chloride	Nil	2,500
Soda Ash	Nil	1,22,100
Sodium Bicarbonate	Nil	11,250
Caustic Soda	1,440 (Tittaghur)	39,400
Sodium Silicate	1,700	2,630

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Chemicals	Indigenous Annual Production in Tons	Annual Import in Tons
Potassium Nitrate	7,000	Nil
Liquid Chlorine	Nil	345
Bleaching Powder	2,760 (Tittaghur)	17,150
Calcium Chloride	Nil	1,275
Calcium Carbide	Nil	4,300
Ammonia Anhydrous	Nil	192
Sodium Bichromate	Nil	420
Potassium Bichromate	Nil	1,500
Borax	Nil	2,680

Sulphuric acid is one of the most important key chemicals of the industrial world. It is required for the manufacture of all sulphuric salts and most other acids and therefore most other salts. There is no other independent chemical, the tonnage production of which is greater than that of sulphuric acid. Its biggest consumption, about three-fourths of the total, is in the manufacture of fertilisers—ammonium sulphate and superphosphates. Because of the corrosive nature of the acid and its low cost of production, the transport cost exceeds the latter and therefore very little of it is imported. The chief material for its manufacture in India is sulphur. No sources of sulphur which can be economically tapped has yet been discovered in India and therefore the whole of it is imported—total imported amount for 1937 being 46,500 tons, of which one-fifth is utilised in the manufacture of the acid. In these days of autarchy (self-sufficiency) aimed at by all countries of the world and in view of the possibility of the stoppage of import of such an important raw material in time of war (as happened to import from Sicily during the last Abyssinian war), an earnest and intensive search should be made for it. At present, this acid is manufactured by eleven different concerns for their own consumption as well as for the market; four of these are situated in Bengal. Besides this team of eleven, all the iron-producing (from ore) concerns and the coal mines converting coal into coke at the mining centres manufacture sulphuric acid for their own consumption. But yet the total annual production is only 28,000 tons, i.e., 0.0028 per cent of the total world production, and the population of India forms 17 per cent of that of the world. The production of sulphuric acid measures the industrialization of a country and according to this measuring stick India is a pigmy.

But it will be observed that India supplies its own demand of this chemical and every sulphuric acid factory has been working at underload. Unless industries are developed there will be no consumer for further production. As a matter of fact, recently there was over production of this commodity and manufacturers had to come to a mutual agreement fixing the minimum sale-price and maximum production allotted to each.

The biggest consumer of the acid is the fertilizer industry. The following are the figures (1937) for the import of fertilizers excluding oil-cakes:—

Fertilizer	Amount in Tons	Value in Rupees
Sodium Nitrate	3,005	2,92,338
Ammonium Sulphate	48,136	48,24,419
Potassium Chloride	2,222	2,22,294
Other Potassium Salts	1,147	1,30,330
Superphosphates	7,762	5,68,747
Other phosphates	3,189	3,52,471
Ammonium Phosphates	3,081	4,63,966
Fish manures	1,801	71,690
Other manures	1,471	1,36,660

India being *par excellence* an agricultural country its expected fertilizer requirements should be very heavy but the cultivators being very poor and the lands being parcelled out into small plots, the capital necessary for the purchase of artificial fertilizers for intensive cultivation cannot be collected. Most of the fertilizers that are produced in the country and imported are consumed by the tea plantations and sugar-cane cultivation. Intensive cultivation should be resorted to and a part of the cultivated area should be released for crops other than food materials. The quantity of food required per head cannot be increased indefinitely, only its quality and variety can be changed. Inefficient nature of Indian agriculture is evident from the fact that rice from Burma and wheat from Australia are imported to India. For intensive agriculture artificial fertilizers will be needed, for the manufacture of which some indigenous substantial source of potassium salts must be discovered and method of working the same invented; phosphates must be obtained from animal bones which are now exported, and immediate steps should be taken to convert all ammonia obtained from by-product coke-ovens into ammonium salts. According to present statistics only 12,000 tons of ammonium sulphate are produced and four times that amount imported every year. In the year 1937, a little over 25 million tons of coal were raised in India. If we assume all this amount to be bituminous coal it should have been worked to yield approximately 2,50,000 million cu. ft. of coal gas, 17.5 million tons of coke, 1.5 million tons of tar and 62,500 tons of ammonia or about four times this amount of ammonium sulphate. Burning of soft coal should be prohibited by law. The tar, ammonia cyanogen compounds and sulphur should be recovered from all coals. This one single step would considerably accelerate the industrialization of the country and would necessitate a large increase in the production of sulphuric acid.

India's coal resources are reported to be inadequate and as yet chiefly located in one region. Southern India has not yet been blessed with discovery of coal mines. A project is being worked out in Mysore to manufacture ammonia synthetically according to Haber's process and sulphuric acid by contact process. Unfortunately, India

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is far behind other industrial countries not only in the quantity of production but also in the method. The old lead-chamber process is followed in every factory except the Tata's at Jamshedpur where vanadium contact catalyst is used.

Next in importance in the lines of heavy chemicals is the alkali-chlorine industry. The total demand is met by import; the only factory which manufactures caustic soda and chlorine in any appreciable amount is the Tittaghur Paper Mills but it consumes fully its own production. The Imperial Chemical Industries (India) Ltd. will, according to available report, begin production of these chemicals in the Punjab and in Bengal, and the Mettur Chemical and Industrial Corporation Ltd., in Madras Presidency is erecting a factory at Mettur Dam for the production of caustic soda, chlorine and bleaching powder. But until the products are successfully sold in the market continuously for two or three years the economic success of the venture would not be taken for granted. Many a much-rumored industrial venture was ship-wrecked in the past because of undercapitalization, bad organisation, nepotism, and overlooking of "tremendous trifles" like supply of good water etc. Closing of Shri Shakti Alkali Works of the Dharangadra State for the production of sodium carbonate and bicarbonate by the olvay process should serve as a sharp warning to all future industrial enterprises. But it is reported that the Works will be reopened under new management. The starting of a new chemical company under the management of the Tatas has been advertised in the papers. They have funds at their command and it may reasonably be expected that they would begin the manufacture of heavy chemicals and later go into specialized products.

Caustic soda is consumed in textile mills, soap industry, petroleum refineries, vegetable oil refineries etc. According to the method of production prevalent now, chlorine and hydrogen are obtained as by-products. But the present demand for chlorine and hydrogen is not of the same magnitude as that for caustic soda. To compete successfully with imported caustic soda the manufacturing company must find avenues for the consumption of these inevitable by-products. One of the possible schemes for such utilization may be mentioned here as an illustration. A big soap factory requires a large quantity of caustic soda; if it produces its own caustic soda, then the hydrogen produced along with it may be utilized for hydrogenation of cheaper fish oil and vegetable oils with their subsequent consumption in the soap-factory itself. Caustic soda is used in soap-manufacture in the form of solution but it is bought from the market in solid form, so by the production of caustic soda in the factory itself, the

considerable cost of concentrating to solid form may be avoided. It is only by production on a large scale and by utilization of the by-products as far as possible that the present and the future industrial concerns producing heavy chemicals will be able to successfully compete with the imported goods.

In this short survey of the heavy chemical industry in India it is only proper that the names of the firms who may be styled as pioneers in the field at this undeveloped stage should be mentioned.

Names of Firms	Heavy Chemicals Produced
Messrs. D. Waldie & Co. Ltd., Bengal	Sulphuric, Hydrochloric and Nitric Acids; Sulphates of Alumina and Iron; Alum; Zinc chloride solution; Lime-sulphur; Red lead and White lead.
The Bengal Chemical & Pharmaceutical Works Ltd., Bengal	Sulphuric, Hydrochloric and Nitric Acids; Alum, Sulphates of Alumina, Iron and Magnesium.
Dr. Bose's Laboratory Ltd., Bengal	Sulphuric, Hydrochloric and Nitric Acids; Alum; Aluminoferric, Copperas Magnesium and Sodium Sulphates; Lime-sulphur solution.
The Bengal Acid and Chemical Manufacturing Co., Ltd., Bengal	Hydrochloric and Nitric Acids; Sodium sulphate and Soda crystals.
The India Chemical and Pharmaceutical Industries, Bengal	Sulphuric, Nitric and Hydrochloric Acids; Alum; Sulphate of Alumina, Aluminoferric, Copperas and Sodium Sulphate.
Messrs. Perry & Co., Madras	Sulphuric, Hydrochloric and Nitric Acids; Sulphates of Magnesium, Iron and Sodium; and Calcium Superphosphate.
The Madras Alkali and Chemical Works, Ltd., Madras	Hydrochloric Acid, Sodium Sulphate, Soda, Ammonium Chloride, Copper Sulphate, Iron Sulphate and Zinc Chloride.
The Eastern Chemical Co., Ltd., Bombay	Sulphuric, Hydrochloric and Nitric Acids; Sulphates of Iron, Sodium and Magnesium and Soda crystals.



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Names of Firms	Heavy Chemicals Produced
The Dharamjee Morarji Chemical Co., Ltd., Bombay	Sulphuric, Nitric and Hydrochloric Acids; Sulphates of Alumina, Sodium and Magnesium; Alum; and Calcium Superphosphate.
The Ramco Chemical Works, Bombay	Sulphuric, Hydrochloric and Nitric Acids; Sulphates of Alumina, Iron, Magnesium and Sodium.
The Baroda Chemical Works, Baroda	Sulphuric, Nitric and Hydrochloric Acids; and Sodium Sulphate.
The Cawnpur Chemical Works, Ltd., U. P.	Sulphuric, Nitric and Hydrochloric Acids; Alum Sulphates of Alumina and Iron.
Messrs. Shambhu Nath and Sons Ltd., Punjab	Sulphuric and Hydrochloric Acids; Alum; Aluminoferric and Copper sulphate.
The Pioneer Magnesia Works Ltd., Bombay.	Magnesium Chloride, Magnesium Sulphate, Potassium Chloride, Magnesium Oxide and Carbonate, Calcium Chloride and Sodium Sulphate.
The Tatanagar Chemical Co., Ltd.	Artificial Red Oxide.
The Mysore Iron and Steel Works	Methanol, Methylacetate and Calcium Acetate.
The Tittaghar Paper Mills Ltd. Bengal	Causitic Soda, Bleaching Powder.
Messrs. Lever Bros. (India) Ltd., Bengal	Glycerine
The Tata Oil Mills Co., Ltd.	Glycerine

Names of Firms	Heavy Chemicals Produced.
The Tata Iron and Steel Co., Ltd.	Sulphuric Acid and Ammonium Sulphate.
The Bengal Iron Co., Ltd.	
The Indian Iron and Steel Co., Ltd.	
Loyabad Coking and By-products Recovery Plant	
The Bararee Coke Co., Ltd.	
The E. I. Railway Coke Plant	Sulphuric Acid.
The Tin Plate Co. of India Ltd.	

The term "Chemical Industries" include industries producing not only heavy and fine chemicals which are definite chemical compounds but also includes those industries which manufacture goods in the production of which pronounced chemical reactions take place. In all such industries chemist and chemical engineers play leading roles and heavy chemicals are consumed in large quantities. Below is given a list of such commodities with their values and quantities of imports and the indigenous production, as far as available for the year 1937.

Articles	Weight in Tons	Value in Rupees	Indian Manufacture in Tons during 8 months (April-Nov. 1939)
1. (a) Paper of all kinds	1,87,012	4,00,31,739	40,120
(b) Wood Pulp	10,126	15,51,860	?
2. Glass & Glass ware	....	1,50,26,202	?
3. (a) Paints & Varnishes (including lithophone, white lead, red lead, zinc white &c.)	14,339	78,56,898	?
(b) Painters' Materials (including turpentine, varnishes &c.)	....	25,96,669	?
Total	....	1,04,53,567	18,055
4. Synthetic Resins	?	?	Nil
5. Sugar	16,734	20,78,136	1,79,528
6. Rubber (a) Raw	2,264	14,73,600	?
(b) Manufactured	....	2,09,01,224	?
7. (a) Silk, Raw and manufactured	....	3,18,89,800	....
(b) Silk Artificial—Yarn		2,21,99,478	
Hosiery		2,44,44,508	
Mixed Goods I		5,66,11,091	
Mixed Goods II		6,99,946	

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Articles	Weight in Tons	Value in Rupees	Indian Manufacture in Tons during 8 months (April-Nov. 1939)
8. Soaps	2,177	24,94,833	?
9. Toilet Requisites	....	69,74,612	?
10. Drugs and Medicines	....	2,29,67,707	?
11. (a) Ferrous Metals & manufactures thereof	....	8,32,21,544	26,76,622
(b) Non-ferrous Metals & manufacture thereof; of these, Aluminium	....	5,13,96,949	?
(i) Wrought	3,221	49,24,736	?
(ii) Un-wrought	4	?	?
12. Manures excluding Oil Cakes	73,238	71,00,619	....
13. Coal-Tar Products—			Nil
(a) Dyes and Colours	9,910	3,66,29,317	?
(b) Disinfectants:—			?
(i) Napthalene &c.	566	2,08,778	?
(ii) Others	1,062	6,47,126	?
(c) Pitch and Tar	2,851	2,19,374	?

Many other commodities can be added to this list, but as it is, it indicates the line of possible future developments.

In spite of very favourable protection afforded by the Tariff Board, paper manufactured within the country meets less than one-fifth of the present total demand. One of the chief causes for slow development in this line seems to be the scarcity of suitable wood for manufacture into pulp. It is surprising that India with her area and favourable climatic conditions should not possess the proper species of trees to yield the necessary pulp. Either a proper search has not yet been made or the transport difficulties stand in the way. The United States of America had so long been importing most of her wood-pulp from Canada, but recently after intensive study and research a kind of pine is being grown in the southern States which after five years of growth yield the necessary wood for pulp. With planned afforestation and deforestation it is announced that very soon that country will be independent of Canadian wood pulp. A similar serious attempt should be made in India. At present (up till 1937) there are only nine paper mills in the country—two in U. P., three in Bengal, three in Bombay, and one in Travancore. Of the total of 6,698 men employed, 4,856 belong to the three Bengal Mills. The chief raw materials used are grass and bamboo. The demand for paper is increasing every year and there are vast possibilities for expansion of this industry.

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There are fifty-nine glass factories located all over India, eleven in Bengal, two in C. P. & Berar, five in Bombay, one each in Madras and the Punjab, thirty-five in U. P., and four in the Native States. Most of these are small concerns, less than seven thousand men being employed by all these fifty-nine factories together. The products are also very ordinary glasswares. All raw materials for the industry except soda ash are already available in the country and there is no reason why, with the help of foreign experts if necessary, glass of better quality and in larger quantities should not be manufactured in India.

Paints are manufactured by eleven different factories in India; seven in Bengal, one each in Bombay, C.P., Delhi, and Mysore with a total labour-strength of 1,678 men. The productive capacity of none of these is definitely known. But the total production for 8 months in 1938 was estimated at 18,055 tons. Turpentine and resin are manufactured by four concerns—two in Kashmir, and one each in Bareilly and Lahore. With these poor figures it is no wonder that more than a crore of rupees worth of paints, varnishes etc., are imported every year.

The present age may aptly be called the age of alloys. But the dawn of a new age is fast approaching—the age of glass and synthetic resins. India, as usual, is lagging behind. No synthetic resin is manufactured, but though figures are not available in the government reports it is apparent that the imports of celluloid and celluloid articles, bakelite powder and bakelite goods are increasing every year.

There are three rubber plantations in Travancore and two in Cochin but the figures for individual and total productions are not available. There are eighteen factories manufacturing rubber goods from indigenous rubber and imported raw rubber—eleven of these are situated in Bengal, four in Bombay, one each in the Punjab, Bhavnagar and Travancore. And the total value of imported rubber goods is more than two crores of rupees.

A novelty of the new civilization lies in the ingenuity and industry of man in imitating nature and manufacture of artificial goods. Nowhere it is more evident than in the phenomenal growth of synthetic fibre industry, specially artificial silks. In America already suggestions are being put forward to find new outlets for cotton as the cotton textile products will perhaps be considerably replaced by artificial silk. In India even, where people are too poor to clothe themselves adequately, more than five crores of rupees are paid for the purchase of foreign artificial silk and the import shows signs of increase. Not a single yard of artificial silk yarn is manufactured in the country at present. Here is an avenue for industrial venture for big capitalists. Soaps and toilet goods satisfy man's sense of cleanliness as well as his vanity. With the increase of wealth and of urban population the demand

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for soaps and toilet goods will increase and there is enough field for expansion.

Though the total value of the imported drugs and medicines imported to India annually comes up to more than two crores of rupees, it is not a very big amount compared to European and American standard, the *per capita* yearly consumption of imported drugs and medicines being about one anna. It does not mean prevalence of healthy and sanitary conditions in India. As a matter of fact, incidence of diseases and epidemics is greater in this country than in Europe owing to climatic conditions and under-nourishment. The indigenous system of medicine partly meets the needs of the Indian patients but that also requires to be prepared according to more scientific methods. Indian medicinal plants are exported to foreign countries and come back to us in the form of pharmaceutical preparations. This form of trade should be stopped. With proper organisation and helpful co-operation of medical men and chemists, industrialists can build up factories like those of Parke Davis, Burroughs Wellcome and Bayer.

In the field of metallurgy India is making some progress, specially in iron, but even in this case it has not yet been possible to manufacture special steel and ferro-alloys.* More rapid progress may be expected in near future. India is yet known to be poor in natural deposits of ores, and coal-mines are located in one region only. Geological prospecting has not yet been made with satisfactory thoroughness. Iron ores are converted into ores on a large scale in only four places—Jamshedpur in Bihar, Kulti and Asansol in Bengal, and Bhadravati in Mysore. Of ferrous metals and manufactured articles, India imports forty times of what she produces within the country. Copper is extracted from its ores in only one place and that at Moubhandar in Bihar.

It is surprising that with her vast deposits of bauxite of fairly good quality in C. P. and other places, manufacture of aluminium has not been started so long. It is rumoured that very shortly an Indian concern will start operations in this line. Aluminium utensils have caught the imagination of the people and its import is on the ascendance. Previously India used to import only aluminium wares but within the last few years several factories have been started in different parts of the country for working imported wrought circles, and sheets etc., and unwrought ingots, blocks, and bars into aluminium articles of all kinds. The total value of the import of this metal and manufacture thereof in 1937 was nearly fifty lacs of rupees. Because of cheapness, lightness, durability in water and air, and of its brightness, this metal will replace more costly brass and bell-metal in the manufacture of utensils.

*See SCIENCE AND CULTURE, 4, 709, 1939.

Every country is now paying intensive attention to its fuel resources. India (minus Burma) has discovered only one workable oil-field and that in Assam. Her coal mines are located in the borderland of Bihar and Bengal and an inferior quality has been discovered in Assam and Central Provinces. Considering the vast area and population, India is poor in fuel. In 1937, about twenty-five million tons of coal was raised from the mines and most of it was burnt as such, as is proved by the fact that instead of a possible yield of about 2,00,000 tons of ammonium sulphate, of only 12,000 tons is recorded. This means a loss of all by-products. Bituminous coal is full of treasures; the tar obtained from it by destructive distillation can under suitable treatment yield many products as is well known to all students of chemistry. The trade reports issued by the government tell us that coal-tar products of the approximate value of four crores of rupees were imported into India in 1937. A plan should be drawn up by governments concerned prohibiting burning of raw coal and to arrange for destructive distillation of coal on large scales at different centres. Next steps should be to distill the tar obtained and recover as many products as are possible from it.

It is not possible to make a comprehensive survey of the present and future conditions of chemical industries in India in this short article. From what has been described it will be apparent that most chemical industries are interdependent. So, to achieve success a very big concern with vast capital should be set up in which products and by-products of one branch may be utilized by some other branches, or different independent concerns may be started on a co-operative basis safeguarding each others interests.

Before taking any step in further industrial venture a regular survey should be made by every provincial government in co-operation with the central government. As a matter of fact, much is yet to be known of the natural wealth of the country both on the surface of the earth and under it.

The present is the time of industrial planning, resorted to by all countries whether communistic like Russia, totalitarian like Germany and Italy, or firmly capitalist like the U. S. A. The *laissez-faire* policy of the past is being no longer followed, some form of State-interference has become imperative. It is a good augury of the times that the Indian National Congress has entrusted this stupendous task with its National Planning Committee. With the co-operation of the provinces and the States it will be possible to put the recommendations of the Committee into effect. One possible great obstacle in carrying out the recommendations lies in the fact that the customs, tariff, and excise are in the hands of the central government which is yet to be popular. But it may be expected that with the war-menace in the East and the West, the British Government will be eager to make India industrially self-sufficient and co-operate with the Congress to a considerable extent in the work of national planning.

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Assessment of Physical Fitness

THE old adage "Survival of the fittest" is no longer tenable under the modern conditions of life. Today we can mould our environment to suit our bodily needs. We build protective walls round the weak from the cradle to the grave. The cost of this protection, in other words, expenditure on national health is enormous. As a consequence of this, a serious question arises. Is the race degenerating? Our progressive civilization makes greater and greater demands upon the qualities of its bearers. Has this increasing demand impaired the qualities of the race? This question was raised by Professor David Burns in his presidential address at the physiology section of the British Association Meeting at Dundee last September. He then discussed the tests of physical fitness and suggested certain methods.

If comparative death rates are in any way a measure of fitness to environment, we find that these in all countries and at all ages have decreased. In England and Wales, the death rate for adults has fallen from 21.4 per thousand in 1871-1880 to 12.1 in 1921-1938 and of infant mortality from 146 to 59 per 1000 births. A closer analysis of figures of mortality rate, however, shows that infant mortality is closely related to the rate of breeding. Those families who do not have more than three children and breed at the model rate *i.e.*, the first child when the age of the mother is between 20-25 years and next two children spaced not less than two years apart, have an exceedingly low death rate irrespective of social class and almost irrespective of economic status.

The rate of breeding in all civilized countries is declining. The present level of birth and infant deaths is largely maintained by people who are least fitted physically, mentally and economically to form the basis of the next generation. These ten percent of the population who are responsible for 35 per cent of the future generation, are from the ranks of the unemployed, the unhealthy, malnourished, mentally subnormal, reared in unsatisfactory environment and subject to social and economic hardships. Under these conditions the mean intelligence quotient of the population, according to J. B. S. Haldane is expected to decline 1-2 per cent, in each generation. This should offer serious food for thought.

There is yet another aspect of the problem. The present low birth rate combined with the increased longevity of the race will produce a greater proportion of people of high ages. According to one estimate, the present old age pensions bill of Great Britain will increase from 40 million pounds to sixty million in 30 years. By 1960, the children (under 14) and the aged (over 60) will form 38 per cent of the population and with a sex ratio of 0.9 only 30-35 per cent of the population will have to support the rest. This will create economic difficulties which may be almost insoluble.

There is clearly one way out of this confusion and mounting difficulties. The level of physical fitness of the coming generation must be markedly increased over the present one. How can this be done? What is physical fitness?

According to Cathcart a fit person will be well balanced physically, mentally, emotionally and capable of adjustment to his immediate environment. He will have harmony of motion, grace of carriage, pride of body, mental concentration, quickness of reaction, happiness and contentment. How can these qualities be assessed and developed?

At present there are numerous tests of physical fitness. These may be divided into three classes: (i) somatometric, (ii) physiological and (iii) psychological. To the first category belong those based on measurement of status, weight, chest girth or such indices as the Pelidisi or the A.C.H. Experience has shown that none of these is valid as a measure of fitness. Fitness is functional. Among the physiological tests one is based on the determination of the alkali reserve of the blood. The fit must have a large enough reserve to cope with the acid released in muscular exercise. Others are based on the vaso-cardiac efficiency and muscular tone. Among these the former can be tested by noting the return of the cardiorespiratory mechanism to normal functioning within a limited time after exertion. The latter is dependent on many factors and its assessment is more complicated.

The condition of the mind is another factor in the amount of work and the goodness of work done by a person. One of the conclusions drawn from exhaust-

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ive investigations in U.S.A. is that good sociological conditions are of paramount importance if good work is to be expected. Tests to assess the ability of a person to react rapidly and accurately to changes in environment have been proposed.

The means of increasing the mental and physical fitness lie in wise physical training, co-operative effort and feeding. These will go far in reconditioning the youth of our generation. It must be clearly understood that real strength lies in our men and women and not in the machines that they tend or the battle ships they man.

Cinchona Cultivation in India

AT the suggestion of the Indian Research Fund Association and the Central Advisory Board of Health, the Imperial Council of Agricultural Research deputed in 1937 Messrs. A. Wilson (Deputy Director of Agriculture, Cinchona, Madras) and T. J. Mirchandani (Agricultural Chemist, Bihar Government) to undertake an enquiry into the prospects of cinchona cultivation in India. Their report (*Miscellaneous Bulletin* No. 29, 1939) just published makes interesting and useful reading.

Cinchona trees are indigenous to South America where it grows at altitudes between 2,500 ft.—9,000 ft. above sea level. The bark contains the alkaloid, quinine, as well as others such as cinchonidine, cinchonine and quinidine, all of which are useful in the treatment of malaria. The most important species is *Cinchona ledgeriana*, which yields yellow or ledger bark and which grows best in India at 4,000 ft. 94 per cent of the world's plantations are of this species. Less important species are *Cinchona calisaya*, *Cinchona officinalis*, *Cinchona succirubra* and *Cinchona robusta*. Their distribution in India is as follows:—*C. ledgeriana*—72%, *C. robusta*—22%, *C. officinalis*—5% and *C. succirubra*—1%.

The history of cinchona in India shows that, within a short period of thirty years, the plantation industry had been abandoned by private enterprise by 1800, following overproduction and a catastrophic drop in prices. All that remained in India were the cinchona plantations belonging to the Governments of Madras and Bengal. These were the pioneers in the work of establishing the plant in India from seed obtained from South America. The early planters could only utilize those seeds offered in India and the variety was mainly *Cinchona succirubra* or red bark, a worthless variety so far as quinine is concerned but enjoying remunerative market in the early days of cinchona growing in India on account of its other alkaloids—cinchonidine, cinchonine etc. Ceylon followed India in growing *Cinchona succirubra*, but Java, after an uncertain start when failure seemed more evident than success, took to the quinine-yielding family

generally termed *calisaya*. When therefore seeds of the rich *ledgeriana* variety and of *Cinchona calisaya* was on offer in 1865, it was Java which recognised the possibilities and later Bengal. Java, by systematic scientific work and the possession of optimum conditions for growing cinchona, gradually obtained a complete command of the world's quinine market and now dominates it to the extent of nearly 97 per cent.

The lessons of history which have been gathered in the report are:

(i) That the cultivation of *Cinchona ledgeriana* on land suitable for this variety should be India's goal; (ii) That as public health is concerned with the certainty of indigenous supplies, the State should assist this renaissance by freely placing disease-free seedlings on offer and at the same time should equip a Research Station under the Imperial Council of Agricultural Research for the isolation of strains of high quinine content, the examination of the problems of cultivation and manufacture as well as for the collection of necessary statistical data; (iii) That planting schemes, no matter what agency is employed, should be framed on the results obtained from trial or experimental plantings in each locality; (iv) That it is advisable to consider the employment of private enterprise in cinchona either by contract with private planters or by a State-aided cottage industry, should the latter be feasible; (v) That a close liaison should at all times be maintained between the State and the cinchona grower so that schemes of distribution leading to adequate consumption should be framed.

Possibilities of Cinchona Production

FOR an early resumption of cinchona growing there are at present available some 38,000 acres distributed in Bengal, Assam, Orissa, Bhutan, Sikkim, Madras, Travancore, Cochin, Mysore and Coorg. India's consumption today is about 210,000 lbs. of quinine of which roughly 70,000 lbs. are made in the country and the balance or 140,000 comes from factories using Dutch East India bark. But the real need of India is provision for 1,000,000 sufferers for whom 45 grains should at least be provided. This will use up some 600,000 lbs. of quinine sulphate annually. Even if Java can supply this quantity by extending its production, an enlightened public health policy regarding malaria in other countries might well leave India with uncertain or inadequate supplies. India should therefore grow its own requirements of quinine by building up an organisation to meet the actual needs of India i.e., 600,000 lbs. of quinine annually. A scheme of planting 778 acres annually under an estimated yield of 180 lbs. of quinine sulphate per acre will in course of 12 years provide 140,000 lbs. annually. But this is a long time to wait. A modified scheme providing for 1,000 acres a year for 6 years and thereafter 778 acres a year will hasten the production and in 7 years a production not far short of the present import

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of quinine can be looked for in this country. For the real needs of India, calculation indicates an annual planting of 3,333 acres to give an annual outturn, under present conditions of 600,000 lbs. by 12 years. But for this purpose there is not now enough suitable land, and there should therefore be no delay in assessing the value of most of the hilly lands in the Mikir, Naga, Khasia and other hill ranges in Assam. It will be to Assam that India will look for more space after the 38,000 acres are used up. The cinchona tree requires a deep rich, well-drained soil, acidic in reaction and well supplied with organic matter. The pH range extends from 4.2 to 5.66. A nitrogen level of about 0.2 per cent. in the top foot and not less than 0.1 per cent in the third is necessary for successful growth.

An essential feature of any scheme of planting new areas should be the provision of nurseries for the supply of vigorous disease-free seedlings from the start and both seedlings and grafts of high quinine strains later on. There is also a need for a comprehensive system of costing to be laid down by an expert. Tentatively the following costs have been given in the report. Granting a bark yield of 3,600 lbs. of 12 years and containing 5 per cent quinine sulphate and 2 per cent other alkaloids, (a) the total cost of producing 1 lb. of cinchona bark is 6 annas; (b) the cost of 1 lb. of such cinchona bark to the factory, after allowing for the value of other alkaloids is 5 annas per lb.; (c) the cost of 1 lb. of quinine sulphate in bark form is Rs. 6-4-0 per lb.; (d) the total cost of quinine sulphate therefore will be Rs. 15 in Madras and Rs. 13 in Bengal. Research is needed in such direction as to assist in reducing the cost of extraction and the distribution. Not only should there be plentiful supplies but there ought to be also a rate which will make it available to everybody.

Quinine Preparations in India

IN the course of an all-India survey of the quality of drugs and medicinal chemicals, the Biochemical Standardisation Laboratory, Calcutta, made a study of more than 125 samples of quinine preparations of various categories, such as quinine sulphate mixtures, quinine sulphate powders and tablets, quinine bihydrochloride powders, tablets and mixtures, quinetum, quinine ethyl carbonate, tinc. quinine ammoniata, quinine tannate, pillula quinine, ionized quinine, etc.

The samples were obtained from nearly all the provinces of British India through the co-operation and courtesy of the heads of the medical and public health administrations and were analysed according to the methods laid down in the British pharmacopoeia, quantitative estimations being made in each case. Of the samples tested only 26.4 per cent were found to be up to standard or to agree with the claims made on the

labels of the containers. Out of the total of 75 stock solutions of quinine sulphate secured from city or mofussil hospitals or dispensaries, only 12 (16 per cent) were found to contain the stated strength of quinine sulphate. As many as 49 were below strength, of which 21 contained less than 30 per cent of the active ingredients. Two stock mixtures, claiming to contain five grains of quinine sulphate per ounce, did not contain even a trace of the drug. Curiously enough, a few samples also contained a higher percentages of quinine than that stated on the label. Out of 19 other samples assayed, five (about 23 per cent) were found to contain as adulterants, inorganic salts and other cinchona alkaloids in place of quinine. Out of ten brands of quinine tablets, both of indigenous and foreign make, five revealed deficiency in their quinine contents. One brand contained less than 50 per cent of the active ingredient.

Some form of State control by which regular periodic checking and standardisation of drug may be carried on is clearly indicated by the above results. It also seems imperative that the profession of pharmacy in India should be placed on a better footing so that the 'compounders' who compound, dispense, or otherwise distribute drugs, are given such training and status as to enable them to discharge in a more responsible manner the duties and responsibilities attached to their calling.

Air Conditioning for Health and Efficiency

IT is due to the researches carried out by engineers, in particular Willis Havilland Carrier, that it is now possible to control the movement of the air, the temperature, the humidity and the degree of purity of air in a closed space. This "air conditioning" may be done in a single room by a single unit or in several rooms, or in an entire building by a central equipment. By air conditioning, draughts could be avoided and uniform and gentle circulation of air is maintained. Dust, smoke, and other impurities could be removed from the air by passing it through filters in the machine. Another effect is the diminution of outside noise in the closed room without interfering with ventilation.

In cool and equitable temperature a man can work much better. This is specially true in countries where the atmosphere is hot and humid for the greater part of the year. Air conditioning will there counteract the climatic handicap and increase the efficiency of the workers. The greater the variation of temperature, humidity, etc., the greater the concentration of dirt and dust in the atmosphere and the greater is the incidence of the diseases. It was noticed among the Philadelphia Electric Company's employees that 75 per cent of the total number of absentees from work suffered from colds and other respiratory diseases. After air conditioning was installed the number of absentees was reduced by over 50 per cent. Investigations carried out among large groups of office, shop, and factory workers have

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shown on an average a 50 per cent reduction in time lost through respiratory infection with the introduction of air conditioning.

The utility of air conditioning of hospitals is also very great. A comfortable and restful atmosphere contributes to a cheerful outlook among patients. Such an atmosphere also minimises respiratory infections during their stay in the hospital. Kerr of the University of California carried out experiments and concluded that "infective agents do not thrive in the respiratory tracts of individuals living under ideal atmospheric conditions". Kerr and Lagan in their studies of the common cold, inoculated 28 normal subjects with material from the noses of patients suffering from common colds. None of these experimental subjects developed colds while remaining in a room conditioned at a dry bulb temperature of 70° F and a relative humidity of about 50 per cent. It has also been found that patients often catching cold in an atmosphere of high humidity remains free from the disease in an atmosphere with humidity of 50 per cent with a temperature of 68° F. Blackpan and Yaglon have shown that air conditioned nurseries with a relative humidity of 60 to 65 per cent and a temperature of 80 to 100° F according to the age and weight help favourably towards the growth of infants.

Air conditioning has been found to be valuable in the relief of hay-fever and, to a certain extent, asthma. In cases of asthma an ideal atmospheric condition may be achieved and thus can bring great relief to the terrible

sufferings. In America it has been found that asthmatics are more likely to benefit from a low relative humidity. In Europe many asthmatics visit the Alps where the humidity is low and they keep better there. The same factor for relief may be produced anywhere, at home or in hospital, by air conditioning a room and this man-made atmosphere by air conditioning can be kept constant. In acute respiratory infections like sinusitis great relief was obtained by conditioning the air at a drier level (about 35% relative humidity at a temperature of 72 to 74° F). It is most likely that if researches are carried out in this direction a suitable atmospheric condition may be found which might bring great relief to some of the distresses due to diseases of the respiratory system.

In the tropics there are many diseases which cause high fever. Cool room can do much to keep down the temperature to a great extent and give immense relief to the patients. We owe this method to a country doctor practising in one of the port-towns of America. Ships coming there brought not only the cargo but quite a load of men suffering from tropical diseases with high fever. He used to see their sufferings and wanted to keep the temperature down by packing with ice. There was a great dearth of ice at that place. He felt the need of cooling chamber and spent all his time to find a way to produce artificial ice. He succeeded at last but could not try the method on a large scale for dearth of money. Many improvements have been made since then and buildings can be kept at any temperature and humidity we like. It is a great pity that none of the hospitals here possesses a single air conditioned room.

Tissue Culture

G. Sankaran

Professor of Biochemistry and Nutrition,
All-India Institute of Hygiene and Public Health, Calcutta.

It is an irony that a biologist dissatisfied with the methods of his science should seek the foot-prints in the trail of physical research and after an arduous trek when he hoped to see some light he was told to retrace his steps and develop techniques native to the genius of his subject. Yet it was the sad but wholesome experience of the writer when he was landed with the book, *Beyond Physics*, thought provoking though sometimes the senile lucubrations, of a one time eminent savant, Sir Oliver Lodge. Therein he says "It will be rash for a physicist to trespass on biological territory but of late there has been an indication that barriers are beginning

to break down in a way rather suggested by the names, biochemistry and biophysics, and a new technique has been evolved by biologists themselves which is of good promise. A discovery of this kind can only be in its infancy; it is bound to have extensive development and cannot fail to have ultimate application to scientific medicine. Hence it would appear that no longer need those engaged in physiological and pathological researches be working in the dark. They can actually see what is happening under refined and simplified conditions; and it seems difficult to exaggerate the importance of such a discovery. Physicists, chemists and biochemists will

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be brought together, younger workers will be trained, medical practitioners co-operate and the ultimate outcome must be something that no one can yet foresee". This caused as it were the return of the prodigal son.

The reference was to the tissue culture work chiefly in the Strangeways Laboratory, Cambridge, opened and initially endowed in 1912 by the enthusiasm of the Cambridge University Lecturer in Special Pathology, the late T.S.P. Strangeways and a few medical friends.

Histology which is the very basis of all studies in physiology and pathology was from its early days essentially a study of dead material. Tissues are removed and soaked in a fixative such as chromic and osmic acids, then in alcohol, then in cedar wood oil, then in hot paraffin wax, is then cut with a razor, the paraffin removed with zylol and zylol with alcohol and alcohol by water, and then dipped in iron alum, in aqueous hamotoxilin, again in alcohol then in zylol and finally mounted in Canada balsam before it is seen under the microscope. It is not surprising that many turn sceptic and doubt whether the resulting microscopical image bears any resemblance to the original cells. Yet with such drastic treatment of tissues a good deal of useful information was obtained concerning the general arrangement of cells in the different tissues and organs in normal and pathological conditions. After a time the gross microscopical structure of most of the body tissues had been investigated and described in both health and disease and histology as a method of research had begun to fall into disrepute. Histologists like Alexander sighed for more worlds to conquer and saw their degenerating into a mere technique for clinical diagnosis.

To the historian of science the explanation of the cause for development of knowledge is beset with the same folly that the historians of human affairs have shown in their study. The latter unconsciously disposes events of the past around ideas that he has found in the human society. It will ever be a moot point if the Alexander of science ventured into the unknown with an impelling urge to overhaul the present views or that the urge sprang, as Einstein states, from the "imperious demands of empirical fact."

With the turn of the century Haberlandt in 1902 was most possibly a sceptic and questioned himself if it was not possible to examine cells in their living condition. He made some abortive attempts. This perhaps encouraged Ross Granville Harrison in 1907, who was more lucky and succeeded in not merely seeing living cells but also watched them growing under his very eyes. He demonstrated that small fragments of the central nervous system of a frog immersed in a hanging drop of lymph clearly exhibited the outward migration

of nerve cells and the subsequent outgrowth of nerve fibres from the cells. This event is pointed as a landmark in the genesis and growth of tissue culture. But it was that savant Alexis Carrel, the American surgeon, who saw in this a great future. With the skill and courage shown in stitching the vessels of a beating heart and the remarkable patience displayed by him in treating gangrenous war wounds, he, in fact, nurtured this new born infant of the biologist. He in collaboration with Burrows developed Harrison's original technique until it became possible to maintain excised tissues in a state of active multiplication for years, probably indefinitely.

To him really is due all our regard and respect, however much Manimoff might claim priority in point of time to the successful work of the kind. Leo Loeb claims to this day to have observed the cell wandering in blood coagulum and agar *in vivo* and also to have done this *in vitro* as early as 1897, but the description of the technique was not published. Atomic theories in physics have ever been the stock in trade of the philosophies of the ancient Greece and of India in centuries before the birth of Christ, but who would deny to Niels Bohr the laurels for satisfying us "the imperious demands of empirical fact". The Nobel Foundation appropriately chose to honour Niels Bohr and Alexis Carrel.

Histologists were thus provided with material of extraordinary possibilities, and the explanted cell became to the histologist what the guinea pig is to the physiologist. It is however surprising that the development of this technique should have been delayed so long. From very ancient time man has practised the art of growing plants from cuttings. A twig of a healthy growing rose plant by merely sticking in the soil and watering in due course will grow into a bush and produce fragrant flowers. A cutting from a wine creeper will similarly yield the delicious grapes. Such simple methods practised by the earliest man should have shown biologists that a living organism could be grown from out of a part of the body. While apparently plant life is so different from animal creature the essential features of life processes are common. Looking down in the scale of animal kingdom it will be difficult for any but a specialist to recognise some of the coelenterata as animals. A twig of this animal will grow and branch as freely as a plant. Certain animals too like worms or planarians by no means possessing any resemblance to plants can be cut and made to grow from parts. The higher animals however have defied such attempts at multiplication. The present activity of tissue culturists is, if anything, an emulation in animal life of the activities of a horticulturist, those ever so limited in scope, yet far more difficult of achievement. It is however possible to recognise in a way the impediments and consequent delay in succeeding to culture cells from higher animals.

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An essential feature of animal life in the higher scale is the evolution of a constant internal environment to ensure cells in different parts of the body to specialise in the performance of their functions of physico-chemical nature requiring well balanced set of conditions. The lower organisms do not possess to such a large degree an arrangement to maintain a constant internal environment, hence their cells have not become so specialised and could perform their functions under indifferent conditions. The specialisation of cells of higher animals under well assured conditions of constancy of environment, from its more adaptable forebears, is the same story as is told again and again in the history of various forms of parasitism. A free living organism when it decides to become a parasite barter its freedom and independence to a set of well assured constancy of environment to enable it to devote intensely to propagation of its species and in a way becomes a specialist in that function. The cells of higher animals have specialised in a similar sense and became parasitic in their own way. It is well known that parasites become helpless and hardly survive when removed from their hosts. It is perhaps due to a similar form of parasitism that it is difficult to make cuttings of higher animals survive. If however one is acquainted with the precise conditions obtaining in the environment of these specialised cells it will be possible to provide these to enable a survival. The slow and steady progress of the science of physiology has provided us with the necessary information, and one had to wait till recently for this year before the tissue culturist could achieve any degree of success. The conditions under which the cells of higher animals thrive in their natural surroundings are indeed not many. A certain concentration of chlorides of calcium, potassium and sodium and of osmotic tension obtained in the interior of red blood corpuscles; with some sugar and easily diffusible nitrogenous compounds of the nature of proteoses, and a few growth promoting factors, most probably of the nature of vitamins maintained at body temperature, are all that are necessary. With careful attention to details of composition and temperature of media, the earlier workers struggled for long without any degree of success in making the excised or explanted tissue cells to grow. There grew instead the low form of organism bacteria in a luxuriant manner. The medium and temperature was indeed an ideal pabulum for most forms of these. They are ubiquitous. Their rate of growth too under ideal

conditions is something prodigious. Not content with merely growing, they produce toxic products in sufficient quantities to destroy all cells in their vicinity. In higher animals, especially those, that have developed blood circulating system the ravages of these lowly organism bacteria is held in check and overpowered by a system of antibodies and particularly by the mobile white blood corpuscles, the leucocytes. Such a system of defence mechanism is not easy to provide in explanted tissue *in vitro*. There could be a way out of this impasse if we could exclude bacteria in the cultures. It is the knowledge of bacteriology and asepsis so essential to a surgeon that enabled Alexis Carrel to devise techniques which today form the very foundations of this exceedingly tricky technique of tissue culture.

Short though has been the period of development of these studies and intricate have been the procedure involved, we are now provided with a very effective method for study of living cells. The so-called classical histology of the last century was concerned with space in its three dimensions, length, breadth and width. The modern cytology of explanation has added a fourth dimension, time. We are then now in an era where anatomy and its ancillary sciences have spatio-temporal dimensions. This new outlook is one with far reaching consequences in our outlook of living material from higher animals. While it is conceded that Einstein had introduced the fourth dimension in physical concepts with revolutionary results, it is hard for us at present to think of a dynamic living activity without a time factor and yet we were content in the past, and in that light we should assess the service tissue culture has rendered to the science of the biology of cells.

In recent times the phrase, tissue culture, has a connotation that its study is an object in itself, whereas it is in reality a technique for the investigations of the properties of cells under conditions previously not available and of particular service in the fields of embryology, histology, pathology and immunology. In short there can scarcely be found any problem in experimental medicine that could not take advantage of the tissue cultivation method. To give even a brief survey of work already done with this technique would take us far beyond the scope and limit of the present note. The applications of the technique of tissue culture in the various fields mentioned may form the subject matter of a subsequent note.

RESEARCH NOTES

Oxidation-Reduction Potential of Soils

For making accurate determinations of the oxidation-reduction or 'redox' potentials of soils, it is necessary that satisfactory methods should be employed for collecting, preserving and analyzing samples of soils for 'redox' studies, such that (a) bacterial action is inhibited so as to prevent reduction within the sample after removing it from the field, (b) oxidation of reduced compounds existing in the field is prevented, and (c) substances existing as solid matter in the soil are not dissolved appreciably. Volk (*J. Amer. Soc. Agron.*, 31, 344, 1939) has recently devised a satisfactory procedure for such purpose, in which soils are cooled to just above the freezing point and oxidation of reduced compounds in the soil is prevented by the use of water saturated with nitrogen and by performing analytical operations in an atmosphere of nitrogen. Smooth straight wire platinum electrodes 2 c.m. in length have been found superior to foil since roots clinging to foil electrodes caused misleading results. Volk claims that in the procedure which he has devised the 'redox' potentials (E_h values) of 15-20 soils can be determined per hour by using a battery of 30 aspirators involving 30 glass electrodes and 120 blank electrodes. The method devised by Volk merits close examination by soil chemists who may be interested in such studies.

S.P.R.

Cytonuclear Ratio in Plant Cells

Beginning from Sachs (1892) to the present time much work has been done on the problem of the nucleocytoplasmic ratio in plant cells, and the literature on the problem is very extensive but the results still remain confusing and contradictory. Strassburger and others maintained that a constant size relation of nucleus to cell exists in the meristem of the higher plants for he reports finding a ratio of 2:3 between nuclear and cell diameters in a wide range of species as contrary to the view maintained by Bailey and others that the cytonuclear ratio is an extremely variable one.

In a recent work on this problem of by Vivian V. Trombetta (*Amer. Jour. Bot.*, 26, 519, 1939), an attempt has been made to study the problem from the point of view of determining the quantitative relationship of nucleus to cell in meristematic plant cells and secondly to show how this relationship is altered as the meristematic cells develop to their natural conditions. A variety of material was used and in most cases it was found that the nucleus increases in size less rapidly than the cells in cells of different sizes in the same stage of development, so that the actual cytonuclear ratio changes considerably. A constant relationship was found however between rates of change in size of the two structures indicating a physiological interdependence between them.

In root meristems the nuclear volume often increases about two thirds as fast as the cell volume. But this relationship is subject to wide variability. In stem meristems, the relative growth constants of nucleus to cell are lower than in the root.

In later development where division has ceased and the cells are enlarging greatly three distinct types of cytonuclear ratio is noted: (i) the relationship of nucleus to cell found in the meristem is maintained throughout the active period of enlargement (ii) the relationship of nucleus to cell which occurs in the meristem is not maintained throughout the enlargement period, and (iii) similar to the second type but modified and there was practically no nuclear growth in the meristem. The author has tried to explain the differences of the three developmental types on the basis of absorption of water and dissolved substances between the nuclear and the cytoplasmic membrane. Imbibition, permeability and osmotic concentration between cell sap and nuclear sap may be an important factor in regulating the amount of cell and nuclear enlargement. As nucleus controls the physiological, morphological and genetical behaviour of the cell, it is highly important to study its changes in the life cycle of the cell and to discover how it exerts its influence.

B.K.K.

RESEARCH NOTES

The Zodiacal Light

At a meeting of the Hyderabad Science Association held on 28th August '39, Prof. Mohd A. R. Khan delivered a lecture on the zodiacal light. He gave a brief sketch of the history of human acquaintance with the phenomenon in old Arab and Aztec references, Childrey's account, Cassini's attempt to explain its origin on the hypothesis of a ring of meteoric matter and comet-debris round the sun, countenanced by Schubert, Laplace and Poisson. He quoted Humboldt from his south American voyages, concerning the great brightness of the zodiacal light as seen in the tropics; its variable nature both from day to day and occasionally in the course of the same morning or evening—facts confirmed by later observers. He referred to his own experiences at Begumpet how a part of the variability was due to meteorological changes in the earth's upper atmosphere as evidenced by simultaneous observations on the length and durability of meteor trains. He mentioned the series of observations on the zodiacal light made by the Rev. George Jones during a long voyage in the United States Japan Expedition, 1856, and published with 357 plates of drawings of the apparition, and commented on H. Von Seeliger's work regarding the polarization of the zodiacal light and the ellipsoidal shape of the original nebula surrounding the sun. He described at some length W. F. Denning's views on the nature and origin of the zodiacal light and alluded to Fath's spectroscopic work on the light revealing it to be sunlight reflected by rather fair-sized particles.

He gave a detailed account of Bonsfields' observation of the zodiacal light, the zodiacal band and the Gegenschein in Australia; dwelt on the mysterious nature of the Gegenschein and the current views concerning its origin.

He finally mentioned Hoffmeister's theory of rings of meteoric matter surrounding the sun; one inside the orbit of Venus and the other beyond the earth extending up to Mars or even farther, laying stress on the importance of 'Distinguished Points' postulated as due to small and as yet undiscovered asteroids undergoing disintegration in these regions. To account for these rings he referred to Roche's Limit for satellite disruption similar to what happened probably in case of Saturn.

Incidentally he referred to the dangerously near approaches of some recently discovered asteroids like Adonis (1½ millions miles) and Rainmouth's object which came within 4 or 5 hundred thousand miles of the earth and speculated on the chances of earth's collision with them resulting in meteor craters like that of Arizona or wholesale disasters as those associated with the hypothetical meteor of 1908 in the Tunguska Valley.

He discussed the so-called corona extension of the total solar eclipse of 29th July, 1878, observed by Langley, showing in reality the extension of matter responsible for the zodiacal light extending right up to the sun with increasing density, a fact confirmed by Honda's observations on the total solar eclipse of 19th June, 1937.

He then mentioned Elvey and Roach's paper (*Astrophys. J. of April, 1937*), pointing out greater activity of the zodiacal light in the seasonal influx of meteoric matter in the neighbourhood of the sun. He put forward a hypothesis of short-period meteor bursts to account partially for the casual variations in the intensity of the zodiacal light as sometimes noticed in the course of the same morning or evening.

M.A.R.K.

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PROCEEDINGS AND PUBLICATIONS

Indian Chemical Society

(Calcutta, August, 1939, J.I.C.S., 16, 371-422, 1939)

M. K. SRINIVASAN AND B. PRASAD: Viscosity of aqueous solutions of formic, cyanoacetic and oxalic acids.

R. K. BAHL AND SURJIT SINGH: Periodates of yttrium, erbium and cerium.

S. M. MEHTA AND M. B. KABADI: The hydrogen ion concentration of solutions containing zinc hydroxide and sodium hydroxide.

C. T. ABICHANDANI AND S. K. K. JATKAR: Dissociation constant of β -resorcylic acid.

DUKHAHARAN CHAKRAVARTI AND BRAJESWAR MAJUMDAR: Synthesis of coumarins from o-hydroxy-arylalkyl ketones. Part II. Formation of o-coumaric acids from o-hydroxy-aldehydes.

P. C. MITTER AND HITENDRANATH MUKHERJEE: Action of oxalyl chloride on phenolic ethers.

RAFAT HUSAIN SIDDIQUI: Strychnine and brucine. Parts I and II. The alkaline degradation of strychnine.

P. C. MITTER AND PHANINDRA NATH BAGCHI: Studies in long-chain acids. Part I. An extension of the isoprene rule.

RAVI SARUP JALOTA, KARTAR SINGH NARANG AND JNANENDRA NATH RAY: Rottlerin. Part IV. Derivatives of iso-Rottlerin.

RAFAT HUSAIN SIDDIQUI: Studies in the pyridine series. Part I. An attempt to synthesise 2-methyl-4-ethylpyridine.

RAFAT HUSAIN SIDDIQUI AND ABDUL QUDDUS KHAN: Studies in the pyridine series. Part II. A new synthesis of 2-methyl-4-ethylpyridine.

HARENDRA NATH ROY: Rapid method of estimating small amount of iron and manganese in copper-nickel-zinc alloys.

SALIMUZZAMAN SIDDIQUI: A note on the alkaloids of *Rauwolfia serpentina*. Benth.

Botanical Society of Bengal

(Calcutta, 30th August, 1939)

H. P. CHAUDHURI: The 1938 International Horticultural Congress held in Berlin in August last.

RESEARCH WORK IN INDIA

Benares Hindu University

Below is a review of the work done in the mathematics department of Benares Hindu University during the academic year, 1938-39. The hypotheses which are verifiable and the postulates that are strictly mathematical in substance and hence unverifiable have been, during recent years, subjected to a very severe scrutiny by workers in general relativity. In particular, the logical validity of the hypothesis that infinitesimal material bodies and photons trace geodesics in a curved space-time, which is used to satisfy the three crucial tests, has been questioned by Einstein and his coworkers in several of their papers; for, according to them, the field equations of general relativity should be sufficient to account for both matter and motion. The oftquoted result that the geodesic hypothesis is implicit in the equations of conservation of momentum and energy is recognized to be not true.

The central problem of a theory of gravitation is the problem of n bodies in the treatment of which Einstein has discarded the geodesic hypothesis and given practically a new turn to general relativity. Eddington and Clark, on the other hand, have stuck to the geodesic hypothesis and obtained among other results, the striking one, viz.,

$$E = T + V + \frac{1}{2} \frac{d^2c}{dt^2} \quad (A)$$

where E is the total energy, T the kinetic energy and V the potential energy, c being the moment of inertia of the system of n bodies about its centre of inertia.

In the mathematics department of the Benares Hindu University the relation (A) was examined on its own merits and it could not be reconciled with established results of dynamical astronomy. The source of inaccuracy in the treatment of Eddington and Clark was traced and the formula (A) was found to be wrong. The correct result should be, when the

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necessary second order approximations are carried out,

$$E = T + I \quad (B)$$

Einstein's new treatment of the n -body problem also led to (B). The study of this question brought one astonishing fact to light, namely, that although Einstein's and Eddington's methods are utterly divergent, one making use of only the field equations

$$G_{\mu\nu} = 0$$

while the other uses the geodesic hypothesis and the equations

$$-KT_{\mu\nu} = G_{\mu\nu} - \frac{1}{2}Gg_{\mu\nu}$$

the field of two gravitating bodies is the same ($g_{\mu\nu}$ is the same) up to the second order of masses in the two treatments. Following Einstein's method some new conclusions regarding the interaction of two bodies were also obtained.

Einstein's new treatment of n bodies does not provide a mechanics of radiating masses. This failure was found to be due to the boundary condition that the space-time is flat at infinity. A revised set of boundary conditions was considered so as to accommodate non-static masses within the framework of Einstein's new theory.

The general theory of relativity suffers from an internal contradiction due to the duality of field and matter. This duality sets up a distinction between field energy and the energy of matter as usually represented by $T_{\mu\nu}$. This conflicts with the relation $E = mc^2$ indicating that all energy has mass. The repercussions of this contradiction on the relativistic treatment of world-models were fully studied.

University of Allahabad

A summary of the important investigations in which the botany department of the Allahabad University was engaged during the session 1938-1939 is given in the following account.

Fungi.—In 1938 Robbins and Kavanagh found that *Pythium hyphalostictum* Sideris failed to grow in their medium C, which was a concentrated synthetic nutrient liquid medium. It has been shown that the failure of the fungus to grow in the medium was due to its high concentration since the fungus grows well in it when it is diluted (*Cur. Sc.* 8, 81, 1939). Work on the physiological and cytological studies of the genus *Pythium* is in progress. Investigations into the disease of *Impatiens balsam* caused by *Cercospora balsamina* is being continued. Work on the cytological studies of the vegetative mycelium in five species of the *Saprolegniaceae* has progressed (*Jour. Ind. Bot. Soc.* Vol. 17, 1938). It has been shown that the growth substances Indolyl-3 acetic acid and phenylacetic acid do not in any way stimulate the growth of these fungi (*Cur. Sc.*, 8, 362, 1939). Work on the cytology and development of zoospores in *Achlya dubia* Coker has been finished and work on the physiological and cytological studies of some species of the *Saprolegniaceae* is in progress. The cytology and physiology of *Saprolegnia delica* Coker, and the conditions effecting zygospore formation in certain members of the *Mucoraceae* and *Choanephoraceae* have been studied and a cultural study of certain *Deuteromycetes* has been finished.

Spermatophyta.—A list of the flowering plants in Allahabad excepting grasses has been compiled. The study of morphology of *Orobanchae aegyptiaca* Pers., *Casuarina* sp. and of some genera in the family *Rubiaceae* is in progress. In microtechnique the paraffin method in plant cytology has been studied (*Cytologia*, Vol. x, 1939). More work on the cytogenetical studies in *Cajanus indicus*, *Phaseolus mungo* and *Phaseolus radiatus* and on the meiotic chromosomes in *Chlorophytum elatum*, *Moringa pterygosperma* and *Roheo discolor* is in progress.

Plant Physiology.—In this section studies on the wheat plant have been initiated and the effect of manures on the total nitrogen and amino acid nitrogen in *Triticum sorghum* and soil, and the influence of molasses on the nitrification of soils have been determined.

BOOK REVIEW

AN INTRODUCTION TO GENETICS—by A. H. Sturtevant and G. W. Beadle. (W. B. Saunders Company, Philadelphia; London, 1939). Pp. 391, figs. 126. Price \$3.25.

The authors of this textbook have both spent their lives in pioneer research on the frontiers of genetical exploration. The senior author was one of Prof. T. H. Morgan's original band of graduate students at Columbia in 1910 when *Drosophila* work was first started. The junior author has already achieved an enviable international reputation. It is doubtful whether another pair of men could be found better equipped to expound the science of genetics or to discriminate what is of most value for an introductory course. In this book they have achieved a particularly attractive and logical method of presentation. The cytological mechanisms and the genetical ratios are presented together, the former elucidating the latter.

That genetics is a science of ratios is emphasised and at the start the reason for the sex-ratio of 1:1 is demonstrated. From this it is logical to pass on to sex-linkage, autosomal inheritance and classical Mendelian ratios. For classes, this arrangement permits an immediate application of the textual material in breeding studies with *Drosophila*. The phenomena of linkage and crossing-over are approached from results of actual experiments with two, and then three, gene pairs involved. This is clarified by excellent diagrams of meiosis in which four-strand crossingover (chiasma-formation in split chromosomes) is shown. Crossing-over values lead to chromosome map-making which is illustrated by *Drosophila melanogaster* and *Zea mays*. The role that abnormalities, such as attached-X chromosomes in *Drosophila*, and translocations and inversions, have played in elucidating genetical principles is explained. The value of the now famous giant salivary glands for identifying chromosomal regions and for direct observation of inversions, duplications and deletions of segments is demonstrated by diagrams

and micro-photographs. Clear explanations are given of other genetical phenomena which are frequently mystifying to the beginner, including balanced lethals, multiple-crossovers, ring formation and semi-sterility produced by reciprocal translocations, multiple alleles, position effects, non-disjunction and mutations.

In the last third of the book, the authors deal in a masterly manner with matters of wide implication with respect to evolution. The most important of these are: the genetic basis of sex, selection in relation to continuous variation, practical breeding phenomena, polyploidy, the genic relationships in heterogeneous populations and between species. Two chapters of particular interest which deal with the very latest research results are those on "Extrachromosomal Inheritance and Maternal Influences" and "Genes and Phenotypes" in which problems of development are considered.

The authors have expressly refrained from including an extensive bibliography but adequate references are provided in every chapter. Instructive sets of genetical problems are also given with each chapter. The book concludes with a brief and appropriate historical summary.

The *Drosophila* school's method of designating wild type genes by a plus sign and the recessive alleles by the small initial letter of the name of the gene is followed. When discussing the hypotheses for blood group inheritance in man, the genes are denoted in the more usual manner i.e., *A* for dominant and *a* for recessive. A footnote on the latter method of writing allelomorph pairs would be helpful to many readers. Those who have had no experience with *Drosophila* may well feel doubtful of the ability to distinguish between some of the eye colours shown in plate I. This is purely a matter of training and can be done unfailingly by the "*Drosophila* people," even as a shepherd easily recognises each of his sheep.

BOOK REVIEW

This book can be confidently recommended, not only as a beginners' text, but to mature students whose genetical knowledge is rudimentary, or obsolete, or otherwise in need of refurbishing.

E.W.E.M.

MANUAL OF PRACTICAL BOTANY—by Dr Jogjiwan Singh and Mr Bhagatram Vasisht. (Ram Lal Suri & Sons; Lahore). Pp. 350. Price Rs. 3-8.

The good features of the manual are a number of illustrations and the citation of common vernacular examples (of course, in local dialect). The reviewer is doubtful if it will cover the degree course though it embraces fully the Intermediate (I.Sc. botany) syllabuses of the universities. Slight inaccuracies (which do not detract from the usefulness of the book and which will be corrected at the subsequent edition) noted here and there are: citation of *Ocimum* at p. 100 as an illustration of typical verticillaster inflorescence,

no mention of the swollen parts of radish and turnip at p. 11 as hypocotyls (only the tapering ends being roots proper), the poor illustrations of the few types of algae and fungi figured (specially figs. 85, 88 and 89) and the lack of illustrations of uredospores, teleutospores, aecidia and spermatogonia as seen under the microscope. The exact mode of formation of columella in *Mucor* (Chapter XIV) has not been explained; elementary students would be curious, however, to know how the columella is formed by gradual fusion of dome-shaped layer of vacuoles, ultimately forming a dome-shaped cleft between the two portions of the protoplasm of gonidangium.

We are glad to find a number of Indian text-books in botany rapidly appearing in different parts of India, incorporating the vernacular examples for the benefit of local botany students of different provinces; all of them run more or less on the same plan. The present manual is expected to meet well the needs of the Intermediate botany students of the Punjab.

S.R.B.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

On the Nematode *Camallanus Anabantis* Pearse

Camallanus anabantis was found by Pearse in 1933 from the intestine of *Anabas testudineus* at Bangkok and it was first reported from India by the author.¹ The worms which I collected exhibit certain differences from the description given by Pearse. In this paper I would dwell upon these differences and compare my specimens with the members of other species of genus *Camallanus* recovered from fish hosts. The genus *Camallanus* includes the following species which parasitise various fishes. These are *C. lacustris* (Zøga) 1776, *C. ancyrodirus*², *C. oxycephalus*², *C. cotti*³, *C. wolgensis*⁴, *C. anabantis*⁵, *C. ophicephali*⁶, *C. trichogasterae*⁷ and *C. sweeti*⁸.

cephalic papillæ, buccal capsule consisting of two lateral chitinous valves, internal surface provided with

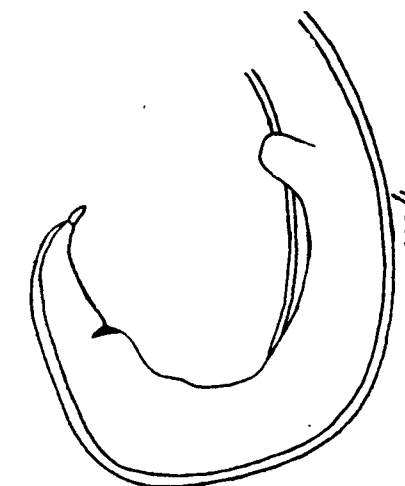


Fig. 3

Fig. 3. *Camallanus anabantis*, Male. Tail end showing the pre-caudal ala and single caudal spine. Spicules and papillæ not shown here.

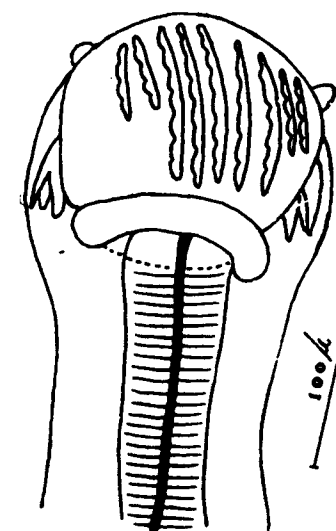


Fig. 1

Fig. 1. *Camallanus anabantis*, Female. Head end showing the tridents, cephalic papillæ and beaded ridges of the buccal valve.

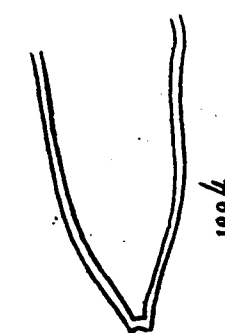


Fig. 2

Fig. 2. *Camallanus anabantis*, Female. Posterior end showing the bifurcation at the tip of the tail.

The worms collected by me are characterised by the following features: slender; filiform; transverse striations on the body; dorsal and ventral pairs of

nine pairs of beaded longitudinal ridges; ridges shorter at the dorsal and ventral extremities; trident in both sexes; chitinous ring at the commencement of oesophagus; muscular and glandular portions of oesophagus; tail in male curved ventrally and the tip furnished with a spine; short pre-caudal ala; spicules unequal, right one being longer; five pairs of preanal, five pairs of postanal, one pair of adanal and three pairs of elevations at the tip of the tail; tail in female bifurcated at the tip; viviparous.

Measurements in millimetres

	Male	Female
Length	6.15	21.5
Breadth	.15	.45
Muscular oesophagus	.4	.45
Glandular oesophagus	.55	.98
Chitinous buccal capsule	.1	.15
Nerve ring from behind the buccal capsule	.1	.1
Tail	.12	.25

LETTERS TO THE EDITOR

The relevant literature being unavailable, my specimens could not be compared with the type species *C. lacustris*. According to Lewaschoff, however, the buccal valve of the worm possesses twenty-five ridges and the number of caudal papillæ is twelve of which seven are preanal and five postanal.

The description as given by Ward and Magath (1917) for *C. ancyloides* is very insufficient, but it appears that the size of this worm is bigger than that of my specimens and the former differs from the latter in possessing spicules nearly equal in length. *C. oxycephalus* has, however, been found upon female specimens only and, therefore, I do not compare my specimens with it here.

Lewaschoff's species *C. wolgensis* is distinguished from my material by its small size and the buccal valve containing 15-17 longitudinal ridges without beads. Moreover it contains six pairs of cephalic papillæ and six pairs of preanal, two pairs of adanal and three pairs of postanal papillæ. Spines at the tip of the tail are wanting.

C. sweeti (Moorthy) differs from my worms in its small size and in having a wide chitinous ring which separates the jaw from oesophagus. It differs also in the number and arrangement of its caudal papillæ.

In *C. cotti* (Fujita) the cephalic papillæ are wanting and the buccal valve is provided with sixteen parallel ridges without beads. The size of the body in both sexes is very small.

In comparing my specimens of *C. anabantis* with those of *C. ophicephali* (Pearse), I am of the opinion that Pearse has really dealt with a species of *Paracamallanus* for, according to Yorke and Maplestone the presence of pharynx behind the buccal valves is the diagnostic feature of the genus *Paracamallanus*.

C. trichogasterae (Pearse) greatly differs from my specimens in the body length and in the buccal valve bearing 14-20 ridges without beads. Pearse has neither mentioned the cephalic papillæ and tridents in the text nor has he shown them in the figures.

C. anabantis (Pearse) and my specimens have been recorded from the same host. There is more or less close resemblance in the body length of males. It is, however, very peculiar that the female specimens in my

collection are longer and possess tridents, while those of Pearse are smaller and do not bear tridents. This apparent absence of tridents in the female specimens of Pearse is probably due to the immature condition of the animals as has been pointed out by Lewaschoff in *C. wolgensis*. It appears, therefore, that there is direct relation between the attainment of maturity and the development of tridents. Besides these, my worms closely resemble those of Pearse as regards structures and bodily measurements.

From the above comparisons it is evident that my specimens differ from all the aforesaid species excepting, of course, *C. anabantis* and I consider, therefore, that my specimens are synonymous with it. Notwithstanding all these resemblances there are a few points in which my specimens do not agree with those of Pearse. According to him the tail in male ends in two spines, but in my specimen the number of spine is one. The caudal papillæ also vary greatly in their number and position. According to Pearse there are four pairs of preanal, five pairs of postanal and three pairs of discoidal elevations at the tip of the tail. In my specimens, however, there are five pairs of preanal, five pairs of postanal, one pair of adanal and three pairs of elevations at the tip of the tail. The cephalic papillæ seem to be wanting as nothing is indicated either in the text or figure by Pearse. Further he has not mentioned anything of the precaudal ala. On the other hand the depression on the dorsal surface in front of anus as recorded by him has not been observed in my specimens. In view of these differences a re-examination of the specimens of Pearse is suggested.

Department of Zoology
University College of Science
Ballygunge, 9-10-39.

G. K. Chakravarty

Chakravarty, G. K., SCIENCE AND CULTURE 3, 298, 1937.

Ward, H. B. and Magath, T. B., Jour. Parasit 3, 57, 1917.

Fujita, T., Jap. Journ. Zool. 1, 169, 1927.

Lewaschoff, von M., Zeits. f. Parasitenk 2, 123, 1930.

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Moorthy, V. N., Jour. Parasit. 23, 302, 1937.

Yorke, W. and Maplestone P. A., Nematode Parasites of Vertebrates, pp. 378-379 (1926).

ERRATUM

In the last September issue (Vol. 5, No. 3) p. 196
Col. 1, on last but two line.

Read the figure 3 after Ξ within parenthesis.

SUPPLEMENT—Abstracts of Sectional Presidential Addresses at the British Association for the Advancement of Science 1939

Chemistry

Film Reactions as New Approach to Biology

E. K. Rideal

It has been said that macro-molecules of substances like proteins, derivatives of starches and celluloses can be spread as monolayers on the surface of liquids. These, when suitably compressed, acquire rigidity and interesting elastic properties. The molecules in a monolayer associate with one another through three separate factors: (i) the monopolar side chains forming a hydrophobic surface; (ii) association through the—CO—NH—linkages in the chains and (iii) association between some of the polar heads of the substrate. If the molecules in the monolayer react with a reactant dissolved in the substrate, the rate of reaction can be modified by the change in the molecular orientation of the former. For example, the rate of oxidation of erucic and brassidic acid monolayers by dilute permanganate solution can be lowered by compressing the films. It has also been shown that film reactions can also be carried out with minute concentrations of strongly absorbed reactants. Thus the hydrolysis of a monolayer of lecithin can be effected with a concentration of snake venom as low as 2.5 X 10⁻⁶ per cent. The reactions between a monolayer and a reactant injected under it have been classified into three types: (i) penetration of the monolayer by the reactants injected under it to form a complex monolayer; (ii) dispersion of the monolayer owing to the stronger tendency of the molecules of the reactant to associate with those in the monolayer; (iii) adsorption of the head groups of the reactants by similar groups of the monolayer without resulting in penetration. By spreading monolayers with various head groups and following the reactions produced on injection of reactants under it, it is possible to identify the reacting group in the protein monolayer. A characteristic group of protein complexes formed in monolayers are the lipo-proteins; thus gliadin forms a remarkable complex with cholesterol in the ratio of 4:1 by weight. At high pressures the cholesterol is forced up above the protein monolayer and the surface becomes one essentially of cholesterol. On releasing

the pressure, however, the original structure of the monolayer is regained. Saponin which penetrates cholesterol with extreme ease, but proteins only slightly, has been found to penetrate the lipo-protein films when the pressure is not so high as to expel the cholesterol molecules from the monolayer.

It has been suggested that materials such as cytoplasm and especially in the more stratified chloroplast may be regarded as a protein gel framework to which are attached the enzymes, the phosphatides and lipoids; the means of attachment being the interaction both of the non-polar as well as of the polar portions of the molecules concerned. Mention has been made of several biological analogies. Thus since lysis of blood cells can be brought about both by protein and cholesterol penetrants, it has been concluded that they (blood cells) have a lipoprotein surface. Micro-organisms can also be sensitised for lysis by cholesterol penetrants by previous treatment with cholesterol. Judged by the criterion of penetration it has been inferred that cilia of *Mytilus* is mainly lipoidal and those of *Paramoecia* chiefly protein. The biological activities of Heparin and the synthetic sulphate celluloses have been reported to run parallel to the ease with which they penetrate films of cholesterol.

Examination of the carcinogenic hydrocarbons by the monolayer technique has shown that whilst they themselves are unreactive, they are readily converted into extremely reactive water soluble photo-oxides. These active substances are not only reactive to protein monolayers but also are Paramoecidal, the parallelism between the biological activity and monolayer reaction being maintained. In conclusion, it has been remarked that many of the modes and types of the reactions which can be effected in monolayers and which can be defined with precision and their mechanism established with a considerable degree of assurance, are unique for such interphases, but are again observed in living and organised material.

B.N.G.

to the interpretation of the constitution of physical matter. It seems logical therefore to take as axiomatic the existence of life, not as a vital force which animates something different, namely matter, but as the activity of which renders it unanalysable by the standard methods of the physicist and chemist.

The third question which he selects is the lengthening of life perspective. The three methods which are generally canvassed to estimate the time during which the earth life upon the earth have been in existence are physical, geological and biological. The latter form of estimate, he points out is problematical and unsatisfactory. He discusses several views that are extent on this subject and sponsors the general view that by breaking up radio-active minerals in the rocks we can get a fair estimate of the reputed ages of geological formations which are now gradually finding its way into text books. He further brings forth Lord Rayleigh's summary of the physical evidence from the breakdown products of uranium. Geological and physical estimates weld together in substantial agreement and thus allow us to say that life has existed upon the earth for perhaps 1,200 millions of years; and then to complete the picture that the birth of the earth, and as the new cosmology seems to indicate, perhaps also at the same time the stupendous birth of sun and stars, took place about 2000 million years ago. Thus from the question of time concept of life he turns to same striking features of evolution. He points out that although evolution chiefly depends upon variation there are at least some examples which remained unaltered through countless generation in spite of changes in the environment. He cites several examples to show this point of view. Time estimate of evolution of several species has been given as examples to show the extreme slowness of evolution. He however criticises Hay's views on the origin of a single new species of mammals since the first interglacial stage.

Prof. Ritchie concludes that if this time factor is a necessary element in the evolution of species in nature, doubt is thrown upon the validity of arguments concerning evolution based upon laboratory experiments in which intensification of means produces rapid change.

He then passes on to the question of man's advent into the world and his evolution. He points out that

modern man (*Homo sapiens*) "appeared only at the close of the Würm Glacial stage, no longer than 25000 to 40000 years ago" and his relation to fauna and flora. He attaches a new significance to man's interference to his animate environment showing to what extent he has cast his influence on the general problem of evolution of the flora and fauna. He closes this topic by saying that such is the remarkable conclusion to which the long view of man's place as a natural agent brings us—that he has set in motion forces which, in our era and mainly in the last three hundred years, have wrought faunal changes which can be compared only with the great secular changes of world evolution. And when the ridiculously short span of his interference is contrasted with the slowness of natural processes, the probability forces itself upon us that in a few more thousand years of man's inheritance of the earth the old order of nature will be superseded in the faunas of the world by a new order of mankind.

In discussing man in evolutionary perspective he raises the question of evolutionary future of man. He summarises the views of Prof. Julian Huxley and others. To some it has seemed likely that future progress will be along the lines of individual development, that brains and mind will become more perfect in their working until man is master of all nature. Others look to a future in which not the individual as a unit, but society as an integration of individuals will become more closely knit and more perfect in its functioning.

It is short view of man's future. He then criticises the long view of man's future as contemplated by Sir James Jeans when the progress of humanity will be doomed by the extinction of life many millions of years hence. He gives ample reasons for upholding the view that it is not possible to give a verdict on the long view of man's future, and looking back over that 1,200 million-year vista of the steady climb of life upon the path of evolution, it seems presumptuous to suppose that man, the latest comer is the last word or the final crowning glory amongst many, and that with his coming the great steps in evolution have come to an end. The long future of evolution upon the earth is unknowable, so far as science is concerned.

H.K.M.

Indian Science News Association

Fourth Annual General Meeting

THE Fourth Annual General Meeting of the Indian Science News Association was held at the University College of Science, Calcutta on the 8th October last 4-15 P.M.

On the motion of Mr. H. P. Bhaumik, Dr. S. C. w, President of the Association, occupied the Chair.

The proceedings of the last Annual General Meeting re read and confirmed.

On behalf of the Secretaries, Professor S. K. Mitra submitted the following report of the working of the Association for the year 1938-39.

ANNUAL REPORT

The Council of the Indian Science News Association have pleasure in submitting the following report of the statement of accounts for the year July, 1938 June 1939.

MEMBERS

The total number of Life-members of the Association at the end of the year covered by this report is 83. We regret to announce that we had to remove the names of 7 members for being defaulters. 2 members had their names transferred to subscribers' list as they expressed their inability to complete the life-membership fee. Against these, 7 new life-members joined us during the year.

ACTIVITIES

Our main activity is still the publication of the monthly journal 'SCIENCE AND CULTURE' through the medium of which we are disseminating scientific knowledge and news amongst the public. As you are aware, the publication of the journal is now completely in the hands of the Council. The journal is still not self-supporting, though, we are glad to record that the work which has been done so far augurs a bright future. We should like to extend our activities to organization of lectures, building up of a small reference library etc., as soon as we have been able to make the journal self-supporting.

You may have noticed that we have been able to secure the co-operation of a number of distinguished scientific men whose names are printed in the journal as editorial collaborators. We take this opportunity to express our grateful thanks for the valuable help we have received not only from our editorial collaborators, but also from other scientists and specialists all over the country. We are glad to inform you that some of our

articles, editorials and other features have been quoted and referred to in Indian newspapers and journals and some abstracts of the articles have also appeared in foreign journals.

NEW FEATURES OF THE JOURNAL

During the period under review we introduced two new features in our journal. A section on 'Medicine and Public Health' has been introduced in which we are trying to give to our readers accounts of the latest medical discoveries. We also publish in this section articles written by experts on topical problems which are likely to awaken intelligent interest in the methods which should be adopted for improving the health of the nation. We have also added a sub-section in the University and Academy News under the heading 'Research Work done in India.' We publish under this head short accounts of research carried out in the different laboratories during the previous academic session. Eight such accounts from the different university laboratories and research institutions have been published in the issues from November '38 to June '39.

SUBSCRIBERS

The total number of inland and foreign subscribers of the journal at the end of the period under review was exactly 500 including life-members, patrons and donors. The number of new members enrolled during the period was 115 though the net excess has only been 45. This is because we had unfortunately a large number of subscribers who did not pay their subscriptions nor replied to our repeated reminders. We have therefore been compelled to write off the dues of such subscribers and delete their names from the list. We would point out, however, that the list of subscribers which we have at present is a more consolidated list than that of the previous year and we expect there will be very few defaulters now.

COMPLIMENTARY COPIES

We continued our practice of sending the journal regularly to a number of eminent foreign scientists in order that they might be conversant with the original contributions to science made by Indian workers, regarding which short notices are published every month in the journal. A few copies were also sent regularly to a number of distinguished men here, some of whom, we are glad to say, have begun taking interest in the journal and have enlisted themselves as our subscribers.

EXCHANGE JOURNALS

We revised our exchange list and at present we are receiving 23 Indian journals and Government publications and 39 Foreign journals and 3 Calcutta newspapers and one weekly. In order that the journals might be more widely used by our members, we published from time to time a complete list of the journals in 'SCIENCE AND CULTURE' and intimated our members that they could take these out on loan.

REGISTRATION OF THE ASSOCIATION

In pursuance of a resolution of the Council, a sub-committee was formed to revise the rules of the Association preliminary to registering the Association under Act XXI of 1860. The amended rules have been approved by the Council and we shall soon convene a general meeting of our members to adopt the rules.

ACCOMMODATION

We again express our grateful thanks to the authorities of the Calcutta University for allowing us accommodation in the building of the Science College. We have recently shifted to a commodious room and propose to have the journals on display there.

DONATIONS AND GRANTS

We are glad to announce that the University of Calcutta, the Indian Association for the Cultivation of Science and the Bengal Chemical and Pharmaceutical Works renewed their annual grants. Mr. Alamohan Dass of India Machinery Co., Ltd., has made a substantial donation to encourage us in our work. We express our sincerest thanks to them. The list of the grants and donations are as follows:—

University of Calcutta	Rs. 500
Bengal Chemical & Pharmaceutical Works, Ltd.	500
Indian Association for the Cultivation of Science	100
Mr. Alamohan Dass	250

APPEAL

In conclusion we beg to repeat our appeal for more funds for fuller realisation of the objects of the Association.

We, on our part, have been trying to increase the income by enlisting more subscribers and securing more advertisements for our journal. Still, as mentioned before, our financial position has not yet improved sufficiently to make us self-supporting. The present war has unfortunately put additional handicaps to our efforts. Some of the advertisements have been suspended and prospective contracts have been kept in abeyance. Our estimated annual income is about Rs. 7,000 and estimated annual expenditure is about Rs. 8,500. This deficit of Rs. 1,500 we will have to meet from the lump donations which we are fortunate enough to receive from time to time. You will agree that we cannot permanently

depend on such donations. Moreover, we have been compelled to spend from the life-members' fee fund which ought to have been kept in reserve. It is therefore necessary that our members and our well-wishers should lend us their support for not only securing more subscribers and advertisements but also for collecting donations, so that a permanent fund may be created.

In view of the fact that the Association has taken upon itself the arduous task of awakening the interest of the public in the methods of application of science to national regeneration, and also that this Association is not a profit earning concern, we can certainly claim sympathy and support from the Government, from the various industrial organisations and from the intelligent public.

OFFICE-BEARERS

The following office-bearers of the Association and members of the Council were elected:—

President—Dr. S. C. Law. *Vice-Presidents*—Sir U. N. Brahmachari; Dr. Baini Prashad; Prof. M. N. Saha; Dr. S. P. Mookerjee; Prof. P. N. Ghosh; Dr. B. C. Law. *Treasurer*—Prof. P. C. Mitter. *Secretaries*—Prof. S. K. Mitra; Prof. B. C. Guha. *Members*—Prof. P. Ray; Mr. N. C. Ray; Mr. H. P. Bhaumik; Lt.-Col. A. C. Chatterji; Dr. P. K. Ghosh; Dr. M. Qudrat-i-Khuda; Dr. B. S. Guha; Prof. N. R. Sen; Prof. J. N. Mukherjee; Dr. S. C. Mitra; Prof. B. B. Ray; Prof. H. K. Mookerjee; Prof. D. M. Bose; Mr. B. N. Maitra; Dr. D. S. Kothari; Dr. S. Bhatnagar; Prof. J. C. Ghosh; Prof. S. P. Agharkar; Mr. Rajsekhar Bose.

The board of editors of the journal during the current year was reconstituted with Professors M. N. Saha and J. C. Ghosh, Dr. A. C. Ukil and the two Secretaries.

REVIEW OF WORK

On behalf of the editorial board of SCIENCE AND CULTURE Prof. M. N. Saha reviewed the work of the journal. The following is the full text of his speech.

After the report of the secretaries, I wish to inform you that we have been fortunate this year in receiving further donations. We have received a further donation of Rs. 1,500 from our President here and his brother Dr. B. C. Law, a great patron of historical research, has encouraged us by giving a donation of Rs. 1,000. Also we have received Rs. 500 from our eminent Vice-President, Sir U. N. Brahmachari. So we have got about Rs. 3,000. My colleague Dr. S. K. Mitra has just told you that our journal was not yet self-supporting. Fortunately as a result of intensive work last year the deficit has been narrowed down from Rs. 4,000 in the first year to Rs. 1,500 this year and we hope if we go on in this way, we shall be able to wipe out the deficit in course of the next few years. In this connection I would very much like to tell you that the other day I was reading the obituary notice of Mr. MacMillan,

head of the famous firm and founder of the well-known English journal, 'Nature,' after which we are trying to model ourselves. The journal was founded in 1872 by the astronomer Sir Norman Lockyer, and I was surprised that even in a place like England this journal became self-supporting after thirty years in 1902 and it was mentioned in the obituary notice of Mr. MacMillan, that for thirty years the founder had to bear all the additional expenses. I think with this example before us we have not much to complain of.

Last year, we had the privilege of having as the guest of our Annual Meeting Mr. Subhas Chandra Bose, who was then President of the Indian National Congress. Mr. Bose has been taking a good deal of interest in our journal and he wrote an article for an earlier issue of our journal. He is one of the few leaders in our country who appreciate modern scientific civilisation and he is a sincere believer that India should get all the benefits of modern civilisation. His action last year as Congress President was quite true to what he said here. As President of the Indian National Congress he took no time in bringing into existence the National Planning Committee which has been going on under the distinguished Chairmanship of Pandit Jawaharlal. In Pandit Jawaharlal we have got another leader who recognises without any reservations the benefit of science. I just give to you a relevant part of the message which he was kind enough to send to our journal on the occasion of the Silver Jubilee of the Science Congress.

"I am entirely in favour of a State organisation of research. I would also like the State to send out promising Indian students in large numbers to foreign countries for scientific and technical training. For we have to build India on a scientific foundation to develop her industries, to change the feudal character of her land system and bring her agriculture in line with modern methods, to develop the social services which she lacks so utterly, and to do so many other things that shout out to be done. For all this we require a trained personnel."

With the patronage of these two leaders of the Congress, we hope very soon that the cause for which our journal has been started and which we have been preaching for the last four years, would strike root in the soil of the country.

You are probably aware that the National Planning Committee has been sitting for a number of months and it has appointed a number of sub-committees, about 8 of which are dealing with industrial and scientific subjects. In those sub-committees, you may notice that most of our editors and editorial co-operators are serving the National Planning Committee either as president or secretary or members. That shows that we have been thinking ahead in matters of application of science to problems of national planning in this country and I think the articles which have been written in our journal

by the various experts and scientific men will be found very useful for sketching out plans for national reconstruction in the years to come.

We are living in a troublesome time. We have got a war hanging about us and nobody knows how far this war will take us. The task of the government of India by Indians might come earlier than we thought. I pointed out at Allahabad during the last meeting of the N. P. C., that the first duty of the National Government would be to work out a plan for industrial organisation whose necessity we are feeling all the more urgent now that the war has already dislocated to some extent our normal business life. As a matter of fact, if you go through our contributions last year in "SCIENCE AND CULTURE" you will find that our whole thought has been dominated by the idea of application of science to national life. Amongst the articles which have been contributed I might mention a few. The first was about the 'Next 25 years of Science' in this country. In this article we have tried to show that science has not yet taken root in the soil of the country, because we are not yet alive to the advantages of science. If you read newspapers you will find that they do not treat scientific news seriously and they never attempt to give an intelligent analysis of the way in which science enters into national life and our individual life. You will hardly come across any article that deals with development of power, machinery industry, manufacture of heavy chemicals, etc., and how these affect industry.

But science not only provides the basis for the reconstruction of the industrial life of the country, but it supplies also the ethical basis on which new human life in the world should be reconstructed. It is the object of this journal to show that science can also afford all those ethical principles which were so long associated with religion and other forms of mysticism. In our journal we have discussed national schemes of education, we have dealt with Indian Historical Congress. In the editorial on Historical Congress, it has been stated that the history of India as we read is an unending story of assassinations, murders, invasions and destructions. History cannot be simply a story of assassinations and murders but should also describe the progress of national life. It may mean that during the last 2,000 years our national life has not been creative. We think it is the duty of our historians to show how national life could be creative. The eminent Italian Philosopher, Croce, said that history ought to be written by a philosopher, and philosophy by a historian. We are trying to give effect to this idea. In one of the articles recently published we have tried to place before the public the history of decipherment of the Brahmi script by James Prinsep because this event opened up the whole historical past of India, and this matter ought to have been celebrated in a befitting fashion by the historians of India. We have discussed many other problems in our journal, such as India's

mineral wealth, Bengal fisheries, calendar reform and have discussed the question of national planning in Sweden. One of the regular readers of our journal is an eminent Swedish physicist, Prof. Siegbahn. After reading our articles on national planning, he got interested, and I received a letter from him to the effect that our journal was giving the right direction to the country and he drew our attention to National Planning in Sweden. It appears that after the last War, Sweden was in a very bad state, because it did not get foodstuff and coal. After the War they mobilised all their scientific men and started national planning and as a result of the last 25 years work Sweden has attained *autarchy*, i.e., self-sufficiency in all matters essential to life. I wanted from Prof. Siegbahn an account of the national planning in Sweden and he was very kind enough to refer me to a book *Democratic Planning in Sweden*. The interest of the book lies in the fact that planning was so long associated with Fascist countries like Russia, Italy and Germany. It has been thought that planning cannot be done unless you have a dictator. But this book tells us that it can be done even in democratic countries and very efficiently. After the war, the Swedish people put their heads together and planned their national life and have made a very fine contribution not only to industry but also to science.

We have dealt with many industrial problems of great importance, notably manufacture of motor vehicles, fertilizers and ammonia and fuel etc., possible schemes of electrification in this country. We were happy to receive an article from Mr. Ghandy about the Tata Iron and Steel Company. Last year was the centenary of its founder, the late Mr. J. N. Tata, the great industrial pioneer in India. In his life sketch, Prof. J. C. Ghosh has told us how Mr. Tata about 50 years ago thought about all the plans of industrial development which are now engaging the attention of the public, electrification, power supply and metal industry. I have not referred to another activity of Tatas, namely the foundation of the Indian Institute of Science. Two years ago when I was in

America I made a remark to one of my American colleagues that but for the contributions of Carnegie and Rockefeller and other contributions towards industrial and scientific research the United States of America would have been not much different from Latin America. But these institutions have enabled them to forge ahead in matters of scientific research. Here in India, the Tatas might be said to be the Rockefeller and Carnegie of India. We hope that when industrial life of India blooms in its fullest vigour, we shall have much more help for scientific research. A country which can produce Tata cannot despair of its future. When the national government comes, it will be its first duty to organise the industries of India, and it will have to complete the work which was started by the late Mr. Tata on a national scale, and from the point of view of the nation's interest.

PRESIDENT'S ADDRESS

Dr. S. C. Law in his presidential address dwelt at length on the most puzzling question as to why Indians who while experimenting with atoms and electrons in the laboratory still grovelled in absurd superstitions at home. In one word why they could not integrate science with life. According to Dr. Law this abnormal position obtained because according to the apostles of our new culture science was to be the means of our material upliftment, it was to touch us only in the externals of life and was not to be allowed to intrude into our spiritual existence. This notion has been preached and popularised till it has become the intellectual habit with most educated Indians to regard science solely as a technical instrument of our economic regeneration. In the spiritual, ethical and intellectual sphere we propose to cling to our unchanging soul.*

Lt.-Col. A. C. Chatterji in proposing the vote of thanks recalled Dr. Law's contribution to scientific research and his munificence for promotion of learning.

*Full text of the speech will be published in a subsequent issue.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

DECEMBER 1939

VOL. V

NO. 6

Science and Life *

ONE of the primary objects that the Indian Science News Association has in view is to popularize and disseminate the knowledge and progress of science. If you are to judge from this view-point the degree of success achieved by the Association, you have to consider, apart from whatever work the Association has done, also its complementary aspect *viz.*, how far and in what manner the public has reacted to its efforts. How far their interest has been aroused, or in other words, the degree of their responsiveness, how far they have shown signs of being alive to the bearing of scientific activity on their life and thought—these are all-important questions to ask in connection with the work of our Association. Science as it is may be pursued in seclusion. But popularization of scientific knowledge has no meaning when the audience is unresponsive and indifferent.

In taking up this question in relation to the work of the Indian Science News Association, I should like, with your permission, to make a passing reference to a personal experience. It may be known to some of you that I started and conducted for many years a scientific magazine, *Prakriti*, in Bengali. Ill-success in that undertaking made me somewhat sceptical about the receptivity of our educated public in respect of science. After all, the proof of the

*Adapted from the presidential address of Dr. S. C. Law at the Fourth Annual General Meeting of the Indian Science News Association held on the 8th October last at the University College of Science, Calcutta.

pudding is in the eating. Perhaps such misgivings are not absent in the minds of the conductors of "SCIENCE AND CULTURE," although, being conducted in English, they can approach an all-India instead of a purely provincial clientele. Their main purpose is to reach the lay public and make them conscious and appreciative of science. Until this aim can be realized, what incidental service the editors can render to the scientific workers themselves, as they have been doing, will not entitle them to claim success in the light of the avowed objects of our Association. It may be assumed that the end they have in mind in bringing out and conducting a magazine like SCIENCE AND CULTURE is to help men and women of this country who have not received a specialist's training in science to become alive to its cultural significance. These men and women may not become scientists themselves by so awakening to the value of science, but they will use science to broaden and enrich not only their daily work and daily lives but also their inner being and spiritual outlook. They will find no satisfaction in compartmentalizing science. While experimenting with atoms and electrons in the laboratory, they will not grovel in absurd superstitions at home. In one word, they will be men and women who can integrate science with life.

Now, the question naturally arises, have we been able to create such men and women or at any rate the atmosphere which could favour their development? At this point of the investigation, we become conscious of the existence of two groups in our midst, who

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approach science from diametrically opposed poles. There is first the group consisting of technicians and specialists, who are competent scientists; secondly, there is the common herd which wants only its credulity to be fed and sensationalism tickled. But apart from them the educated elements of our upper and middle-classes seem to be singularly dead to science as a disinterested and elevating pursuit and study. This insensitiveness to the highest values in science becomes all the more inexplicable when placed against the alacrity with which our people are turning to modern mechanical contrivances of various kinds. They do not find the slightest intellectual or moral difficulty in adopting electricity, or the internal combustion engine, or steam power, and are submitting willy nilly to the revolution in their day-to-day existence which the adoption of these mechanical contrivances entails. India neither will nor can resist the machine technique of the West. But an altogether different picture faces us when we consider the cultural aspect of science—its ethos as I would say, which just like philosophy or religion, concerns life as a whole and touches it at its deepest as well as broadest. In this sphere we are not only divided by qualms and hesitations but are also a prey to reactionary ideas. Submission to the externals of science and rebellion against its soul is thus the great paradox of the intellectual outlook of modern India.

Perhaps my point would become clearer to you if I were to tell you a story which has come to my ears and which, I have every reason to believe, is authentic. One of the most eminent men of India is reported to have said that he did not believe in broadcasting through the radio as a means of spiritual or moral persuasion. On another occasion, replying to a scientific agnostic, he is also reported to have said that there was more humbug in science than in religion. Yet the same personage does not hesitate to make use of scientific means of locomotion and communication. If moral teaching contrives to lose its value when transmitted through ether, it is not likely, one should imagine, to retain all its pristine effectiveness when multiplied by the electrically driven printing press. A great deal of the misuse of science which is found in the present day world is, I am afraid, to be attributed to this attitude. Is it any use complaining against the murderous applications of science if we ourselves adopt it only in so far as it suits our material convenience and remain not

only insensible but actually hostile to its intangible values?

I am not attributing this confusion about the true character and purpose of science solely to India. I know too well that as yet modern science—a relatively new activity of man—has nowhere, not even in Europe where it has arisen, had the time to leaven the entire existence and outlook of man. On the contrary, it is all too obvious that the technical achievements of science have far outpaced our moral capacity to receive and utilize them. Otherwise we would not have seen the tragic spectacle of one of the great successes that science has had—the conquest of air—turned to its worst possible use. This gap between knowledge and the principle of its employment is perceptible in all human affairs. About three years ago in a very striking speech, Mr H. G. Wells, a believer in science if ever there was one, regretted the ineffectiveness of modern knowledge by which he meant scientific knowledge. In it he stressed that we were living in a world of unused and misapplied knowledge. To use his vivid language, “the human species regarded as a whole is extraordinarily like a man of the highest order of brain, who through some lesions or defects or insufficiencies of his lower centres, suffers from the wildest un-co-ordinations (St. Vitus's dance, agraphia, aphonia) and suffers dreadfully (knowing better all the time) from the silly and disastrous gestures he makes and the foolish things he says and does.”

As Mr Wells was speaking from his experiences in his own country, we may take it that the failure to employ science for the highest profit of man is fairly glaring even in the West. But when all is said and done, we in India seem to suffer from a more pronounced disability. Our attitude to the highest aspects of science is not simply negative, it has an element of positive antagonism in it. Unless we can spot and remove this, the aims of an Association like ours is bound largely to be frustrated. We must therefore put this question to ourselves and try as best as we can to find an answer to it: What is at the bottom of the insensibility and antagonism of our educated classes to science?

That this is partially due to mere ignorance of what science is and does is beyond doubt. This kind of ignorance may be removed and counteracted by more and more energetic dissemination of scientific information. But it is also evident that part of our attitude has deeper and stronger foundations. I am inclined to see these foundations in the basic idea on which the entire culture of modern India has been built up by all the great Indians from Ram Mohun Roy downwards.

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They have all worked on the hypothesis that a synthesis of the East and the West is the spiritual mission of modern India. A peculiar feature of this notion of synthesis is that it has tended more and more to relegate western ideas to the control and shaping of our temporal affairs and to retain our moral and intellectual activities as a preserve of the older Indian traditions. In this connection, I would recall to you how Bankim Chandra posed the contrast. In *Ananda Math*, he makes the physician console Satyananda in these words:

“Satyananda, be not crestfallen. Whatever is, is for the best. It is so written that the English should first rule over the country before there could be a revival of the Aryan faith. Harken unto the counsels of Providence. True Hinduism is grounded on knowledge and not on works. Knowledge is of two kinds—external and internal. The internal knowledge constitutes the chief parts of Hinduism. But internal knowledge cannot grow unless there is a development of the external knowledge. The spiritual cannot be known unless you know the material. External knowledge has for a long time disappeared from the country and with it has vanished the Arya faith. To bring about a revival, we should first of all disseminate physical or external knowledge. Now there is none to teach that; we ourselves cannot teach it. We must needs get it from other countries. The English are profound masters of physical knowledge and they are apt teachers too. Let us then make them kings. English education will give our men a knowledge of physical science, and this will enable them to grapple with the problems

of their inner nature. Thus the chief obstacles of the dissemination of Arya faith will be removed, and true religion will sparkle into life spontaneously and of its own accord.”

Here, to my mind, we have the very core of the matter. Science, according to the apostles of our new culture, was to be means of our material uplift, it was to touch us only in the externals of life and was not to be allowed to intrude on our spiritual existence. This notion has been preached and popularized till it has become the intellectual habit with most educated Indians to regard science solely as a technical instrument of our economic regeneration. In the spiritual, ethical and intellectual sphere we propose to cling to our unchanging soul.

Although science does not profess to minister to the spiritual and moral needs of man, the setting up of an antithesis between science and spirituality appears to me to be wholly fallacious. Science is also as much of a whole as religion. It is impossible, or at any rate undesirable, to separate the employment of science as an instrument of material improvement from the scientific approach to life. By making and hardening this distinction we have served the interests neither of India nor of science. We have, therefore, to move away from this position, to obliterate the distinction we have artificially created and preach science as a whole, as a ‘total’ activity. It will not be by spreading scientific information alone that we shall be enabled to do so—we have to introduce a certain amount of proselytizing fervour in our mission to take science to the layman.

The Artistic Sequence of the Rock Paintings of the Mahadeo Hills

M. E. and D. H. Gordon

Up to this time two articles* have been written on these investigations, covering a period of over two years, which were undertaken by the authors in the jungle country of the Central Provinces surrounding Pachmarhi. The cultural aspect of the rock paintings was dealt with in an article "Indian Cave Paintings" in *IPEK* 1935, Leipzig; and in *Indian Art and Letters*, Vol. X, No. 1., 1936, the paintings were discussed from the artistic point of view, and though these periodicals were extremely generous with their illustrations, the former reproducing fourteen photographs and eight line drawings on seven plates and the latter fiftyone line subjects on twenty plates, this is only a fraction of the mass of over fifty photographs and three hundred line drawings which were made. It is hoped in the course of these articles to reproduce a large part of the really important material which still remains unpublished.

In the articles it was possible only to mention very briefly the framework of five series which we constructed to tabulate the paintings in their correct sequence. Confronted as one was in many of these shelters with a bewildering mass of paintings, one was faced with the task of reducing them to some sort of order by certain criteria such as style, colour and subject. We started by recording nearly every single painting, some seven hundred in all, in two large and prolific shelters, and making a note of colour in every instance. The superimposing of figures was also carefully recorded and this showed that certain colours tended always to be overlaid by others. Attention was then turned to style, and it became evident that to a great extent certain styles were associated with certain colours, and in this way, constantly checking and re-checking as each new shelter was discovered, a framework of style-colour sequence was built up.

To start with, we worked on five series, the first divided into Early and Late, the second, third and

fourth into Early, Middle and Late, and the fifth undivided. It was soon apparent that what with transitional types cropping up, and occasional uncertainty owing to bad drawing, this was too cumbersome; so finally the first four series were divided into Early and Late and the fifth remained as before, and it was assumed also that to indicate continuity certain types had to be recognized and classed as transitional.

The first thing that stood out as obvious was that there was a type in white ochre present in nearly every shelter, on the whole, well executed and covering a wide range of activities. There were also paintings in red, pink, grey, and cream, and the white ochre paintings of good style were superimposed on these wherever found. Red and pink were in their turn superimposed on the grey, cream and occasional white of poor primitive style. These red and pink paintings were of a style approximating to the good white ochre ones, and there were also some white ochre paintings more closely allied to red and pink and which could therefore be grouped with them. This group then became a series, the red, pink and occasional allied white ochre being early, and the good profuse white ochre late, these becoming ultimately the Early and Late 3rd Series.

The paintings in grey and cream, which, where there was superimposing, lay below the red and pink, were primitive but naturalistic. These also formed a series, the second, and this was subdivided into Early and Late, the early being crude, and with only the rudiments of naturalism, the late showing an increase in naturalism and a tendency to grouping.

Besides those already mentioned there were classes of paintings in polychrome red and white, and red and cream, and outline drawings in red, and a special group of paintings showing a strange stick-like convention in brick, dark, and pinkish reds, also in

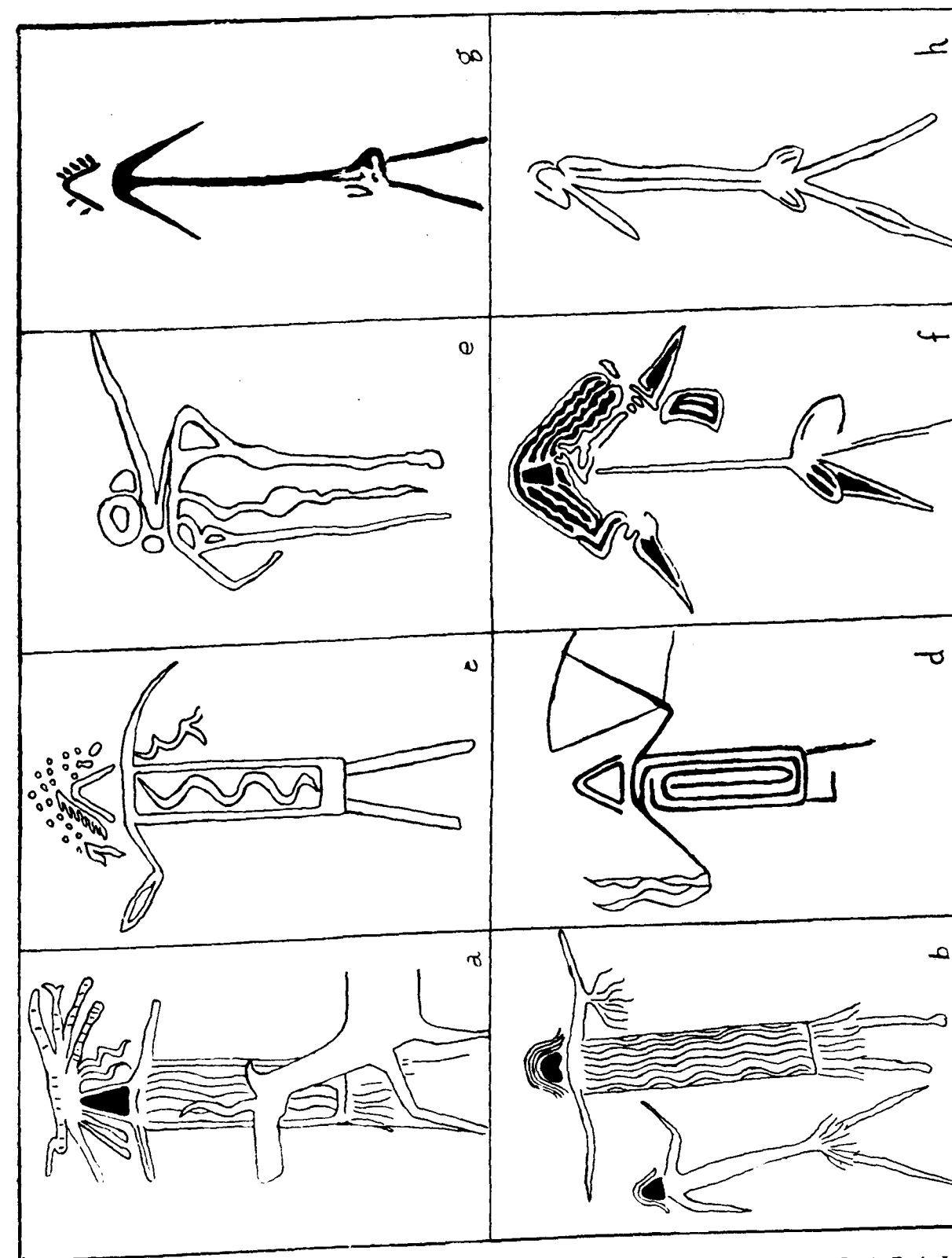
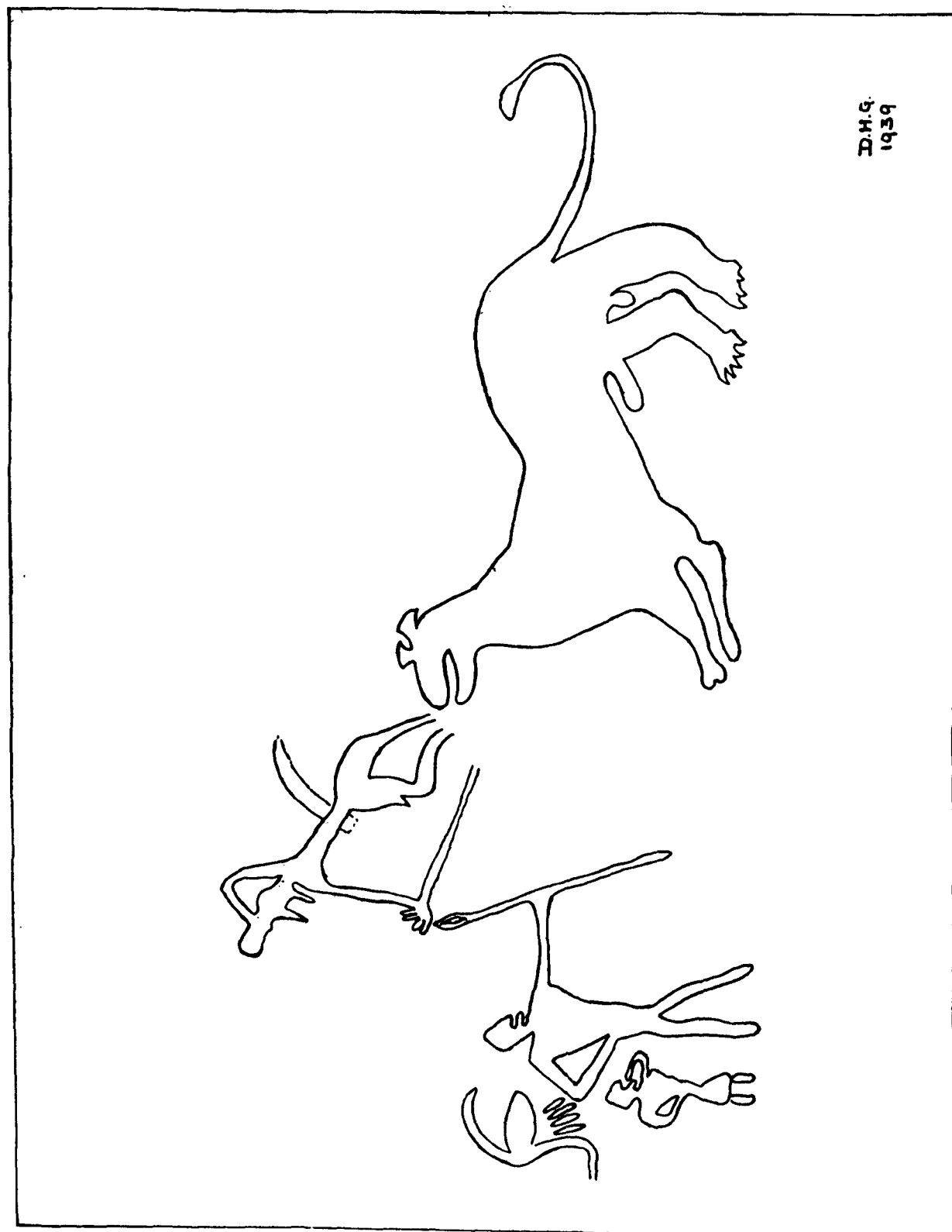
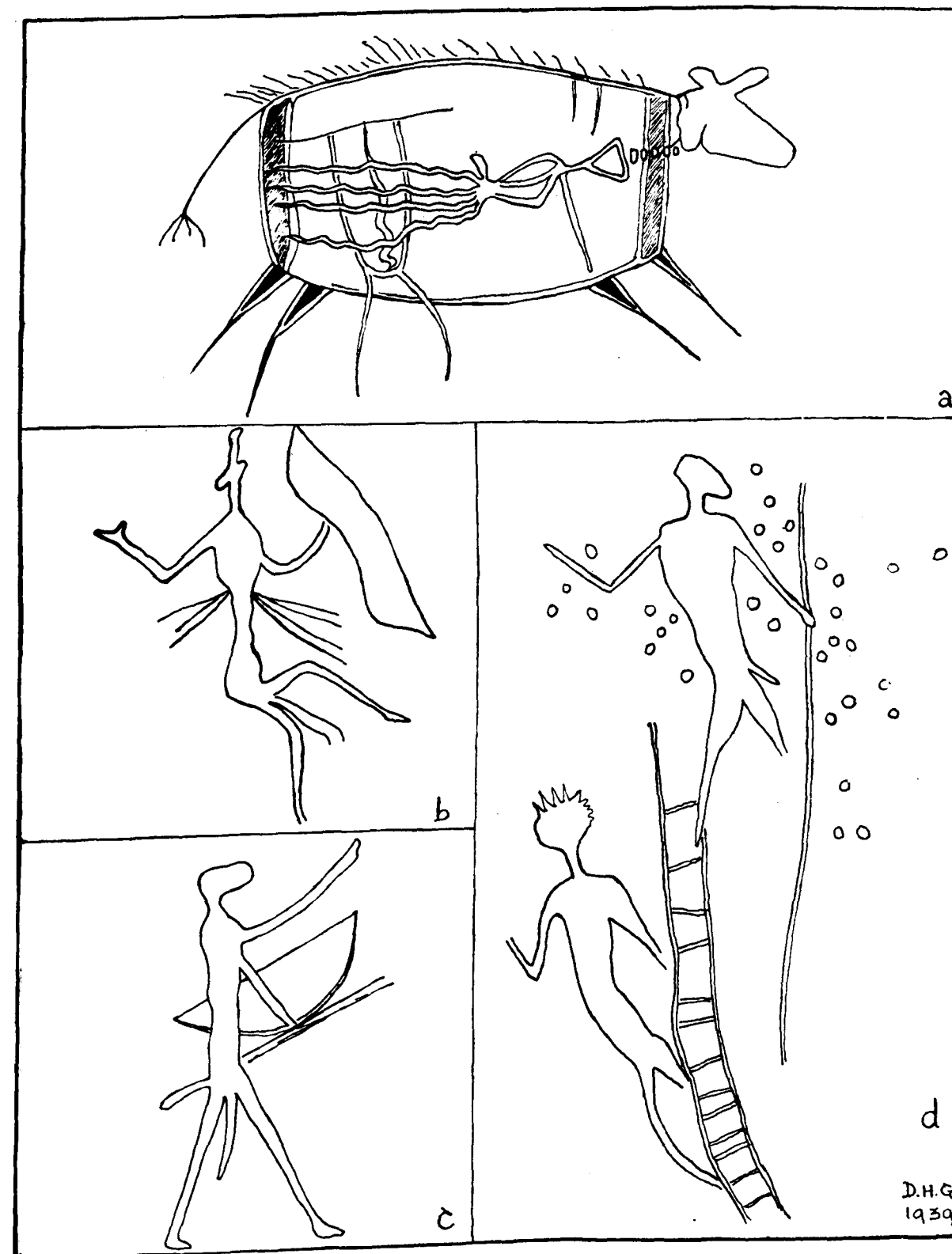


PLATE 1—(a & b) Red & Cream, Jambudwip No. 4. (c) Pink, Monte Rosa No. 4. (d) Dark Red, Monte Rosa No. 4. (e) Cream, Dorothy Deep. (f) Red & Cream, Son Bhadra. (g) Dull pink, Bori. (h) Red & Cream, Jambudwip No. 4.



D.H.G.
1939

PLATE 2—A group of people attacked by a tiger, Cream, Marodeo 2nd Group, No. 4.



D.H.G.
1939

PLATE 3—(a) Superimposed figures, Cream upon pink upon red and cream, Monte Rosa No. 4. (b) Cream, and (c) White, both from Monte Rosa No. 4. (d) Cream, a honey taking scene from Son Bhadra Caves.

THE ARTISTIC SEQUENCE OF THE ROCK PAINTINGS OF THE MAHADEO HILLS

brown and yellow brown. One style of red and white was merely the white Late 3rd Series with a red outline, and another, more elaborate, was a later and poorer continuation. These then became the Early and Late 4th Series. The red outline figures were possibly transitional as they are Late 3rd Series figures in red outline only.

The red and cream figures are extremely scarce and are below all other types wherever superimposing is found. They are therefore the oldest extant figures, and they link with the stick-like figures through transitional types, some of which are found grouped with the stick figures; these then became the 1st Series with the polychrome early and the stick figures late. This leaves only the fifth Series which consists of a few animals in a greenish yellow ochre, found in only two caves they are the latest and are quite unimportant.

Now with the plates let us trace out the sequence which we have established above. The first plate shows a number of the strange figures which form the 1st Series. The left hand pair are typical with their red and cream polychrome colouring and their square shape, the one on top has an animal of the Early 2nd Series superimposed. The next pair show transitional types, above is a square figure in pink with a single serpentine line down the centre, below this is a dark red figure, companion to three dark red stick figures, it has the triangular head and a square body formed by a continuous flattened spiral. This is one of the earliest figures shown with a bow.

On the right is a cream schematic figure showing traits of both early and late types, and below this, one of the three polychrome figures, red and cream, which have been found of "Late" stick-like type. Finally on the right a normal stick figure, the type figure of the Late 1st Series, and below a polychrome, one of the few that can be claimed as a link transitional to the 2nd Series.

Consecutive superimposings are shown on plate 2., where a figure in cream having a Late 1st head-dress and characteristic Early 2nd wavy lines lies over a pink figure of transition from early to late 1st, which

again is superimposed on a typical Early 1st red and cream animal. Below this on the left are two bowmen displaying the characteristics of the 2nd Series, the cruder one with the exaggerated neck being early and the animal headed one late. Animal headed figures are common in the 2nd and Early 3rd Series and probably depict masked hunters. The few animal headed in later types can be classed definitely as demons or mythological beings.

On the right of the plate is a honey taking scene, the earliest so far recorded. Such scenes are fairly common, and the presence of wild honey bees in the caves at the present day indicates that honey taking was regularly practised by the people who lived in these shelters and painted the pictures. A more advanced and elaborate picture of men engaged in this work is to be found on plate V. of the article in *Indian Art and Letters*, No. 1, 1936. Very fragile ladders of split bamboo were employed by the men who smoked out the bees for me (D.H.) at Singhanpur. They were formed of quite thin strips of bamboo spliced together and were lowered over the cliff, down these the men swarmed, when the smoke had done its work, to dislodge the nests. They looked extremely flimsy and unsafe.

With the 2nd Series one gets occasional narrative grouping showing those primitive hunters in their struggles with wild beasts, and on plate 3, there is a spirited picture representing an encounter with a gigantic tiger. Though the painting may show a certain continuity, with the transition to the 3rd series the basic culture appears to change, and one breaks away from the primitive hunters, and the community becomes warrior and pastoral, and the painting more careful and sophisticated.

Plate 4 shows left to right at the top a crude Late 2nd Series figure with a lance, then two very similar dancing figures of the same Series, and finally a warrior of crude transitional type. Below are again figures of warriors which also indicate clearly the transition from the Late 2nd to the Early 3rd Series. From this point a steady improvement will be observed till in the best paintings of the Late 3rd and the Early 4th Series one finds the highest peak of expression reached by this Cave Art.

(To be Concluded.)

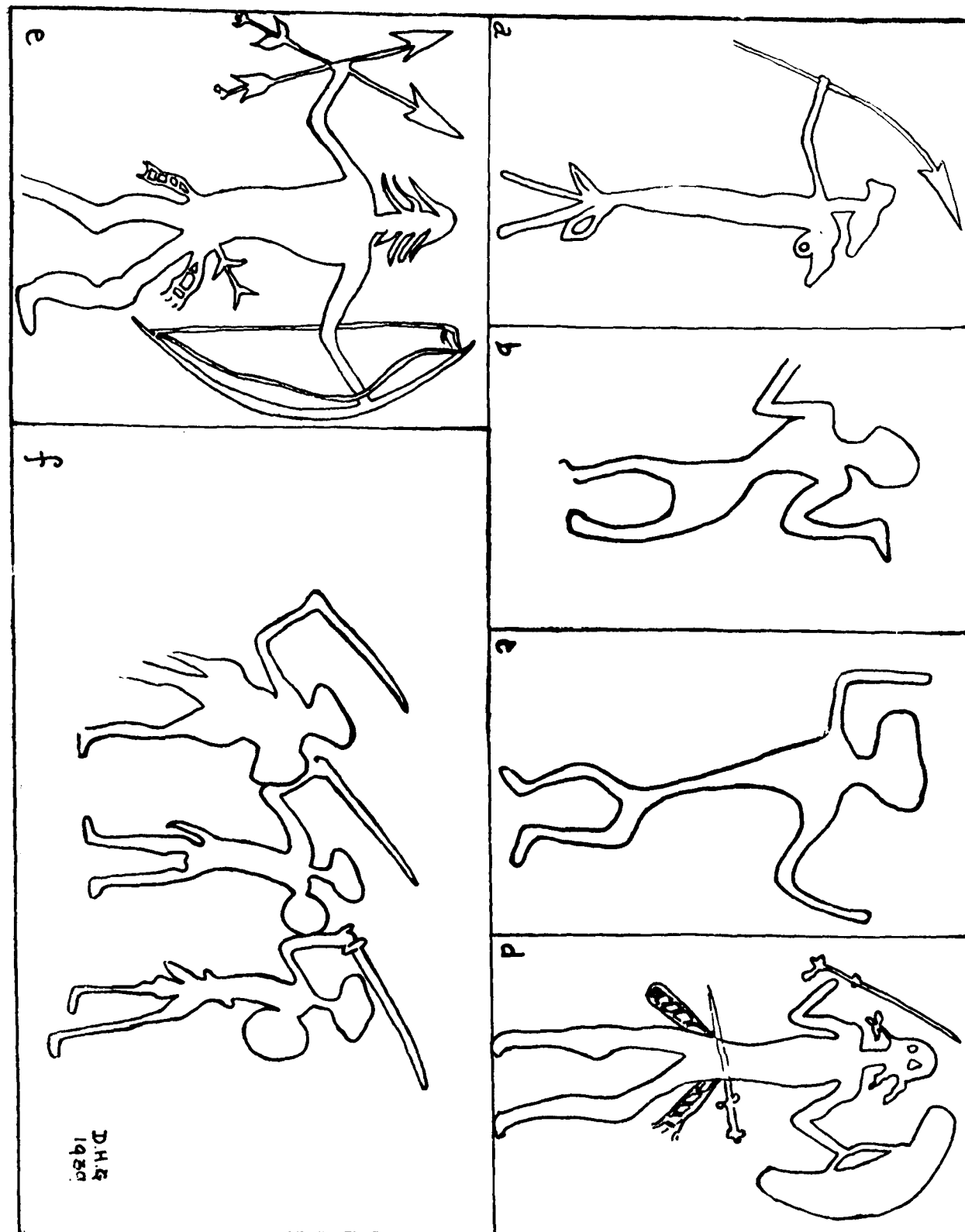


PLATE 4—(a) Cream, Monte Rosa No. 4. (b) Grey, Jambudwip No. 4. (c) White, Kajri Ghat. (d) Greyish Yellow, Jambudwip No. 1. (e) Cream, Jambudwip No. 4. (f) Dark Red, Jhalai.

The Science of Crop Production

B. M. Dabral

THE prehistoric man was primarily a hunter. Later he reared sheep and cattle for food and clothing etc. With the advance of time he began to take care of certain plants belonging to the families of *Graminac*, *Compositae* and *Leguminosae* etc., and found it even more economical and comfortable to live on herbs and seeds grown by him round his dwelling. The economic necessity of maintaining an ever-growing population gradually led people to find out the reasons of low and high productivity of different crops, their suitability to various localities and they devised different practices of handling them. Thus, in all countries, traditions grew about proper kinds of seed; suitable periods of sowing and harvesting, and proper methods of cultivation, manuring and irrigation.

But it was only from the middle of the 18th century, that the science of agricultural botany (physiology and genetics) and chemistry (soils and manures etc.) developed very rapidly and influenced agriculture to a great extent. Mendel's paper on 'Plant Hybridisation' originally published in 1865 and republished in 1901 revolutionised the methods of plant improvement. Since the latter date, the science of agricultural botany has developed very rapidly. Mendel's conception about the inheritance of characters as independent units which are transmitted to the offspring obeying the laws of chance in their assortment and combinations and his list of various exceptions to the rigid rule led to a search for a physical basis of heredity. The natural sequel to such enquiry and thought devoted to plant improvement has been the marked development of three branches of botany namely, plant breeding, genetics and cytology. From the time when "principles of vegetation" was the main enquiry before scientific men, practical men have utilised all available knowledge to increase yields from the soil. The role of living organisms in the soil in helping plant nutrition and soil changes through fixation of atmospheric nitrogen and the processes of oxidation and reduction etc., of organic

components in the soil, have been discovered comparatively late. The science of soil microbiology has now acquired a status equal to that of soil chemistry or physics. Mycology and entomology have further grown as necessary adjuncts to agriculture, because plants require to be protected against ravages of insect pests and diseases.

The science of crop production in a very wide sense embraces a long range of subjects, taking something from many branches of modern science, both pure and applied, e.g., geology, meteorology, physics, chemistry, zoology, botany and mechanical engineering etc. It is necessary to synthesise all these into a part of one great applied science. After long experience in India, A (now Sir Albert) and G. L. C. Howard¹ (1929) very thoughtfully wrote,

"During the progress of the work (Botanical Research in India) it became increasingly evident that the organisation of an Agricultural Research Institute, on the basis of practical agriculture on the one hand, and on the separate science on the other, was by no means the ideal arrangement. It was soon discovered that the problems presented in the improvement of a crop cannot be split up into a number of parts without great detriment to the whole. The centre of the subject of crop production must always be the plant itself, which can only be effectively studied in relation to the soil in which it grows, to the conditions of village agriculture under which it is cultivated and with reference to the economic uses of the product."

In agriculture, the plant must be made the centre of all activities and thought. It is the medium and living agent through which the raw materials from the soil and the atmosphere are made available to man. By suitable changes in the internal qualities of the plants and external conditions of its growth, the

¹Howard, A. and G.L.C., *Application of Science to Crop Production*. (Oxford University Press, 1929).

agriculturist can induce it to yield the largest quantity of the best quality. Dr. Jarvis² (1931) of the Ontario Research Foundation has defined this concept in a very able manner. He says, "the culmination of all agricultural research must be, first, the determination of the optimum conditions for growth of individual plants or varieties, and second, equally accurate determination of individual environmental 'coincidence' under which the agricultural industry must operate in a given area." 'Coincidence' is the name given to the optimal inter-relation of all growth factors to which a plant is subject in any locality. Dr. Jarvis has pointed out the fact that in spite of great advances in genetics, mycology, entomology and soil sciences etc., the average crop yields per acre have not increased to any great extent, while, (quoting from Dr Jarvis) "on the other hand, the almost unlimited possibilities for increased production have been demonstrated continually by the phenomenal yields achieved both on experimental plots and on individual farms." Why is this inconsistency between the accumulation of scientific knowledge in relation to agriculture and the lack of increase in yields per acre?

The last ten years' experience of the present writer* on different problems of cotton cultivation in Sind has convinced him that where the primary aim of research is improvement in quality and quantity of any crop, a wider outlook is very essential. Every conceivable factor, which may *a priori* seem to be not very important, has also got to be taken into consideration and studied in relation to the whole. The artificial boundaries of science and sophisticated attempts at classifying knowledge at every step hinders progress. Mrs G. L. C. Howard³ (1923) in her presidential address to the botany section of the Indian Science Congress held at Lucknow remarked that in agricultural experiments, "We are apt to focuss attention on the beginning and the end only, that is on the conditions provided and the yield obtained. We tend to ignore the changes and processes which have been taking place in the plant." What is needed today is a co-ordinated study of the different sciences so that agronomical practice may be based on a study of the physiological requirements of plants and the purpose of physiological studies will be the elucidation

²Jarvis, T.D., *Sci. Agr.*, No. 12, 1931.

*As Cotton Physiologist at Agricultural Research Station, Sahrand, Sind.

³Howard, G.L.C., *Agri. Jour. Ind.*, XVIII, 1923.

commercial product from each crop. The farmer is chiefly concerned with the plant, with the soil and manures, and with the climatic and biological (insects etc.) environment under which the plants grow. But how the plant grows, the conditions under which it thrives or suffers, the substances of which it is made, its mode of branching, root habit and leaf adaptation, how it feeds upon the soil and the air, how the various constituents in the soil are made available to it and the agencies responsible for their transformation etc., work, and finally how the air, the soil, the plant and the animal are related to each other in the cycle of nature and the perpetual round of constructive and destructive changes, all these are some of the main questions which require to be answered by the crop-scientist. The science of crop production tries to solve them as an united whole by co-ordinating the knowledge gained by pursuing individual subjects according to the most up to date methods.

Every science pure or applied, in due course of time, develops its own methods and terminology. Crop production when studied as a co-ordinated whole has also its own methods of study and interpretation. In its widest comprehensiveness, it is most nearly allied to plant-ecology and its methods approach those of experimental ecology. "If I were to try to surround agronomy with one all inclusive term, I would say that it might be a matter of plant-ecology which has very definite economic implications" said Bressman⁴ (1932). The comparatively new interest of the ecologist in economic plants and the necessity felt by agricultural workers for a more detailed knowledge of the plant in its relation to the environment, indicate that both types of studies are essentially similar in their objectives and methods.

The concept of *ecotypes*, by Gregor⁵ (1933) and Gen-ecology by Turesoon (1922), have great potentialities for the future. It seems reasonable to suppose that since the three components (soil, atmosphere and biology) of the environmental complex constitute to a large extent the principal determining factors in the survival, the distribution and the propagation of biotypes under natural conditions, the same control will be exerted upon the prevalence of crop plants. While studying the factor for the acclimatisation of exotic varieties of cotton in the new canal-irrigated

⁴Bressman, E.N., *Ecology*, XIII, 1932.

⁵Gregor, I.W., *Ann. Appl. Biol.*, XX, No. 2, 1933.

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tracts of Sind, the present writer* found out how one or the other of the above mentioned factors of the environment came in operation during some phase of crop growth, and determined the survival of the variety in Sind. A successful variety is one which is capable of withstanding all strains during all the phases of its development. The detailed knowledge of factors throughout the growing period is thus of very great importance in directing plant breeding and hybridisation work into definite and fruitful channels. In wild nature, the process of natural selection operates on the various species and biotypes by their continual 'interactions and adjustments' to the 'habitats' concerned. In planned agriculture, the environment (specially the soil) can be modified by cultural treatments to some extent; but the limits of possible extension of any one variety or species are ultimately laid down by natural ecological factors. Beyond a certain point it may be even uneconomical to attempt to modify the environment to suit the plant. In acclimatisation of exotics as well as in the breeding of new varieties of crop plants, ecology plays a very dominant part. The problem of adaptation whether in nature or under artificial conditions, is essentially similar in that the end-result in both is the attainment of equilibrium between the 'habitat conditions,' and the "inhabiting forms." Expressions of the hereditary potentiality depend to a great extent on suitable conditions which allow particular features and no others to appear on the plant. The normal path of development in a plant at least is only one of the many possibilities of expression of its inherent characters. According to Adams⁶ (1935) the activities of plants and animals are continually colliding with environmental changes. Some of the internal factors responsible for plant or animal growth are clearly imposed by their ancestral history or heredity and probably restricted by their physico-chemical limitations, but the external limiting factors are likewise varied and complex, and have to be taken into consideration.

The dynamic concept of crop production as a continuous process of adjustment between heredity and environment, between the natural forces working in the soil, the atmospheric factors and man's efforts to modify them is of immense value in all studies on agricultural practice like cultivation, irrigation and

*Dabral, B.M., *Proc. of Conference of Scien. Research Workers on Cotton in India*, 1937.

⁶Adams C.A., *Ecology*, XVI, 1935.

manuring. For each crop, there is thus the need of determining what may be called its 'ecological amplitude,' as well as the optimum 'habitat' factor under which it makes the best growth. In purely agronomical experiments, results are often arrived at in an arbitrary manner, and the methods are too vague though inclusive. In purely physiological investigations, the enquiry is simplified as much as possible and the experiment is reduced to a minimum number of variables. The living organism displays so many different activities and functions going on at the same time, that it has to be brought under constant conditions before the influence of one factor alone can be elucidated. Moreover when such a control is brought about by simplifying the environment, the normality of the plant is disturbed and the study may say nothing about the actual response of the organism in the field, that is, in the presence of a variety of factors.

Under these circumstances, the study of crop plants with a view to improve the quantity and quality of their commercial products must be based on methods capable of application in the open field. According to Lundegardth,⁷ "the phenomena one observes in nature are always the resultant of the interaction of a number of more or less independent factors. For the ecologist, (as also for the agriculturist) the inner mechanism of the living organism is a problem of secondary importance, he looks upon this mechanism as the weapon with which the plant has to maintain itself in the struggle for existence. Success in the struggle is above all a question of "intensity of living" that is rapidity of metabolism, growth and reproduction; and it is the aim of experimental ecology (and crop science) to examine the influence on these fundamental life process of fluctuations in the plexus of external factors."

It is thus clear that in future agricultural research in India, as elsewhere, should accept the agro-ecological concept of crop production as the soundest basis for progress not only in the fundamental aspects of science but also in interpreting scientific results in terms of actual farm practice for the benefit of individual farmers. The present tendency among scientific research workers on crops to unduly classify the subjects is regrettable and this obscures the central objective of crop improvement under a definite set of agro-ecological factors.

⁷Lundegardth, H., *Environment and Plant Growth*, (Edward Arnold & Co., 1937).

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It would be appropriate here to illustrate the new methodology by a simple example. While studying the water requirements of the cotton crop under irrigation in Sind, the present writer found that the problem was in reality far more difficult of attack than appeared on the surface. If the physiological method of finding out transpiration-ratio on potted plants was adopted, the results would have been of little value as the cotton plants do not thrive well in pots, especially under controlled water conditions. If, however, the agronomical method of replicated tests on field plots etc., was adopted, the results, though useful, would yield no information regarding the actual utilisation of water by the plant throughout its life-cycle. In all probability, the final values would be contradictory to each other. It was therefore felt that the best method would be to determine the dynamic changes in the soil and the air surrounding the crop consequent on a treatment and follow them up throughout the growth of the plant. A careful analysis of the soil, layer by layer, for moisture, etc., throughout the season was undertaken and correlated with the growth of plants and the yield of the crop. Simultaneously, the amount of water supplied by irrigation, or received as rainfall etc., was recorded along with the other climatic factors. In short, instead of controlling all other factors except the experimental variate (as in physiology) all relevant factors which had any bearing on the growth of plants were recorded in situ and studied. The data from this method of study have given very valuable indications as to the manner in which the cotton plant uses the water at its disposal from time to time. It has opened up fresh lines of attack and revealed still greater difficulties which must be surmounted before a true picture of the water-balance of a crop plant in the field could be drawn correctly. At any rate, the

method employed has given a rational basis for revising current irrigation practice and helped to explain the many discordant results that are commonly arrived at when performing *ad hoc* experiments. Similarly a truly rational basis for manurial and cultural treatments for increased yields can be had only after a thorough record is kept and analysis made of all possible ecological factors and their dynamic relationship with each other.

It appears that in spite of accumulation of scientific knowledge there has not been much improvement in average agricultural yields per acre for the whole country, because the central idea to view all "agents in their inter-active relationship as individual plant environments" has been neglected. Application of science to agricultural practice should be based on a simultaneous study of all agro-ecological factors in a given locality and their bearing on crop growth. This demands accurate recording of a large number of factors such as latitude, altitude, climatic data, natural soil fertility, species, variety and ecotypes of crops, possible diseases and insect pests, past history of the locality etc., and their correlation with developmental data on individual crops. There is at present great need of a co-ordinated survey of Indian agriculture which should be based primarily on ecology. Results from such a survey will at once reveal the "ecological amplitude" of different crops, the optimum conditions under which they can grow and the possible limits to which improvements can go. Even for smaller areas the agro-ecological survey may greatly help to find out the actual and the potential "intensity of living" for each crop after which the road to improvement will be direct and laid out on a rational basis.*

*The writer is indebted to the authorities of the Forest Research Institute and College, New Forest, Dehra Dun, for affording him facilities of the library etc., while writing the above note.

The Scope and Limitations of Anthropology

Zoological Position of Man

EXTENSIVE researches in comparative anatomy carried out in recent years have substantiated in general the view held by most anthropologists that the human phylum evolved from a common ancestral group which also gave rise to the modern anthropoid apes. The general thesis has been modified to the extent that the not insignificant part played by parallelism *i.e.*, convergent phenomena in evolutionary differentiation has come to be recognised. All cases of anatomical resemblances cannot, at present, be held to indicate genetic affinity. The latter can only be assessed on comparative anatomical data by the proper evaluation of anatomical character with due regard to their taxonomic importance.

The fossil lemurs of Madagascar which showed striking simian traits, were at one time regarded as a transition from lemurs to monkeys, but it is now found that the monkeys appeared much earlier than the Madagascar fossils; and that the *Lemuroidea*, unlike the higher primates are highly specialised in certain directions. Hence the latter cannot be held to have passed through a *Lemuroid* phase, and the simian character of the Madagascar fossils are cases of evolutionary parallelism. The same applies to remarkable similarities in the structure of the brain, skull, limbs etc; found between the cebus and the macaco, though the New and the Old world monkeys diverged very early in Tertiary times. There is some positive evidence to suggest that some of the striking resemblances between man and the higher primates have their origin in parallelism. Unlike man, the gorilla, for example, showed some specialisation in its upper and lower extremities. The two must have diverged early in geological age from some small and agile common ancestors, who had none of the *Gorilloid* specialisations, adapted to arboreal life. It follows that many of the manlike characters of the gorilla, *e.g.*, the large and well convoluted brain and many details of the skeleton, are parallel developments due to the increase in body-size both in

gorilla and man. It would be however ignoring the evidence of comparative anatomy and palaeontology to suppose that the higher primates are unrelated to man. Indeed the very fact that parallelism has occurred between man and the higher apes indicates that both have inherited common evolutionary potentialities from some unspecialised but anthropomorphic common ancestors. The relationship of man and the anthropoids are well expressed in their inclusion in the large group, *Hominoidea*. (Simpson). It is interesting to note that the group iso-agglutinins and the group iso-agglutinogens found in the serum and the red corpuscles of the anthropoid apes are identical with those of man; yet there is evidence to suggest that man and apes evolved their blood groups independently.

The Palaeontological Evidence of Human Origins

During the Miocene age, several genera of primitive anthropoid apes (*e.g.*, *Dryopithecus*) were widely distributed over the Old world. Our evidence about them comprises mostly preserved fragments of jaws and teeth, some of which are quite generalised, while others approximate to the gorilla, chimpanzee, and orang-utan. Certain species of *Dryopithecus*, and allied genera (*e.g.* *Ramapithecus*) betray astonishing similarities with man in their dentition. The *Dryopithecus* stock therefore, would seem to have given rise to the modern genera of apes and to man by divergent evolution during early Miocene times. The limb proportions at this phase of evolution of the higher primates were not specialised as in modern anthropoid apes. The earliest *Hominidae*, we know of, are the *Pithecanthropus* (Java), and *Sinanthropus* from the early Pleistocene of China. Too much was made of their individual variations, resulting in their classification as two distinct genera. Since the discovery of the type-specimens, however, the remains of other individuals have been found, which demonstrate the wide range of variation in both the groups. Indeed, they may be said to overlap in this respect and should be classified as one and the same genus, *Pithecanthropus*. Notwithstanding many simian traits in skull, brain etc., the limb bones of the *Pithecanthropus* were similar to

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Homo-Sapiens. The contrast in this respect between man and the anthropoid apes had thus been achieved in the early Pleistocene and the two must have begun to diverge at a much earlier period.

Skeletal Evidence in the Study of Human Evolution

The information regarding the path of human evolution which can be gained from the study of fossil remains of an extinct type of man is usually rather limited, being confined to single isolated specimens, in contrast to an extensive palaeontological series. The evolutionary status of a fossil can only be assessed by intensive anatomical comparisons with man and the anthropoid apes. For determining whether a fossil belongs to an aberrant side-line of evolution or to the main line ending in man, a generalised common ancestor must be hypothesized (with the help of comparative anatomy), who had none of the specialisations of the modern anthropoids. Any fossil which shows characters intermediate between this hypothetical ancestor and modern man may be regarded as bearing an ancestral relationship to him. Fossils showing specialised characters not present in modern man may be held to belong to side lines. It is certainly legitimate to make general inferences on purely morphological evidence, even if these must await final corroboration from other palaeontological data. Thus the Neanderthal (later Mousterian) man was held not to belong to the main line of human evolution, because of his many specialised features. The inference has been corroborated by other palaeontological evidence and it is now known that pre-Mousterian man was less *Neanderthaloid* than the later *Mousterian* and more akin to *Homo-Sapiens*.

In the study of single fossil skulls, errors may arise from ignoring the extraordinary range of variation in modern human types. For example, small aberrations in the suture pattern in certain fossil skulls have been held to indicate a side line of evolution; simply because they were not known to conform to those of the modern man. Similar aberrations are however to be found in a small percentage of modern human skulls.

The Evidence of Endocranial Casts

The endocranial casts offer much valuable information regarding the size, shape and proportions of

the brain, the pattern of the meningeal vessels and even of some of the surface features of the cerebral hemispheres. Unfortunately the information is limited; for the convolution pattern of the brain does not impress itself on the bones of the human or anthropoid ape skulls with the clarity found in many lower mammals. Many surface irregularities of a human endocranial cast are caused by quite other factors. In interpreting these irregularities, we should depend on satisfactory objective evidence, or errors may arise as in the identification of the simian sulcus of the occipital lobe. The identification of individual sulci and convolutions on endocranial casts are not always a practical proposition. The lower and the front parts of the frontal lobe and the lower part of the temporal lobe sometimes show the convolution patterns more distinctly and give an idea of the degree of general complexity of convolution.

Skeletal Evidence in the Study of the Individual

Some details about the individual, *e.g.*, body height, approximate age, body proportions, muscular development and pathological conditions of bones and teeth may be secured from a study of the fossil skeleton. The earliest known men were rather undersized and narrow shouldered in comparison with the modern Europeans. Squatting facets on the tibia and talus may indicate the common posture assumed by early man during rest, while platymeria and platygnathia probably depended on nutritional defects.

The pelvic bones among other parts of the skeleton facilitate the determination of sex. But this is not always easy or possible. Where the skull alone survives, the uncertainty is considerable.

Physical Anthropology of Race

The ethnic groups of to-day have been classified in a system of primary and secondary races. The former are distinguished by well-marked physical traits based on genic differences. But the secondary races are more difficult to define, because of their reticulate evolution, *i.e.*, a complicated process involving periods of divergent modification alternating with periods of hybridisation, which explains man's wider range of genetic variability in comparison with other animals.

In selecting characters for comparative racial studies emphasis should be laid on those depending on genic differences,—skin and eye colour, head form etc.

*Being an abstract of Prof. W. Le Gros Clark's presidential address at the Anthropology Section of the British Association Meeting at Dundee this year.

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Cranial and facial measurements, body proportions etc., are more or less susceptible to peristaltic influences and may obscure fundamental differences. Blood groups seem to be non-adaptive characters and their study has yielded much information regarding racial relationships and race movements. But they may be linked to some distinctly selective racial character. Identical blood-groups may appear in different localities due to parallel mutation.

While indirect evidence on the evolution, differentiation and subsequent migrations of human races is obtainable from the study of living populations, the direct evidence consists of skeletal remains from old burial grounds and prehistoric sites. A correct diagnosis is sometimes difficult even for modern skeletons, not to speak of prehistoric ones. It may be easy to identify distinctive Negro, Australian or European skulls, but so great is the variation within the group that not all skulls of each group permit a dependable racial diagnosis. Elliot Smith showed that the Grimaldi skulls, supposed to be definitely negroid, were only variants of the Mediterranean type.

The wide range of variation in the anatomical characters of the skull even in a homogeneous population, has led to the development of an elaborate technique of measurements and of statistical methods, formulae etc., for their analysis. None the less, owing to the wide range of variation of the human beings, our knowledge of the affinities and origins of the different human races has been progressing but slowly. Prof. R. A. Fisher, who has discussed the limitations of craniometric methods, points out that the study of the living may be more profitable, because of the precise information available for the living regarding sex, blood relationship, social status, linguistic grouping etc.

Human Genetics

For the purpose of practical eugenics it is necessary that not only some of the pathological, but also all those mental and physical characters which may have some significance for human welfare should be analysed to determine whether they have a genetic basis at all and what may be the nature of the genetic differences on which contrasting characters depend. This will enable us to foresee the effects of the selection applied to such characters. The study of genetics will also enable physical anthropology to, employ only those

characters, whose genetic bases are known, as criteria in studies of racial affinities. The relative importance of genetic and environmental factors must ultimately be determined for characters which are partly governed by heredity and partly by post-natal influences. The possible linkage of phenotypic characters, if intensively investigated may permit the recognition of latent defects when linked with a physical trait capable of superficial observation or measurement. The possibility of a genetic linkage of characters opens up the question how far inherited physical traits may be related to inherited mental disposition, particularly to racial temperament, and criminality.

Physique and Nutrition

A broad relation between nutrition and physique has always been accepted by anthropologists, *e.g.*, in regard to stature, weight, chest dimensions etc. Dieticians now suggest that the effects of malnutrition may be much more extensive not only as causal agents underlying many types of variation in physical characters, but also in determining susceptibility to different types of infection.

The relation of different racial types of physique to diet was first demonstrated by McCarrison, who observed that in India there is a correlation between physical type and the presence or absence of certain food factors in the diet. This has opened up important lines of research and experimentation on diet and involves important practical issues. In Great Britain, for example, evidence has been put forward, suggesting that malnutrition may be far more extensive in the lower economic orders than hitherto suspected. This national defect should be corrected as soon as possible. But it is the task of physical anthropology to collect precise information regarding the extent, distribution and degree of undernourishment before the problem can be tackled. For this purpose an adequate standard of normal physique for Great Britain must be established as a basis of comparison for determining cases of malnutrition. This may be done by a complete survey of the country by the systematic examination of samples of population of various social strata from all the districts; physical anthropologists, clinicians, medical officers of health, dieticians and social workers collaborating in the survey.

Prof. Bigwood of Brussels has recently summarised the various somatometric indices which have been from time to time contrived as the basis for the assess-

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ment of nutritional status, *e.g.*, Rohrer's Index, v. Pirquet's Index, Franzen's A. C.-H. Index. Recent work shows that Tuxford's Index— $(\text{Wt.}/\text{Ht.}) \times (381 - \text{Age in months})/54$, which gives a nutrition quotient of about 1,000 for average children is more advantageous, as it picks out $\frac{3}{4}$ th of the boys assessed by doctors as subnormal. For obtaining a really adequate somatometric index of malnutrition, physical measurements may be equated to physiological tests, *e.g.*, those for determining vitamin and iron deficiencies.

Observations on the relation of malnutrition to physique, capacity for work and susceptibility to disease have still to be carried out among native peoples in many parts of the world. The elucidation of deficiencies in diet must surely in the future be a powerful factor for success in colonial administration. To carry out nutritional surveys in native populations, the physical anthropologists may have to modify the somatometric indices applying to European peoples and adapt them to local types.

Future of Physical Anthropology

Whereas the study of human palaeontology will progress with the fresh discovery of fossils, it is doubtful whether physical anthropology as a historical science with its present limitations will very much advance our knowledge of racial origins and racial differentiation beyond its present stage. In the future, physical anthropology must convert itself from a museum science, studying fossils and bones etc., to a field-science, studying living populations, particularly in regard to problems of Genetics, relation of physical characters to environment, the study of growth processes and of comparative racial physiology. It must provide adequate data regarding the physical nature of man in his present environment, so that there may be a systematic approach to practical problems such as the improvement of health and physique and their relation to nutrition and climatic factors, the effects on physical type of the redistribution of populations, the results of hybridisation, the relation of changes in the reproductive rate to human variability and composition of regional populations.

A. K. M.

Forced Evolution

A purely aquatic animal has been transformed into a land animal. The subject of this change is a Mexican Salamander, known as the Axolotl. The Axolotl is an eight-inch long tadpole-like creature with long external gills, no eyelids, and fins on the body and tail. It is the Peter Pan amongst animals, for in Mexico it never grows up, remaining for the whole of its life in the imperfect larval form. Science, however, has found a way of accomplishing what

Nature has failed to do. After a few small meals of thyroid, this aquatic animal leaves the water and takes to land. The gills and fins vanish, the flattened, paddle-shaped tail becomes rounded, being no longer of service as a swimming organ, and eyelids are developed. The Axolotl in question took exactly three weeks, from the time it was given its first thyroid meal, to complete its transformation.

—*Armchair Science.*

The Cambridge Observatories and Total Solar Eclipses

Sir Shah Sulaiman

Federal Court, India

THE Cambridge University Observatory is very ancient and its Syndicate's records of 1818 still exist. The Syndicate has been in continuous existence for over 110 years since April 6, 1829. Last year the Observatory was constituted a Department in the Faculty of Mathematics, and the old Observatory Syndicate was discharged. Sir Arthur Eddington, assisted by Dr. Woolley, is now in charge. There has been a recent addition to its equipments. Mr. Steavenson, an amateur astronomer, has under an arrangement been allowed to erect his own 30-inch reflector just behind the Observatory.

The Solar Physics Observatory (Cambridge) had been established first at South Kensington (London) in 1879, and was originally under the direction of a Committee. In the year 1885 it came under the direction of Sir Norman Lockyer who continued to serve as Director until 1913. On April 1, 1913, the Observatory was transferred from South Kensington to Cambridge, and came under the Cambridge University, which appointed a Solar Physics Committee to administer grants for carrying on investigations and to act in an advisory relation to the Director. The Solar Physics Observatory was located on Madingley Road, next to the old Observatory Building. As the work of the new Observatory was to be fused with that carried on by the Astrophysical Department of the Cambridge Observatory, it was not considered necessary to transfer all the instruments. Some were left in charge of Sir Norman Lockyer. On the other hand the Board of Education lent a 36-inch reflector to the Observatory for a term of years which still remains here. Prof. Newall became its first Director. Dr. Stratton is the present Director.

1912. An early attempt in England to measure the spectrum of the limb was made by Prof. Newall

on the occasion of the partial eclipse of the sun in April 1912. The eclipse was seen under perfect conditions of the sky and photographs of the spectrum of the sun's limb were taken. Prof. Newall inferred that instruments of high power might be used to great advantage.

1911. An expedition was sent out to Crimea to observe the total solar eclipse on August 21, 1914. Preparations had been made for observation of the solar eclipse near Theodosia, Crimea, and Mr. (now Dr. Stratton, the Assistant Director, with his party carrying a 6-inch Rowland concave grating for observations of the spectra of the sun's limb and of the corona, travelled out through the Mediterranean and the Black Sea. They arrived at their destination Theodosia on July 25, four days before the posting of orders of mobilisation of the Russian troops. Mr. Stratton was recalled to join the Officers Training Corps at Cambridge and had to leave Theodosia on August 11, just ten days before the eclipse. The rest of the party returned later. Messrs. Campbell and Curtiss tried to make observations at the Russian eclipse of 1914. The instruments had to be left behind and remained stored at Odessa for a long time. Unfortunately the weather conditions were unfavourable and observations were completely foiled by cloud.

After the War was over, the Assistant Director rejoined his Observatory, having been promoted to the rank of Brevet-Lieutenant-Colonel for services in the field, and also made a Chevalier of the Legion of Honour by the French Government.

1918. After the announcement of Einstein's theory in 1915, Mr. Campbell observed the eclipse of June 8, 1918, in British Columbia (United States) but did not get full displacement. He suggested that possibly plates sensitive in the red will enable stars to

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be photographed which would otherwise be drowned in the corona.

1919. No member of the staff of the Solar Physics Observatory went out to observe the eclipse of 29.5.1919. But the University Observatory sent out Mr. (now Sir Arthur) Eddington with the British expedition in the company of Mr. Cottingham to the Isle of Principe in the Gulf of Guinea (West Africa). Curiously enough, the first measurements of the Principe photographs "pointed with all too good agreement to the half-deflection i.e., the Newtonian value which is one-half the amount required by Einstein's theory" (Eddington). The weather conditions had not been favourable. Two selected plates out of the sixteen plates exposed showed the five stars most essential for the determination, and were believed to furnish good results. The mean deflection was found to be $1''.61 \pm 0''.30$. Further correction for second order terms of refraction, aberration and orientation showed the deflection as $1''.98$. There was, however, a distortion of the field.

1922, 1923, 1925, 1926. No British expedition was sent out to observe the 1922 eclipse in East Africa and Australia, the 1923 eclipse in America, the 1925 eclipse in the United States or the 1926 eclipse in East Africa, Sumatra and the Phillipines.

1927. There was again a total eclipse of the sun on June 29, 1927. But the altitude of the sun would not exceed 13° in any site in England at the time of the total phase. So Prof. Newall, the Director, and Dr. Carroll went over to Norway, and after considerable exploration found a site—a level one not already occupied by a house or a farmshed—most difficult to find in that rocky and wooded region. This was at Aal in Hallingdal, where the altitude of the sun would be twice as great. The observing party with their apparatus left Newcastle for Norway on June 4. Mr. (now Dr.) Smart accompanied the Solar Physics Observatory expedition to Aal. The instruments were erected and adjusted under unfavourable conditions of weather. Unfortunately on the morning of the 29th, observations of the eclipse were completely frustrated by thick clouds.

1929. Dr. Stratton succeeded Prof. Newall as Director of the Solar Physics Observatory on the latter's retirement in December, 1928. Two British

expeditions were sent out to observe the total solar eclipse of May 9, 1929, but both were unsuccessful. At Pattari in Siam, where Dr. SStratton was stationed, the sky was heavily overcast throughout totality. The expedition to Pattani was organized by the Joint Eclipse Committee of the Royal and Astronomical Societies. The King and Queen of Siam had visited the eclipse camp on several occasions and were present at the time of the eclipse. At Ator Star in Kedah, where Dr. Carroll was in charge of the Observatory Expedition, the eclipse was seen through clouds, sufficiently dense to rob the observers of any results of scientific value. There were only impressions of rings on the plates but no image of measurable density. It was in this year that Dr. Freundlich, after four previous failures in 1914, 1922, 1923 and 1926, had better fortune and succeeded in obtaining good photographs showing an excess of 25 per cent. over Einstein's value.

1932. On the occasion of the solar eclipse of August 31, 1932, an expedition headed by Dr. Stratton, accompanied by Dr. Carroll and others, under the auspices of the Joint Eclipse Committee, was sent to Magog in Southern Quebec to observe the eclipse. There was a great gathering of British astronomers, including the Directors of several Observatories, and also a number of Canadian and other physicists. An unusually extensive observational programme had been prepared. It was most unfortunate that a completely cloudy sky on the day of the eclipse totally prevented any observations being made.

1936. Dr. Stratton, Dr. Redman, Major Bagnald and Dr. Allen proceeded to Kamishari in Hokkaido to observe the total solar eclipse of June 19, 1936. Dr. Royds, Director of the Kodaikanal Observatory, was sent to observe the eclipse by the Government of India and joined the expedition. Mr. A. D. Thackeray from Mount Wilson Observatory, Dr. Astor from Travancore, Prof. Nakaya of Sapporo (Japan) University and also some others joined them. The whole programme was well planned out in advance.

The sky remained clear during the partial phase. Dr. Royds completed his programme (measurement of wavelengths of the Fraunhofer lines during the partial phase, a contribution to the elucidation of the limb effect) up to totality, with complete success save for his last plate. Gathering clouds in the last few seconds before totality did not prevent second contact from being observed, and flash spectra were obtained

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through clouds with three instruments. As regards flash and coronal spectra in the extreme ultra-violet and in the photographic region, Dr. Redman's spectrograms obtained with the specially designed repeating back camera showed that the Fraunhofer lines persisted up to about one second before the disappearance of the continuous spectrum. A good deal of structure was shown in the lines of hydrogen and ionized calcium, such as Mr. Evershed has observed in prominences.

Within a few seconds of the commencement of totality the sun was entirely obscured by clouds too dense for any success even with the infra-red photographs of the corona. Dr. Astor was able to observe the polarization of the sky near the eclipsed sun just after second contact, but the whole coronal programme was undone. This was all the greater pity as the corona was apparently much brighter than usual, being clearly visible to the eye some seconds before totality.

Ten minutes after third contact, the clouds cleared away, and Dr. Royds was able to continue his programme of observations without further interruption. Strangely enough Dr. Royds' observations of the spectral shift of light from the edge of the sun showed a shift twice as much as Einstein's value.

Mr. Williams had accompanied an eclipse party led by Prof. Carroll to Omsk, and his party were more fortunate in their weather.

1940. Before the War was declared, great preparations were being made to send out expeditions to South Africa to observe the total solar eclipse of October 1, 1940. A strong Cambridge deputation, headed by Dr. Stratton and accompanied by Dr. Thackeray, was to join the Greenwich Observatory expedition headed by Dr. Davidson, who was to be assisted by Dr. Woolley. They were to go to Nelspoort on the main railway from Cape Town to Johannesburg

reaching there in September. It was proposed to measure

- (1) Spectral shift of light from the solar disc.
- (2) Polarisation of light from the corona.
- (3) Spectrum of the extreme limb from the absorption to the emission (during the transition) ranging about H and K.

For measuring the shift, the party intended to take with them a spectrograph with three prisms possessing a higher dispersion than the previous one. Mr. John Evershed was intending to join the expedition and was considering whether he could take his large liquid prism with him. The Cambridge Observatory also was making preparations for a determination of the sun's apparent magnitude, which was to be carried out by Mr. Davidson and Dr. Woolley. Mr. Jeffreys was assisting Dr. Woolley in making laboratory experiments in preparation for the work. Full equipment was to be taken out for the eclipse. The full programme had of course not been settled and it was expected that some other astronomers also would join.

A photo-electric cell and a valve amplifier were to be used for the photometry. The accuracy of the apparatus is such that it is possible to measure the transmission in sensibly monochromatic light of a dark glass cutting down three magnitudes, with a probable error of 0^m.01. A preliminary determination of the co-efficient of reflection from an unsilvered glass surface had already been made, and the polarization of a spectrograph was carefully determined in several wave-lengths. Investigation was being made of the non-linearity of the connexion between the photo-electric current and the intensity of the light, in the hope of increasing the accuracy to 0^m.002.

War has now unfortunately intervened and it is not certain whether the Cambridge Observatories would be able to send out their astronomers to South Africa. Disappointment must have come to Prof. Stratton, who has unfortunately met with ill-luck on previous occasions; but it is to be earnestly hoped that he will ultimately be able to arrange his going out to observe the eclipse with success.

Nobel Laureate in Physics, 1939 —Prof. E. O. Lawrence

PROFESSOR E. O. Lawrence to whom the Nobel Prize in Physics for 1939 has been awarded is best known to the scientific world as the discoverer of the cyclotron. His father migrated to America from Norway and it is said that Lawrence had to share his father's early hardships. He is at present professor of physics at the University of California, Berkeley.

The cyclotron was discovered by him in 1932. It is an apparatus for giving to elementary charged particles like the proton, deuteron or the α -particle energies amounting to several million volts. What is the necessity of having such high energy particles? The importance of Lawrence's discovery cannot be understood unless this point is cleared up. At the present time probably even the layman knows that the atom consists of the nucleus and an outer shell of electrons. An atom like sodium, which is No. 11 in the Periodic Table has got 11 electrons, all going round the nucleus having a central positive charge of 11 units, and containing the whole mass of the sodium atom. The nucleus may be said to form the heart of the atom. It is of extremely minute dimensions and occupies about a hundred thousandth part of the total diameter of the atom. The ordinary chemical and physical reactions of an atom arise from the external electrons. The nucleus controls them, but does not otherwise take part in them. It is only in heavy bodies like uranium that the nucleus is found to emit spontaneously charged particles and this phenomenon under the name 'Radioactivity' is well known.

For a long time physicists have been trying to attack the heart or the nucleus of the atom by laboratory methods, but with very small amount of success. Gradually it dawned on them that the nucleus could not be approached unless particles of extremely high energy were used, as the charge on the nucleus repels the particles. In the language of atomic physics, the energy is measured in electron volts. It is the energy which is obtained by allowing an electron to fall through a potential difference of one volt. In

everyday life we seldom use more than 200 to 400 volts. In deep therapy X-ray work, voltage of the order of 100,000 is used and the electrons which produce X-rays have energies of the order of one hundred thousand volts. But calculations showed that to get at the nucleus, particles must be endowed with voltages of the order of a million and the technical problem was to make some kind of generator which would produce a voltage difference of the order of a million. This appeared a very formidable task. One method of approach was that of Van de Graff, an American worker who took the old electrostatic machine and improved it to such an extent that it can give about million volts. It is impressive to see a machine of this type giving a spark of about 30 to 40 ft. in length. But such a machine requires lot of space and depends for its work on good meteorological conditions. Another method was a voltage multiplication method by charging a battery of capacities in parallel and discharging them in series. This under the name Neutron Generator has been placed on the market by Messrs. Philips & Sons. This also has insulation difficulties and requires a very large space.

By consensus of opinion, the most useful apparatus has been designed by Lawrence. Supposing we have a vertical magnetic field and project a charged particle at right angles to it, i.e., horizontally, then as students of elementary physics know the particle describes a circle. What Lawrence does is to take a vertical electromagnet and between the two pole pieces he puts two semi-circular hollow brass vessels each of the shape of a D with their straight sides open, parallel and close to each other and completely enclosed in a third vessel and insulated from each other. These brass vessels are known as the Dees, on account of the similarity of their form to the capital letter D. Now these two are connected to a generator of electricity giving an alternating voltage of about 30,000 volts. This reversal of the E.M.F. takes place at an interval of about, say, twenty millionths of a second. This time is so chosen that it is just equal to the time

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taken by an electron in describing a complete semi-circle within one of the Dees. When it comes to the edge of one of the Dees, it gets an increment to its energy equal to 30,000 volts. It then describes a second semi-circle within the other Dee and by the time it has come to the other edge, the voltage has just changed sign and it is again accelerated through 30,000 volts. In actual practice the orbit is slightly different from a semi-circle and is in the form of a spiral which is gradually expanding. The electron gradually comes to the rim of the Dee. If in this progress it makes 200 complete turns, the energy acquired will be six million electron volts. This is the simple idea with which Lawrence started. But calculation shows that the amount of energy will depend upon the magnetic field H and the square of the radius r of the pole piece, according to the relation

$$V = \frac{1}{2} \cdot 10^{-1} H^2 r^2 \text{ for protons.}$$

So one has to build up an electromagnet with as large pole pieces as possible and at the same time the field has to be of the order of 10,000 to 15,000 Gauss. The cost of construction of such an apparatus becomes prohibitive for an ordinary laboratory, as a cyclotron which can deliver 5 million volt protons will cost not less than 2 lakhs of rupees. But financed by liberal grants from the American public and charitable bodies like the Rockefeller Foundation, Lawrence was able to put his idea to actual test. His first cyclotron was a very modest one giving about one million electron volt protons, and he has been gradually increasing the size and the latest one has a pole piece of about 63" diameter, which gives 25 million volt protons. Encouraged by the great results he obtained, to be described later on, other laboratories in America and several other countries are now going in for cyclotrons. About thirty of them have so far been constructed and three-fourths of them are in the States.

What has been achieved with the cyclotron? It has enabled the physicist to go beyond the alchemist's dream of transmuting one element to another, because Lawrence takes a high energy beam of protons (or deuterons or α -particles) and allows it to fall on every element in succession. Then he removes the element and finds that this has been transformed into elements which do not occur in nature, but which are radioactive, i.e., emit electrons, positrons and γ -rays.

This miracle is brought about by the fact that some of the high energy particles go straight to the heart of the nucleus, and disturb the order there i.e., they are made artificially radioactive. He has manufactured hundreds of artificial elements and opened a new chapter in physics.

The same effect can to some extent be obtained if one has a large quantity of radium and utilizes the α -rays given by radium but 1 gm. of radium costs about 100,000 rupees. But Lawrence's apparatus is able to achieve as much as 100 gms. of radium which would have cost about one crore of rupees. This is the pure physicist's achievement.

But the discovery has also opened a new pathway in biology. Some of the common elements which we take along with our food or medicine like carbon, sodium, nitrogen, can be made radioactive by this process. When these are administered either in the form of medicine or food, the radioactive atom is carried through the human system in the ordinary process of digestion and circulation and we can take a sample from any part of the human body and find out in what proportion the different atoms spread through the human body. With ordinary atoms it would have been impossible to identify their individuality. But every radioactive atom carries a sort of hall mark with it which is very easy to identify. So a new subject of 'molecular biology' has grown up. We quote from the *Review of the Rockefeller Foundation of 1938* an account of progress on this line.

"During the nineteenth century, when biology was proclaiming the cell as the unit not only of the structure but of the physiological activity of the living organism, the physical sciences had already advanced to a point where they were dealing with the molecule and the atom. In the twentieth century, the physical sciences have probed inside the atom, have blasted it apart, and have identified several of its constituent elements. In that progress toward greater refinement of detail, the biological sciences have also shared. Using many of the delicate and exact instruments which the physicist devised in his attack on inorganic material, they are beginning the description and analysis of biological phenomena, not in terms of cells as units, but in terms of genes and other critically important subdivisions of cells; and recently even in terms of molecular structure and forces. This marks, for the biological sciences, an advance which prove to be as revolutionary and significant as the discovery of the living cell in the nineteenth century. A new biology—molecular biology—has begun as a small but significant salient in the whole field of biological research.

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Biology has always had to wait on the development and application of the physical sciences before it could

perfection of the microscope the biologist was in the main limited to what his unaided senses told him. It was by means of the compound microscope that the development of the cell theory was made possible in



The photograph which is reproduced here from the *Review of Rockefeller Foundation* shows Prof. Lawrence inspecting his latest cyclotron. He is the first figure on the righthand side. With him is working an Indian student, Mr. B. D. Nag Chowdhury, late of the Allahabad University. He is standing last on the left.

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go very far along the road. Without physical optics there would have been no microscope, and until the nineteenth century. Similarly it is by means of the new tools and techniques developed in many instances by the physical sciences that the door to a biology of molecules has only recently been opened. The fundamental interrelation of all knowledge was never more dramatically illustrated. The fallacy of the argument for a moratorium on research in physics and chemistry was never so adequately exposed. Biology and medicine can go just so far, and then they must wait for new ideas, fresh techniques, and more powerful instruments. These techniques or instruments may well be developed in a chemical or physical laboratory, in an astronomical observatory, or in the brain of a mathematician. Neither the physicist nor the astronomer nor the mathematician is necessarily thinking of biology, nor is he necessarily interested in it. But success in pushing out the bounda-

ries of knowledge in any one discipline is bound to have its repercussions in all.

* * * *

During 1938 the Foundation made a number of grants for the development of projects in this new field of 'molecular biology.' Two were made to Washington University, St. Louis. A number of other grants were made for work which included important elements relating to this general topic. Three will illustrate one type of such grants. To the University of California, the Foundation appropriated \$30,000 towards expenses in connection with the installation of a cyclotron. Two grants were made in support of research employing the two different varieties of "tagged atoms." Columbia University was given \$71,500 towards the cost of research with the aid of chemical isotopes and a grant of \$35,000 was made to the University of Rochester towards the cost over a period of three years of research with radioactive isotopes."

Science as a Basis for Ethics

Science affords a sound basis for ethics in spite of the fact that it is regarded as natural rather than supernatural in origin and development. It accounts for the fact that codes of ethics differ greatly among different peoples and in different stages of culture, which would be difficult to explain on any other basis than that of evolution. With increasing knowledge of nature and man many codes have been shown to be unreasonable and unethical, and science has helped to replace these by more rational and humane ones. Science is knowledge of nature and of man, and ethics is necessarily dependent on such knowledge; it is therefore impossible to divorce ethics from science.

But science did not create nature or man or ethics and cannot be held responsible for their imperfections. It is as absurd to attribute human greed, aggression, hate and war to science as it would be to hold it responsible for hurricanes and earthquakes and pestilences. It is because science regards ethics as a natural phenomenon that it can hope to determine the cause of unethical behavior and thus attempt to improve ethics by controlling those causes. This is the way in which progress has been made in the control of bodily diseases and there is every reason to believe that it will be equally effective in controlling social disorders.

—The Scientific Monthly

NOTES AND NEWS

OBITUARY

PROFESSOR JOJI SAKURAI

PROFESSOR Baron Joji Sakurai, the great promoter of scientific research in Japan, passed away in January last, at the ripe age of eighty years. Born at Kanazawa in the province of Kaga on August 18, 1858, he went to Tokyo in 1871 and studied chemistry under Prof. R. W. Atkinson. In 1876 the Japanese Government sent him to England to prosecute his studies in the University College, London. Here he studied under Prof. Williamson, Carey-Foster, Lodge, Morris and others and won gold medals and scholarships for proficiency in physics and chemistry. On his return to Japan he was appointed lecturer and then professor of chemistry in the University of Tokyo. By his example and teaching he exercised a profound influence in the direction of chemical studies in Japan and he was the founder of a great school of chemical research in Japan, many of his pupils becoming university professors and leaders of chemical researches. It may be said that the position which his country occupies today in the world of pure and applied science is largely due to his initiative, energy and foresight. He was one of the most active members of the Tokyo Chemical Society of which he was elected president several times. As a result mainly of his efforts, the Institute of Physical and Chemical Research was established in 1917. He then felt the necessity of a national organization of wider scope which would have for its object research in all branches of science and as a result of the efforts of Sakurai and his friends and colleagues backed by royal patronage and State aid, the Japanese Society for the Promotion of Scientific Research came into existence with Prof. Sakurai as the chairman of the Board of Directors. He was elected president of the National Research Council of Japan in 1918 and remained in this office till his death. As the scientific representative of his country he attended many international meetings and congresses. He was twice elected a vice-president of the International Chemical Union and at the third general Assembly of the International Council of Scientific Unions (1937) was elected a vice-president, filling the vacancy created by the death of Marconi. Many honours came to Sakurai from foreign countries. He was elected an honorary member of the Chemical

Society of France, the American Chemical Society and the London Chemical Society. His own country showered distinguished honours on him and he was created a baron shortly before his death. Throughout a long and laborious life Sakurai tried to promote peaceful, cultural relations of his own countrymen with peoples of other lands and to build up an amity of nations.

Bicentenary of the Royal Swedish Academy of Sciences

THE bicentenary celebration is being held this year in Stockholm of the Royal Swedish Academy of Sciences which was inaugurated on June 2, 1739. A meeting was held that year at the Riddarhuset (House of Nobles) to form a scientific academy for the promotion of the useful sciences and the name Swedish Academy of Sciences was adopted on the advice of Anders Celsius, one of the original promoters. The first president chosen was the celebrated scientist Carl Linnaeus then a young man of thirty-two, and the first secretary was an influential young nobleman Von Hopken. The statutes adopted at the inaugural meeting received royal consent later and the king permitted 'Royal' to be added to the title of the society. The Academy was immediately successful and in a few years the membership reached one hundred, a number to which the Swedish membership was later formally limited. One of the earliest endeavours of the society was the building of an astronomical observatory for which the city of Stockholm contributed the site and the State a grant. Pehr Wilhelm Wargentin, the famous astronomer and statistician became its first director; he was also the secretary of the Academy from 1749 until his death in 1783. After his death the society suffered a period of decline and satisfactory progress was resumed when the celebrated chemist J. J. Berzelius took the post in 1818. Berzelius brought about changes in the constitution with the object of making the Academy purely scientific. Berzelius considered it to be duty of the members to keep in touch with the progress of research and the annual festival of the Academy was chosen for the delivery of reports on the different branches of science and these reports were augmented and published. This practice was kept up till Berzelius's death in 1848.

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The Academy gradually became possessed of large museum collections which it finally presented to the State. Then grew up the National Museums of Sweden which, however, are still supervised by the Academy. Among the notable institutions administered by the Academy are the Nobel Institute for Physical Chemistry of Arrhenius which has been of late replaced by the Nobel Institute for Theoretical Physics, the Kristineberg Marine Zoological Station, the Mittag-Leffler Foundation for Mathematics, the Physical Institute, the Abisko Natural Science Station and the Committee for the Protection of Nature.

Recent Archaeological Excavations in Syria

IN a recent report published in the *Times*, Sir Leonard Woolley has given a preliminary account of the further excavations carried out on the ancient site of Allalakh in Syria, the great meeting place of the civilizations of East and West. Excavation of the earlier palace has convinced Sir Leonard that it cannot be much later than the time of Hammurabi, and it has been tentatively assigned to the 18th century B.C. The construction conveys the sense of dignity and propriety combined with an unusual appreciation of space and air.

Some much desired evidence of the contact with Crete, for which mainly the excavation of this site was undertaken, was obtained from a private house of the fifteenth century, in the form of a fresco, exactly similar to a scheme of decoration found at Knossos, and a 12-wick lamp in the form of the capital of a column which would be hailed at Knossos as the typical and unusually fine example of Minoan art. The most important discovery made at the close of the season was a temple, throwing light upon the religion of the people and giving examples of their major arts. Superimposed remains of at least four temples dating to about 1200-1500 B.C., have been detected. Among the more interesting finds are sculptured lions, a bronze spear head deemed to be a cult object and a hidden stature of a god or a king in white limestone with fifty lines of cuneiform inscription. The excavation has really provided a mass of evidence about the character of Hittite art of an early date, presumably of 1200-1500 B. C.

The Leonardo Da Vinci Exhibition at Milan

AN exhibition of Leonardo Da Vinci arranged in the *Palazzo dell' Arte* in Milan has provided a comprehensive and magnificent testimony to the versatile genius and activities of the great master. Exhaustive examples of his multifarious interests have been gathered and to provide a background, in other rooms are exhibited the works of his masters, contemporaries at Florence and at Milan and the pupils of his school.

There are numerous drawings and designs by himself, also examples of his sculpture and some copies of his paintings, showing his superb mastery in drawing and design. His manifold achievements in the field of science as demonstrated by the collections are not less impressive. Anatomy and botany occupied much of his attention and the results of his investigations in these fields have been fully portrayed. In the domain of physics, and mathematics also he was ahead of his age as would be evident from the collection of models and charts and diagrams of his work on astronomy, optics, mathematics and geophysics. Much space has been devoted to a record of his engineering qualities. Innumerable models and drawings give evidence of Da Vinci's ingenuity and power of invention in mechanical devices of almost every kind, to mention a few: printing press, cranes, water wheels, belt-driven machines etc. The wars of the period brought out his genius as military engineer and models of his multiple gun, bridges and fortifications are records of the adaptability of his great knowledge.

Heads of Chief Racial Types of India

THIRTY bronze heads, representing the chief racial types found in India, have been purchased by the Government of India, for the Ethnographical Gallery of the Indian Museum, Calcutta, from Mrs. Marguerite Milward, a distinguished sculptress and pupil of Bourdelle. The figures will enable visitors to form a correct picture of the main races of India. Mrs. Milward spent two years in India, travelling extensively in search of representative specimens of the aboriginal tribes, her itinerary including even distant hills and jungles. The sculptured heads are made from living individuals selected for Mrs. Milward by anthropologists and local officers belonging to the Government of India and the Indian States, who are intimately acquainted with the different tribes and know their peculiar somatic features. The heads, besides being works of artistic excellence, are illustrative of the somatic peculiarities of the different tribes with an exactitude of details which it is difficult to surpass. Among these there are the busts of a Negrito Kadar with his frizzly Melanesian hair, fair representatives of the Proto-Australoid group such as the Santals, Mundas, Maria Gonds and the Chenchus of Hyderabad, representatives of the Mongoloid tribes of the sub-Himalayan region and Assam, such as the Tibetan and the Lepcha of Sikkim, the Abor and the Mishmi from the extreme northern frontiers of Assam and the Angami and the Konyak Nagas of the Naga Hills. The busts also include the head of a Toda of the Nilgiri Hills and a Bengali Brahmin of a well known family of Calcutta.

Figures of different racial types in the past were prepared from descriptions and photographs and these

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lacked in accuracy, the workmanship being largely influenced by the imagination and personal leanings of the modellers. As the aim of the ethnographical museums is to demonstrate actual physical types and customs of the people, conventionalised figures not based on personal knowledge of the modellers cannot completely fulfil the scientific needs for which such figures are intended. This defect was first recognised by the Field Museum of Chicago which deputed Melvina Hoffman, the world famous sculptress, at a cost of \$100,000, to visit distant parts of the world and prepare figures from the living types which were selected for her by competent anthropologists and of which no less an authority than Sir Arthur Keith wrote a descriptive account.

Library Movement in Bombay

IT is an obvious and well recognised fact that libraries help to preserve the culture of the country and promote the advancement of the education of the people. Their great educational value in encouraging the habit of reading among the public cannot be overestimated. Citizens and nations cannot afford to remain aloof from the world advanced in knowledge; and the main means of getting into touch with it is through good books. The existence of good libraries, therefore, has an important bearing on the culture and advancement of the people.

A comprehensive library movement designed to cover the country with good libraries must be sponsored by the State, as the State alone can make such a movement a success on a country wide scale. If libraries are to fulfil their function, they must be located in every place—village, town and city. There should be smaller libraries at smaller centres, and bigger libraries common to each group of such smaller centres, still bigger libraries being located at important places and all these having some sort of inter-relation and communication with each other. It is pleasing to note that the Government of Bombay recently initiated a move to undertake to help the establishment of village libraries as a necessary adjunct to adult education in the province. The whole scheme is ready and will be launched next year when funds are allotted for the purpose. The Bombay Government also intends to establish a Central Provincial Library in the City of Bombay and three Regional Libraries one for each linguistic centre, viz., Poona, Ahmedabad and Dharwar. Under the Press and Registration of Books Act, 1867, Government receives free of charge from printers a copy of every book or publication published in the Province. The Act will be amended as may be necessary in order to make it obligatory on the printer of any book or other

publication to supply free two copies (instead of one as at present), one to the Central Provincial Library and another to the Regional Library concerned. Under such an arrangement the Provincial Library will be the recipient of all copy-right books published in the Province and the Regional Libraries at Poona, Ahmedabad and Dharwar will receive all the books published in the regional language of the area. In order to make the project a success the Government of Bombay earnestly appealed to the organised agencies working for social welfare, philanthropic people and the general public at large to lend their full co-operation in this worthy cause. In many of the other provinces movement for adult education have been started and it may be hoped that the move initiated by the Bombay Government will be followed elsewhere and the provincial Governments would undertake similar schemes for the establishment of a chain of libraries in their respective areas.

Prehistoric Finds in Bihar

SOME of the large number of prehistoric building sites and graveyards, scattered all over Chota Nagpur, particularly in the Ranchi and Singhbhum District of Bihar, have recently been brought under protection by the Government of India under the Ancient Monuments Preservation Act. The sites were first brought to notice by Rai Bahadur Sarat Chandra Roy the well-known anthropologist of Ranchi, who made a preliminary survey and carried out some trial operations. Mr Roy found that the building sites contained evidence of two or three periods of occupation, ranging from the Neolithic Age to the early Iron Age. Brickbats are usually found scattered all over the area and sometimes even traces of damaged brick-walls. Crystal beads, stone arrowheads and potsherds with a red slip or a high black polish, are among other surface finds. The graveyards are strewn with pottery burial jars of various sizes, containing human bones, covered with huge stone slabs placed over them. The jars are incised with geometrical designs, foliated patterns and less frequently with symbols, having affinities with some of the symbols on ancient punch-marked coins. Associated with the jars are found bracelets and finger rings of copper, bronze or iron, beads of stone or bone, as also neolithic celts.

The present day aboriginal population of Chota Nagpur ascribe the sites to the ancient 'Asuras.' Whether their own ancestors were the authors of the 'Asura' culture or whether another race was responsible for this culture it is difficult to say. It appears probable, however, that the culture of this region is connected on the one hand with the Copper Age of North India and on the other with the Megalithic and Iron Age cultures of South India. The Archaeological Department recently surveyed the 'Asura' sites at Khuntitoli, Kunjla, Belwadag, Saridkel, Katahartoli and Hansa, all within a radius

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of six or seven miles from Khunti, a sub-divisional headquarters in the Ranchi District. The Government notification is intended to prevent unauthorized excavation on these sites till such time as the Department is able to detail a specialist for such work in Northern India, the need for which has been stressed lately in his report by Sir Leonard Woolley, the archaeological expert.

A Strange Factory

A STRANGE factory is under construction for the Simonds Saw and Steel Co., at Fitchburg, Mass., U.S.A., where the necessity of providing any windows for the building has been totally eliminated by making it completely air-conditioned and artificially illuminated throughout. This has made possible a great economy of space, the productive machinery covering nearly 17½ acres being concentrated into one-third the area of production space. From this area day light has been completely excluded and arrangements for artificial lighting are being installed in nearly 1500 positions each consisting of a 100-Watt lamp provided with a porcelain reflector. In the working rooms throughout, this would produce an illumination of not less than 20 ft. candles. The plants will be operated intensively on a three shift basis, the work going on continuously day and night. Service mains for water, gas, steam, power, light, air and oil are laid between the floors through ducts direct to more than 1,000 machines and furnace positions. Dust and exhaust gases are also removed through underground ducts, served by thirty dust removal units. The entire building is air conditioned and the humidity and temperature controlled through hydrostats and thermostats. Man-cooler systems have been provided for the comfort of men working at the furnaces. Air will be circulated through the building at the rate of about 400 cu. ft. per minute and this air will be blown through water-sprays before being distributed.

Upper Air Observations in India

FOR safety in flying it is necessary to know the actual weather along the course and the changes that may be expected in it, the direction and velocity of wind at various heights and the height of the clouds. The Agra Observatory which is the pioneer upper air observatory in India has designed and manufactured locally, various instruments and devices for making upper air measurements accurately and expeditiously. Arrangements have been made to take observations of wind direction and velocity at the upper levels in the atmosphere at 34 stations on the usual air routes. These

observations are made by letting off hydrogen-filled balloons called "pilot balloons" and observing their free movement in the atmosphere. The pilot balloon carries with it a "tail" consisting of a measured string to which are attached two paper flags at fixed distances. The motion of the balloon is observed with the help of a theodolite and the observations enable to determine the height, distance, and direction of the balloon minute after minute as it ascends in the free air. From these the direction and velocity of wind at different heights can be easily calculated. For pilot balloon work at night, the ordinary "day-theodolite" has been adapted by special attachments illuminating the field of view of the theodolite and the paper flags in the tail are replaced by paper lanterns illuminated by torch light bulbs and batteries. Usually two men are required to take pilot balloon observations, but binocular theodolite recently developed at the Agra Observatory enables a single observer to follow the balloon, to take the scale readings and dictate the figures through a telephone to another observer in the office room, so that the latter can proceed with the necessary calculations simultaneously with the observations of the flight of the balloon. These binocular theodolites would enable the upper wind data being made available very much more expeditiously than is possible at present with an ordinary theodolite.

Self-recording instruments are also sent up with balloons, one of the simplest of such instruments being the Dine's meteorograph. Such instruments are let off regularly from Agra and Poona, and sometimes from Calcutta, Sambalpur (Orissa), Madras, Hyderabad (Deccan), Bangalore, Ahmedabad or other selected stations. They are tied to hydrogen-filled balloons and when they reach heights of about 15 miles the balloons burst and the instruments come down to the earth. In India meteorographs have reached heights as high as 30 kilometers or 19 miles and nearly 50 per cent of the instruments are generally retrieved.

For determining the height of the base of low clouds, a knowledge of which is very useful to the aviators, small balloons inflated to a size of about 15 inches in diameter are let off. Knowing the rate of ascent, the height of the base of cloud is obtained by observing the time taken by the balloon to disappear in the cloud. At night, a paper lantern is attached to the balloon and the time taken for the light to disappear in the cloud gives the required height of the cloud. Where electric installation is available, a search-light is however, utilised for determining the cloud ceiling. A vertical beam of the search-light is projected on to the cloud and the angle of elevation of the illuminated patch on the cloud is taken from a fixed and known distance away from the search-light. These known angles and distances give the heights of the clouds.

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Indian Trade Review for 1938-39

A PART from sugar and jute, production of most other Indian industries was on a high level, says the Economic Adviser to the Government of India in his Review of the Trade of India in 1938-39, prior to the outbreak of war. Production of paper attained a new record level amounting to a high figure of 1,184,000 cwts as compared with 1,076,000 cwts in the preceding year. Two new paper mills were started and stocks were reported to have increased. Exports of Indian coal including coke were higher and the condition of the iron and steel industry was quite healthy, though the boom conditions of the previous year had passed away. Low cost of production stabilised and improved the industry and, as a result, imports were smaller. On the other hand exports of pig iron were well maintained; though less in quantity than in the previous year, their value was almost the same. As a result of these favourable factors the intrinsic position of the industry continued sound though it was in a less buoyant position. Production was on a higher level.

On the whole, prices of industrial commodities did not slump to any great extent for any of the industrial products in India, coal excepted. The satisfactory position of industrial prices shows that the industrial depression had not very adversely affected the price position in Indian industries during 1938-39. But owing to the recession in business activity and the consequent shrinkage in world trade the total value of India's foreign trade in merchandise fell from Rs. 363 crores in 1937-38 to Rs. 322 crores in 1938-39. Both exports and imports fell in equal magnitude. The total value of India's exports to all countries including Burma amounted to Rs. 163 crores as compared with Rs. 181 crores in the preceding year. The total value of imports into India declined by Rs. 21 crores to Rs. 152 crores. The merchandise balance of trade in favour of India increased by Rs. 1.68 lakhs to Rs. 17.56 lakhs. If transactions in treasure are included then the total visible balance in favour of India mounted to Rs. 29.44 lakhs in 1938-39 as against Rs. 30.24 lakhs in the preceding year.

India's internal trade has been increasing in volume during the last few years, but this tendency was slightly checked during the year. The total inland trade in important commodities decreased from 785,000,000 maunds to 781,000,000 maunds. Prices of many of India's staple articles continued at a low level after the sharp fall in the latter part of 1937-38. Except for raw jute and rice, prices of which were affected by short crops and other conditions peculiar to them, the prices of all other agricultural products were on a much

lower level than in the preceding year, but the actual fall was not as sharp as in the latter months of 1937.

The world depression in agricultural commodities meant a shrinkage in the income of Indian agriculturists. As these are the main customers of the Indian industries a reduction in their purchasing power led to a smaller consumption of manufactured articles. Conditions in most industries were quite prosperous till the end of 1937 and the profits declared during 1938 were the reflection of boom conditions that prevailed in India during the preceding year. Since then, however, business conditions have deteriorated.

Science Book Club

A NUMBER of advanced students of the science classes of Calcutta University have organised the Science Book Club and undertook the publication of a quarterly journal which will contain up to date resume of recent developments in different branches of science. The first two numbers of the journal have already appeared in print and contain interesting articles on nuclear two-body problem and physics of the Ionosphere. The aim of the organisers is to provide the student readers with a back ground of up to date knowledge and adequate bibliography of different subjects so as to help them to pursue the study of these subjects further. The organisation is entirely run by students and as such reflects credit on those who are responsible for the publications.

Drug Manufacture in India

OPENING a recent conference of Chemical and Pharmaceutical Manufacturers in Calcutta, Col. R. N. Chopra, Director of the School of Tropical Medicine, reviewed the present state of drug manufacture in India and made valuable suggestions for putting this industry on a sound foundation. Referring to the requirements of drug manufacturers and their difficulties in securing supplies, Col. Chopra remarked that the chief difficulty lies in the fact that India does not at present possess facilities for producing certain essential basic materials. He stressed the need for developing this vital industry of the country. A Committee to collect data regarding the requirements of the chemical and pharmaceutical industry and to take suitable steps in co-operation with the Government and other important suppliers to obtain supplies has been formed with Bt. Col. R. N. Chopra, a representative of Imperial Chemical Industries (India) Ltd. and the representatives of the premier drug manufacturing companies in the country. Another committee to consider the possibilities of the development of the manufacture of new lines of chemicals in India will comprise Dr. H. K. Sen. Bt. Col. R. N. Chopra and others. The following were elected to the Committee of the Indian Chemical Manufacturers Association for the year 1939-40:

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President—Sir P. C. Ray; Members—Raj Mitra, B. D. Amin, Mr. J. N. Lahiri, Dr. H. Ghosh, Mr. Mohamed Hanif, Capt. N. N. Dutta, Mr. J. Chakravarti, Dr. B. N. Ghosh, Mr. B. Maitra and Mr. R. L. Nopany.

Growth of Joint Stock Companies in Bengal

THE Report on the growth of Joint Stock Companies in Bengal during the period 1900-1 to 1935-36 published by the Intelligence Section of the Department of Industries, Bengal, is a study on the pace of progress which the province has been able to achieve in the matter of industrial undertakings. With regard to the progress of company promotions, the study reveals that in most of the branches of industrial ventures a definite impulse manifested itself only after the last Great War i.e., from about 1918-19. In fact the quinquennium ending 1920-21 was the first period in the economic history of the Province when the largest number of companies was registered with the largest amount of authorised capital. Banking, insurance, trading and manufacturing companies, mills and presses, mining and quarrying companies grew in large numbers and the impetus has been more or less maintained ever since. Even the growth of hotels, theatres and other entertainment companies which are regarded as natural accompaniments of an industrially advancing community synchronised with this industrial development.

In respect of the progress of industrial undertakings there were at work on the 31st March, 1936, altogether 4916 Joint Stock Companies with a paid up Capital of Rs. 133.42 lakhs as against 398 Joint Stock Companies with a paid up capital of Rs. 15.47 lakhs working on the same date in 1901. It is also shown in the Report that the average paid up capital of each company was Rs. 3.9 lakhs in 1900-01 which has dwindled to Rs. 2.8 lakhs in 1935-36.

In respect of Bengal's position vis-a-vis India as a whole in the matter of the growth of Joint Stock Companies the Report reveals that the total number of Companies working in Bengal at the close of 1920-21 was 45.6 per cent of the all-India figures, while the total paid up capital formed 44.3 per cent of the corresponding figures for India as a whole. At the end of 1933-34, however, the corresponding percentages stood at 49.6 and 44.2 respectively. The average paid up capital of a company in Bengal is only Rs. 2.8 lakhs as against Rs. 8.2 lakhs in Bombay, Rs. 2.9 lakhs in U. P. and Rs. 12.8 lakhs in Burma.

The average rate of company failures per 100 working has varied between 1.5 and 17.5 during the quinquennium beginning from 1900 while the rate of company failures per 100 registered has varied between

14.7 to 60.2 during the same period. The wastage of capital involved in all the company failures till 1935-36 has been computed to be Rs. 40.7 crores in which the share of trading and manufacturing companies is Rs. 15.5 crores and that of banking, insurance companies is Rs. 7.7 crores. The analysis of 450 balance sheets of companies which had come into existence during the quinquennium ending 1924-25 and another set of 400 balance sheets of companies which had been registered during the quinquennium ending 1913-14 shows that hardly 30 per cent of the total number of companies declared dividend while about 19 per cent of the companies went into liquidation and the rest were working without declaring any dividend. On the basis of averages the Report suggests that in the pre-War period the average period taken by the different categories of companies for declaring a dividend varied from 3 years to 6 years, while in the post-War period, the period varied from 2 years to 5 years. The rate of dividend also varied from $3\frac{1}{2}$ to 15 and from 4 to 16 during the respective periods. But it must be understood that the success of these companies depended on patient labour and cautious management.

Announcements

THE Nobel Prize for Literature for 1939 has been awarded to Francis Eemil Sillanpaa of Finland whose novels on peasant life have been translated in many languages.

THE Nobel Prize for Physics for 1939 has been awarded to Professor Ernest Orlando Lawrence of California University for his discovery of cyclotron.

THE Nobel Prize for Chemistry has been awarded jointly to Professor Butenandt of the University of Berlin and Professor Ruzicka of Zurich.

The prize for 1938 which was held over has been awarded to Professor Kuhn of Heidelberg University.

THE Nobel Prize for Physiology for 1939 has been awarded to the German professor, Gerhard Domagk, for his work on a bactericide called "prontosil."

The prize for Physiology for 1938 has been awarded to the Belgian professor, Corneille Heymans, for research into sinus and aorta mechanisms.

THE Clement Cleveland medal has recently been awarded to Mlle. Eve Curie by the New York Cancer Committee in recognition of her biography of her mother. This is the first time that this distinction has been conferred upon a foreigner and a woman.

MR John Cobb of London is reported to have set up a new record for speed on land. Riding in his Railtow Red Lion Motor-car, at Bonneville Salt Flats, Utah, he reached an average speed of 368.85 m.p.h.

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over a measured mile. The previous record of 357.70 m.p.h. was set up over the same course by G. T. Eyston about an year ago.

THE third session of the Indian Statistical Conference will be held in Madras in the first week of January 1940. It has been provisionally arranged that the Conference will be opened by His Excellency the Governor of Madras on the 3rd January 1940. On the invitation of the Mysore University arrangements have also been made for holding a special session in Mysore possibly on the 6th and 7th January. In Madras the work of the Conference will be carried on in active co-operation with the Indian Science Congress as in previous years. Arrangements have been made for joint meetings with the Sections of Mathematics, Physics, Agriculture, and possibly the Section of Medicine and Public Health. There will also be a special session on Economic Statistics. The Government of India, different Provincial Governments, many of the important Indian States and Universities in India have given their official recognition to the Conference and are expected in many cases to send official delegates. The subscription for ordinary members of the Conference is Rs. 5 and for Associate and Student members Rs. 3 and Re. 1 respectively. Members of the Indian Statistical Institute will be entitled to become Ordinary members of the Conference without payment of any additional subscription. Ordinary members of the Conference will have the right to contribute papers, to attend all scientific and other meetings of the Conference and to receive free of charge all publications relating to the conference.

Papers and scientific contributions should be sent so as to reach the Honorary Secretary, Indian Statistical Institute, Statistical Laboratory, Calcutta, before the 15th December 1939. Enquiries in regard to local arrangements and accommodation should be addressed to the Local Secretaries, Prof. P. J. Thomas, University of Madras, or Prof. K. B. Madhava, University of Mysore.

MR S. N. Mukherji M.Sc. A.M.I.E. (Ind.), a member of the Research Staff, Government Test House, Alipore, has been awarded by the Institute of Marine Engineers, London, the prize of £50 under the Herbert Akroyd Stuart Award 1937-39 for his paper on "The Origin and Development of Heavy-Oil Engines" for the best paper on the subject of oil engines. The award is given every two years as provided under the Will of the late Herbert Akroyd Stuart. The Awards Committee reported that the 'entries received on this occasion

were of a very high standard of merit,' and they have specially complimented Mr Mukerji on his excellent essay.

THE following special lectures have been arranged by the Faculty of Science of Lucknow University for the session 1939-40. These lectures will be later published in the *Lucknow University Studies*. December 16 and 17: Dr. D. S. Kothari on Quantum statistics, December 20, 21 and 22: Sir C. V. Raman on New light on crystal physics. January 10 and 11: Dr A. C. Chatterji on Stability of colloids, January 12, 13 and 14: Professor N. N. Sen Gupta on The vicissitudes of the mind: (i) The course of mental growth. (ii) The profiles of the mind. (iii) Disintegration and decay of the mental personality. January 16 and 17: Mr. Boshi Sen on Vernalisation. January 24 and 25: Dr R. S. Verma, on Whittaker functions and wave mechanics, January 29, 30 and 31: Dr S. Hasan Zaheer on Sterols and related compounds. February 2 and 3: Mr. Kali Prasad on Planes of intelligence: (i) Criteria and the technique, (ii) Data and their interpretation. February 5 and 6: Dr Makund Behari Lal on Helminthology: (i) Host-specificity as applied to Helminths. (ii) Recent additions to our knowledge of Avian Trematodes. February 8, 9, 10 and 11: Dr A. N. Singh on Some modern theories of integration. February 15, 16 and 17: Mr A. C. Banerji, on Galactic dynamics: (i) Formation of arms of a spiral nebula. (ii) Polytropic gaseous configurations. (iii) The origin of planets and satellites. February 19 and 20: Mr S. B. L. Mathur, on Cosmic rays and subatomic particles. February 25, 26 and 27: Dr A. B. Misra on Reproduction in India birds.

THE 11th session of the Indian Mathematical Conference will be held at Hyderabad under the auspices of the Osmania University from 21st to 23rd December, 1939. The inaugural address will be delivered by Prof. N. R. Sen, Ghosh Professor of Applied Mathematics, University of Calcutta. Apart from the reading of papers, two symposia will be held on (i) Generalised Geometry, including Relativity and Field theory, and on Waring's problem. A discussion on the teaching of mathematics in schools and colleges will also be held. Three public lectures will be delivered on (i) Meteoric Astronomy (ii) Mathematical Recreations and (iii) Mathematics, the Handmaid of Arts, Sciences and Economics. Excursions to the famous Ellora and Ajanta caves are also being arranged.

Those who wish to attend the conference should communicate with the Local Secretary, Department of Mathematics, Osmania University, Lallaguda, Hyderabad (Dn).

SCIENCE IN INDUSTRY

Electrochemical Industries

THE general belief that the electrochemical industries are not economically possible in a country which lacks in cheap hydro-electric power is no longer valid, and has lost much of its cogency, largely due to the remarkable increase in efficiency of steam or thermal power stations in recent years. The efficiency has increased so much that in many cases the balance of advantage is now on the side of the thermal stations. In the first place, many of the best sites for hydro-electric power stations in most countries are in such places which are almost inaccessible in the matter of raw materials on the one hand and the finished product on the other, secondly the cost of electric power in many electrochemical industries is often a comparatively small factor, and in the third place the capital costs of thermal stations are as a rule, considerably less than those of hydro-electric plants, in view of the present high efficiency of the latter.

The cost of electricity as a percentage of the selling price of the product has been the subject of many statistical studies, and some of the latest approximate figures are as follows: 0.5 to 0.1 per cent in the production of cadmium, and in the refining of copper, nickel, and lead; 1.1 per cent for ferro-tungsten; 4 per cent for copper extraction; 8 to 9 per cent for magnesium; 11 per cent for certain important chemicals such as chlorine, caustic soda, and potassium chlorate; 12 per cent for ferro-manganese; 13 per cent for aluminium; 17 per cent for zinc; 18 per cent for calcium carbide; 20 per cent for ferro-chrome; and 27 per cent for ferro-silicon.

The third point, that of relative costs of electricity from thermal power stations and from hydro-electric sources, has also been the subject of elaborate statistical investigation in recent years. It has been estimated that the cost of electricity, generated at a thermal station of the latest approved type erected at a capital cost of Rs. 240 per installed kW, is about the same as that obtained from a hydro-electric station erected at a capital cost of Rs. 655 per installed kW, and considering recent advances in the efficiency of thermal stations it seems legitimate to conclude that a modern thermal

station can deliver electric power on equal terms and sometimes on lower terms than a water-power station. This does not mean that the erection of water-power stations are to be discouraged, because in many cases they have their special importance and advantage over thermal stations.

Electrolytic methods are gradually gaining field over chemical methods and in many cases they have completely supplanted the latter, in point of view of both advantage and efficiency. It is high time that steps should be taken in India for the electrolytic production of chlorine, caustic soda, various per-compounds, such as hydrogen per-oxide, per-chlorates and per-manganates, oxygen and hydrogen from electrolysis of water (though here the cost of electricity is very high) also several metals and alloys, such as aluminium and magnesium and their alloys, and the minor metals, such as sodium, calcium, lithium, beryllium, ferro-alloys, calcium carbide, etc.

It will not be out of point to mention here that Germany is producing nearly one-third of the total world production of aluminium and the power supplied is entirely from her efficient thermal stations.

—N.K.S.G.

Control of Mango Hoppers

THERE are three species of mango hoppers, *Idiocerus atkinsoni*, *Idiocerus niveosparus* and *Idiocerus clypealis*. The first two species are easily distinguished from the last by their large size, and between themselves they can be recognised by facial markings.

Trials made during the past mango season by the Agriculture department of the Government of Bombay have shown that sulphur is an effective remedy for dealing with the mango hopper provided unusual weather conditions do not prevail during the season. The species which is most susceptible to sulphur treatment is *Idiocerus clypealis*. Cloudy weather and late rains received in January are the two factors that are very favourable to the development of the hoppers and in years when these conditions are obtained, the pest assumes serious dimensions.

Sulphur dust was used in the demonstrations by means of Peerless Dust Guns. The flowerheads were

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thoroughly dusted, but care was taken not to leave a thick deposit on the flowers which sometimes drop down as a result of the harmful effect of the dust. Sulphur of good quality was therefore employed. When dew fall was heavy, it was discovered that the dust had a tendency to "cake"; but this could be avoided by lightly dusting the inflorescences at different applications.

The quantity of sulphur required to cover flower-heads at different flushes is said to vary greatly. It was found necessary to repeat the operation as long as new inflorescences were being formed and also to renew the coating on older ones as the dust weathered off.

It is often contended that, if a sulphur and cyanogas mixture is applied at the pre-flowering stage, the infestation of hoppers can be much reduced. Experience shows, however, that pre-flowering dustings are not likely to be of much value since the species of the hopper which are responsible for much of the damage during the flowering season, viz., *Idiocerus clypealis* and *Idiocerus niveosparus*, are not found in the pre-flowering period. The species found on the mango trees during the latter period is *Idiocerus atkinsoni*, which is found in small numbers in the flowering season and therefore probably responsible for the least damage.

One of the factors generally responsible for the failure of the sulphur treatment is the quality of sulphur used for dusting mango inflorescence which should be of the order of 300 mesh fineness and free from admixture. There are several other conditions under which sulphur dusting does not give the desired results. The proximity of gardens to rivers, close plantings and insanitary conditions encouraging weeds all tend to favour the rapid development of the hopper by increasing the humidity of the atmosphere and probably by providing shelters in weedy situations in gardens. For successful control with sulphur dusting, it is very essential that gardens should be kept clean of weeds during the flowering season and that closely planted gardens should be thinned out to permit of adequate sunshine.

Filtered Water for Irrigation

THE Imperial Dam and its associated desilting works and canals together form one of the important engineering projects ever undertaken. The dam has been built to supply water for irrigation purposes from Colorado river to the Imperial Valley in California. From engineering point of view the dam itself is not so important but the idea of desilting the water and then sending this clear water through canals is quite novel. Colorado river water contains much silt, so much so, that a flow of 12,000 cusecs, which is the initial amount of water that will be diverted from the river, will carry

with it 60,000 tons of silt a day, and if not dealt properly would cause rapid silting of the canals, with the necessity of almost continuous dredging. In figures it has been estimated that though the desilting works have cost 1,500,000 dollars, they will save about 1,000,000 dollars per annum.

There are three desilting basins each of which covers an area of 500 ft. by 800 ft. by 12.5 ft. deep. Provision has been made for the addition of a fourth basin, if necessary, when the ultimate diversion of 15,000 cusecs from the river is reached. The water from headworks comes through inlet canals which are constructed in a way to ensure that the water flows at a velocity sufficiently high to prevent silting when one or two of the basins are closed down. From these canals water enters through radial gates to tapering inlet channels which extend down the centres of the desilting basins thus dividing each basin into two halves. From these tapering channels water will be distributed to the half basins on each sides through vertical slots. The slots serve the purpose of reducing the velocity, and therefore the turbulence of the water entering the basins. This will assure uniform distribution of the inflow both as regards depth and width. Due to this sudden reduction of velocity all materials larger than 300 mesh will settle. Each half-basin is provided with 12 centre-drive rotating scrapers. Each of these scrapers is 125 ft. in diameter and revolves at a peripheral velocity 30 ft. per minute making one complete revolution in 13 minutes. In this way they will continuously scrape the settled silt into a central collecting trench, from which it will flow through sludge collecting pipes into the river, where it will be carried downstream by the flood water over the dam. The scrapers work on the principle of Dorr Thickeners, and raise their scraper arms when there is overload, i.e., they scrape less deeply into the silt, if the load becomes too great. There is also a provision for by-passing the water into the irrigating canal without desilting. The collected sludge will be carried away for use in sea reclamation purposes in cities like Los Angeles, San Francisco, etc.

—N.K.S.G.

Enemies of Historical Records

THE Imperial Record Department has been waging a relentless fight in its efforts to preserve thousands of old records, of which it is the custodian, against minute worms, difficult to detect with bare eyes, grubs and mature specimens of a hard winged insect and that voracious pest, the silver fish. The silver fish eats away the paper but spares the binding. The other two seek their nutrition from the binding. They bore tiny tunnels through the binding boards until they are reduced to pulp. They do not appear on the surface and incessant tapping of the affected parts alone frighten them out of their hiding.

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Experience shows that the pests attack straw-board bindings only and leave the teak boards alone. But even in these latter the binding leather is not immune.

Some insects are particularly fond of a special kind of paste or a particular class of paper and these have to be avoided like poison—while a poisonous paste specially prepared for the department is used. Recently three little packets have been forwarded by the Imperial Record Department, Government of India, to specialists at three different places. The first went to the Institution of Chemists in Calcutta, the second to the Agricultural Entomologists at New Delhi, and the third to the Forest Entomologist at Dehra Dun.

Mineral Substitute for Corks

VERMICULITE is a hydrated mineral derived from certain micas and the mode of occurrence appears to be similar to that of apatite. It may have been formed by a weathering process, or by a hydro-thermal alteration whereby some of the potash of mica leached out. Until 5 or 6 years ago it was a little known mineral and now it is gaining commercial importance. By heating the mineral to a temperature of 900 to 1000° C. for a few seconds and then cooling as rapidly as possible, the mass exfoliates due to the loss of combined water. The result is a granular material possessing an accordion-like structure of exceedingly low specific gravity. The final bulk-density depends upon the rapidity of the heating and cooling process, the highest figure being 14 lb. per cubic ft., while the best grades range from 4 to 6 lb. per cu. ft. The latter grades are thus lighter than regranulated cork of similar size which weighs 9 to 10 lb. per cu. ft. When properly expanded in the above way, vermiculite possesses a thermal conductivity of about 1.5 as compared to 1 for cork and about 3 for asbestos. Vermiculite resists heat in a similar manner to asbestos and consequently it is a better material for insulating purposes than cork and cork substitutes which are inflammable. It does not sinter till about 1250° C. has been reached, and does not melt under 1350° C. The size of the particles is of importance, and the heat-treated and expanded material must be accurately graded. Fine materials which are not so suitable for insulation purposes are employed in plaster compositions for acoustic purposes, and is also used in conjunction with magnesium oxychloride for steam pipe insulation, and other light-weight fire-proof cork substitutes. The coarser material is being used as a special lagging in recent high pressure boilers, directly against the outer metal shell in electric furnaces, and as an insulating material in close proximity to furnace doors, for the protection of furnace attendants. Similar to

asbestos boards vermiculite boards are also being produced.

The analysis of vermiculite indicates 38 to 45 per cent silica, 21 to 25 per cent magnesia, 6 to 12 per cent alumina, 5 to 9 per cent iron oxide, 2 to 7 per cent potash, 0.5 to 1.5 per cent soda, 0.5 to 1.5 per cent titanium oxide, 1.5 to 3 per cent lime, and from nil to 1 per cent manganese oxide. Carbon dioxide is present in the raw material but this is evolved during the subsequent burning. Water is present both as moisture and combined water. The colour is widely variable, but the most common shades are black, dark brown, golden yellow, and white. At present U.S.A. is the chief producer, some 25,000 tons were produced in 1937. It is also being developed in Russia, and vast deposits have recently been discovered in Transvaal, South Africa.

—N.K.S.G.

Indian Telephones

THE Government Telegraph Workshops at Alipore, Calcutta, in 1938-39, produced 2,450 telephones. They are the first telephones of the hand microphone type to be regularly produced in India.

The Workshop had a modest beginning as a repair workshop, but has grown now into a factory employing 1,400 workmen who have received training in tool and gauge manufacture. With the plants and machinery at its disposal, it is now in a position to meet the entire needs of the department for line-construction stores with the exception of wires and insulators. The manufacture of almost all components used in telephone including moulding of parts in bakelite, is to be undertaken in the near future. The technical practice of the Workshop is to be continuously improved by the provision of modern machinery for testing of materials and the expert examination of completed components.

The Workshop was first instituted at Agra in 1854 and was known as the Central Telegraph Workshops. It supplied a very small number of instruments for Telegraph Offices.

In 1857, the Workshop was transferred to Calcutta and a branch workshop was also opened at Bangalore. After some transfer of plants from Bangalore to Calcutta and from Calcutta to Bangalore, the Workshops were finally located at Calcutta at a new site known as "Iron Bridge Premises" in 1861. It was in 1920-21 that the manufacture of high-speed telegraph apparatus previously imported from Europe, was started. In 1934-35, the Workshop undertook repairs of wireless apparatus and the manufacture of switchboards, charging panels, trunk line panels and trunk line commutators.

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Synthetic Fibre from Soya Bean

AN albuminous-base fibre is being made in Japan from Soya bean albumen and is being sold under the name of "Silkool." There is plenty of raw material, for some 5,000,000 tons of soya beans are produced annually in Manchukuo, Japan, and Korea, yielding about 2,000,000 tons of crude albumen. The whole of this is

not of course available for textile purposes but if only one per cent is utilised in this way, the supply is considerable. The properties of Silkool as compared with Lanital, Tiolan, etc., show that it compares favourably with these in respect of tensile strength, elasticity etc. Like the other synthetic fibres mentioned above it does not appear to stand up very well against wet conditions, though the elastic properties closely approximates those of real wool.

—N.K.S.G.

Reference Ambient Temperatures for Indian Conditions

As Applicable to Limits of Permissible Temperature Rise under British Standard Specifications

B. B. Ray

It is generally accepted that limits of temperature rise given under B.S.S., A.I.E.E., V.D.E., and I.E.C., standards are not adequate for Indian conditions in the plains where the maximum shade temperature in summer may go up to about 120° F. which is followed by humidity of 100% during the monsoon months. Consequently electrical machines such as industrial motors, generators and transformers which are designed according to European or American standards are not satisfactory under Indian summer conditions.

In order to get over this difficulty, some of the bigger electric concerns, the railways and steel companies have been using an ambient temperature varying between 45°C and 55°C, to accommodate for Indian conditions. Alternatively some concerns use the same reference ambient temperature as given in B.S.S., but the actual temperature rise is reduced so that the ultimate temperature may be the same as given in British Standard Specification. There has been a tendency to work on this basis on account of lack of scientific information on the probable average ambient temperature which might be taken as a basis for Indian conditions. In order to arrive at some idea, the writer analysed a large number of temperature readings taken in summer months in different factories and power houses in India.

British, American and Continental Standard Specifications may be summarised as under:—		
BRITISH STANDARD SPECIFICATIONS		
<i>Ambient temperature.</i>	<i>Specification No.</i>	
40°C	225-1935	
<i>Industrial machines.</i>	226-1925	
	168-1926	
	171-1927	
	116/2-1937.	
40°C Peak	}	116/1-1937.
45°C Average		
<i>Maximum permissible temperature rise.</i>		
55°C	2251-1925 relating to	
By thermometer.	alternators of the steam-driven type.	
55°C	BSS 226-1925 relating to	
By thermometer.	large generators and motors, A. C. winding stators and rotors.	
40°C	168-1926 relating to industrial motors and generators (Class A).	
By thermometer.	171-1927 relating to oil immersed transformers (Class A).	
55°C		
By thermometer.		

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INTERNATIONAL ELECTRICAL COMMISSION STANDARD		
Type of machine	Ambient temp.	Permissible maximum rise
Winding of turbo-type machine Class A.	40°C	50°C
Industrial A.C. & D.C. machines.		

It will be noticed that the maximum temperature rise is 50°C which is lower than that specified in B.S.S. indicating an attempt to allow for overseas and tropical conditions.

V. D. E., STANDARD.		
Type of machine	Ambient temp.	Permissible maximum rise
A. C. windings of alternators	35	50
A. C./D. C. windings of industrial machines.	35	60
Oil immersed transformers	35	70

These are much higher than limits specified in B.S.S., or I.E.C., standards.

As mentioned above, in order to get over the difficulty, some bigger electrical concerns in India specify an ambient temperature varying from 45°C to 55°C. But in order to arrive at some definite conclusions, temperatures were taken in different power-houses, sugar mills, steel works, jute mills and electric power-houses in different parts of India. The maximum temperature near river side (pump house, cooling water inlet for power-house) varies between 45°C and 47°C, the maximum sun temperature in oil on the same day varying between 65°C and 66°C. One is likely to take the maximum ambient temperature in shade as the maximum temperature on which the machine might have to work but it has been found from experience that the maximum ambient temperature inside buildings, such as switch board galleries of a power station, can be very much higher than the maximum ambient temperature in shade. The maximum temperature on switch board galleries of power-houses varies between 50°C in Calcutta to about 54°C at Jamshedpur and Bhowra. On one occasion, temperature inside a kiosk sub-station has been found to be actually higher than the sun temperature outside.

The soil temperature remains practically constant at a depth of 4 ft. underground and varies between 36°C and 33°C, these temperatures being taken by buried resistance thermometers. It is interesting to note the difference between maximum and minimum temperatures, which can be as high as 40°C. Thus for outdoor machinery, such as power transformers and crane motors, in addition to the heavy strain of working in ambient temperature considerably higher than that for which the machine is designed, the machine has also got to stand an additional mechanical strain due to sudden heating and cooling. It must be also remembered that humidity may vary from extreme dry conditions during the day to nearly dew point during the night. This may be one of the reasons why transmission line failures in India generally occur during the early hours of the morning.

With forced ventilated alternators where the circulating air is pre-cooled, this difficulty is greatly minimised. For outdoor machines, it must be remembered that the sun temperature in oil is very much higher than shade temperature.

Many of the equipments which might survive the actual summer months have failed during the monsoon following the dry heat. Machines which are liberally rated or derated to meet tropical conditions and temperature rise are found to be more satisfactory during the monsoon months and give less trouble.

Experiments have been made in this country with air-conditioned power-houses where standard machines are used and been found to be satisfactory. For very big power-houses with forced ventilated machines, air conditioning is actually cheaper than using larger sized machines derated to meet tropical conditions.

In conclusion, for Indian condition the most probable and suitable reference ambient temperature may be taken as 50°C instead of 40°C as specified in B.S.S., or I.E.C. The 35°C reference temperature specified in V. D. E. is totally inadequate for Indian conditions. The permissible temperature rise should be reduced correspondingly so that the maximum ultimate temperature may not exceed that given in B.S.S. and I.E.C. standards.*

*A detailed paper on the subject has been published in the *Electrician*.

Can Indian Natural Essential Oils Compete with Synthetic Products of Foreign Countries

Jitendra Nath Rakshit

Rakshit Gardens Laboratory, Ghazipur, U. P.

In the paper* on "Development of Essential Oil Industry" a preliminary scheme of work was outlined. It is now intended to discuss the question whether the natural compounds mentioned in the paper will be able to compete with the corresponding artificial products of other countries. The following compound are principally used in the preparation of artificial perfumes and perfumed products.

Allyl-dioxybenzene methylene ether, Benzaldehyde, Benzyl acetate, Benzyl alcohol, Benzyl benzoate, Bornyl acetate, Coumarine, Dinitro-butyl-meta-cresol methyl ether, Diphenyl oxide, Ethyl para-cresol, Ethyl β -Naphthol, Geranyl acetate, Linalyl acetate, Methyl anthranilate, Methyl benzoate, Methyl eugenol, Methyl β -Naphthol, Methyl para-cresol, Phenyl acetic aldehyde, p-oxy-benzaldehyde, Terpenol, Trinitrotertiary butyl xylene, and Vanillin.

The above compounds are used in blending the following principal products in some countries; Carnation, Heliotrope, Jasmin, Lavender, Lilac, Lily of the Valley, Neroli, Rose, Sweet pea, Violet and Zlang Zlang.

They are also widely used in producing blended perfumes with fancy Indian names; Bela, Chameli, Champa, Dauna, Dilkhush, Gulab, Bulstan, Har Singar, Hena, Juhi, Kesari, Ketaki, Khas, Nageshwar and Rose.

B. N. Singh has prepared a list of perfume and essential oil yielding plants of India (*Indian Journal of Pharmacy*, Vol. I No. 3 July 1939 page 115). The following are being cultivated in the gardens of the author with an object of natural photo-synthetic and enzymic production of most of the above mentioned aromatic compounds, and then subsequent application of suitable methods of extraction of scents.

Oil bearing trees.	
Surbuti ..	Citrus Decumana
Zambiri ..	Citrus Acida
Kaghzi (I) ..	Citrus Limetta
Kaghzi (II) ..	Citrus Limetta
Kaghzi (III) ..	Citrus Limetta

*SCIENCE AND CULTURE, 5, 108, 1939.

Sweet scented flowering trees.	
Kamini ..	Murraya Exotica
Sefali ..	Nyctanthes Arbor-Tristis
Ach (Bengali), Achi (Hindi) ..	.....

Oil Bearing plants.	
Sweet Basil ..	Ocimum Basilicum (Var. thyrsoiflorum)
Sweet Basil ..	Ocimum Basilicum (Var. purpurascens)
Sweet Basil ..	Ocimum Basilicum (Var. album)
Sweet Basil ..	Ocimum Basilicum (Var. Crispum)
Mamri I (Hindi) ..	Ocimum pilosum
Mamri II ..	Ocimum Canum
Sritulsi (Bengali) ..	Ocimum sanctum
Krishna Tulsi ..	Ocimum sanctum
Dauna (Hindi) ..	.....

Sweet scented flowering plants	
Juhi ..	Jasmin Auriculatum
Chameli ..	Jasmin Catalanian
Bela, Single ..	Jasmin Arabian
Bela, Double (Oval petals) ..	Jasmin Arabian, Motia
Bela, Double (Round petals) ..	Jasmin Arabian, Mogra
Bela, Double (Nabamallika) ..	Jasmin Arabian
Rose (Several varieties) ..	Polianthes, Rajanigandha
Tuberose ..	Gardinia florida, Cape Jasmine.
Gandharaj ..	Lady of the night
Hasunu-hena ..	.....

Oil bearing grasses.	
Rusa Grass ..	Andropogon Schoenanthus
Ginger grass ..	Cymbopogon Martini
Motia Grass ..	Andropogon Martini
Khas Khas ..	Vetiveria Zizanoides
Lemon grass ..	Andropogon Citratus
Citronella ..	Andropogon Nardus
Camel Grass ..	Andropogon Laniger

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Aromatic compounds generated in the above trees and plants are mostly known. Most of the well-known synthetically made aromatic compounds of commercial importance can be derived directly from vegetable products in India, or indirectly through one or two chemical processes from those natural products.

In India there are a large number of flowers which grow with very little care and can be made to produce with reasonable profit quite nice perfumes when properly exploited (Rakshit, *Perfumery and Essential Oil Record*, July 20, 1937, page 241). These delicate flower perfumes which can be conveniently extracted by easy means, and some of which are obtained by steam distillation are expected to give perfumes of higher grade. By organised efforts and proper exploitation of unemployed labour and the spare time of our villagers on abandoned and undeveloped lands the production of such compounds at a competitive rate may be quite practicable.

The principle involved in the building of these aromatic compounds is either photo-synthesis or enzymic production in the living plants. These natural products will have a higher market value on account of their beneficial effects on the nervous system. Most of the artificial perfumes contain traces of their parent compounds which are generally harmful to human system. For instance, traces of toluene and its chlorinated derivatives in common artificial compounds like benzaldehyde, benzyl alcohol, or benzyl acetate may not always be fully removed. The celebrated French perfume chemist, Dr Eugene Charabot said "The industry of natural perfumes was destined to evade these disturbing influences: and we have seen the artificial industry born and develop, not merely without inflicting the least injury to the industry of grasses, but even assisting its progressive evolution. Nature maintained the monopoly of the fine perfumes, whilst the art of chemist created odorous products of low price, which enabled composition to be prepared within the means of humbler customers. New needs are created by the possibility of satisfying them, so that the use of perfumes has extended to all classes of society" (E. J. Parry, *Perfumery*, Page 84).

Consequently a wide and extensive market now exists for perfumers of all grades. If we can develop in India better and beneficial natural perfumes at a competitive rate, our scheme stands to be successful and adequately profitable, because there will be no dearth of market.

Thanks to scientists, by the discovery and introduction of cheap artificial perfumes—they have already

created an extensive market in India as well as in other countries, which could not have been done by old and expensive natural products like perfume of the violet flower. Ionone from citral made the use of perfume of violet very common. The task now is to capture the market by means of superior quality of citral either from lemon grass oil or from *Ocimum canum*.

By the introduction of cultivation of perfume yielding trees, plants, and grasses we may fully exploit, the spare time of cultivators, the surplus land, the uneven and unploughable land, the hill tracts and the services of unemployed educated young men. Introduction of these cultivations will not only increase varieties of crops but will also lead to the evolution of extensive cottage industries in remote villages and unemployed science graduates may start synthetic factories.

How these natural products will resist the competition against those artificial compounds, which are now in use? It is necessary for the manufacturers of synthetic perfumes to use some basic materials, e.g., citral. Therefore there are good prospects of crops which would yield cheap and good quality of citral and compounds similar to this. A very large quantity of such basic products can be easily grown from several Indian trees, plants and grasses. Demands for such basic products are quite large throughout the world. There are also many sweetly scented compounds, which are widely used in perfumery. These can be efficiently obtained both artificially and naturally, as for example, methyl cinamate. In western countries such synthetic products are frequently made from suitable materials through human effort by utilising electric power. In this tropical country of India such synthesis is being done by nature by using light rays from the sun through the agency of trees, plants and grasses. A list of experimental crops cultivated here has been given above, and out of these at least 20 are producing quite a large number of sweetly scented chemical compounds of considerable value in perfumery. It has been found in small scale experiments done in the gardens as well as by cultivating in five villages lemon grass, *Ocimum basilicum*, at the instance of the local Perfume Producers Co-operative Society that these crops would give profit of Rs. 20 to Rs. 40 per bigha (nearly 1/3 acre).

An interesting fact may in this connection be noted. A plot of land in the gardens of the author was set aside for growing seedlings of an improved kind of double *Bela* (see Rakshit, *Perfumery and Essential Oil Record*, l.c.) for free distribution to promising cultivators. A batch of local cultivators of single *Bela* flowers was asked to see our crop of double *Bela* in the experimental reserve field. All of them appreciated the double size and superior scent of the variety and they wanted to cultivate these

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immediately in replacement of their old single *bela*. Unfortunately spare seedlings were only enough for one man during this season. The cultivator, who got the seedlings, is growing them in his field. Indian cultivators though so very conservative and illiterate seem therefore not altogether incapable of being convinced of agricultural improvement.

Perfume Producers' Co-operative Society was started a few years ago and is having its normal growth. It is expected that in near future it will expand and be able to produce very good quality of citral, linalol, geraneol, eugenol, etc., in large quantities through photo-synthesis in plants without any extra cost of energy and material. It is now the duty of all industrial chemists, and university professors of organic and applied chemistry to inspire batches of young scholars to take up laboratory chemical synthesis of ionone, esters of linalol, geraneol, eugenol etc., on commercial scales. There is a market for such synthetic products of about 50 lacs of rupees per year.

With production of economic natural aromatic compounds and their chemical derivatives, the art of compounding will have to be developed in India. Compounding of perfume is a great art, which requires good taste, a particular talent for such work, experience, perseverance and thorough knowledge of certain essential principles of blending. The following points are of importance in this connection:

- (1) A delicate odour should never be covered by a heavy and strong one.
- (2) Pleasantness of the finished perfume depends on the smooth and harmonious blending of all the component odours used, therefore no one odour should predominate heavily.
- (3) In introducing a new blend one should first decide his base, which should not be too

volatile and must retain its original scent for a long time.

- (d) A perfumer having decided on his base should combine it with other components to produce a fully harmonious scent, by the fusion of neighbouring odours and that of balancing opposed scents.
- (5) Aromatic compounds which are too sharply contrasted should be avoided in the same mixture. Aromatic compounds sympathetic to each other should be selected for the purpose of blending.
- (6) The finished perfume should always possess at least a shade of resemblance to a natural scent.
- (7) A perfumer or a blender may always bear in mind that first attempts to compound a new perfume are rarely successful. Only after numerous combinations have been tried, the desired result will be achieved. The subtle and delicate qualities of a blended product can only emerge after the mixture has been allowed to mature for some time.

At present most of the Indian made perfumed products are prepared with imported scents blended in foreign countries. As stated above most of the components of such blended scents may be produced in India in any desired quantity. Those who possess the instinct of blending may commence experimenting with natural products of India with the object of manufacturing marketable and popular scents. This co-operation will be an additional help to the introduction of natural scents in replacement of the somewhat harmful foreign synthetic products.*

*The author desires to thank the Research Fund Committee of the Chemical Society of London for a grant which has in part defrayed the cost of these investigations.

MEDICINE AND PUBLIC HEALTH

Causation of Appendicitis

THE immediate cause of appendicitis is a bacterial infection, but although the disease is a common one, the causes that predispose or precipitate an attack still remain but little understood, though stagnation of the intestinal contents in the appendix resulting in the formation of hard concretions is probably an important factor in many cases. There is a certain amount of information which suggests that habits of life, and in particular, dietary habits, are of importance in predisposing to the disease.

In a survey of mortality statistics of Great Britain and of certain other countries and the statistics of certain hospitals sponsored by the British Medical Research Council (*Special Rep. Series No. 233. H. M. Stationery Office*) the figures show an increase in the frequency of the disease. It has been found that the mortality in the highest social class is at least two and a half times greater than in the poorest social class, although the majority of diseases, especially those involving bacterial action, are commoner among poorer people. A curious feature of the mortality rates from appendicitis in women is that the figures strongly indicate that the mortality is greater among single than among married women.

Nature of diet either an excess of food or possibly certain types of food have been suggested to be a predisposing factor. It is significant that mortality from appendicitis in females fell during the war years 1915-18, when food restrictions were imposed, and increased afterwards. The taking of purgatives is another cause suggested and this practice is probably more common in the higher social class and among women.

Ipecac Cultivation in India

THERE are suitable localities in India where Ipecac, one of the most widely used vegetable drugs and one of the few known remedies for dysentery, can successfully be grown, according to a survey lately made by the Industrial Section of the Indian Museum, Calcutta (Botanical Survey of India). A considerable quantity of the crude drug is at present imported into India. The drug of commerce is the root of the plant popularly known as Rio or Brazilian Ipecac. Most of

it is produced at Matta Grosso in Brazil. The United Kingdom and the United States of America, each imports about 50,000 pounds a year.

Nearly allied to cinchona, the plant is indigenous to the dense, humid tropical forests of South America. In fact, it thrives best in forest areas preferably on river sides with a sandy loam of loose texture, rich in potash, magnesia and lime. An annual rainfall of 90 to 100 inches distributed over monsoon, winter and spring and annual temperature varying from 50 to 100 F. and a fairly even temperature throughout day and night are amongst the other desiderata. Frost is detrimental to its growth. For the first time in 1866, a parent plant was introduced into India by the Royal Botanic Gardens, Calcutta from Kew. Nine plants were raised from it and five sent to the Cinchona Plantations at Mungpoo in Darjeeling. By 1933, there were over 226,000 plants in Mungpoo.

The plant grows as a small ever-green bush to a height of three to four feet. Root is harvested at two to two and a half years from the date of planting in the permanent beds. A healthy plant gives six to eight roots which, when dried, weigh one to two ounces. In large scale production, the average yield is usually much less, the estimated weight of dried roots being about 600 lbs. per acre per annum.

Jorhat and Srimangal in Assam, Moralganj, Kaliganj, Chittagong and Jalpaiguri in Bengal, and the Balasore district of Orissa are a few of the localities that fulfil the requisite climatic conditions. But the nature of the soil in these areas should be studied before plantation is attempted.

Rural Medical Scheme in Madras

A SCHEME of medical relief in rural areas by subsidising medical practitioners and midwives has been initiated in Madras Presidency since 1925. The scheme is in operation in district board areas only. The policy of Government is not to sanction the opening of subsidised rural dispensaries in places where private medical practitioners have already settled down and also within five miles radius. The actual working of the scheme is entrusted to the respective district boards.

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Under the scheme, the Government pay a subsidy to the medical practitioners and the district boards, in special cases, pay additional subsidy to the practitioners and midwives from their own funds for remoteness or unhealthiness of the locality or for any other special reason. The district board gives to the medical practitioners a free supply of medicines, as per list approved by Government, sufficient to treat for a year a daily average of 30 patients.

On the suggestion of the Director of Public Health the Government have permitted the district boards to utilize the services of medical practitioners in charge of subsidised rural dispensaries for the furtherance of public health work such as, the verification of vaccination, births and deaths, the control of epidemic diseases, on payment of an honorarium from the district board funds, such work being carried out under the guidance of District Health Officers.

Practice of Indian Medicine

A PROPOS our editorial on Rural Medical Relief in India in the last October issue, we are glad to find that Sir Nilratan Sircar also thought the same way in his convocation address at Andhra University. He said, 'With the establishment of provincial autonomy in the provinces, efforts are being made to give official recognition to the Ayurvedic, Unani and Homeopathic systems of medicine. The basic sciences of chemistry, physics, biology, physiology, pharmacology, pathology and bacteriology are the same all over the world. The present tendency to register practitioners of various so-called systems of medicine, lacking systematic scientific training of any sort, is a move in the wrong direction. We do not call a barrister or an advocate now practising in India according to communal denominations. Science is progressive and must be the same throughout the world. The criterion of the right of a doctor to medical practice, or to the privilege of registration, must depend on the basic knowledge he possesses of the fundamental sciences of chemistry, physics, anatomy, physiology, pharmacology, pathology and of medicine, surgery, midwifery, and other cognate subjects. No system of medicine, Ayurvedic, Unani or any other can get on without the help of modern basic sciences. There should be no spirit of communalism or opportunism or false economy concerning matters of life and death of millions of ignorant and helpless villagers whom we have failed to educate or elevate. The question of prevention of epidemic diseases cannot be successfully solved, unless scientific methods of proved efficiency are adopted. How can we apply all the different systems of medicine towards this end? The proper move should be to have only one medical science which has been worked out by the scientists all over the world, incorporating into it

whatever good there may be in the indigenous medical sciences of the country. If this is done there will be only one medical register in the country which should facilitate the control of medical relief and sanitation for the entire population. It is for this reason that I am compelled to discourage the teaching of the so-called medical systems, without the help of the basic sciences.'

Medical Education in India

IN his convocation address at Andhra University, Sir Nilratan Sircar, gave a hint on the future of medical education in India. When the British came to India they brought with them some British Surgeons, who held charge of hospitals for British soldiers, chiefly catering to the needs of the army. The need for training Indians in Western medicine arose out of the necessity of having moderately paid Indian assistants to these surgeons. The first medical school after the Western system was opened in Calcutta in 1824. Between that year and 1835, when the Medical Colleges of Calcutta and Madras were started, medical training was imparted in the vernacular by translating English books, as also by assimilating the essential features of the indigenous systems of medicine, by organising teaching through the agency of the Sanskrit and Madrassa Colleges in Calcutta. Although the first two medical colleges established in Calcutta and Madras were founded in 1835, they were affiliated to the universities in 1857 and 1863 respectively. There are now ten university grade Medical Colleges in India, including one exclusively for women.

With the passing of the Indian Medical Council Act in 1933, attempts have been made to raise undergraduate medical teaching to a higher and more uniform standard. The medical curricula have undergone many changes since 1892 when direct connection was established between the Indian medical colleges and the General Medical Council of the United Kingdom. The Medical Council of India has recently made mathematics a compulsory subject in the premedical science course of studies, and has suggested that the first two years should be occupied in the study of professional scientific subjects, with an introduction to clinical methods. The Council has also rightly laid down that throughout the whole period of study the attention of the student should be directed to the importance of the preventive aspects of medicine and of measures for the assessment and maintenance of normal health.

Although the Indian Medical Council has done good work within the short period of its existence, handicap to co-ordinated progress in the teaching of medicine and surgery in India has arisen as a result of the control of this body by the General Medical Council of the United Kingdom. Indian conditions should receive special emphasis from the teachers. A fair amount of research work has been carried out by Indian workers

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on diseases prevalent in this country within the last 4 or 5 decades; hence an Indian orientation to medical teaching can very well be given now. Every teaching institution must also encourage research work among its teachers and students. Researches into the etiology and pathology of unexplained diseases and on therapy, particularly in the domain of indigenous drugs, should receive special attention. A time has come when we should give more stress on a public health orientation to medical teaching, and this should be in consonance with the needs and the environment which a student or a medical practitioner or a public health worker will have to deal with. Every medical student should be made to participate in public health activities as part of his training in medicine and public health.

Survey of Rural Health Conditions

BEFORE any scheme for medical relief is initiated, it is essential that a proper survey of the factors to be tackled is made. The following suggestions regarding factors to be investigated offered by the Inter-Governmental Conference of Far Eastern Countries on Rural Hygiene held at Bandong are worthy of attention in this connection.

1. *Size:* Topography and climatic conditions of the area to be surveyed.
2. *Population:* (a) Total number of inhabitants; and (b) Density of population and the manner of distribution (e.g., circumscribed villages or widespread communities). (c) Composition—homogeneous—of one race and religion with similar customs, or mixed.
3. *Communication:* Accessibility of centres of population, large or small.

Uncertainties in Indian Demography

Benoy Kumar Sarkar

Department of Economics and Politics, Calcutta University.

POPULATION is essentially a quantitative science dealing as it does with numbers. It should then be a very exact science. But curiously enough, no discipline is more speculative and therefore vague and inexact than that bearing on population. The reason is obvious. One of its most vital aspects is economic. It has to discuss the problems relating to the standard of living, indus-

4. *Economic Conditions:* Land tenure system of ownership of movable property; family income and expenditure, covering not only costs of medical treatment and remedies of all kinds, but also the outlay on other items such as taxes, food, clothing, housing, heating etc., and expenditure on social and religious customs on the occurrence of the festivals, births, marriages and deaths.

5. *Endemic and Epidemic Diseases:* their nature and prevalence, and any ascertained effects upon the condition of the population.

6. *Agencies Whose Work Affects the Health of the Area:* (a) Enumeration of every agency, official or unofficial, which is directly connected with medical care and the prevention of disease. (b) "Similarly an enumeration of agencies not necessarily curative and preventive, but indirectly related to health, e.g., agricultural departments, education departments, co-operative societies, credit systems, missionary organisations, etc. (c) A study of the work and activities of all such agencies and particularly of the methods adopted to apply curative and preventive medicine. (d) A special study of the expenditure of all such agencies, and the cost per head of population of the services provided and the extent to which the population contributes directly towards it. (e) The flexibility of the medical and public health organisation and its adaptability to varying conditions. (f) The results obtained by the means and methods employed. To what extent has the practice of sound methods of personal environmental hygiene been established and to what extent is the demand for medical treatment being met.

7. *Methods and Means* whereby the bulk of population obtain treatment when ill and amount spent from the family budget in this connection.

*These should include any urban institutions which provide facilities for the rural population under investigation.

trial efficiency, social progress and such other larger issues. All these items are fundamentally questions that admit of diversity of interpretations in addition to discrepancies in data. These difficulties are to be encountered even in regard to countries like the United Kingdom, Germany and the U.S.A., where statistical information of varied categories has long been available

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on a somewhat extensive scale. So far as India is concerned such difficulties are enormous. In order to avoid misunderstanding, the speculative and tentative character of a great deal of demographic science is to be postulated at the very outset.

The trend of population growth in India is rendered difficult of investigation on account of two circumstances. In the first place, as admitted by the Public Health Commissioner with the Government of India in his Report for 1936, "births escape registration more easily than deaths." While exactness is not the virtue either of the birth or of the mortality statistics, the birth statistics are said to be more inexact than the mortality. In other words, there are greater underestimates in births than in deaths. In the second place, statistics relating to the fertility of women are defective.

There is hardly any exaggeration in Kuczynski's statement that, as matters stand, any prediction of the future population trend of non-Eur-American countries would be mere guess.* India is certainly one such country.

Modesty of an equal, if not greater, degree is to be claimed likewise for the statistics relating to the standard of living of the people, i.e., concerning the indices of poverty or prosperity of the general masses of population. In the first place, "data relating to food production are incomplete," as says the Public Health Commissioner again. "Estimates of food production in India are unreliable and in most cases underestimates." Increases in production due to improved methods have not been taken into consideration in estimating the yield per acre." Secondly, "few accurate observations have so far been made of the existing standards of nutrition in different parts of the country and amongst different communities."

On account of the absence of adequacy and precision in regard as much to the demographic factor as to the economic, the studies in Indian population question are bound to be halting and somewhat indefinite in conclusions. Indeed, it is not permissible to "judge whether the growth of population is outstripping available food resources." The amount and kind of data may be discouraging. But it is quite possible on the strength of the facts and figures available to attempt discussions such as are likely to be helpful in theory as well as policy.

*Annual Report of the Public Health Commissioner with the Government of India for 1936 (Delhi, 1938), pp. 4-6, 18.

"Population History and Statistics" in the *Encyclopaedia of Social Sciences*, Vol. XII (New-York 1934).

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Population Growth in India by the World Standard

During the fifty years from 1881 to 1931 the population of India increased from 253,896,330 to 352,837,778.¹ The total increase was 98,941,448. But the area for which the population was censused increased by 426,055 sq. miles during this period, and this accounted for an increase of 10,301,035 in population. For the same area, then the actual increase was measured by 88,640,413. The half-century's rate of growth or natural increase, then, was as follows:

Year	Absolute Increase	Increase for the same area
1881	100	100
1931	139	135

At 1931 the increase in reference to 1881 was 35 or 39 per cent. The rates of increase were different in the different provinces. Without going into those inter-provincial diversities we may place India in the following table which gives the percentage rates of increase for several countries of the world during the same period (1880-1930):²

Country	Percentage of increase
U. S. A.	86.0
Japan	74.1
Great Britain	54.1
Italy	46.8
Switzerland	43.5
Germany	42.2
India	39.0
Spain	36.8
France	11.3

In comparative growth statistics India does not exhibit any extraordinary phenomenon. The increase of population in India has been at a lower rate than in Germany, Italy, Great Britain, Japan and other countries. In case we are to accept Moreland's view³ in *India at the Death of Akbar* (London 1920, p. 22) we shall have to say that India's population about 1590 is to be estimated at 100 millions. The total evolution up to 1931 yields the figure, 353 millions. In 341 years the increase is 3.5 times. It is interesting to observe

¹Census of India, 1931. Vol. I. India, Part I Report (Delhi 1933) p. 5.

²Statistique Generale de la France Annuaire Statistique (Paris, 1932) pp. 12*, 202*-203*; Compendio Statistico Italiano (Rome 1930), p. 11; Statistical Abstract for the United Kingdom (London 1933), pp. 4-5.

³The calculation has hardly any scientific value. But in the absence of other data it may be presented here for what it is worth, especially since it yields a fine round figure.

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that the growth of population in Italy has followed nearly the same trend as in India. From 1550, as indicated by Nice-oro* at the World-Population Conference (Geneva), 1927, the population was estimated at 11 millions. In 1925 it was nearly 30 millions. The index rose from 100 to 352 in 375 years (cf. India's 100 to 353 in 341 years). We shall now take England and Wales. From 8,893,000 in 1801 the British population rose to 41,031,000 in 1937 (estimate). This is an increment of more than 4.6 times in 136 years. Even if the Indian population rises up to 400 millions in 1941, the increment would be only by 4 times in 341 years from 1590.

The Indian growth may be placed in the British perspective as follows (in 000's):

Year	1600	1801	1881	1931	1941	Growth
					(estimate)	since 1600
Indian	100,000		253,896	352,838	400,000	4 times
British	5,000	8,893	25,974	39,948	41,030	more than (1937) 8 times

The total Indian growth is 4 times by the side of more than 8 times in the British population trend. The period covered is some 340 years for each region.

In the paper* on *La Population de terre et des continents* presented to the International Congress on Population at Paris, 1937, Halbwachs observes that from 1650 to 1929 the population of the world has more than quadrupled in less than three centuries but that the population of Europe has almost quintupled during the same period. India's growth rate would thus appear to be lower not only than that of Europe but even than that of the world in general.

Altogether, there is no ground for believing that the actual growth of population or the rate of natural increase exhibits any menacing features in India. The rate of growth or natural increase (i.e., birth minus death) may be examined somewhat intensively. In regard to India the dynamics of growth rate during the

*"Development of Population in Italy" in *Proceedings of the World Population Conference, 1927* (London 1927) p. 66.

*K. C. K. E. Raja: "A Forecast of Population in India at the Census of 1941" (*Indian Journal of Medical Research*, Calcutta, April, 1937).

**Statistical Abstract of the United Kingdom* (London 1939) p. XV, A. M. Carr-Saunders: *Population* (Oxford 1926), W. Cunningham: *Growth of English Industry and Commerce in Modern Times*, Part II. (Cambridge 1912), p. 935.

**Congress International de la Population, Paris, 1937*, Vol. VII (1938), p. 8.

six decades from 1872 to 1931 can be shown in the following manner:

Decade	Per 1000 per year
1872-1881	1.5
1881-1891	9.6
1891-1901	1.4
1901-1911	6.4
1911-1921	1.2
1921-1931	10.6

The fluctuations in the Indian growth rate down to 1931 were violent and abrupt. It is difficult to think of a uniform trend or law of population growth for India as for many other countries. All the same in a calculation made in 1931 for the paper presented at the International Congress of Population, Rome, it has been shown by the present author that with the growth-rate for India at 6.8 as well as the U.S.A. at 8.4, Italy at 11.2, Holland at 12.8, Poland at 14.8, Japan at 15.2, Chile at 16.2, and Russia at 21.0 some 500 millions of the peoples outside of India are going to double themselves in much shorter periods than some 250 millions of British India."

The censused population of Soviet Russia in December 1926 was 147 millions. In January 1939 it increased by over 23 millions to 170 millions. It rose 15.9 per cent in twelve years. During the same period the population of Europe minus Russia increased by 37 millions, i.e., by 8.7 per cent. The annual rates of natural increase (in percentage) for Soviet Russia and several other countries are as follows: Russia, 1.23; U.S.A., 0.67, Germany, 0.62, Great Britain, 0.36, France, 0.08.

By 1941 the population of India is likely to reach the 400 million level. That would imply a rate of increase of about 13.4 per cent compared to 1931. The demographic conditions in India would thus be somewhat similar to those in Russia, India marching at a much slower pace and in any case behind the latter.

Fallacy about Indian Growth Rate

As a rule demographer and statisticians working on Indian data have been struck by the 10.6 per cent of

"*Census of India, 1931*, Vol. I India Part I Report pp. 29-52.

See also L. S. Vaidyanathan, "Actuarial Report on the Age Returns" Table XXIII in the same volume, p. 143.

*B. K. Sarkar: "Comparative Birth, Death and Growth Rates" in the *Journal of the Indian Medical Association*, Calcutta, May, 1932.

*H. Voznessensky, Vice-Chairman of the Council of People's Commissars, writing on "The 1939 Census of the USSR."

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1921-31. They have not attached adequate importance to the solid sum total of increment during the half-century 1881-1931. This is 39 or rather 35 per cent only. The trend of population growth has therefore been modest. This is the most fundamental plank of Indian demography. From this standpoint there is not much force in the following statement made in the article published in the *Indian Journal of Medical Research* for July 1935 (p. 208). "Compared with many other countries India has exhibited a high rate of increase." The article takes no cognizance of the trend as statistically known since 1881 while establishing this proposition. It points out, further, that the Soviet Republic's corresponding rate is 38.6 per cent (beside India's 10.6). To this the only observation offered is as follows: "The Soviet Republic is an exception." It is questionable, however, if the demographic situation in Russia may be dismissed in such a simple manner. The population of Russia, vast as it is, (146 millions in 1926) cannot by any means be held to be negligible as an absolute factor in world-demography. The extraordinarily high rate of increase that Russia exhibits is a powerful element in the population pressure on the world. No scientific study of the world's population problems can afford to ignore the Russian growth-rate, unless it be obsessed by certain fixed ideas in regard to the Indian or some other demographic situation.

The rates of growth or natural increment vary from decade to decade and quinquennium to quinquennium. It is not safe, therefore, to proceed to calculate the probable trends on the strength of a rate prevalent at any particular point of time. The calculations offered by the present author in 1931 are bound to be substantially different from those that may be made on the basis of the rates available in 1935 or 1939. The positive basis for study is a somewhat long period, in case the relevant figures are available. This is what has been done in the present paper by taking the long-range view of Indian demography since 1881. Such a view cannot be entitled to formulate, as we have seen, "a high rate of increase" for India.

High, medium and low are relative or comparative terms. For the purposes of comparison the article in the *Indian Journal of Medical Research* (July 1935) has cited the rates from some of those countries whose growth is known to be rather low. But there are many regions in the world today exhibiting quite high rates, e.g., Argentina, Mexico, Chile, Poland, Holland, Bulgaria, Portugal, Lithuania, Rumania, Greece, Hungary and

*K. C. K. E. Raja: "Probable Trend of Population Growth in India."

so forth.* In the perspective of these countries, the Indian rate should not appear to be "high." In any case India would be found to be in quite a good company.

The high growth-rates in international demography may be seen in any number of the *Statistical Year-Book of the League of Nations* (say, the one for 1936-37, p. 41). At the same time the question of Soviet Russia being "an exception" would likewise be solved in the negative. Two points will have to be noticed by every student of comparative demography. First, the trends require to be indicated with as many decades or generations as possible in the past evolution. Secondly, in regard to the demographic regions or zones the selection ought to be as exhaustive and comprehensive as possible in regard to climate, race, socio-economic conditions. The fallacies of demographers and statisticians about India have in the main arisen from the fact that they have as a rule ignored or not paid adequate attention to the implications of these two items of comparative methodology.

The Fall in the Birth Rate: An Indian Phenomenon

A noteworthy item of Indian demography is the slow but continuous fall in the birth-rate. To this fact the attention of the International Congress of Population held at Rome in 1931 was drawn by the present author's paper. This was the subject also of his paper at the All-India Medical Conference held at Calcutta in 1939. It was pointed out that the decline in the birth-rate was a world-phenomenon and that India's participation in it was a statistical reality.

It is curious, however, that Indian demographers and statisticians either ignore this reality or do not care to attach any importance to it in their discussions. An instance may be cited. The birth-rate for British India is given by A. J. H. Russell and K. C. K. E. Raja in the paper on "The Population Problem in India"

"B. K. Sarkar: "I Quozienti di Natalita di Mortalita e di Aumento Naturale nell' India attuale nel Quadro della Demografia Comparata." (*Proceedings of the International Congress for the Study of Population Problems, Rome, 1931* See specially Chart 9).

"See the previous foot-note as well as his "Comparative Birth, Death and Growth Rates" (*Journal of the Indian Medical Association*, Calcutta, May 1932), "The Trend of Indian Birth Rates" (*Indian Journal of Economics*, Allahabad, April and July 1934) and "Open Questions and Reconstructions in the Sociology of Population" (First Indian Population Conference, Lucknow, February 1936).

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published in the *Indian Journal of Medical Research* (Calcutta October 1935, p. 558) as follows:

Period	Rate
1901-1910	38
1911-1920	37
1921-1930	35
1931	35
1932	34
1933	34

Evidently the birth rate has declined. But the authors maintain that it "has been more or less stationary." In the subsequent paper, "A Forecast of Population in India at the Census of 1941," for the same journal (April, 1937, p. 1185) one of these authors has quoted the same figures and observes, again, that the "birth rate has been more or less steady from the beginning of the century."

One wonders as to why statisticians should persistently try to ignore the reality. The decline in birth rate is a solid fact of demographic India, however modest it be.

The fall from 38 to 35 (34) implies a decline of 7.8—15 per cent. It is not negligible and although not considerable, it is certainly palpable. In any case it should not systematically escape the attention of the statisticians of the Public Health Commissioner with the Government of India and of the All-India Institute of Hygiene and Public Health, Calcutta. It appears that these and other authors are anxious to prove the thesis of over-population in India and propagate the cult of birth control. They are therefore naturally disinclined to mention or attach value to the statistically recorded decline in the birth rate. It is regrettable that the Annual Report of the Public Health Commissioner for 1935 (p. 5) has reproduced such views without comment.

We should question also the accuracy of Carr-Saunders's statement to the effect that in India "there is no sign whatever of a decline in the rate during recent years as in Japan." It is to be pointed out that in regard to India this demographer is likewise an exponent of over-population and birth control ideas. His judgment is thus worded: "India, or in any case large areas of it is overpopulated." And, then, again, "family limitation is the only way of escape." His indifference to statistical reality may therefore be due to the impact of his conclusions on the objective sense.

It is of course patent that the rate of decline from 38 to 35 (34) is very low. But it is interesting to

"World Population (Oxford, 1936) pp. 270, 275, 277.

observe that Carr-Saunders attaches importance to a much lower rate of decline in another context. For instance, in order to establish his thesis that India is over-populated he asserts that the percentage of the population engaged in industry has declined from 10.7 per cent in 1921 to 9.8 per cent in 1931 (p. 274). In case the one low rate of decline is important enough for notice the other low rate ought to be noticed too in scientific analysis.

In a subsequent section it will be shown that Carr-Saunders is wrong in his statement about the alleged decline in the proportion of industrial population. The decline is "apparent rather than real," as explained by the Census authorities of 1931 on account of the mere transfer of the gainfully employed persons from one group to another."

The Problem of Net Reproduction Rates in India

Studies in Indian demography conducted up till now have been based on the crude rates of birth, death and growth as furnished by the Census department. The population trends calculated on this basis have been found to be meaningless for all countries by L. J. Dublin and A. J. Lotka in their paper "On the True Rate of Natural Increase" in the *Journal of the American Statistical Association* (Sept. 1925) and Kuczynski in his *Balance of Births and Deaths* (Washington) Vol. I. (1928) Vol. II (1931) as well as *Measurement of Population Growth* (London 1935). The problem of age composition has brought in the questions of "specific" fertility rates and "specific" mortality rates (i.e., birth and death rates of women in the productive age).

According to Kuczynski, "the ordinary census birth rate (yearly births per 1000 inhabitants) has no reference to the age composition of the people. It might be useful only if the age composition of the population and in particular the proportion of women at child bearing age does not change. The correct birth rate can be computed by showing the average number of girls born to woman who lives through child bearing age". This age is between 15 and 45 in Kuczynski's calculations. But the League of Nations in the *Annuaire Statistique* for 1937-38 (p. 56) has taken the period from 15 to 50 for the reproductive age.

Now the "gross reproduction rate" would be the number of female children (i.e., future mothers) likely to be borne by 1000 women of the reproductive age. But many women die between the ages of 15 and 45 (or 50). Hence the gross reproduction rate have to be

"See the India volume of the *Census Report*, Part I (1933), p. 281.

"Population Movement (London 1938), p. 41.

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"corrected with the aid of life-tables in order to arrive at net production rates." The net rates are necessarily below the gross rates, the difference depending on the mortality of women in the various age-groups. A "net reproduction rate" of 1000 (i.e., 1000 girls born to 1000 women living between 15 and 45 or 50) is just sufficient to maintain the population figure in the long run.

Many of the countries are in a position to furnish such figures. But it is not possible for India to do so. Hence the corresponding trend cannot be exhibited from the Indian side in order to explain India's position in international demography. Be it observed, however, that countries like Japan, South Africa, Portugal, Canada, Italy, Bulgaria, Poland, Holland, Finland, and Hungary are above 1000 ranging from 1,571 to 1,008. The following countries are below the 1000 level, namely, U.S.A. (0,961), Australia, New Zealand, Denmark, France (0,866), Latvia, Norway, Great Britain (0,760), Germany (0,757), Sweden and Esthonia (0,728). The countries of the second group are tending to get depopulated. As for the first group, the countries may be said to be just maintaining themselves in demographic strength. There is no special case for over-population. To which group India belongs it is not possible as yet to assert.

The Role of Women in Indian Population

The paper on the "Probable Trend of Population Growth in India" published in the *Indian Journal of Medical Research* (July 1935, p. 209) says that "as regards the age distribution, the 1931 census population is perhaps more favourable for growth of population than during the three previous censuses." But this conclusion is hardly warranted by the figures quoted in the paper (Table IV), at any rate in the form in which it is presented. The paper gives in that Table seven age periods 15-19 to 45-49 for each of the four censuses since 1901. The proportion of women at each age group per 10,000 females shows that (1) in the three age-groups 25-29, 30-31, and 40-44 the proportions have been invariably declining from census to census and (2) that it is in the remaining four age groups, 15-19, 20-24, 35-39, 45-49 that the proportions have been rising. The statement made in the paper is then somewhat fallacious and requires to be modified.

Another statement in the same paper runs to the following effect: "Table V also indicates, in a general way, that the numbers of women at the successive periods of the productive ages are more favourable to growth in 1931 than at previous census periods." This statement likewise requires revision and some modification in deference to the actual figures given in the Table.

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It is the proportion of married women at different age periods per thousand women at the same ages that is furnished in Table V. There we find that the figures have been going down since 1901 in the case of the two age groups, 35-40 and 45-50. In regard to the five other age-groups the rise in the proportion is indicated below:

Ages	1931	1921	1901
15-20	818	771	777
20-25	886	877	876
25-30	869	863	859
30-35	824	797	793
40-45	627	599	584

An analysis will indicate that during the twenty years from 1901 to 1921 the rise was rather low. There was an actual fall in the age-group 15-20. Then in the age-group 20-25 the rise was to be measured by only 1. As for the period from 1921 to 1931 the mentionable rise is to be found in the age-group 15-20 (namely, 47 from 771 to 818). The rise in the age-group 20-25 is only 9, that in 20-30 only 6. The rise in 30-35 and 40-45 is somewhat higher being 27 and 28 respectively.

It is admitted in the paper (p. 210) that "fertility rates at the earlier age periods are definitely higher than those at later periods." We are, therefore, to understand that the "favourableness towards growth" will depend mainly on the actual rise in the proportion of married women in the three age-groups, 15-20, 20-25 and 25-30. The rates of rise in these groups do not, however, appear to be substantial as we have seen above. The conclusion therefore should be that the trend of growth or natural increment of the population is likely to be modest. One will of course, have to concede that "the 1931 census population is more favourably constituted towards growth than those of the previous census." But it will have to be added that this "favourableness" is not of an extraordinary dimension.

On the strength of the figures presented in the two tables the paper ought to agree therefore with the statement in Enid Charles's *Twilight of Parenthood* to the effect that the population of India is "probably slowly increasing instead of considering it to be a serious under estimate of the trend of events" (p. 217). The "rate" of growth has undoubtedly been "low" in the past and the 1931 census as indicated above, does not lead one to believe that the rate will be high. The evolution, especially in its long range, is therefore that of a "slow increase".

Altogether one may accept the following statement of Carr-Saunders in *World Population* (Oxford 1936, p. 275) without binding oneself to his other observations: "The respect is therefore that growth of population will be slow and fluctuating." And here it is worth while to invite attention once more to the fact

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that the British growth from 1600 to 1937 represents an increment of more than 8 times while even at the 400 million niveau in 1941 the Indian growth for the same period would represent only an increment of 4 times.

The Effective Persons in the Indian Population

The question of scientific measurement of the balance of birth and deaths remaining unsettled for the time being, let us analyse or appraise the man-power of India as it is.

In India the expectation of life at birth (0 age) has improved in the following manner.

Year	Male	Female
1911	22.59	23.31
1931	26.96	26.56

In spite of this improvement, the position of India is the lowest among the statistically recorded countries. From the *Annuaire Statistique for 1937-38* (Geneva pp. 48-50) the expectation of life for males at 0 is found to be 65 as the highest in the case of New Zealand and 26.91 in the case of India. In the interest of a scientific computation of the numerical strength of the country in the international perspective or by the world-standard it would not be justifiable to treat two regions A and B as identical simply because each happens to have 100 persons according to the census calculations. The region with the higher expectation of life has more "effective" persons than the region with the lower; although the number of "nominal" persons is the same in both. The region A with E. L. (50) has double the number of effective persons as to the region B with E. L. (25) in spite of the "nominal" persons being equal in number. In other words, the region B with E. L. (25) does not have 100 "effective" persons of the A standard. It has really 50 persons corresponding to 100 of A. It should be easy on this basis to ascertain India's position in "effective" persons in comparison with any country of the world. It is nothing but a problem of weighting in statistics.

Suppose in 1941 India has 400,000,000 "nominal" persons and suppose the E. L. for males at 0 is 27. Then in comparison with Russia whose E. L. is 41.93 or 42 India has really 27/42 or 9/14 of 400 million i.e., nearly 257 million "effective" persons of the Russian standard. In this calculation we are assuming the other circumstances, e.g., capital per head, tools and implements, general culture etc. as remaining the same. Since the Japanese E. L. is 44.82 (or 45) India's effective population by the Japanese standard is 240 millions. In Italy the E.L. is 53.76 (54). By the Italian standard

India's effective are 200 millions. The E.L. is 59.84 in Germany and 60.13 in Great Britain, say, 60 in both regions. Then by the Anglo-German standard of effective persons India possesses only 180 millions.

These comparisons and equations are not to be taken at their face-value. But we are in a position to visualize that even without bringing in the question of India's backwardness in technocracy, capital power, cultural equipment etc., India's man-power is fundamentally very low, if we bear just one factor, namely the expectation of life, in mind. The nominal numbers as furnished by the Census Department should not mislead one into statements about excessive population growth, not to speak of over-population in India.

As long as the expectation of life in India continues to be as low as it is now, neither economically nor sociologically can it be expedient for the theorist or the statesman to go in for a reduced population. There is no magic in the mere restriction of numbers. The curtailment of births or rather of natural increments cannot by itself serve to raise the expectation of life, productive capacity, or standard of living and efficiency.

The Logistic and other Laws of Population

It is necessary to observe at this stage that the biological or historical laws enunciated in recent years about the demographic developments of the world are not frightening. There is "logistic curve" which was established by Verhulst, the Belgian mathematician, in 1838 and re-discovered by the American biologist, Pearl in 1920. In his *Biology of Population Growth* (London 1926, p. 22) Pearl describes this law in the most elaborate manner. According to this law every cycle or phase of culture is marked by the growth of population along the same lines. At first the increase is rather slow. Then it becomes rapid for a certain period. Later it becomes slow again. And finally it becomes stationary.

In 1927 Jainisch published his *Das Exponentialgesetz als Grundlage einer vergleichenden Biologie* (Berlin) in which the logistic curve was demonstrated in biological phenomena independently and without knowledge of Pearl's work.

In Pearl's judgment every attempt to calculate the future trends of population on the hypothesis of a growth-rate prevalent during a certain period is fallacious. According to the logistic curve the growth-rate is bound to be different in different periods in each cycle or phase. The damping factors must be recognized. No rate can be postulated to continue indefinitely to manifest itself undiminished". It is worth while to add

"R. Pearl: *The Biology of Population Growth* (London 1926), p. 75.

MEDICINE AND PUBLIC HEALTH

that the growth of Indian population has been found to conform to the logistic law".

The law of population growth as objectively manifest in history is not one calculated to inspire pessimism according to Carr-Saunders. In the *Population Problem* (London 1922) and *Population* (1925) he establishes the proposition that the increase of population has been stationary during "long" periods, although it has been continuous and rapid in historic times. The nightmare of over-population need not then scare the student of science.

In the paper on population published in the *Rassegna Italiana* (Rome 1930) Gini speaks of the parabola of demographic evolution. According to this law every racial group gets its biological or vital force exhausted at a certain phase of its history. The exhaustion implies senescence, decay and perhaps annihilation until or unless counteracted by mixture with new blood. This law likewise might counsel the demographer to practise indifference to the scare of over-population.

For all practical purposes the ideas of Carr-Saunders and Gini may be regarded, although on independent foundations, as but applications or deductions of Pearl's biological law of the logistic curve, or rather belonging to the same complex. The tendency among biologists and semi-biological demographers is to accept the position that there is a maximum height to which a demographic group can rise. An excessively, indefinitely and eternally increasing population may be taken to be out of the question, no matter what be the race, region or cycle.

A fourth tendency may also be noted. In a paper *Sur l'existence d'un mouvement cyclique de longue durée dans la population* (On the existence of a cyclic movement of long duration in population) presented at the International Congress of Population, Paris (1937), Gaston Bouthoul has suggested the possibility of demo-

"S. Swaroop and B. B. Lal: "Logistic Law of Growth and Structure of Indian Population" (*Population*, London, August 1938).

graphic cycles corresponding to the economic cycles." There are the epochs of "depression" followed and preceded by those of "boom" so to say in the history of population growth. It is possible to illustrate this secular rhythm in France from the thirteenth to the twentieth century. In case the fluctuations be accepted as realities every period of active population growth may be expected to bring as it reaction a period of passive and slow growth.

Altogether, the economic and sociologist find themselves today in an atmosphere in which the over-simple law to the effect that population tends to increase indefinitely and incessantly cannot be taken seriously. Every race, phase or cycle is said to have a limit which its population is not likely to exceed.

Besides, the limit,—the stationary state, the stabilization,—does not depend exclusively, as Yule maintains in "The Growth of Population" (*Journal of the Royal Statistical Society*, London, January 1925), on the limit of the means of subsistence."

This is an aspect of demographic theory to which attention deserves to be seriously drawn when India is heading towards the 400 million level by 1941. No theorist or statesman can however be said to be discharging his duty as a rational being or a moral person if he feels thoroughly insured against the danger of over-population, lower standard of life and efficiency, increasing poverty or socio-economic misery etc., on account of these alleged laws of maximum increase in population or ultimate emergence of the stationary population. In every region and in every period human beings are called upon to combat the existing and potential sources of poverty and wretchedness adapted or relative to their circumstances. In other words, the adoption of measures calculated to increase the wealth and welfare of the people thereby counteracting the inroads of eventual over-population must be regarded as the eternal preoccupation of man which he can hardly ever afford to neglect in a mood of cocksureness at any moment of his existence.

"Congress International de la Population, Paris, 1937 Vol. I. (Paris 1938) pp. 64-69.

"J. Delevsky: "Les tendances démographiques actuelles" in *Congres International de la Population Paris 1937* Vol. I. (Paris 1938), pp. 74-75.

RESEARCH NOTES

Optical Method of Fourier Summation as applied to Crystal Structure Analysis

In a note in *Nature* (143, 678, 1939) W. L. Bragg described a method of obtaining the atomic arrangement projected on a given crystal plane from the X-ray measurements of the intensities of beams diffracted by the crystal, by optically accomplishing the two-dimensional Fourier summation. In the summation

$$\sum \sum F + (\text{hol}) \cos \left\{ \frac{2\pi hx}{a} + \frac{2\pi lz}{c} + \alpha(\text{hol}) \right\}$$

representing the projected electron density at a point x, z on the (010) plane the phase term $\alpha(\text{hol})$, is not given by X-ray diffraction and so the method of trial and error is to be adopted for its determination. If the required projection has a centre of symmetry $\alpha(\text{hol})$ may be either 0 or π , and in the special cases where further the centre of symmetry is occupied by atom or atoms much heavier than the rest it takes the single value of zero for all reflections. The method consists in plotting the reciprocal lattice on a thin plate of brass and drawing at the lattice points holes whose areas are proportional to the structure factors of the corresponding planes. The cross grating thus obtained is illuminated by a parallel beam of light and the diffraction pattern formed by it at the principal focus of a lens, gives the required pattern.

This procedure is applicable only to the special case where the projection has a centre of symmetry and a high concentration of matter occurs at the centre of symmetry. M. J. Buerger has developed in a recent paper (*Proc. Nat. Acad. Sci. Am.* 25, 383, 1939) a method for optically accomplishing the Fourier summation for the more general cases where there is only a centre of symmetry. The grating is placed between crossed polaroids and a small strip of polaroid is placed on each hole with its vibration direction at 45° or 135° with that of the analyser according as $\alpha(\text{hol})$ is zero or π

The structure analysis of a crystal consists of trying different phase combination of 0 and π . Such trials thus take very much shorter time by the optical method than by numerical calculation.

Buerger has further shown that the optical method has a still greater usefulness for the Patterson Synthesis, in which the vector distances from the origin of the maxima in the summation

$$\sum \sum \frac{F^2}{\text{hol}} \cos \left\{ \frac{2\pi hx}{a} + \frac{2\pi lz}{c} \right\}$$

represent vectorially the interatomic distances projected on the (010) plane. Following Bragg's method this summation can be carried out by making the areas of the holes in the reciprocal lattice proportional to F_{hol}^2 . X-ray diffraction spots may be obtained in positions coincident with the corresponding points of the reciprocal lattice by a method described by de Jong and Bouman (*Zeits. krist.* A98, 456, 1938). The exposures will be proportional to F_{hol}^2 except for the Lorentz and polarisation factors which may be compensated for by a suitable rotating sector. A positive print of this film taken by the method of Dawton (*Proc. Roy. Soc. A* 50, 817, 1939) will be an opaque film with transparencies at the lattice points proportional to the original exposures, and thus it is the required grating for obtaining the desired Patterson pattern. An adaptation of the method is also described by which the three-dimensional Patterson-Harker synthesis can be effected optically.

K. B

Post-Natal Development of the Human Nose

In an interesting paper (*Proc. Am. Phil. Soc.* 1939) Mr C. B. Davenport discusses the changes in size, form and development of the human external nose. For this purpose a series of measurements was made on foetuses, on infants and on children from three to twenty years. Also on individual children the nose was measured during 5 to 15 years. His

RESEARCH NOTES

conclusions are that nasal height increases with stature but is higher in boys than in girls. Nasal width grows rapidly before birth corresponding to its early development in phylogeny. The growth of nasal salient nearly ceases temporarily at about one year, probably due to development of the maxillae and tooth germs. Nasal depth at root is late in developing as it is phylogenetically a late acquisition. There is a widespread difference in nose size and proportions among different people. The feeble-minded tend to have a nose that is exceptionally deep at apex and root. The Mongoloid dwarf has a low, shallow, narrow and unprominent nose. The difference between the nose of the Mediterraneans and of the Nordics is nowhere great, that between Negroes and Europeans is striking in the great breadth and low root of the former. The diversity of the shape of the nose in various races suggests the presence of numerous genes each with multiple allelomorphs. The ontogenetic development of the nose follows in the steps of phylogeny since the later ontogenetic steps are built upon earlier ones as the later phylogenetic stages are constructed upon

earlier ones. A number of plates aptly illustrating the conclusions of the author have been reproduced in the journal.

T.C.D.

New South-African Stone Age Culture

Dr E. G. N. van Hoepen recently drew attention to presidential address to Section E of the South African Association for the Advancement of Science, July 5, 1939 certain aspects of South African archaeology. A number of cleavers from Wellington, made from river boulders with one side showing the original surface, is of more primitive form than the Vaal cleavers, and though pineal in shape, in technique represent an earlier flake industry. This industry has been provisionally named Wellington; it is contemporary with Stellenbosch. A second new culture comes from Brakfontein farm, and is a congeries of flakes and implements which cannot be placed in any of the known industries. The flakes are large, a breadth of twelve inches being not uncommon. This Brakfontein culture may have been contemporary with the earlier Mossel Bay culture.

T.C.D.

UNIVERSITY AND ACADEMY NEWS

PROCEEDINGS AND PUBLICATIONS

Royal Asiatic Society of Bengal

(Calcutta, 6th November, 1939)

MISS R. GRACE LEWISON: Folk-lore of the Assamese.

D. CHATTERJEE: Studies on the endemic flora of India and Burma.

E. W. GUDGER: The alleged pugnacity of the Swordfish and the Spearfishes as shown by their attacks on vessels.

MAJOR H. HOBBS: J. A. Hicky 'Bengal Gazette'—1780-82.

SIR DAVID EZRA: A chameleon.

Geological, Mining and Metallurgical Society of India

(Calcutta, March, 1939, Quart. Jour., 11, 1-47, 1939).

D. SWARUP AND M. PRASAD: Bismuth and cadmium in type metals.

R. D. GODBOLE: Geology of the area around Phonda and Bavda Jahgir.

D. SWARUP AND T. V. N. KIDAO: Heat treatment of high carbon stainless steel. (Calcutta, June, 1939, Quart. Jour., 11, 49-77, 1939).

S. K. ROY AND A. N. MUKERJEE: Geology and petrology of the iron ore deposits of Mandi State, Punjab.

Benares Mathematical Society

(Benares, Proc. Benares, Math. Soc. Vol I New Series 1939)

MAURICE FRECHET: Sur l'integration d'un systeme canonique d'equations differentielles lineaires a coefficients discontinus.

J. KARAMATA: Einige satze Ueber Iterierte Mittelbildungen.

LUBOMIR TCHAKALOFF: Sur quelques proprietes des developpements de Taylor d'une certaine classe de fonctions.

W. SIERPINSKI: Sur un theoreme de la theorie de la mesure.

A. ERDELYI: Integral representations for Whittaker functions.

N. G. SHABDE: On some results involving Legendre and Bessel functions.

R. S. VARMA: Some infinite integrals involving parabolic cylinder functions.

J. L. SHARMA: On recurrence formulae of the Lamé's functions of the same degree.

A. N. SINGH: Hindu trigonometry.

BRIJ MOHAN: Theorems connecting self-reciprocal functions.

PARMESHWAR DIN SHUKLA: On a non-differentiable function of Denjoy.

Indian Physical Society and Indian Association for the Cultivation of Science

(Calcutta, August 1939, Ind. Jour. Phy. Vol. XXII, Pt. IV)

DEBESCHANDRA ROY: New measurements of aluminium monoxide bands.

M. V. SIVARAMAKRISHNAN: A simple method of coating optical surfaces with aluminium.

S. A. AZIZ: Raman spectrum of diphenyl in the solid state.

J. N. BHAR: Studies of ionosphere at Calcutta.

MOHINIMOHAN GHOSH: Dynamics of the piano-forte string and the hammer, Part III (General Theory).

L. SIBAIYA AND M. RAMA RAO: Surface tension and Lindemann frequency.

L. D. MAHAJAN: Liquid Drops.

UNIVERSITY AND ACADEMY NEWS

Calcutta Mathematical Society

(Calcutta, June, 1939, Bull., 31, 45-86)

HARIDAS BAGCHI: Normal complex of a rigid body.

B. C. MUKHERJI: Note on axial symmetric gravitational field.

H. K. GANGULY: On a steady configuration of rotating heterogeneous fluids.

BRIJ MOHAN: A note on self-reciprocal functions.

HARIDAS BAGCHI: Note on equimomental and orthoconjugate complex of a force-system.

ANNOUNCEMENTS

National Institute of Sciences of India

At a meeting of the Council of the National Institute of Sciences of India, held on the 6th October, 1939, the following gentlemen have been elected Fellows of the Institute:—

Ordinary Fellows:—Dr. K. Banerjee, D.Sc., Reader in Physics, Dacca University. 2. Prof. F. R. Bharucha, B.A., B.Sc., M.Sc., D.Sc., Professor of Botany and Head of the Department, Royal Inst. of Science, Bombay. 3. Dr. R. N. Ghosh, D.Sc., Reader in Physics, Allahabad University. 4. Prof. H. K. Mookerjee, D.Sc., D.I.C., University Professor of Zoology and Head of the Department, Calcutta University. 5. Prof. V. V. Narlikar, B.Sc. (Bom.), B.A. (Cantab), F.R.A.S., Professor of Mathematics and Head of the Department, Benares Hindu University. 6. Dr. C. G. Pandit, M.B.B.S., Ph.D., D.P.H., D.T.M., Offg. Director, King Institute of Preventive Medicine, Guindy, Madras. 7. Major C. L. Pasricha, I.M.S., Professor of Pathology and Bacteriology, School of Tropical Medicine, Calcutta. 8. Prof. L. Rama Rao, M.A., F.G.S., Professor of Geology, Mysore University. 9. Dr. M. Sharif, D.Sc., Ph.D.,

Entomologist, Haikine Institute, Bombay. 10. Dr. K. Venkataraman, M.S.Tech., Ph.D., D.Sc., Director, Bombay University Laboratories of Chemical Technology and Textile Chemistry.

Honorary Fellows:—1. Dr. E. V. Appleton, M.A., D.Sc., F.R.S., Secretary, Department of Scientific and Industrial Research of Great Britain. 2. Prof. Charles W. Edmunds, A.B., M.D., Professor of Pharmacology and Therapeutics, University of Michigan Medical School, U.S.A. 3. Prof. R. A. Fisher, Sc.D., F.R.S., Galton Professor in the University of London. 4. Prof. Waldemar Lindgren, Emeritus Professor of Geology, Massachusetts Institute of Technology, Cambridge, Mass., U.S.A.

Indian Society of Phytosociology

A proposal regarding the formation of a National Committee of the International Phytosociological Association was discussed at a meeting of the Botany section of the Indian Science Congress held at Lahore on the 7th January, 1939 and a Committee was appointed to report to the next session of the Indian Science Congress to be held in January 1940 regarding the action to be taken. The Committee have come to the conclusion that it would be most suitable to start an independent organisation in India which could establish liaison with the International organisation later on.

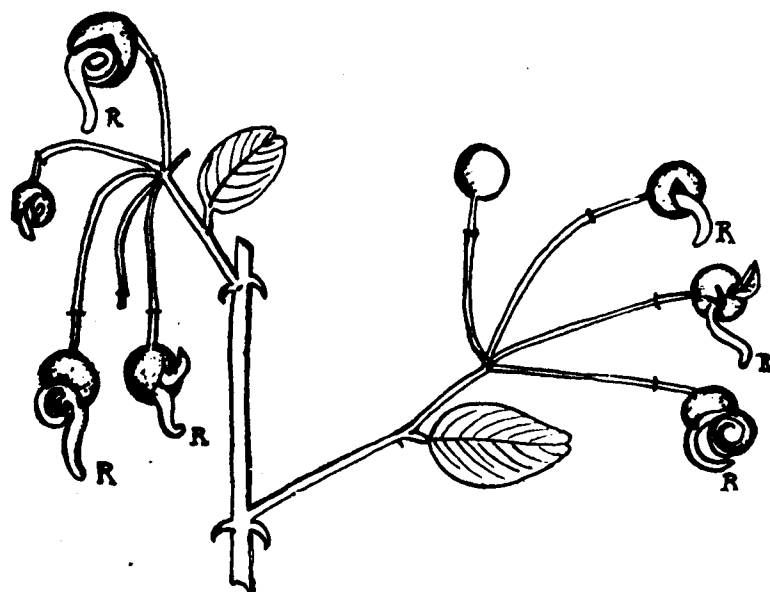
The principal aim of the organisation will be to bring persons interested in phytosociology in mutual contact for promoting the study of Indian vegetation and discussion of the results. In view of the large distances in India, it is proposed to have only one formal meeting annually which will be held at the venue of the Indian Science Congress. It is also proposed to publish an annual report which will include (i) a brief account of the advance made in the study of Indian vegetation during the year and (ii) abstracts of papers published regarding Indian vegetation.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

Vivipary in *Capparis Sepiaria* Linn

Capparis sepiaria is a common shrub in hedges in many parts of Northern Gujarat'. The plant flowers from February to May and the fruits become first evident by about the beginning of March. In July last I came across many ripe fruits of this plant which were cracked and through the fissures so formed the radicles or plumules or both had emerged from the fruit-coat. The fruits themselves, however, were still borne on the parent plants and their stalks were quite green and intact. Obviously the seeds had germinated vivipariously.



[*Capparis sepiaria* Linn. showing viviparous germination of the seeds, R—radicles. (The figure is half the natural size)]

It is well known that the embryos of the *Capparidaceae* are curved or arched'. But to the best of my knowledge such a viviparous condition and the subsequent release of the germinated embryos is not recorded so far in any member of the *Capparidaceae*. Neither Engler and Prantl' nor Hedayetullah' nor Rao' mention anything like this in their studies on this family. It will

be interesting, therefore, to know whether such a condition also exists in any other species of *Capparis* or in any other genus of the family. Mr S. K. Mukherjee, Curator of the Herbarium of the Royal Botanic Gardens, Sibpur, Calcutta, to whom I had made a reference in this matter, informed me that none of the specimens of species of *Capparis* or of any other genera of the *Capparidaceae* in the Calcutta Herbarium shows vivipary. The same is true of the herbarium specimens in the Herbaria in the Bombay Presidency.

Phytogeographically the species of *Capparis* are characteristic of the flora of Indian deserts'. *Capparis sepiaria* and some other species of this genus are among the most successful species on the sandy tracts of Northern Gujarat and Rajputana. It is likely that the viviparous germination of the seeds and the release of the embryos under favourable conditions only, namely, after the rains have set in, might have been an important factor in the autoecesis of the species.

Department of Biology,
Gujarat College,
Ahmedabad, 5-10-39.

T. S. Mahabale.

'Saxton and Sedgwick, *Rec. Bot. Sur. Ind.*, 6, 244, 1918.

'Le Maout Decaisne, *System of Botany* (Eng. Trans. 1893), pp. 233-234..

'Engler and Prantl,—*Die Natürlichen Pflanzenfamilien* (1891), Tiel III 2, Abt. 2, pp. 209-236.

'Hedayetullah.—*Proc. Ind. Sci. Congr.*, XXII, 285, 1935.

'Rao, V. S., *Jour. Ind. Bot. Soc.*, 15, 71, 335, 1936.
—*Ibid.* 16, 69, 1938.

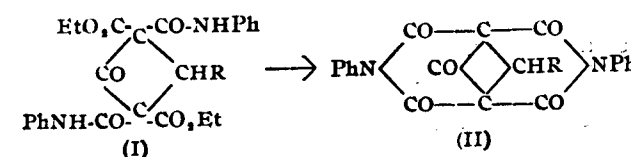
'Calder, *The Vegetation of India* in 'Outline of the Field Sciences of India, (1937), p. 83.

Influence of Groups on the Formation of Certain Tricyclic Compounds

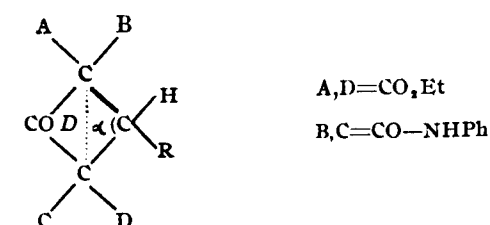
It has been shown' that the formation of the tricyclic compound (II) from the cyclo butane derivative (I) is conditioned by the atomic volume of the group R. The greater the atomic volume of the group

LETTERS TO THE EDITOR

R, the more is the tendency of the compound (I) to pass into (II) with the elimination of two molecules of alcohol.



An attempt has now been made to explain this influence of the group R on the basis of the well-known theory of valency deflection of Thorpe and Ingold'. If the group R possesses a high atomic volume, the angle α between the valency directions will be smaller. This decrease in the angle α is attended with a decrease in the inter-atomic distances (d) indicated by the dotted line) between the two carbon atoms—as a result of which the groupings "A and C" and "B and D" come closer together and thus can link to form the tricyclic compound with the elimination of two molecules of alcohol.



That substituent groups attached to a carbon atom can alter the inter-atomic distances and thus produce a change in molecular structure has been experimentally verified by a study of $\beta\beta$ -dialkylglutaric acids, of the halogen derivatives of methane, etc. So, the formation of the tricyclic compound (II) from (I) appears to be due to the alteration in inter-atomic distances consequent on the attachment of a large substituent group to one of the carbon atoms.

The author's grateful thanks are due to Prof. P. C. Guha for his kind interest in this investigation.

Tejendra Nath Ghosh.

Department of Pure & Applied Chemistry
Indian Institute of Science
Bangalore, 26-10-39.

'Ghosh, *J. Indian. Chem. Soc.*, 12, 693, 1935.

'J. Chem. Soc., 107, 1080, 1915. and subsequent papers.

'Gane and Ingold, *J. Chem. Soc.*, 120, 2267, 1928.

Vol. V No. 6
December 1939

On the Hermaphrodite Flowers of *Morus Indica* Linn

In previous communication' on the subject, the present writer described some interesting forms, which were not reported from India. In this note some new and interesting forms are added and described. The abnormalities observed up till now may be grouped as follows:

1. Those in which the missing sex (Androecium or Gynoecium) is developed. In some cases in a typically male inflorescence, hermaphrodite flowers are found owing to the normal development of the carpels in place of the pistillodes. In other cases in a typically female inflorescence, the flowers become hermaphrodite owing to the development of the stamens.

2. Variation in the number of stamens.

The following are the details of abnormalities observed (figure on the next page):—

1. On a plant found in the garden of the 2nd. Superintendent of Sericulture, Bengal, Tollygunge, Calcutta, hermaphrodite flowers were found associated with the male and the female flowers in the same inflorescence. Perianth segments of the hermaphrodite flowers are like those of a male flower (Fig. 1, a & b.). Stamens varied in number from 4 to 1. The filaments were 3 mm. long. It appears that hermaphroditism in this case is due to the normal development of the pistil in typically male flowers.

2. On a plant found in the Mirganj Central Nursery, Rajshahi, hermaphrodite flowers were found associated either with the male or with the female flowers. 4 stamens sometimes 3 with long filaments (3 mm. long) and 1 short (1-2 mm. long) are developed. (Fig. 2 a). Perianth segments were specially characteristic. They were very similar to those of the female flowers in outline but were mucronate. (Fig. 2 b & c).

3. Among specimens collected from a plant in the Kalitha Central Nursery, Nalhati, Birbhum, hermaphrodite flowers were found in the female inflorescence. The undermentioned types were observed:—

(a) Flowers with 4 stamens with long filaments (3-4 mm.) and short (2-3 mm.) perianth segments.

(b) Flowers with 3 stamens. Perianth segments as in (a).

(c) Flowers with 2 stamens of one whorl were developed. They were short (2 mm.) and included in the perianth segments as in (a). Sometimes one stamen from each of the two whorls was developed.

(d) Flowers with 2 stamens only, one flower observed having 3 small perianth segments (2 mm. long) and a larger fourth one (4 mm. long).

LETTERS TO THE EDITOR

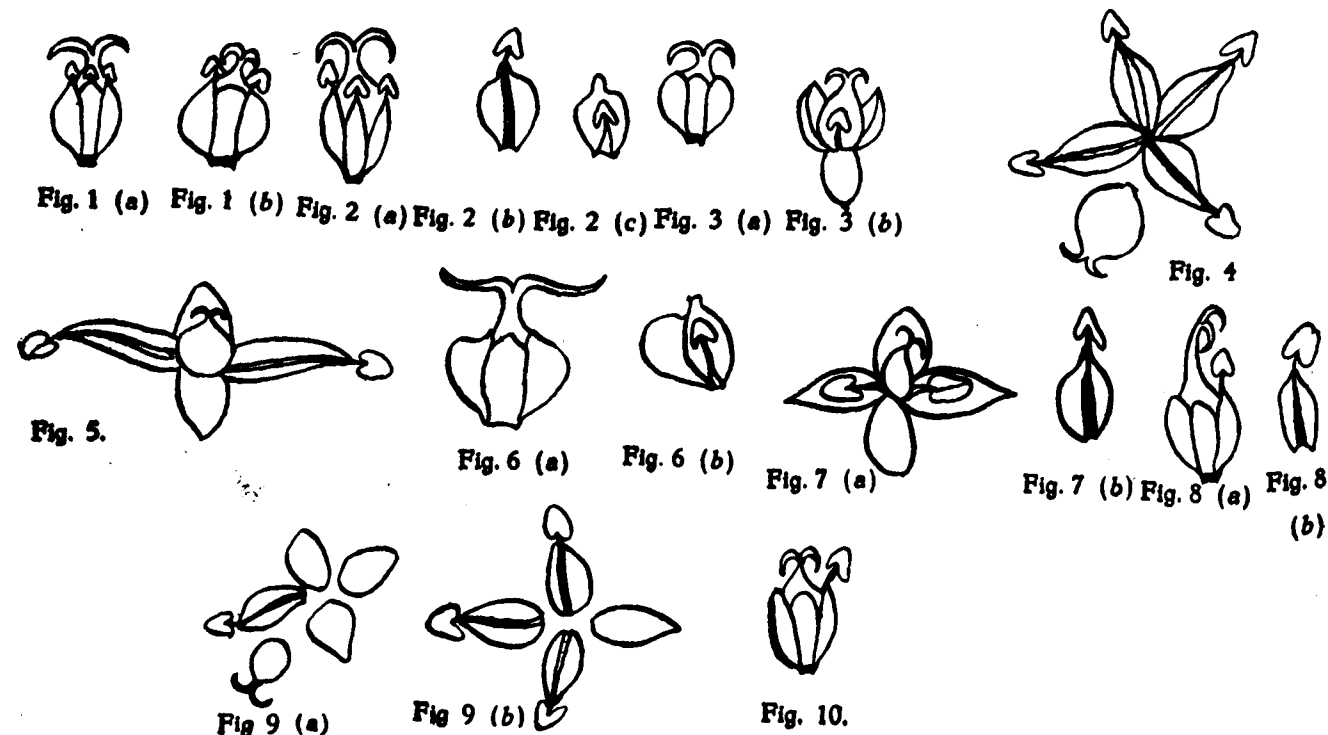
(e) Flowers with 1 stamen having filament (1 mm. long) and perianth segment (3 mm. long) like that of a female flower. (Fig. 3, a & b).

In all the above cases except (e), the perianth segments subtending the stamens were like those of a male flower.

4. Among specimens collected from a plant in the Mirganj Central Nursery, Rajshahi, hermaphrodite

segments resemble those of the male flowers. Style in all cases is very short with 2 short style arms. (Fig. 4).

5. Among specimens collected from a plant in the Berhampore Central Nursery, Murshidabad, hermaphrodite flowers were found associated with the male and the female flowers in the inflorescence. Two stamens of a whorl were developed and subtended by the perianth segments like those of a male flower. Perianth segments were found to be thicker and bigger (4 mm. long) than those (3 mm. long) of the ordinary male flowers, but they were not so hairy. The other two



Explanation of Figures:—Fig. 1 (a) Hermaphrodite flower with 3 stamens. Fig. 1 (b) Hermaphrodite flower with 2 stamens. Fig. 2 (a) Hermaphrodite flower with 4 stamens. Fig. 2 (b). Perianth segment subtending the stamen with long filament. Fig. 2 (c). Perianth segment subtending a stamen with short filament. Fig. 3 (a). Hermaphrodite flower with 1 stamen—stamen included in the perianth segment and not seen. Fig. 3 (b). Hermaphrodite flower with 1 stamen—stamen. Fig. 4. Hermaphrodite flower with 4 stamens dissected. Fig. 5. Hermaphrodite flower with 2 stamens. Fig. 6 (a). Hermaphrodite flower with 2 stamens—stamens included in the perianth segments and not seen. Fig. 6 (b). Perianth segment subtending a stamen. Fig. 7 (a). Hermaphrodite flower with 2 small stamens. Fig. 7 (b). Perianth segment subtending a long stamen. Fig. 8 (a). Hermaphrodite flower with 1 stamen. Fig. 8 (b). Perianth segment subtending 1 stamen. Fig. 9 (a) Hermaphrodite flower with 1 stamen dissected. Fig. 9 (b). Male flower with 3 stamens dissected. Fig. 10. Hermaphrodite flower with 1 stamen.

(The magnification of all the figures are 5 times).

flowers were found associated with the female flowers in the inflorescence. Stamens (4-3-2) were found with filaments (4-5 mm. long). When 4 stamens were present, the ovary was small (2 mm. long). In most other cases, the ovary was larger (3 mm. long). Perianth

perianth segments were smaller (2 mm. long) (Fig. 5). Male flowers with 2 stamens were also found in an inflorescence having both male and female flowers. These were found generally at the base of the inflorescence.

LETTERS TO THE EDITOR

6. Among the specimens collected from a plant in the Berhampore Central Nursery, Murshidabad, hermaphrodite flowers were found associated with the female flowers in the inflorescence. In the hermaphrodite flowers 2 stamens, rarely 1, were found. Sometimes, 2 stamens of one whorl were developed or one stamen from each of the two whorls was developed. Filaments were thick and short (2 mm. long) and included within the perianth segments (3 mm. long) resembling those of the female flowers with mucronate apex (with a flap). (Fig. 6, a & b).

7. Among the specimens collected from a plant brought from Burma in 1938 and grown at the Sericultural Research Station, Narayanpur Colony, Dum Dum, 24 Parganas, only two hermaphrodite flowers were found after the examination of several inflorescences. They were associated with female flowers. Two short stamens (2 mm. long) or 1 stamen with filament (4 mm. long) were found subtended by perianth segments like those of a male flower. When two stamens were developed both belonged to the same whorl. The ovary was small (2 mm. long) and included within the perianth segments (Fig. 7, a & b).

8. Among the specimens collected from a plant found in the Government Sericultural Farm, Vishnupur, Bankura, hermaphrodite flowers were observed associated with the male and the female flowers in the inflorescence. One stamen (3 mm. long) was found subtended by a perianth segment resembling that of a female flower (Fig. 8, a & b). In some male flowers on the same plant 2 and 3 stamens only were observed.

9. Among specimens collected from a plant found at the Kalitha Central Nursery, Nalhati, Birbhum, hermaphrodite flowers were found associated with the male and the female flowers in the same inflorescence. One stamen (3 mm. long) subtended by a perianth segment

resembling that of a female flower was found (Fig. 9, a). Ovary was small (2 mm. long). In some male flowers, 3 stamens were observed (Fig. 9, b).

10. Among specimens collected from a plant found in the garden of the 2nd Superintendent of Sericulture, Bengal, Tollygunge, Calcutta, hermaphrodite flowers were found associated with the male and the female flowers in the inflorescence. One stamen (3 mm. long) subtended by a perianth segment like that of a male flower was found. In one inflorescence, male flowers with 3 stamens were observed.

Recently, Buonocore² reported some types of hermaphrodite flowers in some Italian varieties of *Morus alba* L.

The above observations confirm the author's view that the occurrence of unisexual flowers in the family *Moraceae* is due to the progressive reduction of one sex. This view is also supported by the work of Bechtel³ who, after making an exhaustive study of the floral anatomy of the *Urticales*, found that "there were traces in the staminate flowers, which indicated the earlier presence of a pistil. In other words, these unisexual flowers seem to be derived from bisexual ones and are not simple."

In conclusion, I wish to offer my grateful thanks to Mr S. C. Mitter, Director of Industries, Mr C. C. Ghosh, Deputy Director of Sericulture, Bengal and Prof. S. P. Agharkar, Head of the Department of Botany, Calcutta University for their guidance, encouragement and criticisms in this investigation.

Sericultural Research Station,
Narayanpur Colony,
Dum Dum, 24 Parganas, 9-11-39.

R. M. Datta

¹Datta, R. M., *SCIENCE AND CULTURE*, 4, 301, 1938.

²Buonocore, C., *Boll. della R. Staz. di Gelsicol. Bachicol di Ascoli-Piceno*, 17, 1, 1938.

³Bechtel, A. R., *Amer. Jour. Bot.*, 8, 386, 1921.

ERRATA

In the Letter on the Nematode *Camallanus Anabantis* Pearse published in this section of the last November issue, read founded for found and delete the brackets enclosing the names on p. 318.

In the same text on the fourth line of the last but two paragraph of the left column read Yorke for rorke.

Madras

The Seat of the Indian Science Congress, 1940

Situation and History

Madras celebrated its tercentenary in August 1939, but the history of its suburbs Mylapore and Triplicane could be traced back to the centuries that preceded the Christian era. The Greek geographer Ptolemy refers to it as Mylarphon, which appears to be a corruption of its classical Tamil name Mailapore. The town of Mylapore of which Triplicane seems to have formed a suburb was visited by Marco Polo during his travels. But the nucleus of the modern town of Madras was a piece of waste land adjoining the sea and bounded by two rivers known locally at that time as "Narimedu" (Jackal Mound) and granted to the East India Company by the representative of the Vijayanagar Empire three centuries ago. Even in the *coule* conveying the grant the locality is referred to as Madraspatam. To the north of it was Chennapatnam, which now constitutes the heart of the town. It is said that the Chennapatnam was named after Channamanayaka, the father of the founder—the Tarafdar of Poonamaile—but the origin of the name Madras is still shrouded in mystery.

One account traces the origin to Madrasen, a fisherman, who owned the plot of land first granted to the company, and it is stated that in order to placate the man a promise was made that the factory to be built there will be called Madrasenpatnam. According to another version Madras owes its name to a rich Portuguese family by name Madra who built a church in Mylapore two years before the arrival of the English. Whatever it may be, the original name has changed into the present one Madras.

The city is cut into two by the 'Silvery Cooum' and on the south there is the Adyar river. The Buckingham canal traverses it north to south. There are several tanks in the city which if kept well would greatly add to the beauty of the place.

Modern Madras is a city of distances and it is spread out over an area of about 30 square miles. The city extends about nine miles north to south along the coast with a width of about three miles east to west. The distribution of the population which is over 7,00,000 is uneven and the area north of the Fort is congested. The city has efficient transport systems in the shape of tram, bus and electric train services and during the past ten years has tended to spread to outlying areas. The density of population per acre varies from 15 to 150. Madras is a garden city and like similar cities cannot boast of huge buildings, but its buildings though

smaller are not wanting in historical and architectural interest.

Temples, Churches and Mosques

Kapaliswarar temple in Mylapore dates back to the seventh century. Mylapore in the beginning of the Christian era was a stronghold of the *Saivites* and Jains. There appears to have existed a Jaina shrine and a Siva temple near the sea. But fear of sea erosion seems to have led to the shifting of the Kapaliswarar temple to its present site. It is said that about the end of the 16th century the Jaina shrine was eroded away when the image was removed to Sirramur in the South Arcot district. Inside the temple is enshrined a statuette of a girl believed to have been resurrected by Thirugnanasambandar in the seventh century.

The huge tank to the west of the temple with its fine flight of steps and the central island pavilion is well worth seeing specially on the night of the floating festival when the pavilion, the niches in the parapet walls of the tank, the temple *gopurams* and the surroundings are beautifully illuminated.

The Sri Parthasarathy temple in Triplicane dates back to at least 8th century A.D. when locality was the centre of Vaishnavism. It seems to have been renovated several times and contains stone inscriptions of the Chola, Pandya and Vijayanagar kings.

The more important places of Christian worship are the Cathedral Church of St. George in Teynampet, a fine building in the English renaissance style, the St. Andrew's Church in Egmore, a beautiful piece of architecture owing its origin to the genius of Major de Havilland, the Roman Catholic Cathedral in George Town and the Cathedral in San Thome, near Mylapore. The principal mosques are the Wallajah Mosque and the Anwari Mosque.

Harbour

The Madras harbour of to-day has steadily grown from an insignificant sand bank, founded by Francis Day in 1639, to its present enormous proportions. What nature has denied Madras in the form of a natural harbour has been accomplished by man's industry, patience, and engineering skill. The harbour as it now exists, occupies an area of about 200 acres and several steamers can lie in its still waters in absolute safety. Adjoining the main entrance from the land are situated

spacious warehouses, offices, workshops, railway yards and other buildings which are usually to be found near a growing harbour. Disposal of the sand travelling up and down the coast is an important problem which the harbour authorities have to solve. An average depth of about 28 feet is maintained inside the harbour. The approaches are kept clear and the required water depth is maintained at an annual cost of nearly a lakh of rupees. Incidentally it may be mentioned that zoologists will find the harbour well worth a visit. Species of Sponges, Hydroids, Polyzoa, Echinoderms and Molluscs are abundant and can be obtained easily.

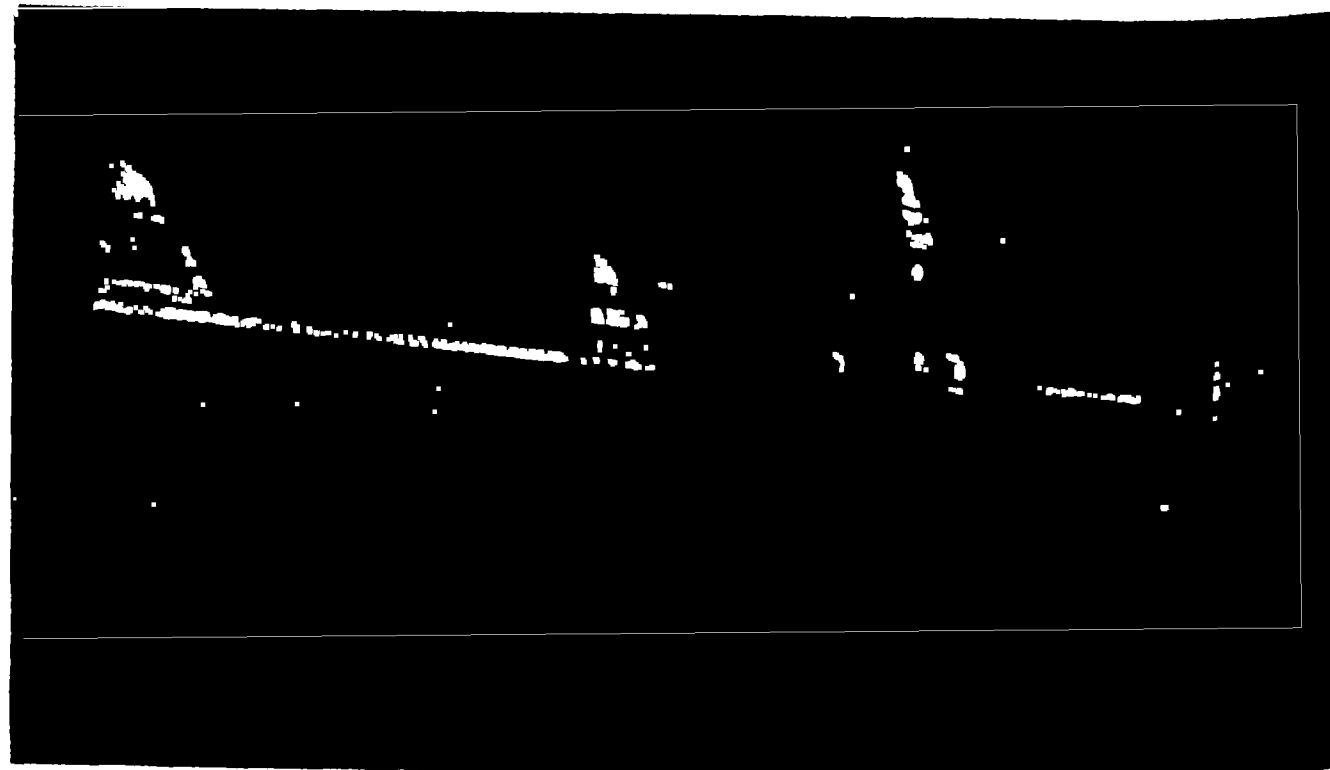
The Madras University

Madras is perhaps ahead of many other cities in India in the matter of higher education. English education had an early start in the presidency and Madras University was inaugurated in 1841. Today the University has fifteen constituent colleges and 54 affiliated institutions. It is no longer a mere examining institution but has departments for higher studies and research in Indian history, economics, Tamil, Telugu,

buildings and the examination hall were completed just three years ago at a cost of over twenty lakhs.

The old Senate House in which the Convocation is held is a building in the Indo-Saracenic style of magnificent mass and proportions situated on the Marina next to the Old Palace of the Nawabs of the Carnatic, in Chepauk. Just a little to the south of the Chepauk Palace is the massive Presidency College built in the Italian Renaissance style; the college has a unique tradition behind it and its centenary is to be celebrated very soon.

Amongst other important educational institutions in the city may be mentioned the Medical College situated in the heart of the city which celebrated its centenary recently. The Pachaiyappa's College founded by a noble-minded Hindu of orthodox family, the Queen Mary's College on the Marina, giving instruction to as many as 250 lady students; and the Loyola College which, though of recent origin, has already established for itself a name amongst the great edu-



The University Buildings

Kannada, Malayalam, Arabic, Persian Urdu. Public administration, geography, and Indian music. In science there are zoology, botany and biochemistry departments housed in separate laboratories. The new university

cational institutions of the city. The Madras Christian College is a Christian Institution financed by a number of missionary bodies in England, Scotland and America. The College made its history in the city of Madras and

its reputation as a first class educational institution is well-known. It has now been removed to Tambaram, at a distance of 16 miles from Madras and at the terminus of the electric railway. Here the College has been planned on a lavish scale and provides for the education of more than 800 students of whom about 500 reside in the spacious hostels attached to the institution. The place is well worth a visit.

Madras is justly proud of its Marina—the envy of other cities—but it is more proud of its new university buildings on the Marina which houses its research workers whose publications in arts and science are steadily growing in volume and excellence.

Aquarium, Government Museum and Victoria Technical Institute

Visitors to Madras should not forget to see the Marine Aquarium, the Government Museum and the Victoria Technical Institute and Memorial Hall. The Aquarium is situated opposite to the Presidency College on the sea side of the Marina. It was started in 1909 by Mr Edgar Thurston, the then Superintendent of the Government Museum. In 1919 it was transferred to the Department of Fisheries and since then has continued to be in charge of this department. There is arrangement for a free circulation of sea water and compressed air to the tanks. There is provision for artificial illumination also. In the fourteen large tanks built within the walls are kept a variety of marine animals, such as sea snakes, sharks, eel, and several beautiful coloured fish belonging to the genera, *Tetrodon*, *Heniochus*, *Therapon*, *Balistes*, *Pterois*, *Lutianus*, *Serranus*, *Hippocampus* etc. The Madras Aquarium is very popular with all classes of visitors to Madras.

The Government Museum is situated on the Pantheon Road, Egmore. It was established in 1851. In the eighties it came under the able guidance of Mr Edgar Thurston who was appointed full time Superintendent. From that time its popularity and usefulness were assured. The collections grew rapidly. Thurston was an indefatigable worker and writer. He issued several bulletins giving an account of the Pearl and Chank fisheries of Mannar and an account of the Fauna of the Gulf of Mannar. He also made several important contributions to the ethnology of South India. Mr J. R. Henderson, the next Superintendent, inaugurated a system of popular lectures and demonstrations. He revised several of the catalogues and started new ones. Dr Gravely, the present Superintendent, has revived the Madras Museum Bulletin which had been suspended for some time, thus affording facilities for the publication of the results of zoological, archaeological and anthropological research work. Additional accommodation has now been provided for housing the priceless South Indian Jain, Buddhist and Hindu sculptures.

The Victoria Technical Institute and Memorial Hall is situated next to the Government Museum, to the South of it. The foundation stone was laid by the late King George V, then the Prince of Wales, on the 24th January 1904. It contains several valuable art products of South India and there is a representative collection of the artistic products of the Presidency for exhibition and sale.

Two important places of very great archaeological interest within easy reach of Madras are Conjeevaram and Mahabalipuram.

Conjeevaram

The small town of Kanchipuram, famous for its Hindu shrines, is situated 40 miles south of Madras and here we can trace the development of the Dravidian style of temple architecture from 600 A.D. Among the more important temples may be mentioned the Kailasanatha temple built by Narasimha II dated about 690 A.D. and belonging to the latter part of the Pallava period. The "Vimana" tower over the central shrine rises majestically above the two gopurams, and the rearing lions and rounded corbels, of which there are several in the temple, are typical of the Pallava period.

The Jain temple of Tiruparathikunram is two miles beyond the Kailasanatha temple across the Vegavati river, and is interesting because it shows three distinct styles of architecture, belonging respectively to the Pallava, Chola and Vijayanagar periods. The small building in the garden of the main temple is of the Pallava period, the main temple itself belongs to the Chola period, while the mandapam with its paintings illustrating the lives of some of the Jain saints is of the later Vijayanagar period.

The Pallava period, is characterised by the vimana tower always dominating the gopurams. Later the fashion changed and the gopurams became the dominating feature of the temple and the vimanams sank to insignificant dimensions. The Vijayanagar artists specialized in elaborate carving. Three of the most important temples may be mentioned. The Ekambaranatha temple which belongs to this period is noted for its imposing gopurams and carved stone pillars of colossal size on either side of the gateway. This temple is dedicated to Shiva. There is no temple however to his consort Parvati. She is worshipped under the local name Kamakshi in a much smaller temple close by.

The third and the most magnificent temple of this period is the Varadaraja temple of Little Conjeevaram. The monolithic pillars supporting the roof are richly carved and their lotus corbels are elaborately finished. Near the entrance to the temple can be seen in a corner a realistic group of cats and pigeons.

Mahabalipuram or Seven Pagodas

These fine specimens of architecture belonging to the latter part of the Pallava period are the work of Mahamalla (son of the Pallava King Mahendra I) in the middle of the 7th century and are situated in a nice little village resting on the sea coast at a distance of about fifty miles south of Madras by road. Mahamalla-puram was the port of Conjeevaram from where Hindu colonists sailed to the Malaya archipelago. The modern name Mahabalipuram is probably a corruption of Mahamalla-puram, but it is now popularly associated with Bali the great mythical King of the *Asuras*.

Mahammala's temples are all monolithic and the best examples are the five *saivite* temples popularly known as the Five *Rathas*. Local tradition regards them as the chariots of Droupadi and the Pandavas. Four of these are designed like Buddhist monasteries and

are pyramidal with a number of upper pillared halls decorated with miniature pavillions. The modern *vimana* type of temple architecture could be traced to the so-called Arjuna and Dharmaraja *rathas*.

The most puzzling and the largest of all the rock carvings is the "Arjuna's Penance." The sculptures to the left of the deep cleft representing according to professor Krishnaswamy Aiyangar three scenes. They are the boar hunt of Siva to the left, Arjuna as an ascetic beside a small Vishnu temple below, and Siva offering a boon to Arjuna on the right. The scene on the right side of the deep cleft represents merely the animal and celestial beings as interested witnesses of the scenes depicted on the left. On the sea shore is a temple erected by Rajasimha who ruled towards the end of the 7th century.

SUPPLEMENT—Abstracts of Sectional Presidential Addresses at the British Association for the Advancement of Science 1939

Geography

Natural Geographical Region

A. Stevens

Mr Stevens takes as his subject the interpretation of that much misunderstood expression: *Natural Geographical Region* originated by Herbertson. He shows that much of the failure now and in the past to appreciate the true basis and function of geographical science is bound up with the incomplete grasp of this fundamental concept. Many writers limit the meaning of the word 'natural' to climatic or physical conditions. In attempts to define the boundaries of a natural region in the physical sense one method has been to plot the prevalence of the various physical characteristics and by superimposing these on one another to determine an area of common denomination. The geographical relevance of the dominant physical conditions in such a region is however generally left out of account.

Current regional treatment in geographical teaching in Europe is mostly confined to the recording of an orderly succession of facts: from physical features, geology, climate, technology and the like to 'human' matter. The whole is a mere addition, and a trespass into the domain of each of the separate sciences touched on. So long as this is so, geography will remain the Cinderella of the sciences. Its proper function is the study of the interrelationship between region and community, between environmental and human aspects. Physical nature is an irrelevance in geography except in so far as it affects man, and the study of man is similarly outside the scope of the subject except in relation to his environment. The geographer of the present day is in danger of being a jack-of-all-trades, without being a master of his own. The author gives some illuminating analogies, his warning of the fallacy of analogy appearing unnecessary in this instance.

The natural geographical region is an organised region. Its boundaries are definite even when difficult to trace, and are unconnected with physical configura-

tion: The organism—the synthesis of community and region—must have continuity in its medium, but this does not preclude variety. The unity of a region is maintained and developed by indigenous organisation and cohesion of which the ruling factors are means of communication, intercourse and industrial development; its extent may be expanded by the spread of organisation and the widening of loyalties. There is frequent mention of the French *pays*: those minor natural regions whose local archaic cohesions have so long been preserved.

The address deals at some length with regional treatment of the partly developed areas of Russia and the United States. Here the pressure of population on the land is low and the region-community organism has not reached the condition of *climax association*. The natural region only emerges in such areas when it has reached the stage of a synthetic whole, when the environmental influence on man has become assessable. The regions in these countries, unrestricted by overlapping organisms, will be on a vaster scale than in Western Europe, local unities will be weaker and will coalesce more readily.

The nation-state of Europe is a community in a natural geographical region, for it is a natural growth limited by peripheral organisms and not by physical circumstances—several states even share a coal-field. Physical conditions change but little in themselves but their significance in the region-community partnership may change rapidly or disappear.

The author makes mention of present conditions in Germany, with reference to *lebensraum*, the *ersatz*, and lost colonies, and concludes by expressing the view that to offer suggestion, perspective and balance to those who have the conduct of affairs is the contribution of geography towards human well-being, to be effected by study of the functioning geographical entities of our time.

C. G. L.

Economic Science and Statistics

Rates and Taxes

—H. O. Meredith

There is an undertone indicating the helplessness of the academic student in the face of the caprices of

administrators in Prof. Meredith's address. But as he indicates, in public finance we meet issues which in a high degree are controllable at will, secondly there is no such thing as the neutral financial policy, and thirdly financial authority does sometime betray discomfort

when confronted by reasoning which it is incompetent to answer. These are his reasons for choosing the subject.

It appears to him certain, if one follows the drift of social and economic evolution, that "a larger and larger proportion of man's energy will be expended, as time goes on, in ways and for purposes whose cost cannot be financed by the scale of discrete quanta to individuals and must be covered by more or less voluntary contribution. But the broad teaching of experience in this matter shows that voluntary association is used chiefly at the stage of initial experiment and in relatively minor undertakings. When it comes to mass-education, mass-insurance, mass provision for reaction, drainage, or what not, the element of compulsion is as unavoidable as in the case of mass-war." Hence the increasing importance of the study of rates and taxes.

Causes of Tax-dodging

Commenting upon the "glum frivolity" characterising budget-discussions the speaker proceeds; "A central difficulty is, undoubtedly, that although we have adopted many of the forms of democracy, citizenship retains in regard to taxation something of the sentiment which belongs to servile status, while government has not quite discarded the mental habit of predaceous authority. Our representative citizen does not enjoy paying taxes." Three reasons are ascribed to account for this recalcitrant temper. The most obvious reason is that "the modern State still is appreciably predatory, the representative citizen still does occupy a quasi-servile position." The remedy for this is to make the financial principle explicit, to show the representative citizen what he is doing in this matter to others or others to him. Secondly, there is the inevitable limitation of the human mind. "Men cheat the Government, much as they cheat a railway company, not only because they dislike or fear it, but simply because it and its doings are beyond their power of comprehension and sympathy. Their relations with it are too amorphous, too direct, too indistinct." The third strain in people's dislike of taxation is the tradition that public expenditure is costly in some further and fuller sense than are private disbursements. "Everywhere we can trace remnants of the ghastly Gladstonian doctrine that money should be left, where possibly, to 'fructify in the pockets of the people'. Actually money will not fructify if it is left either in pockets or in coffers; it will merely weight the swimmer down or sink the ship."

Need for Constructive Planning

Professor Meredith points out that Victorian finance, granted the major premise of *laissez-faire*, had the sovereign virtue of logical cohesion. In recent times while the doctrine has been abandoned, a logical structure of financial principles has not been developed.

"One result of this atrophy of living principle is that whereas the Victorians were capable upon occasion of really large measures of reconstruction in advance of the pressure of necessity, our finance seems more and more to make that fatal error of strategy conforming to the enemy; instead of grasping nettles we wait until we are stung. Alterations in our tax system become more and more a matter of yielding to pressure rather than of constructive planning. It follows incidentally that where that system bears with undue hardship on individuals a large measure of oppression must occur before any relief is accorded, and further, that what relief is granted more frequently resembles a sop to Cerberus than an orderly rationing of food."

After discussing in detail the anomalies of British income-tax allowance in respect of children and the system of de-rating, Professor Meredith proceeds to suggest the lines of reform of British finance. The objection that the main direct taxes *e.g.*, income-tax, death duties and sur-tax inhibit accumulation, according to him, "seems never to have been really cogent during the past century and a half. Today it is no longer even plausible in view of the tendency for desire to save to outstrip the possibilities of advantageous investment."

The taxation of commodities appears in certain respects ridiculous to him. Such taxation was propped by doctrines which the governing class of the past had a 'sinister interest' in believing. As a method of limiting undesirable consumption, taxation, in his opinion, is a 'washout'.

Professor Meredith's plea is for the abandonment of rates and indirect taxes and reliance upon a generalised system of progressive income taxation and taxes on inherited wealth. It is from a feeling of 'civic virtue' that he believes in direct taxation: "not merely because I see in it the only potentially equitable system and therefore (partly) the only truly productive system in the long run, but also because I see in it enormous possibilities of interesting the citizen in the State, in his relation to it, in what he gets out of it and what he gives to it." Of course, the direct taxes need a good deal more refinement and elaboration to suit them to our needs.

Minimum of Subsistence

In his *finale*, the Professor torpedoes the 'one final legacy from the age of *laissez-faire*', namely, the famous canon of exempting from taxation the minimum necessary to subsistence. The ghost of the canon lurks behind several modern procedure. "Ghost, advisedly, since there never has been a time at which taxation failed to nip at least nose and fingers of the ultra-poor." Not only is the canon inapplicable to modern conditions after the end of *laissez-faire*, but it is responsible for the "curious idea of many people that nothing appreciable is really due to the State until one has passed, say,

the £3 a week line for an individual or the £300 a year line for a married couple with two children." The speaker's feeling is that a contribution sufficiently heavy to be felt should be called for from the very bottom of the scale.

"Of all the ideas which we have inherited from *laissez faire* finance the most dangerous for us to continue (granted that we are abandoning *laissez-faire*) are

the notion of the exempted minimum, and the notion that indirect taxes are desirable because men do not feel that they are paying them. The State ought not to mean so little to anyone as that he will not assert his right to contribute towards it." It is a vigorous shake which Professor Meredith has given to the finance ministers and the socialists as well as traditional writers of public finance.

B. N. B.

Geology

Metamorphism and Igneous Action

—H. H. Read

In the first half of his Presidential Address to Section Geology of the British Association for the Advancement of Science, Prof. Read traces the history of metamorphic geology prior to the Great War. He describes the development of the various schools of thought in Europe and America, which, according to him were of nationalistic character.

The German School, led by Rosenbusch recognised two types of metamorphism—contact or thermal and dynamic or dislocation metamorphism. According to them there was no transfer of material from the intrusive rocks into the country rocks during contact metamorphism. And, they regarded dynamic metamorphism to be synonymous with regional metamorphism meaning regional transformations induced in rocks mainly through orogenic movements. To this idea of regional metamorphism, the Swedish School of 'ultrametamorphism' led by Holmquist and the British School, as represented by Teall and Flett, had agreed.

The French School, led by Michel-Levy, Lacroix, and Termier, had views completely opposed to those of Rosenbusch. They believed that the gneisses were not the products of dynamic metamorphism but they were formed by the injection and granitisation of the deeply buried sediments. The French idea was supported by the Finnish School, led by Sederholm, who thought that the various processes of anatexis, poligenesis, migmatization, permeation and injection play important parts in metamorphism.

In Austria and Switzerland, Becke, Heim, Grubenmann and Niggli have been mainly responsible for the development of the important idea of the depth zones (epi—meso, and kata-zones) controlling the grades of metamorphism.

The contributions of American geologists to the metamorphic geology had been mainly along two directions. Mining geologists like Lindgren and others, demonstrated that there is considerable transfer of material at igneous contacts and that metasomatism and replacement are the important processes in the formation of ore-bodies. Another group of geologists represented by Adams, Barlow, Fenner and others dealt with the injection-metamorphism and granitisation in the same manner as the Scandinavians and the French.

The most important British contributions on this subject were those due to Judd, Barrow, Horne, Greenly and others. Judd's conception of static metamorphism was discussed and elaborated by various European and American geologists including van Haise and Daly. Horne and Greenly emphasised the close association of granite injections with metamorphic processes. Barrow made three outstanding contributions to metamorphic geology namely, that concerning filter-press like squeezing out of the liquid residues from the magma and their reaction on the country rocks; the various zones of progressive regional metamorphism characterised by definite minerals, and the association of high grade metamorphism with granitic intrusions.

In the second half of his address, Prof. Read puts forward strong arguments against the prevalent ideas that regional metamorphism is induced by orogenic movements, or by the vertical pressure of the overlying cover of sediments (load or static metamorphism), and not by eruptive bodies. He regards the idea of the grade of metamorphism being directly controlled by depth as erroneous. He classifies metamorphism into two groups—dislocation metamorphism, associated with dislocation of the crust, and regional and thermal metamorphism, associated with igneous activity. He demonstrates from innumerable examples that there is direct genetic relation between the highest grade of regional metamorphism and the process of granitisation and migmatization.

The schistosity of the regionally metamorphosed rocks often coincides with bedding and they are often horizontal over considerable areas. It is difficult to explain this wide-spread horizontal schistosity by tangential pressures or pure dynamic metamorphism. There are many examples (e.g., in Grampian Highlands of Scotland) of detailed sedimentation characteristics such as graded bedding, current bedding, etc., being fully preserved in regionally metamorphosed rocks. These characters ought to have been obliterated if regional metamorphism were induced by dynamic action. To face this difficulty the idea of static or load metamorphism was brought in. But this idea, as well as the allied ones which regard that depth directly control the grade at metamorphism are not tenable on account of the following reasons:

(i) There are innumerable examples of rock-formations which are completely non-metamorphic, though they must have been covered at one time by an immense thickness of superincumbent strata.

(ii) In eastern United States highly metamorphosed stratigraphically younger rocks rest naturally on lowly metamorphosed stratigraphically older rocks. In Sutherland (Scotland) and Norway, high grade sillimanite rocks overlie rocks lower in the grade of metamorphism with no evidence to suggest that these metamorphic zones have been inverted over considerable areas since their formation.

(iii) Daly and Barrell have calculated that high grade regionally metamorphosed rocks of pre-Cambrian times must have been formed in many cases under relatively little cover. Daly has tried to explain this anomaly by assuming that the earth's thermal gradient was steeper during the pre-Cambrian times than what it was afterwards so that regional metamorphism under moderate cover was possible. This explanation is opposed to the doctrine of uniformitarianism and does not appeal to many.

The idea of granitisation,—“the process by which, solid rocks are converted into rocks of granitic nature, has now become completely international. MacGregor and Wilson believe that granitisation is brought about by two processes (a) metasomatism of the country rocks by ‘permeating highly energised fluids—emanations, ahead of advancing magma,’ and (b) a mechanical penetration by the magma. By these processes the granite magma is mixed with the country rocks giving rise to migmatites (mixed rocks). Replacement is the essential process in the formation of the migmatites. Banded gneisses and lit-par-lit complexes are produced by the process of replacement to different degrees along layers of different permeabilities. For the following reasons many of the granites are believed to have been formed by replacement: (1) the regional country-rock structure can often be traced through granitic

masses, (2) there are many thin plane screens of country rock in the granites, (3) there is a great extension of minute ‘lits’ of quartzo-felspathic material in migmatites (4) most of these granites are very heterogeneous in composition. Replacement in sedimentary rocks during granitisation is controlled by the original structures of those rocks, permeation by the magmatic emanations or ichors (magmatic juices) taking place preferentially along certain layers. Prof. Read regards that the foliation of granite gneisses is essentially controlled by previously existing sedimentary structures and not by any process of dynamic metamorphism or piezo-crystallisation.

In regions of granitisation there has been an afflux of material. During the process of replacement, there must also occur through the country rocks an emigration of material which is of several origin and qualities. ‘It consists of (i) the material expelled from the region of granitisation, (ii) the direct emanations from the granitising agent, and (iii) the pore fluids of the country rocks. The different constituents of the material must move with different speeds and may precipitate their loads in various overlapping belts, from each of which further expulsion may take place. This process may be responsible for the production of zones of various characters about the granitisation or migmatite core.

The close association in the field of highest grade metamorphic rocks and migmatites has been differently explained. Harker and most British geologists regard igneous intrusion in the sillimanite zone as an incident in the rise of the isotherms in that region. This rise is a direct invasion of the earth's internal heat, and any solutions concerned in regional metamorphism are for the most part not of magmatic origin. Vast supplies of heat and material are necessary in the granitisation process and the higher grades of regional metamorphism, and both can be supplied more reasonably by igneous invasions. Further, the cases where migmatites and rocks of the sillimanite zone are formed above low-grade rocks, can be easily explained by emanations or magma being injected in such a position, but it can hardly be explained by the rise of isotherms.

From the central theatre of granitisation there is a flow of metasomatising solutions, largely towards higher parts of the crust and they change in composition and temperature as they become more distant from the core and thereby form zones of metamorphism about it. Such a metasomatic metamorphism may account for the superposition occasionally observed of high grade zones on lower grade. In metasomatic metamorphism it is reasonable to expect that original sedimentary textures may be preserved and schistosity and bedding may coincide even in violently folded strata. For, in regionally metamorphosed rocks, folding is usually not coeval with metamorphism but it antedates the latter, crystallisation is ‘post-tectonic’. The unmetamorphosed nature

of deeply buried sediments can also be accounted for by their being inaccessible to igneous material.

A continuous series of changes in composition from low-grade regionally metamorphosed rocks to migmatites has been established. Even in the low-grade rocks changes are perceptible and all must be ascribed to the activity of the material from a granitisation centre. The presence of tourmaline in regionally metamorphosed rocks of all grades indicates the action of ‘emanations’ in high as well as low grade rocks.

Though migmatisation is the prime cause of regional metamorphism, dynamic forces are of considerable

importance in the lower grades of regional metamorphism. This is due to the fact that as the migmatite front invades the crust, stresses are set up by the increase of volume; and relief is obtained in the outer and cooler zones by shearing and in the inner and hotter zones by internal reconstructions.

Thus the views put forward by Prof. Read that regional metamorphism as a whole is genetically related to igneous action, involving the processes of granitisation and migmatisation, explains away many difficulties which face the students of metamorphic geology.

S. K. R.

ERRATA

The abstract of the presidential address at the Psychology Section of the British Association published in the supplementary pages of the last November issue was entitled *Measurement in Psychology* and was prepared by Mr Krishna Chandra Mukherji and the initials should therefore read *K. C. M.* instead of *H. K. M.*

Due to reasons beyond our control, namely, loss of the original copy of the addresses during transit, we regret it will not be possible to publish the abstracts of the remaining addresses.—Ed. Sc. & Cul.

SCIENCE AND CULTURE

JANUARY 1940

VOL. V NO. 7

A Monthly Journal of Natural and Cultural Sciences

Work of the Archaeological Survey of India

EVEN about the beginning of the present century widely divergent ideas prevailed among scholars regarding the origin and age of Indian culture. While the Hindus believed that their civilization was of the greatest antiquity, European scholars of the last century generally believed Indian culture to be of comparatively recent origin. A hundred years' patient work by the Asiatic Society of Bengal had undoubtedly thrown a flood of light on the dim past of India. The decipherment of the Brahmi script by Prinsep unfolded the glorious story of Buddhistic civilization which had spread over the whole of Asia, but gradually came to be forgotten in the land of its birth. But all that was posterior to Alexander's invasion of India and no archaeological evidence worth the name, of pre-Asokan period had been discovered prior to 1923. Though the British Government had, since the inception of the Asiatic Society of Bengal, taken the greatest interest in Indian archaeology, the work during the early days was mostly left in the hands of 'Pioneers,' some of them scholarly, and scientific, but others mere adventurers. In 1862, the work was officially taken under the care of the Government of India with Sir Alexander Cunningham as Director-General of Archaeological Survey.

But it was Lord Curzon who first recognized that archaeological excavation was one of the obligations of the Government of India and in a speech delivered before the Asiatic Society of Bengal on the 8th February, 1900, foreshadowing the establishment of a

government archaeological department, he said: "It is in the exploration and the study of purely Indian remains, in the probing of archaic mounds, in the excavation of old Indian cities, that a good deal of exploratory works of the archaeologist in India will in future lie."

First Twenty-five years

The archaeological department was established in 1902 with Mr (now Sir) John Marshall who had gained his experience under Sir Arthur Evans in Crete as the Director-General and Indian Archaeology remained under his fostering care for the next quarter century. During his regime many of the buried cities of India like Taxila, Sarnath, Sravasti, Bhita and Nalanda were scientifically excavated and a band of Indian and European scholars received their training in archaeology. At the suggestion of Sir John Marshall, Harappa was excavated by the late Rai Bahadur Dayaram Sahni in 1921 and Mohenjo-daro in 1923 by the late Mr Rakhal Das Banerji. Mr Banerji at once recognised in the seals and other objects recovered there, something quite different from the remains of Buddhistic India, and going much further back than Buddhist India. He connected them with the Sumerian civilisation and called the site as Indo-Sumerian. The discovery aroused the attention and interest of the whole world of archaeologists and confirmed the fond belief of the Indians that India was after all 'one of the earliest cradles of human

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civilisation.' Encouraged by the signal success of the department, excavations and explorations of various ancient sites in Sind, Beluchistan and the Punjab as also at Nalanda (Bihar) Paharpur and Mahasthan-garh (Bengal) and Nagarjunkunda (Madras) were undertaken between 1926 and 1931 and the Government of India sanctioned a special recurring grant for the purpose. These operations furnished evidence for the existence of a chain of prehistoric sites all along the northwestern borderland of India. Sites were also discovered in the upper Gangetic valley and as far south as Gujrat which showed that the Indus valley civilisation had probably spread over a large part of India. It was hoped that the department would proceed with the excavation of some of the promising sites which would clear up the prehistory of the country before the date of the Mauryan Empire (300 B.C.).

Financial Crisis of 1931

But these plans which had shown such early promise and met with such phenomenal success during the few years before 1939 could never mature and the department showed quick and positive signs of deterioration from 1931. The cause of this sudden set-back in the work of the department must to a great extent be attributed to the stringent retrenchment measures adopted by the Government in 1931 which meant the abolition of the exploration branch of the department, all the trained staff being disbanded and many of the Sind and Punjab excavations being abandoned. In 1931 six officers, some of them of great experience, retired and instead of their places being filled, a policy of retrenchment was pursued resulting in the abolition of eleven posts in the department. Since then the retirement of Messrs Hargreaves, Blakiston, Dayaram Sahni, and the tragic murder of Mr N. G. Mazumdar have caused further gaps which it is difficult to fill by younger persons having the training and experience adequate for the task. Added to this there were very meagre sums available for excavations since 1931. The money available at this period was about Rs. 25,000 instead of 2 lacs. Work was therefore continued on a very small scale at places like Nalanda, Taxila etc., where trained staff was available. To fill the gap in our knowledge of Indian history between 2,500 B.C. and 300 B.C., the department maintained, though on a very poor way, according as the small grants could,

the excavation work at places where there was likelihood of important finds, namely at Lauriya Nandangarh, Kosam, Rohtak, Charsadda, etc.

Enquiry by Sir Leonard Woolley

The tradition of the department, however, suffered a good deal possibly due to reasons enumerated above and the situation demanded that a thorough sifting enquiry should be made as to the cause of this rapid deterioration—how far this could be attributed to the financial stringency and how far to other flaws and short comings, if any, in the working of the department. Last year the Government of India invited Sir Leonard Woolley, the famous excavator of Abraham's city, Ur of the Chaldees, to come over to India and report on the working of the Archaeological Survey of India. His expert opinion was mainly sought in connection with the selection of the most promising sites for exploration, the best methods and agencies for achieving speedy and fruitful development of exploration activities in general, the best method of selecting and training of officers for exploration work and other relevant matters. Sir Leonard has reviewed the working of the department in many of its branches, and submitted a report which is considered as very adverse to the department. However unpalatable and unsympathetic some of the remarks of Sir Leonard may be, the observations made by him, coming as they are from a man of his position and experience, are sure to carry great weight with the government as well as to the interested and enlightened public. They cannot be entirely brushed aside as being biased.

Selection of Sites Defective

In reviewing the excavation work done by the department in recent years, Woolley finds a lack of any coherent plan for its activities. The immediate objective, according to him, should be the filling up of the gap in our knowledge of Indian history between 2500 B.C., the era of Mohenjo-daro and Harappa, and 250 B.C., the era of Asoka's inscription, the time period which saw the influx of Vedic Aryans to India, and when occurred those mighty human movements which gave to Indian culture its distinctive stamp. Sites selected for excavation should be such that they hold a fair chance of furnishing these missing links and should further satisfy the conditions that the site should have been inhabited over a long period, some of the upper strata at least should belong to known historic periods, and the site should yield not

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only coins and inscriptions but other objects really representatives of the art of their periods and lastly the site should, of course, be one lending itself to excavation. Judged by the above criteria Woolley considers Ramnagar near Bareilly to be a very suitable site where excavation should be started on a large scale under the direction of a really competent archaeologist who has experience of scientific excavation. Ramnagar is by tradition assigned to the latter Vedic age, being Ahichchhatra, capital of North Panchal famed in the *Mahabharata* and occupied up to the Gupta times and Woolley thinks it probable that it will yield objects going back from the Gupta to the early Vedic period. As for the sites already excavated in parts such as Taxila, Mahenjo-daro etc., operations should, for the time being, be postponed as with the limited resources at the disposal of the department, greater attention should now be paid to correlation rather than to concentration on a particular period. Incidentally Sir Leonard has drawn attention to the grave risk of the Mohenjo-daro site being completely destroyed by the Indus within quite a short period unless certain work for its protection is undertaken. It cannot be too strongly urged upon the government to take the necessary measures for the protection of the most famous of Indian archaeological sites where the excavation is not at all complete.

Woolley further thinks it not necessary and desirable that a site should be exhausted as is being done at some places, but the work be stopped when enough has been obtained to establish and illustrate properly the character and history of the place. When as a result of such excavation of several sites, the framework for Indian archaeology has been provided, the Director-General will be in a much better position to decide which particular phase of culture needs further illustration and will select his sites accordingly.

But Woolley advises the departmental activities to be confined to excavation on selected sites he insists that a more complete programme of archaeological survey of the whole country consisting of visiting, listing, mapping of sites should be undertaken and careful selection of potsherds, coins etc., collected from each should be filed for identification when later excavation would make such identification possible. This would enable the Director-General to draw up a programme for future work

calculated most surely and most economically to answer to the varying demands of advancing knowledge. Woolley however appears to have underrated the importance of excavation of Kosambi, a huge mound forty miles to the southwest of Allahabad, which according to the unanimous evidence of ancient Indian tradition was a great city from 1500 B.C. to Buddhistic times. The Archaeological Survey has started excavation at this site and also at Nandangarh where the so-called Vedic burial mounds have to be properly examined before determining whether they furnish any such links, so that the charge that the department was not alive to the task of searching for the missing links between Mahenjo-Daro and Asoke, seems to be baseless. They were as much alert about this important problem as Woolley, but probably Woolley has yet to realise how difficult it is to rouse the government to any progressive scheme.

Sir Leonard Woolley also draws attention to one aspect of archaeological investigations, viz., proto-history, i.e., study of the Stone Age, which has been hitherto neglected in this country, though India is one of the richest countries in the world for remains of earliest phases of man's existence. The study of the Stone Age antiquities is a highly specialised subject and as such requires a particular type of training. For this necessary branch specialists should be engaged at once as permanent element of the staff and Sir Leonard mentions that there are trained and capable Indians who have worked under leading authorities in Europe, who may fill the present gap in the cadre of officers. We may refer in this connection to the excellent work done by the expedition sent by the Carnegie Institution of Washington under Dr De Terra, who explored the old Stone Age sites of the Soan Valley in the upper Punjab and of the Kashmir Valleys.

Excavation by Foreign Bodies

The number of ancient sites in India is almost unlimited, but with the limited budget at its disposal the work of the government archaeological department should and have to be limited to a few sites best calculated to throw light on the obscure periods of India, if they are to serve as useful centres of public education, should possess collections illustrating in a comprehensive manner the known style and periods of Indian art and culture, which very few of them claim to possess now. One way out of the difficulty would be for the archaeological department to share

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the work of excavation with foreign bodies and other Indian institutions and this was the motive behind the amendment of the Antiquities Law by Act No. 18 of 1932. But it had a very poor response from foreign bodies because in Woolley's opinion, not enough has been done to impress upon world opinion the importance of Indian archaeology and directors of museums abroad have not been convinced that they would get a fair return for money spent on excavation in India. The rules framed by the government for the disbursement of finds are somewhat vague and unspecific and Woolley urges that liberal treatment must be categorically assured and in his opinion the example of Syria, which grants to the foreign excavator an exact half of the objects found by him, is the right one to be followed by India.

We are afraid that Woolley has somewhat exaggerated the position; the last American expedition which excavated at Kashmir Valleys did not complain against the provisions of the Act which was liberally enforced by the Archaeological Survey.

There is nothing intrinsically harmful in throwing the field of archaeological excavation open to foreigners. Indeed the world would have remained ignorant of the past of Egypt, Syria or Mesopotamia but for the work of European scholars. But Woolley has forgotten to tell us in his report that with the rising tide of nationalism in Egypt and Mesopotamia, some restriction has been put on unbridled exportation of antiquities out of these countries, and Indian sentiment in a like manner insists that Indian antiquities should *not* be, as far as practicable, allowed to be exported out of India by adventurers, and unscrupulous dealers, but as far as authorized foreign bodies like universities, museums etc., are concerned, Indian sentiment would welcome their co-operation, and would be prepared to make concession in the matter of appropriation of discovered relics; the rules should be framed in such a way that Indian national interest is properly safeguarded and the Indian museums are not starved as a result of parting of the relics.

We are not fully convinced by the arguments advanced by Sir Leonard in support of his special pleading for too generous

treatment of foreign bodies which would even 'allow the departure from the country of objects sometimes even unique and frequently of value to the national collections.' When some 'unique' find would be appropriated by a foreign body and go to decorate the shelves of a public museum abroad, we would have to console ourselves with the hope that the find may not be really unique but is probably one of the whole class and the excavation of contemporary sites would yield similar objects which might then go to enrich the national collections. The attitude is rather too philosophic and Indian sentiment cannot agree to the government passing any law which would in any circumstance allow any 'unique' relic to go out of the country at least so long as it remains unique. Nay, Sir Leonard waxes eloquent and advances further arguments supporting transport of even the very best finds to foreign countries as that would help to arouse the world's appreciation of India's artistic achievement and to that end he considers the sacrifice to be minor. We have to remember that once the door is thrown open to foreign explorers and such tempting terms offered, the result will be that the few Indian bodies that exist will have no chance whatsoever to be able to compete with the foreign ones with their large resources and well-equipped personnel and practically the whole work of Indian archaeology will be transferred from Indian to foreign hands. It is of course in the interests of Indian archaeology that we should welcome foreign explorers to assist in the work of unearthing the relics of old times rather than that they should remain *ad infinitum* under earth. But if terms such as proposed by Sir Leonard are offered to these bodies, within a very short time India will be bereft of many of her valuable and rare archaeological objects which she could ill spare.*

*For the information of our readers, we may add that most of the antiquities recovered by Sir Leonard Woolley's excavations at Ur are now preserved at the Baghdad Museum, and the great wealth of antiquities recovered by Lord Carnarvon and Mr Howard Carter from Tutankhamen's tomb are now preserved and exhibited at the Cairo Museum. National sentiments in these countries have not allowed the antiquities to be exported. It is only in the mandated French territory of Syria, which, according to Lawrence of Arabia fame, is a menagerie of warring communities and where no national sentiment has yet grown, that the foreign excavator is allowed to export antiquities outside the country. (See Lawrence's *Seven Pillars of Wisdom*, Chapter on Syria).

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In introducing any modification to the law permitting foreign bodies to carry on excavations the government should ensure that outside help is attracted but certainly not at a cost too high for India's national interest, or detrimental to the interests of India's museums. We however whole heartedly agree with Sir Leonard's proposed amendment of the other aspect of the existing law regarding excavation by foreigners in India, which relates to the granting of licences. A licence should be granted only to scientific

bodies on condition that the objects accruing to them are to be destined for exhibition in public museums and should not be exploited for private profit and the licensee must be duly qualified as director of field archaeology. Proper publication of the scientific results must also be guaranteed by the expeditions. Sir Leonard also suggests that a great advantage may be secured from the foreign expeditions if the law empowers the Director-General to attach to such expeditions students or officers destined for posts in the department who would thus receive the full benefit of training under the experienced field directors in the latest methods.

To be continued.

Religion and Science

RELIGION and science are the two chief factors which have influenced human development throughout all stages of civilisation: religion as the reaction to an inner impulse as to what is conceived to be sacred and arouses awe or reverence, and science as the accumulation of knowledge of the properties of natural objects—animate and inanimate—in relation to man's needs and his understanding of them through the use of his intelligence. One represents the emotional side of man's nature, as expressed in art and literature: the other—also the product of an inner urge—is the construction of a mental picture which gives acceptable form to what is known, at any stage of inquiry, about the nature and origin of things, visible and invisible. It is in the study of the heavens from these two points of view of devotion or worship and inquiry that religion and astronomy meet in celestial fields.

All religions, primitive and advanced, include three essential elements. First of all is a conception of the nature of the deity or deities in relation to man and the universe, and this, together with an account of the origin and history of the people professing the belief, when reduced to writing, constitutes the

sacred literature of the belief; or the Word of God, as represented in the Mosaic books of the Holy Bible.

The second element of religion is ritual, which prescribes the mode of approach to the deity in a form of worship.

The third is a code of ethics, which prescribes rules of conduct and in its highest development aims to bring the individual into harmony with what is conceived to be the will of God or the divine principle of the universe.

There is really no conflict between religion and science; one is the expression of an instinct for communion with a Supreme Being; the other is a spirit of inquiring into all things visible and invisible in the universe. Science does not set out to establish or depose any particular articles of belief or substance of faith, but to examine critically whatever comes before it in the natural world and to testify faithfully to what is seen.

—Sir Richard Gregory at the Division for Social and International Relations of Science, British Association Meeting at Dundee, 1939.

The Subterranean Gasification of Coal

I. Pavlov

[We publish below a very interesting article on the underground gasification of coal by I. Pavlov. It reveals a remarkable story of how a very original idea aided by a high degree of engineering skill has led to one of the greatest achievements of our times in the Soviet Union. No detailed information regarding the construction of the underground panel and actual working is given, but the article gives a good idea of the principles involved and the mode of solving the difficulties encountered. The pictures have been obtained by the courtesy of Dr C. S. Fox of the Geological Survey of India, who himself visited Russia and got these photographs.]

It would be interesting to know whether similar schemes can be applied to Indian collieries. For Indian coal seams, which are generally thicker than the Russian coal seams dealt with, the method described may not be directly suitable, and underground gasification may also be risky in the thinner inferior grade coal seams in this country. But it is desirable that the matter should be gone into carefully by our own engineers, as the process is obviously of almost revolutionary importance. The waste of coal in India is appalling and the scientific treatment of coal is practically non-existent. It is, therefore, necessary that when we begin the rational treatment of coal, which is one of the greatest national assets that a country can have, the latest scientific methods should be carefully examined.

Ed. Science and Culture/

COAL plays a big part in the life of today. Let us but imagine for a moment the complete disappearance of this commodity, and we shall see that the consequences would be catastrophic: the furnaces of nearly all the industrial plants, power-stations, steam-engines, steamships, and blast-furnaces, would be extinguished, there would be no more warm domestic hearths and mankind would be forced back to a stage of development it has long since passed. Neither oil—the world resources of which are extremely limited—nor wood, nor any other known fuel, can replace coal, which is as indispensable as bread, clothing and shelter. Nevertheless, few of those by whom the everyday use of coal is taken

for granted give a moment's serious consideration to the difficult process of obtaining it or the primitive and wasteful way in which it is put to use.

To obtain it, millions of men in all parts of the world are obliged to spend most of their lives in the dark and unwholesome bowels of the earth, burrowing like moles, toiling and sweating, in order to dig out the great black masses, the beneficent sources of warmth, energy and light and which also supply the raw material for the most astonishing chemical transformations.

When the mineral has been dug out, and conveyed to the surface, countless trains, steamers and barges carry mountains of coal for hundreds and thousands of kilometres to the industries, ports, depots; from the latter, endless lines of lorries and carts distribute it to scores of millions of homes.

At the present time, coal is being used, in an irrational and extremely wasteful way. Calculations have shown that even the most up-to-date and scientific methods of employing this fuel permit us to obtain no more than about 20 per cent. of its useful heating properties. A big proportion of coal turns into dust and is wasted while it is being dug out and during the endless process of transportation. After long exposure to air while it lies on the surface of the pits, it becomes weathered and loses some of its heating and other valuable properties. Immense deposits are to be found in some places in such thin layers or with such low heating power as to render their exploitation at present unprofitable. As a result, vast mineral wealth lies useless, while industries and towns in the neighbourhood have to be supplied with coal from distant parts. Not every kind of coal is suitable for the variety of purposes for which it is now employed. There are kinds that are only good for fuel, others for smelting iron or for the chemical industries.

Imagine what it would mean, then, if coal could be transformed into gas without being removed from

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its earthy bed. This gas could be put to a vast number of uses; it could be employed with equal success as a source of power, and for technological purposes, *i.e.*, for obtaining high temperatures and energy, for manufacture of essential chemicals and for the smelting of metals. This gas could be obtained from any kind of coal, even from the kinds lying useless at the present time. If this idea could be carried out, what a revolution it would work in society. The heavy toil of millions of miners would become a thing of the past; the necessity for the endless wasteful loading and unloading of millions of tons of coal, with the vast amount of labour involved, would cease to arise. A very considerable part of transport—trains, cars, and ships, as well as the labour and materials required for these modes of transport, would be set free for other purposes. Through pipes laid deep down in the bowels of the earth the gas may be conveyed to industrial plant, factories, power-stations, chemical works and dwellings. The cost is much lower than that of coal; consequently, the cost of electric power and manufactured products will be considerably reduced. This, in its turn, will be responsible for a reduction in the cost of agricultural produce.

The idea of the subterranean gasification of coal is not new. In 1913 newspapers recorded the fact that the well-known English chemist, Sir William Ramsay, had discovered a way of converting coal underground into gas. Previous to this, however, the celebrated Russian scientist and chemist, Dmitri Mendeleev, brought up the question at the end of the last century, when as he said, he did not see any insurmountable obstacle to the practical realisation of the idea. But neither Mendeleev nor Ramsay, whose discovery Lenin regarded as "a gigantic technical revolution," was able to carry out his splendid plan. It is being realized in the Soviet Union today.

In 1931, when the industrialization of the country was well under way, the working out of the problem of the gasification of coal underground was begun according to the instructions of the Soviet Government. Soviet engineers and scientists had to begin from the very beginning, since the methods of gasification which were worked out by Ramsay and those that Mendeleev had in view, remained unknown to Soviet science. The methods worked out by the Soviet specialists started with the assumption that the layers of coal

required to be broken up or crushed on the spot previous to gasification. The method of crushing was worked out and tested, but the scientists were dissatisfied with it, as it involved a great deal of underground mining and did not, therefore, help to do away with the pitman's work nor yield the desired results in the cheapening of gas.

Some other way had to be found. A government organization called the "Subterranean Gasification Scheme" ("Podzemgas"), which was made responsible for the work and the methods by which it was to be carried on, announced in 1933, a competition for the best plan of gasification. Chief among the authors of the present method were three young engineers, P. Skaf, I. Matveyev, and F. Filippov, who, basing their theories on experiments and calculations, found the preparatory breaking-up of the coal to be unnecessary. They suggested that the burning of the coal should take place in the seam without any artificial treatment being applied, and that its conversion into gas should be achieved by driving air from the surface to the spot where the coal was burning underground. The experimental centres set up in various colliery districts of the USSR have proved the conclusions and calculations of the young engineers to be perfectly correct.

The main method they suggested is known as the stream-method. It may be explained briefly as follows: coal-deposits, as is well known, are seldom found in strictly horizontal layers. The contraction of the earth's crust in remote geological periods has resulted in the formation of folds and seams, the direction of which the coal-layers follow, so that they are sometimes oblique, almost overhanging.

The panel selected for gasification is prepared by hollowing out two canals leading from the surface and following the slope of the layer, along the sides of the panel. The lower edge of each canal is connected with a third, which forms the lower boundary of the panel and is called the fire-drift. In this, some foreign inflammable substance, the ignition of which starts the process of gasification, is placed. After the panel (*i.e.* part of the mine chosen for gasification) has been thus prepared and separated from the rest of the seam by fire-proof insulating material the pitmen come up to the surface, and the inflammable substance is ignited by the passage of electric discharge through it. In this way the coal in the upper boundary of the fire-drift is set on fire. Simultaneously, air is pumped through one of the two openings into the fire-drift and this fans the flame. The gas thus formed is conducted

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along the second canal to the surface. Since the gas is obtained by "washing" the fire-drift with a stream of the pumped air, the process goes by the name of the *stream-method*.

This, broadly, is the way it is applied. There is a more complicated way of carrying it out, and one which has advantages over that described above, but the principle in both is the same.

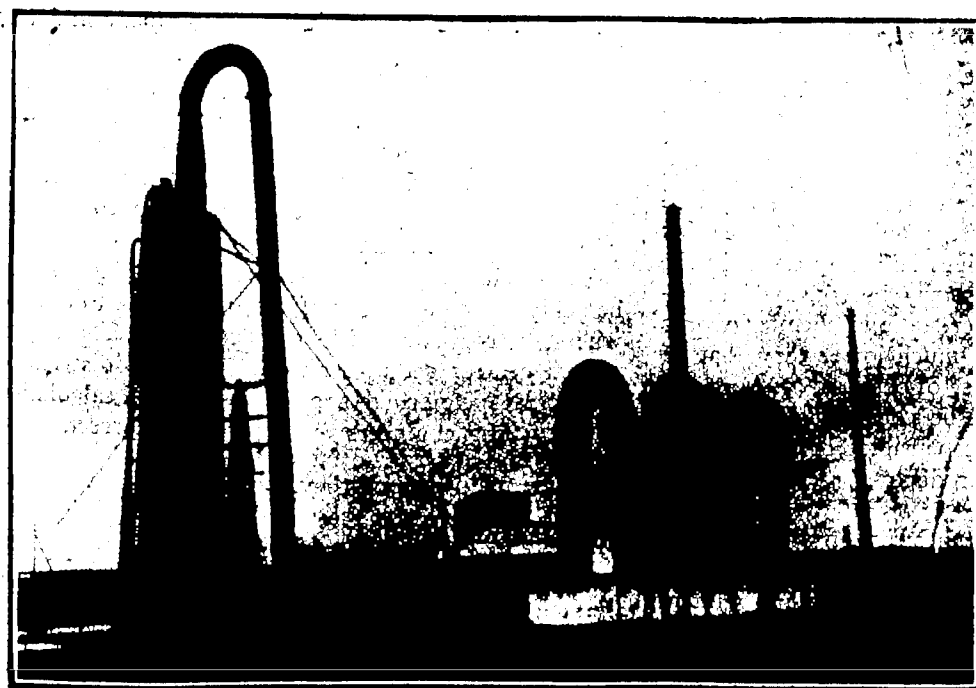


Fig. 1

Surface Plant of Underground Gasification of Coal.

(With acknowledgement to Min. Geol. Met. Inst. of India—Photo by Planet News Ltd., London)

The limits established for the force of air-blowing determine the surface area of each panel, which is about 200 by 300 metres. The output of a panel averages 20,000 to 30,000 cubic metres of gas per hour. One panel is, of course, sufficient for an experimental station, but in the case of an industrial station for the production of large quantities of gas, a single panel might not prove sufficient. Therefore a scheme has been worked out for the construction of stations where two or more panels lying in the same or in different coal-veins could be exploited.

The work done by the experimental stations gives us reason to suppose that the stream-method is every-

where applicable. There may, however, be cases where the roofing (the non-coal-bearing stratum covering the burning layer) proves so friable and unstable that it crumbles away as the burning goes on and, eventually, blocks the apertures through which the air enters and the gas comes out. For cases of this kind (which are, it is true, comparatively rare) the authors of the scheme have worked out another method of preparing the panel; this is the drilling-and-gas-producer method. It was tested and like the stream-method, found to be perfectly practicable.

At the beginning of 1935 an experimental section was prepared for the gasification of coal by the stream-method at Gorlovka (in the Donetz Coal-fields) and in February of the same year the coal was ignited. A few hours later a small cloud could be seen over the opening of the exit-canal. It was underground gas. For almost eighteen months the bowels of the earth yielded inflammable gas unintermittently during summer and winter, day and night. Nine million cubic metres were obtained in this period at the Gorlovka Experimental Station.

When work here was in full swing, it was painstakingly studied

and a great many experiments were tried. The pumped air was oxygenized, which caused the gasification sooner, increased the quantity and improved the quality. By increasing the proportion of oxygen in the pumped air from 21 per cent. (the proportion usually present in air) to 60 per cent., the calorific value of the gas was almost doubled.

Once the Experimental Station stopped the air-blowing for a time. The gas that was then examined proved to possess more calories and great chemical value. It was found to be a water gas, rich in hydrogen, possessing great heating power (so that it could be used for supplying energy) and at the same time suitable for the materials for the chemical indus-

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tries, since synthetic benzene, synthetic ammonia, synthetic spirits and other chemical products—(technological gas)—could be obtained from it. Further experiments showed that the quality of the water gas obtained after the blowing had ceased depended upon the kind of blowing done previously, that is, on the percentage of oxygen used, and the length of time it had been carried on. The concentration of hydrogen in the gas sometimes reached 60 per cent. It was thus found that by regulating the blowing and the

third way, and this was the way eventually selected: the uninterrupted production of technological gas of high calorific value by the action of combined steam and oxygen blowing. The blowing of pure oxygen, however was impracticable, since it would heat the fire-drift to too high a temperature, and there would be a danger of the coal-bed and the fire-proof connections melting and thus disturbing the entire process of the formation of gas and the conducting of it to the surface. Steam was called in to the rescue. The action of the burning coal on steam causes it to decompose into hydrogen and oxygen in the fire-drift. This considerably lowered the temperature of the burning and

at the same time enriched the gas by a valuable element, hydrogen. The thermal power of the gas obtained in this way amounted to 2,600 calories to the cubic metre and, after being purified, to 3,000. This was a kind of universal gas which might be used with equal success both for chemical processes and for obtaining high temperatures.

When the production of ordinary gas of low or medium calorific value is aimed at, it is, of course, sufficient to use for the blowing air that has had only a very small quantity of oxygen added to it or none at all.

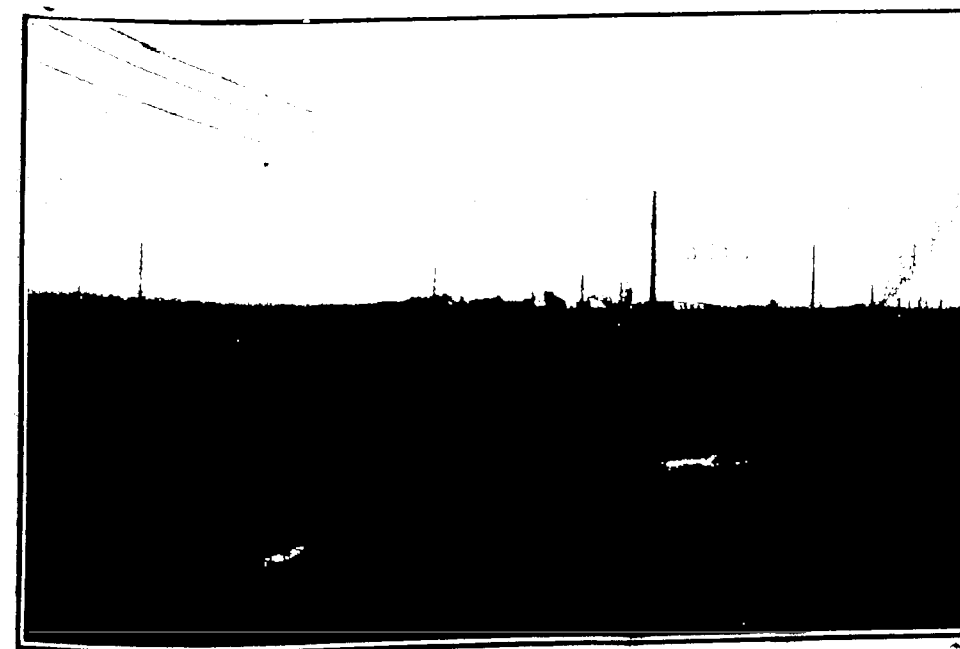


Fig. 2

Surface Plant of Underground Gasification of Coal Showing Pipe Line.

(With acknowledgement to Min. Geol. Met. Inst. of India—Photo by Planet News Ltd., London)

constituents of the air it was possible to obtain in turn gas for power during the blowing period, and technological gas of high quality while the blowing was not going on. Experiments also showed that water-gas could be obtained by insufflation of steam into the fire-drift.

But what system of blowing would best serve the purpose in obtaining gas of high quality? Alternate blowing and cessation of blowing, or alternate action of air and steam on burning coal? There was still a

After the Gorlovka Experimental Station had been working successfully for fifteen months, a station of an industrial type was set up there at the beginning of 1938. A sufficient supply of gas was produced here to serve not only the station itself but the huge boilers of the neighbouring coke and chemical works. The second stage had been reached: the gas produced underground has assumed a position of some importance in industry.

At the same time, there are still several problems awaiting solution upon which the maximum profit to

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be gained from underground gasification depends. As we have pointed out, the panel at the Experimental Station was prepared for gasification by the miners who dug the canals, so that even when this method was applied, human labour underground was required but their number was reduced to a minimum. It should be noted that from 80 per cent to 90 per cent of the fixed capital invested in underground gasification goes on surface work and only 14 per cent to 15 per cent of working expenses on the preparation of the panel itself underground. But human labour underground is to be dispensed with altogether, and drilling machinery and the jointing of the holes, that is, the connecting of their lower edges by a horizontal fire-drift, must be mastered. Drilling directly into the coal-layer will have to be done not only perpendicularly but obliquely as well, and to a depth of 500 metres and more, the diameter of the hole itself being one metre. The results already achieved lead us to suppose that a satisfactory solution of this complicated problem, which has not yet been reached anywhere in the world, will be found here in the USSR.

As for mechanical jointing, it has been found possible to manage this by the hydraulic method when borings are 20 to 25 metres apart. Another problem is the reduction of the cost of oxygen, which plays such an important part in gasification and is required in large quantities. Academician Kapitza has discovered a new method of obtaining liquid oxygen by using special turbines, and this promises to effect a considerable reduction in the cost of gaseous oxygen in the future.

What results have the subterranean gasification of coal in the USSR yielded? The gas produced in this way costs from 0.3 to 0.75 kopeck per 1,000 calories, while the gas used at present in various branches of Soviet industry costs from 1.5 to 2.5 kopecks per 1,000

calories; thus a reduction of from three to five times the cost could be effected. In the Donetz coal-field, at present the average production is 30 tons of coal per month for every man employed in the pits. At the Gorlovka Experimental Station the output, calculated in coal, is 75 tons a month per man. If this is the figure for a relatively small experimental station, then, according to estimates, the production of a big industrial station should reach 500 and 600 tons. Thus, output will be increased by 15 or 20 times, while the heavy underground toil of hundreds of miners will be replaced by the comparatively light work of a few score of technically qualified men employed on the surface.

While, at present, only 60 per cent of the coal worked in the bowels of the earth can be obtained, no matter how highly mechanized the processes may be, subterranean gasification will enable us to obtain the full value of the coal. A cheap and abundant supply of underground gas will enable us to solve one of the most important problems of metallurgy today—the production of “porous” iron straight from the ore without the need of blast-furnaces or coke.

Part of the gas will go to provide electric power, the other in combination with this same electric power to be used in the making of the most valuable chemical products. Industries will be able to rely on a steady supply of cheap fuel and excellent technological raw material.

The Third Five-Year Plan, confirmed in March of this year at the Eighteenth Congress of the Communist Party and intended to cover the development of the country during the years 1938 to 1942, provides for the growth of underground gasification of coal into an independent industry. A number of industrial stations for this are to be built and put into operation in the Donetz and Moscow District coal-fields and in the east of the USSR, and the gas produced is to be used for power, for the chemical industries and for municipal requirements, etc.

The Artistic Sequence of the Rock Paintings of the Mahadeo Hills

M. E. and D. H. Gordon

(Continued from the last issue)

WHEN dealing with paintings of the Late 2nd, and Early and Late 3rd Series one is constantly meeting difficulties which arise from bad drawing and the general crudities of inferior artists. One must, and I think with reason one can, pin one's faith to the fact that the bulk of the pink and red paintings are older than the bulk of the plain white paintings. There are of course exceptions and it is just these exceptions which are so difficult to place.

Our plates however carry us on, showing quite clearly the advance made in the 3rd Series: in the majority of the paintings anatomy is improving and heads are beginning to take shape and develop recognisable features. Plate 1 shows typical Early 3rd figures in red and pink, and a Late 3rd figure superimposed on Early 3rd figures in pink, one of which has an animal mask. The figure in white with a long-necked pot hanging from a stick over his shoulder, is probably Late 3rd but poorly drawn. The lady balancing a large pot so elegantly on her head is Late 3rd of medium quality.

There appear to be in the better drawn figures two definitely recognisable facial types, one with a tip-titled blob-like nose sometimes accompanied by protruding lips, and the other with a pronounced beak-like nose, finer features and a more clearly defined bony structure in the face.

On Plates 2 and 3 are groups from which the most important data was derived with regard to the sequence of superimposing. Plate 2 shows a long-necked animal painted in pink, it is of course not a giraffe but a sambhur doe, and so also is the famous long-necked animal from the Adamgarh Quarry, Hoshangabad, about which there has been so much naive speculation. Next below it is a schematic white figure with bow and arrow, the sambhur is Early 3rd and the bowman

transition Late 2nd to Early 3rd, below again are on the left a procession of animals of the Late 2nd, and on the right a man of the Late 2nd, all these in dirty grey. Someone at some subsequent date added blobs of red paint to the ears of the grey animal and to the body of the pink one.

Plate 3 shows a warrior mounted on a galloping caparisoned horse, they are of transition Early to Late 4th Series. Next come an ox and a sambhur stag in white of the Late 3rd, and finally a sambhur doe, of which only the head is visible, and an indeterminate animal with a long tail both of the Late 2nd.

The final Plate shows at the top a man in red outline only, transition Late 3rd to Early 4th; next in the centre is what must have been one of the finest paintings ever done in these caves. It is however very weathered, there fortunately remains enough to indicate the tremendous sense of movement and vitality, present in many of the paintings but outstanding in this one. On the right is a man, quite definitely a man and not a woman, and therefore not Sarasvati, playing on a “vina”; both these are Early 4th Series. Below on the left is an important person, possibly a chief, seated on a stool brandishing a dagger, transition to Late 4th, and on the right a warrior of the Late 4th Series with dagger and battle axe.

Thus step by step we see the advance of this art from the crudities of the 1st and 2nd Series to the sophistications of the 3rd and 4th. There is of course no finality in this scheme of arrangement and it stands open to criticism and correction. We would however like to emphasise that no criticism of any weight can be produced simply from a study of our writings and illustrations. Alternative theories may be found on such a basis, but they can have no standing until backed by the following minimum investigation.

The following shelters should be visited without fail: Dorothy Deep, Jambu Dwip No. 4 and Monte

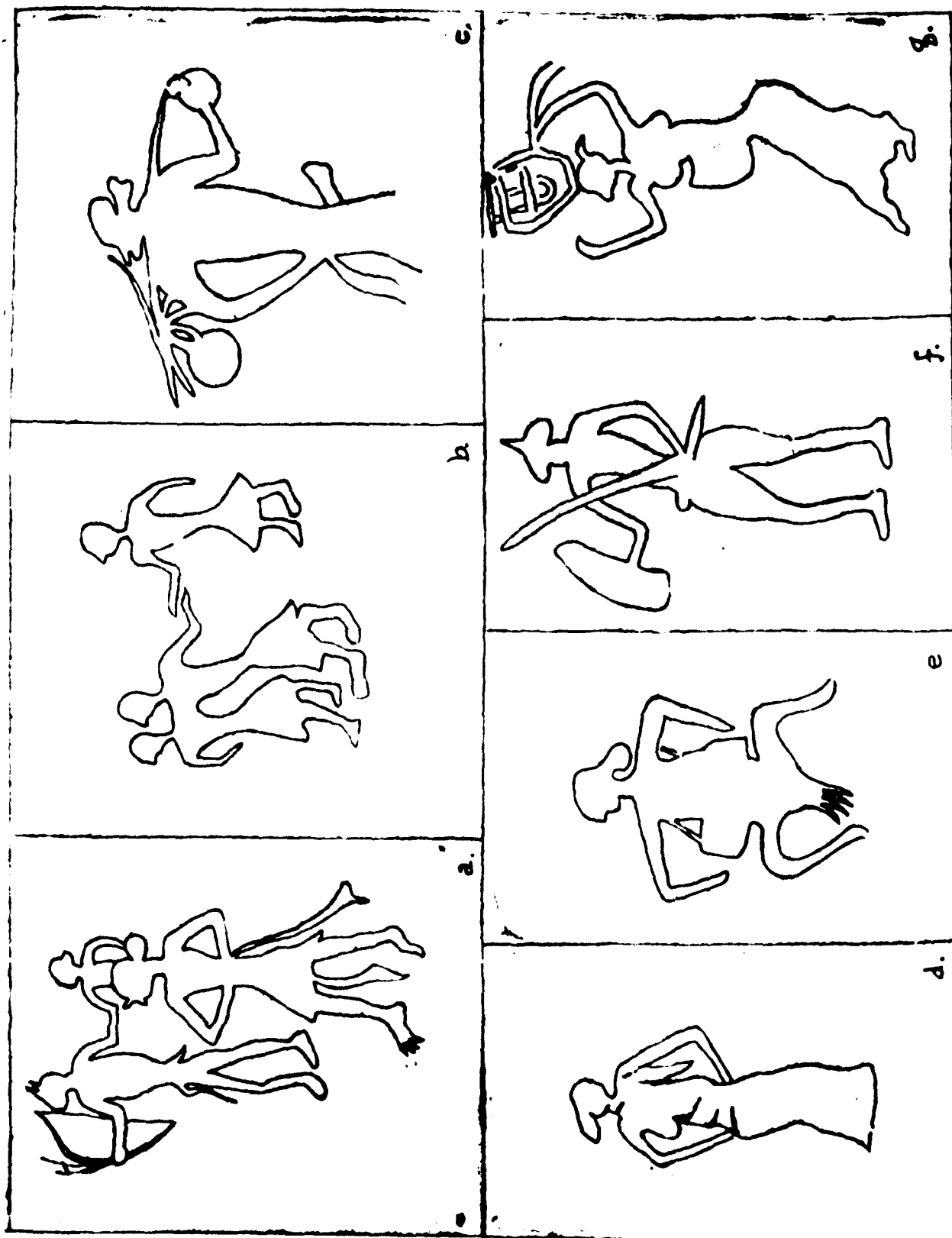


PLATE 1. (a) White figure of Late 3rd Series on pink figures of the Early, Jambu Dwip No. 4 (b) Red Early 3rd figures, Jambu Dwip No. 3 (c) White figure, Marodeo 1st Group No. 1 (d) Pink figure, touched with red, Monte Rosa No. 3 (e) Drummer, Bee Dam Cave (f) Warrior, Jhalab (g) Woman balancing jar, Marodeo 1st Group No. 3

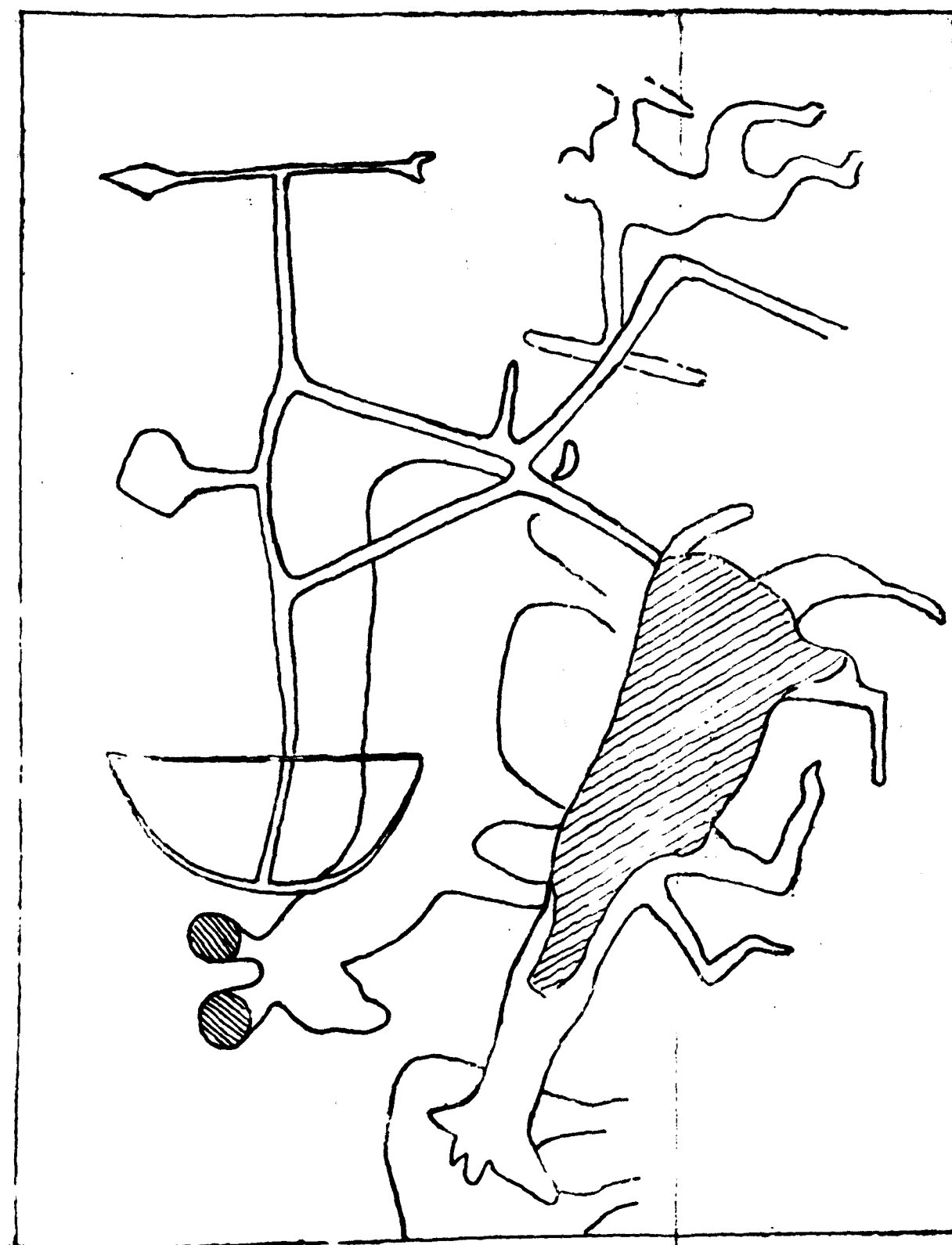


PLATE 2. Superimposed figures, Jambu Dwip No. 4.

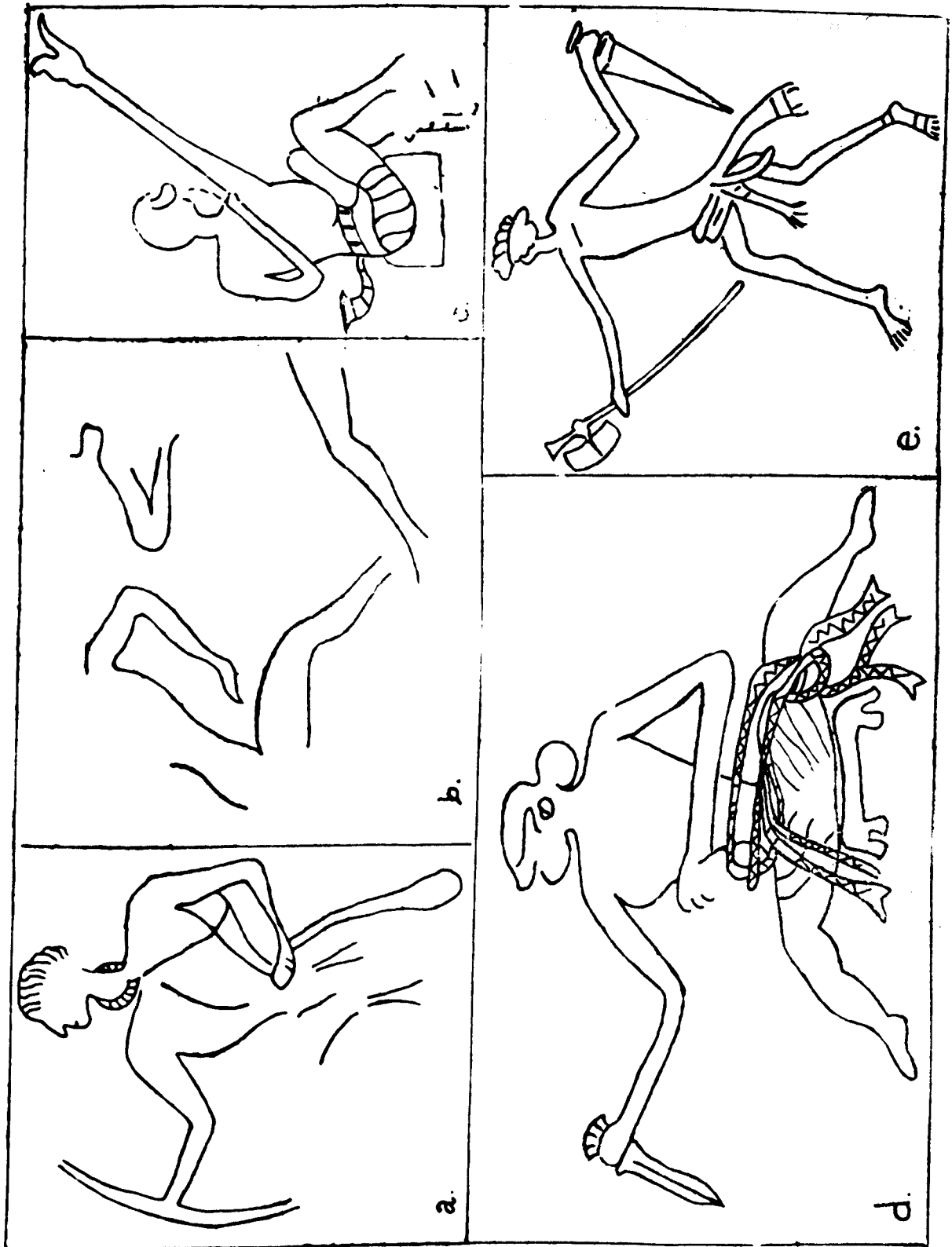


PLATE 4 (a) Red outline figure, Jambu Dwip No. 5. (b) Dancers, Dorothy Deep Cave. (c) Man playing on the "vina," Bazaar Cave. (d) A seated Chieftain, Bori. (e) Warrior, Marodeo 1st Group No. 1.

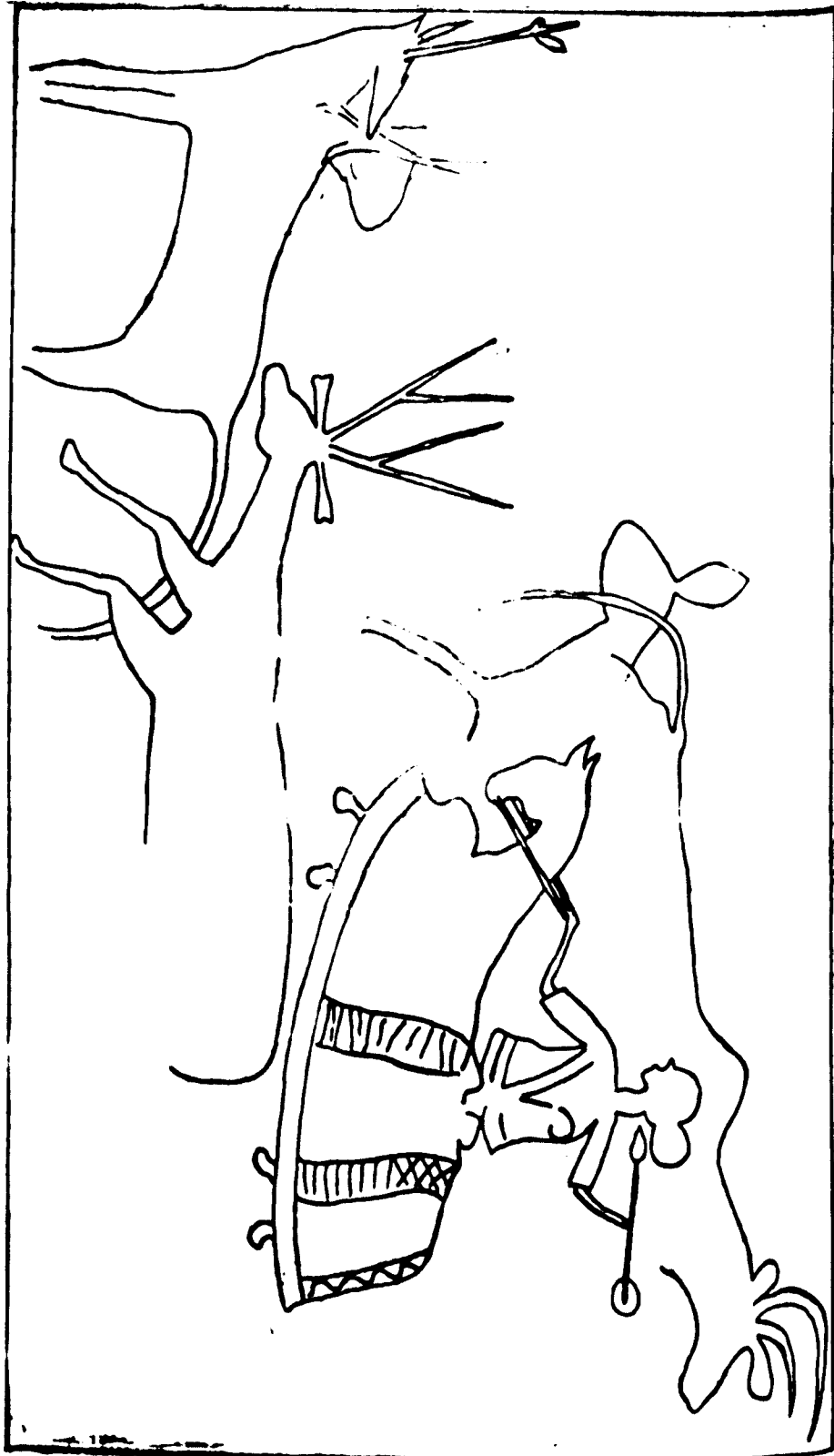


PLATE 3 Superimposed figures, Jambu Dwip No. 4.

ॐ नमो भगवते वासुदेवाय ॐ नमो भगवते वासुदेवाय

ॐ नमो भगवते वासुदेवाय ॐ नमो भगवते वासुदेवाय

The letters or groups of letters immediately below A, B & C are somewhat smudged and indistinct, but the remainder are quite clear, especially those following that marked C.

THE ARTISTIC SEQUENCE OF THE ROCK PAINTINGS OF THE MAHADEO HILLS

Rosa No. 4 shelters, to check up on sequence especially of the first two series; Mahadeo shelter, to act as a check on the results obtained; Mahadeo 1st Group No. 1 and Bori, for a proper appreciation of the style and position of the Late 4th Series; Jhalai and Son Bhadra, to emphasise the similarities and the variations to be found in more outlying shelters. These are only twelve shelters, counting all four at Jhalai and two at Son Bhadra, and as we have visited, and in the majority of cases discovered, forty six separate shelters, this is the minimum experience one can expect of a potential critic.

It will be advisable here to recapitulate the evidence, such as it is, on which the dating of these paintings is based. There is in the India Museum at South Kensington a small statuary group from the Purana Mahadeva Temple at Harasnath, Rajputana, it shows two warriors armed respectively with bow and arrows and sword and shield. They are identical with any of the paintings of warriors of the Late 3rd or Early 4th Series, their hair is arranged in the same large bun at the back, their girdles end in tails hanging between their legs, they wear the same short drawers, and their equipment the straight sword, small round parrying shield, and leaf shaped dagger are all typical of the warriors in the paintings. The date of this sculpture is probably late 10th century, A. D.

Cave I at Ajanta affords a striking parallel. There one may see a warrior with bands having alternate black and white stripes crossed from shoulder to waist. Similar cross bands are worn by a Late 4th Series figure at Jhalai. The same figure at Ajanta has a black

and white neck band, which is a feature of another figure of the same series at Jhalai. A figure at Adamgarh Quarry has a long shield with what is undoubtedly intended to represent a hairy hide covering. Such a shield is present in the Ajanta paintings, giving an indication of the 6th century A.D.

There are also two inscriptions, one in the Dorothy Deep shelter and one in the Mahadeo shelter, they are both in a form of Nagari. The Mahadeo inscription is too weathered to be translated, it only became visible in a photograph, but the Dorothy Deep inscription is for the most part quite clear. It consists of two lines of writing in white ochre, not, as has been stated, in the greenish yellow of the 5th Series animals. The upper line is quite obviously meant to be the same as the commencement of the much longer second line. This inscription has been shown to the late Prof. Thomas and to Dr Barnett, neither of these authorities have made head or tail of it. It would appear to be a form of Nagari of probably the 11th or 12th centuries, and, we feel, is to be dated about the same period as the Late 4th Series or perhaps a trifle later. We are convinced that the evidence indicates a dating from the 5th to the 10th centuries for the bulk of the paintings and that an allowance of 1500 years for the development of this Art from the earliest 1st Series down to its close in the 10th or 11th centuries is ample.

What we have said about art sequence applies equally to dating. Real concrete evidence of high antiquity must be forthcoming before our conclusions can be upset. A patriotic desire to be able to boast of paintings ranking in antiquity with the palaeolithic paintings of Western Europe must not lead investigators to mar their work by theories which are the outcome of subjective predilection.

Some Important Centres of Biochemical and Nutritional Research in America and Europe

B. Ahmad

Department of Biochemistry and Nutrition

All India Institute of Hygiene & Public Health, Calcutta

DURING recent years progress and research activity in all branches of biochemistry have reached enormous and unprecedented proportions. The ready success in the shape of fruitful discoveries, attending almost every phase of this activity has provided increasing speed and momentum to this rapid development. The subject has now invaded into every branch of science and is becoming almost encyclopaedic in its scope. It is impossible for any single individual to keep abreast of such rapidly advancing knowledge. Active centres of biochemical research are to be found not only in the chemistry and the physiology departments of the universities, but also in schools of medicine and public health, which have, incidentally, offered the most fruitful field, in hospitals, in colleges and departments of agriculture, special institutes and foundations and even the laboratories of commercial firms. The activities of these centres are widely divergent. Any account therefore of these centres or their activities, by an individual, cannot be but very inadequate. The account which is presented in this article is based on personal visits, and is hence limited to the interests of the author. The arrangement as adopted is on consideration of presenting a readable and connected story rather than a catalogue of names. The centres included are arranged under six different fields of activity:

- (i) *Energy metabolism*
- (ii) *Vitamins*
- (iii) *Minerals*
- (iv) *Nutrition studies*
- (v) *Physiology of the retina: application to nutrition studies.*
- (vi) *Miscellaneous including*
 - (a) *Chemistry of substances of biological importance.*
 - (b) *Biological oxidation and cellular respiration, and*
 - (c) *Hormones*

From the account which follows, it would be felt that in subjects (i-v), reference is made mainly to research centres in U. S. A., England, Holland and Denmark, while under (vi) the countries which figure prominently are Germany, Switzerland, Sweden and Hungary. Three important countries namely France, Italy and U. S. S. R. have not been mentioned at all. The programme of visits on which this account is based was arranged to include almost all the places important in these fields of science. There can be no doubt that today the gravity of interest in scientific problems related to nutrition lies in U. S. A., England, Holland etc., while for such studies as biological oxidation and reduction, chemistry of physiological processes, isolation and synthesis of substances of biological importance, the most important centres are in Germany, Switzerland, Sweden, Hungary etc. At the present time there are not many important centres in the three countries not mentioned relating to the fields under discussion.

Energy Metabolism

During the last quarter of the 19th century, the Munich school of physiologists under the leadership of Carl Voit was the centre of learning and research in nutrition. This school established that the calorific value of foods was the same in the body as when the food was burnt in a calorimeter. Voit's pupil Rubner working first at Munich and later at Marburg built the first accurate animal calorimeter which provided the triumphant demonstration of the truth of the law of conservation of energy in the animal organism. The amount of heat actually produced by a dog during 24 hours in the calorimeter, was shown to be equal to that calculated from the metabolism for the same period. Following Rubner, Atwater, another pupil of Voit, initiated a brilliant programme of nutrition research in U. S. A., and after many years of labour and great expense, with the help of physicist, Rosa,

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built the 'Atwater-Rosa Calorimeter' large enough to comfortably accommodate a man. This also provided confirmation of Rubner's experiment that the amount of heat produced by man was equal to that set free by the metabolism in the body. Following Atwater, F. G. Benedict built a calorimeter in the Nutrition Laboratory of the Carnegie Institution of Washington, Boston; one was built in the physiology department of the Cornell University Medical School; and another one by the Russell Sage Institute of Pathology in the Bellevue Hospital, New York, built specially for the study of metabolism in disease.

Since then many other calorimeters have been built in nutrition laboratories. There is a large one in the nutrition department of the University of Illinois for the study of metabolism of steers. At the Rochester School of Medicine in the department of vital economics, there is a fine instrument both for direct and indirect measurements with automatic self recording devices. The Nutrition Laboratory of the Carnegie Institution of Washington at Boston, now under Dr. Thorne M. Carpenter contains almost a museum of instruments for the measurement of the gaseous exchange between the living organism and the atmosphere and the simultaneous measurement of the quantity of heat produced by that organism. Many of them are of historical interest only, while others vary from the clinical to the most accurate type. The direct instruments even include a big chamber capable of accommodating as many as 16 people for the study of groups at a time.

While some laboratories are still investigating the metabolism of human beings in different physical states or those of animals, clinical calorimetry still offers many unexplored avenues. Dr Mary Schwartz Rose at the department of nutrition, Teachers College, Columbia University, is studying the effect of standing posture on metabolism. In the Boston laboratory the metabolism of animals in the state of hibernation is receiving lot of attention. At the Russell Sage Institute of Pathology, Dr E. F. Dubois and Dr James D. Hardy are investigating problems connected with heat regulation. Accurate quantitative measurements of the proportion of heat loss through radiation, convection or vaporisation at different environmental temperatures have been made. The effect of air currents and cloth-

ing, exercise and chills on each avenue of heat loss is being studied. Other investigations include the thermal sensitivity of skin to radiations, *e.g.*, sunlight, visible light, ultra violet and infra red radiations of different wavelengths. Accurate methods have been developed for the objective determination of the smallest rate of irradiation which will produce sensation.

Vitamins

Even after a quarter of a century of intensive research activity, vitamins continue to be a fascinating field of study. After the chemical identification and synthesis of the more important accessory factors, fresh interest is being aroused by the discovery of new factors. In U. S. A. with the death of Professor Lafayette B. Mendel and the increasing inclination of Professor E. V. McCollum towards the study of minerals, the gravity of interest in vitamins has shifted to Wisconsin. In the department of agricultural chemistry, University of Wisconsin at Madison, the work of professors H. Steenbock, E. B. Hart, C. A. Elvehjem is bearing fruitful results. It may be recalled that as early as 1915, in this laboratory, Steenbock first recognised the relation of carotenoid pigments to vitamin A which led to the well-known controversy with Dr L. S. Palmer. The later important discovery of Steenbock, of the antirachitic value of irradiated foods, is a source of considerable revenue to the university under Steenbock's patent. Most outstanding contributions are now being made by this laboratory, in the differentiation and identification of the various components of the vitamin B complex. In addition to the well-known factors, B₁, riboflavine and B₆, two additional ones, the filterate and the W, have been recognised. Recently a new 'grass juice factor' has been discovered which is essential for the normal nutrition of the guinea pig. The identification of nicotinic acid or nicotinic amide as the anti-pellagra or the black tongue factor by C. A. Elvehjem and colleagues is indeed the most outstanding discovery of recent times.

With pellagra is intimately associated the name of late Dr J. Goldberger, who with his colleagues, did the most important work on the etiology of this disease and definitely showed its relation to a heat-stable factor of the vitamin B complex. Dr Goldberger's work was done in the nutrition section of the National Institute of Health, Washington, D. C. This section now under Dr W. H. Sebrell is continuing investigations on black tongue and flavine deficiency. With the identification of the anti-pellagra factor it must not be understood that the pellagra problem has been solved.

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Human conditions are always complex and in this direction Dr Sebrell and his colleagues continue to make important contributions. Clinical studies on pellagra are being undertaken by Dr T. D. Spies at the University of Cincinnati.

In the footsteps of Professor Mendel, Professor George R. Cowgill at the department of physiological chemistry, School of Medicine, Yale University, New Haven, is continuing work on vitamin B₁ requirements. Professor Cowgill's newer interests are in the field of practical nutrition. During three summers nutrition surveys have been made in the Panama zone making use of several specific physiological techniques.

In the department of Professor E. V. McCollum, at the School of Hygiene, Johns Hopkins University, Baltimore, investigations on vitamin E and other newer fat soluble factors is being pursued. The chief centre for the study of such problems, however, continues to be the Institute of Experimental Biology, University of California, Berkeley. Vitamin E was discovered by Dr H. M. Evans and colleagues at this Institute. Evans and the Emersons are now the first to isolate *α*-tocopherol, a pure chemical compound possessing vitamin E activity. Other important centres in this line are the department of biochemistry, University College, London, under Professor J. C. Drummond; department of biochemistry, State University of Iowa, Iowa city, under Professor H. A. Mattil; and the department of botany, University of Minnesota, Minneapolis, under Dr G. O. Burr. Dr K. E. Mason of the Vanderbilt University, Nashville, and Mr A. L. Bacharach of the Glaxo Laboratories, Greenford, Middlesex, are also making important contributions. Dr Thomas Moore at the Dunn Nutritional Laboratories, Cambridge, has observed a brown discoloration of the uterus in vitamin E deficient animals attended with muscular dystrophy. Workers at the College of Physicians and Surgeons, Columbia University, New York, however, consider muscular atrophy to be due to a new factor distinct from vitamin E and they have successfully produced this condition in rats, rabbits and guinea pigs receiving adequate amounts of vitamin E in their diet.

An aspect of the vitamin problem receiving considerable attention at the hands of pediatricians, is their function and metabolism. Professor Samuel

Clausen, at the School of Medicine, University of Rochester, N. Y., has perfected a fine technique for the estimation of vitamin A in relatively small quantities of blood. Using this technique it is found that blood level remains almost constant so long as there are any stores in the liver, falling rapidly after the stores get depleted. Investigations along similar lines are being pursued by Professor K. D. Blackfan and Dr Charles D. May at the Children's Hospital, Boston, who find the blood values to rise on feeding concentrates and during lipaemia. The values decrease in nephritis and in conditions attended with liver damage. Dr Hugh W. Josephs at the Herriet Lane Home, Johns Hopkins Hospital, Baltimore, has traced an interesting relationship between the metabolism of this vitamin with that of fat and cholesterol. Dr Thomas Moore and Dr N. R. Lowrie from the Dunn Nutritional Laboratory, Cambridge, show the rapid excretion of vitamin A in pneumonia and kidney damage and high blood concentration in diabetes. Important studies of this nature, particularly with reference to conditions actually met with in hospital wards are being undertaken by Dr Frederick F. Tisdall, Hospital for Sick Children, University of Toronto; Dr R. M. Wilder, Mayo Clinic, Rochester Minn.; and by Professor Walter H. Eddy of the Teachers' College, Columbia University, in collaboration with Dr Gilbert Dalldorf of the Grasslands Hospital, Valhalla, New York.

A decisive factor in the rapid advance in our knowledge about the vitamins has been the development of physical and chemical methods of estimation as opposed to the slow, expensive and not very precise biological techniques. During the early days, the biochemistry department of the University College, London, made important contributions in this field. In the development of spectrographic technique, studies of outstanding importance are being made by Dr R. A. Morton and others from the chemistry department of the University of Liverpool. Perhaps the most active centre for this work now is the Dunn Nutritional Laboratory at Cambridge, under Dr. L. J. Harris. Here was developed the well-known indophenol technique for the estimation of vitamin C, the bradycardia method for vitamin B₁, and recently the successful application of chemical techniques to the assay of aneurin and nicotinic acid in biological materials.

At the Laboratory of Hygiene, Utrecht, work on the chemical estimation of vitamins was started under

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the inspiration of Late Professor L. K. Wolff, and is now being continued by Dr A. Emmerie and Miss Marie van Eekelen and their colleagues. This is the laboratory where Professor C. Eijkman, the discoverer of experimental beri-beri and vitamin B₁, worked. Much fine technique has been developed here for the accurate micro-estimations of ascorbic acid, nicotinic acid, *α*-tocopherol etc. in blood and urine.

For studies on vitamin B₁, one of the most important centres in Europe, is the laboratory of physiological chemistry, University of Amsterdam, under Professor B. C. P. Jansen. This laboratory possesses a fine equipment for the use of photo-electric and spectrographic methods. The latest contribution of Professor Jansen is the fluorometric estimation of thiamin. The method is difficult when applied to biological materials with a low concentration and has stimulated much research in many clinical and commercial laboratories, notably by Professor J. R. Marrack, Hale Clinical Laboratory, London Hospital; Dr. M. A. Pyke, Vitamins Limited, Hammersmith; Dr. Smith, Glaxo Laboratories, Greenford; K. Ritsert, E. Merck, Darmstadt; W. Karrer, Hoffman La Roche, Basel etc. The greatest measure of success has, however, been reached by Dr. L. J. Harris and Y. L. Wang at Cambridge.

The X-ray equipment for vitamin D assay is expensive. McCollum's line test has been developed by Dr Charles E. Bills of the Mead Johnson Co., Evansville, Indiana, where they have a huge rat colony, and have made extensive investigations into antirachitic substances, and methods of vitamin D and other assays. Bills' technique has been adopted by the U. S. Pharmacopia XI, and nearly all public health and other laboratories where routine assays of vitamin D are made. In many cities in U.S.A. the irradiation of the entire supply of milk is required by law.

A new technique involving the use of chicks has now been developed, and is being used by several laboratories, notably by C. A. Elvehjem at the University of Wisconsin, and Dr A. Z. Baker of Vitamins Ltd. Hammersmith. Chicks develop rickets quite easily on a simple and cheap diet containing relatively high calcium and phosphorus. For the line test a diet

pretty low in both these minerals is necessary. Dr Baker's technique of measuring the distance between the bones at the knee joint is simple and elegant. The distance increases as the rickets progress.

In the research laboratories of the Eastman Kodak Co. at Rochester, N.Y., Dr K. C. D. Hickman and his colleagues have developed a new form of molecular still which has many advantages over the older types. With the help of this they have successfully isolated vitamins A and D from fish liver oils in a fairly pure state. Their studies show that vitamin A occurs as a free alcohol only to the extent of 1-3 per cent, the rest being in combination with fatty acids as ester. Fatty acids isolated from this combination range from C₄-C₃₀. At least six different forms of vitamin D have been isolated showing structural variations in the side chain or fatty acid group combinations with the hydroxyl.

Dr Henrik Dam, at the Biochemical Institute, University of Copenhagen, discovered vitamin K, a fat soluble dietary factor required by the chick in addition to vitamins A, D, and E. Work on vitamin K has been more or less confined to this laboratory. Dr Dam has now obtained nearly pure concentrates of this vitamin by distillation in high vacuum of the fractionated material obtained from alfalfa hay. The chemical nature of the substance is being studied. At the Mayo Foundation both in the clinic and in the Institute of Experimental Medicine, Rochester, Drs R. M. Wilder and J. L. Bollman are investigating the effect of vitamin K in hæmolytic jaundice, the former on his patients at the clinic and the latter on experimental animals at the Institute.

Some years ago Burr and Burr showed a new fat deficiency disease which later Dr H. M. Evans and G. O. Burr at Berkeley, identified as a deficiency of essential unsaturated fatty acids and designated it as vitamin F. Dr George O. Burr is continuing these investigations at the department of botany, University of Minnesota, Minneapolis. The technique of the test has been further developed and in an extensive experiment the relative value of different oils in curing the peculiar scaly condition of the tail is being investigated.

Perhaps the most important centre for studies on the pathology of vitamin deficiencies, is the laboratory of Professor S. B. Wolbach, Harvard Medical School, Boston. Professor Wolbach was the first to indicate

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the general keratinisation of epithelial tissues as the primary change in vitamin A deficiency. Important contributions have been made on nearly all the major deficiencies. Their present interests are flavine and B₆ deficiency, and an interesting observation of the early vascularisation of the cornea in the former has been made.

An old and active centre of vitamin research which has not yet found place in this account is the Lister Institute, Chelsea, London. Lot of early work on factors of the B-complex under Miss Harriette Chick, and on vitamin C by Dr S. S. Zilva was undertaken at this Institute. Lately Miss Chick has been studying a pellagra like condition in pigs curable by nicotinic acid. Work on the filterate factor has been pursued from both the yeast and the liver sources and there are indications that the substances derived from the two sources are different.

An excellent organisation for a large scale routine assay of carotene, vitamin A and vitamin D is to be seen at the State Institute of Hygiene and the State Vitamin Laboratory, at Copenhagen under Professor L. S. Fridericia. After the world War and the serious malnutrition that occurred in the country owing to the export of most of their butter, in Denmark all margarine is required by law to be vitaminised. A board of control under the National Board of Health has been established which collects samples for analysis in the laboratory. Among other contributions to the knowledge about the vitamins, it may be mentioned that Professor Fridericia showed the occurrence of refection in vitamin B deficient animals, described its symptoms and pointed out the conditions under which it occurs.

Minerals

The two most important centres engaged in this work are the laboratory of Professor E. V. McCollum at the Johns Hopkins School of Hygiene, Baltimore, and the department of agricultural chemistry of the University of Wisconsin. Dr McCollum and his colleagues have studied the role of magnesium, manganese, sodium, potassium and zinc in animal nutrition, in addition to studies on calcium and phosphorus metabolism and have made very important contributions. At Wisconsin copper and iron have

received considerable attention particularly with reference to anæmias. Work on manganese, zinc and cobalt is also now in progress.

On the metabolism of calcium and phosphorus in infants, intensive studies are being made at the State University of Iowa by Professor P. C. Jeans and Dr Genevieve Stearns, in the department of pediatrics, and by Dr Amy Daniels, professor of child welfare; and by Dr Julia Outhouse, department of home economics, University of Illinois, Urbana. A number of infants are under careful observation at each centre. The studies include calcium phosphorus balance to determine requirements, optimum conditions for normal growth and bone formation, and the utilisation of calcium from different foods.

Investigation on mineral metabolism in the nutrition of poultry are being made by Dr L. C. Norris at the Cornell University, Ithaca; of cattle by Dr H. H. Mitchell, department of nutrition, University of Illinois, Urbana; and of sheep at the Rowatt Research Institute, Aberdeen. The observations of Dr Norris on the development of perosis in chicks on manganese deficient diets, and the work of Dr Margaret Lawrenz in Professor Mitchell's laboratory on fluorine are very interesting.

The most interesting phase in the study of mineral metabolism has begun with the artificial production and use of radioactive isotopes. This has been made possible by the invention and the development of the cyclotron by Professor E. O. Lawrence at the University of California. Cyclotrons have now been built or are in the course of construction in many places including the Franklin Institute, Philadelphia, the Universities of Chicago, Princeton, Rochester, Harvard and Cambridge. Studies on phosphorus metabolism by means of the radioactive isotope of phosphorus P³² are being made by Professor G. Hevesy, Institute of Theoretical Physics, University of Copenhagen; by Dr D. M. Greenberg, department of biochemistry, University of California Medical School at Berkeley; in the department of vital economics, School of Medicine and Dentistry, University of Rochester, N. Y. under Professor J. R. Murlin; and the Laboratory of Physiological Chemistry, University of Amsterdam under Professor B. C. P. Jansen. While studies of this kind are just beginning, the results already obtained indicate that even in a fully grown animal, the mineral ingested finds its way rapidly not only to the muscle and the soft

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body tissues but also to the fully calcified bones and teeth. It has further been found that absorption may be very markedly influenced by the needs of the organism.

Important studies on the metabolism of sulphur compounds are being made at Washington D. C., by Dr M. X. Sullivan at the George Town University Medical School, and by Dr V. du Vigneaud at the George Washington University School of Medicine, with their colleagues.

A problem of considerable practical importance is presented by phosphorus deficient soils, of which there are large tracts in many countries of the world. One of these is in Minnesota extending north and westward to the province of Manitoba, North and South Dakota, and Montana. At the University of Minnesota, the department of agricultural biochemistry has devoted itself mainly to the investigation of this problem. The deficiency does not affect so much the crop yields as the livestock. The Minnesota animals are in poor physical condition, showing osteoporosis, stiffness of joints, addicted to bone chewing and wood gnawing, the characteristic symptoms of phosphorus deficiency. Professor R. A. Gortner and Dr L. S. Palmer are studying the condition experimentally produced in cattle, mineral balance, minimum requirements, relation to milk production etc. It may be of some interest to point out that these conditions have contributed to the poverty, ignorance, low intelligence, and somewhat fatalistic attitude of the farmers in this region.

Conditions of cobalt deficiency of the soil have been encountered in Western Australia, New Zealand and Florida. In Australia and New Zealand where sheep farming is done on a large scale, conditions called 'coast disease' and 'bush sickness' affecting sheep had been known for a long time. These are characterised by enzootic marasmus or progressive wasting and emaciation, together with anaemia. The condition has been traced to cobalt deficiency in the soil and hence in the pastures, and has been successfully controlled by providing the essential element. In Florida a condition of nutritional anaemia in cattle has been found to be due to cobalt deficiency. At the Florida Agricultural Experiment Station, W. M. Neal and

C. F. Ahmann are studying this condition experimentally produced in cattle.

Nutrition Studies

The albino rat has been the central interest in all nutrition laboratories. Its reproductive capacity and its omnivorous habits make it specially suitable for nutrition studies, it grows quickly, matures rapidly, and has a short span of life, thus providing opportunity for discoveries to be made in a relatively short time. The unfortunate influence of this has been for some time at least, that nutrition research became largely a study of the growth of the white rat under different conditions of feeding. A reaction in favour of long term studies is already apparent. In the department of chemistry, Columbia University, New York, under Professor H. C. Sherman, one of the leading nutrition laboratories of the United States, studies of their well-known diets 13 and 16, and modifications of these comprising increase in the level of protein, calcium and lactoflavine are being made by observation of their effect throughout the entire life of several generations of animals. Observations include the weights attained, the number of litters produced, the number of young in each litter, their general physical condition, the behaviour of animals to subsequent dietary stresses and their life span. About 10 per cent increase in average life span has been achieved through dietary improvements. Similar long term experiments on the nutrition of cattle are being undertaken in another important nutrition laboratory in the States, at the University of Cornell, Ithaca. It has been recognised, for example, that it would be more profitable to have a cow yield a larger total output of milk during her entire life span than forcing very high yields at one time which drop off in subsequent lactations.

An interesting experiment to increase life span through retarding growth is also being undertaken at this laboratory by Professor L. A. Maynard, Dr C. M. McCay and their colleagues. It has long been known to the entomologist that the entire life span of an insect is prolonged if one of the stages of development be slowed. Relying on this analogy a colony of rats is being fed restricted amounts of a diet otherwise adequate in every food constituent. The experiment which has now been going on for several years, indicates that by this means as much as 50 per cent. increase in total life span may be attained. It was interesting to note that retarded animals appeared youthful when the controls eating unrestricted amounts of the same food had become senescent.

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This laboratory has specially been interested in the problem of nutrition in old age, a problem which has somewhat been neglected in other nutrition laboratories. Extensive studies are in progress of the changes that take place in the tissues with advancing age. The question of excessive calcification of the blood vessels, kidneys, heart, lungs and brain has been investigated histologically, pathologically and chemically and ways and means are being explored to control these changes.

At the Rowatt Research Institute, Aberdeen, one of the most important nutrition laboratories of Great Britain, the nutritive value of certain human dietaries is being investigated through their effect upon the health and well-being of a colony of rats. Here again the studies include not only the effect upon growth, but also reproduction and lactation through several generations of the animals in comparison to a good stock diet. This method of study seems to be most profitable to determine the ultimate value of human dietaries and of experimentally proving the beneficial effect of any supplements.

A general diet survey on an extensive scale is being directed by Sir John Boyd Orr, at the Rowatt Research Institute, Aberdeen, with the financial assistance of the Carnegie Fund. A survey of some two thousand families of representative areas in different parts of the country, and including different classes and different economic levels, is planned. It will also include nutrition survey of some 6000 children belonging to the families under survey. It may be recalled that first surveys of this nature were instituted in Britain by Professor E. P. Cathcart, department of physiology, University of Glasgow. In U. S. A. perhaps the most intensive and also extensive works on diet and nutrition survey, family incomes and expenditure are being undertaken by the departments of agriculture and public health, at Washington, D. C., Miss Hazel K. Stiebling, the senior economist has already reported several studies. In Toronto, Dr E. W. McHenry of the School of Hygiene is pursuing a diet survey of 100 families, in which the food of individual members of the family is weighed and recorded by a trained and efficient staff of women who actually live with the family during the time of the survey. Dr McHenry considers that in a family the

father usually gets the best food, then the children and lastly the mother, so that it is not justifiable to take the total food consumption and divide it by a family co-efficient. In Chicago Dr Lydia Roberts is instituting extensive nutrition surveys. Excellent work on diet and nutrition surveys is being conducted by certain private bodies and foundations, *e.g.*, the Milbank Memorial Fund, New York; Association for Improving the Condition of the Poor, New York; Elizabeth McCormick Memorial Foundation, Chicago, etc. These bodies are in the happy position of securing the complete co-operation of the families, because they spend large sums of moneys on relief.

A very interesting and important study on the value of individual amino acids in nutrition is being pursued at the department of biochemistry, University of Illinois, by Professor W. C. Rose. The preparation of all the naturally occurring amino acids in sufficient purity and quantity for feeding experiments has entailed lot of expense, labour and thought. Some of these are made by synthesis, others like tryptophane, histidine, arginine, lysine, from the hydrolysate of casein. Threonine is made from blood fibrinogen. The cost of making amounts to \$1.50 per gram of the ultimate amino acid mixture. Dr Rose has established that out of the 22 naturally occurring amino acids only 10 are essential. Tyrosine is not found to be essential. Even cystine is not essential while methionine is. Arginine is only slowly synthesized by the animal but it is not essential. Dr Rose's present work is being directed to determine the minimum requirements of each of the essential acids, and requirements of reproduction and lactation.

Investigations on the intermediary metabolism of fats and proteins involving the use of isotopes of hydrogen and nitrogen are being pursued by Dr Rudolf Schoenheimer and his colleagues at the department of biochemistry, College of Physicians and Surgeons, University of Columbia, New York. They have prepared fatty acids including deuterium and amino acids with heavy nitrogen in the molecule. Methods of micro estimation of both deuterium and heavy nitrogen have been developed. A mass spectrometer has been built up for the estimation of nitrogen capable of detecting the isotope to a concentration of 0.003 per cent. and requiring only one mg. of the gas for analysis. Dr Schoenheimer's studies have brought interesting facts to light. It is found that the animal organism is capable of forming unsaturated fatty acids from saturated ones and vice versa. A higher fatty acid

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can be broken down to a lower fatty acid. The nitrogen of dietary ammonia can also be utilized to a small extent for the building up of amino acids. Of the nitrogen ingested only a fraction remains attached to the original carbon chain, the major part getting rapidly distributed to amino acids of other tissue proteins.

The problem of dental decay is of pressing importance in modern times. With the advance of civilization dental decay has actually been on the increase. Many primitive people show very little tooth decay. The condition is no doubt very largely connected with the diet. Important contributions to the knowledge on the subject have been made by Dr Percy Howe, Forsyth Dental Infirmary, Boston. An active centre of investigation in this field has now been created by Dr Isaac Schour at the University of Illinois College of Dentistry, Chicago.

Physiology of the retina: application to nutrition studies

Some years ago Miss Katherine Tansley working in the department of physiology, University College, London, made the important observation that visual purple, the photo-sensitive pigment of the retinal rods decreased in vitamin A deficiency. The later observation of George Wald that vitamin A was an essential element in the regeneration of visual purple, greatly aroused the interest of biochemists. The relation of night blindness to a dietary deficiency of this vitamin was thus definitely established. Biochemists have since watched with increasing interest the work on the physiology of retina by Professor Selig Hecht, department of biophysics, Columbia University; Professor Ragner Granit, Physiology Institute, University of Helsinki; and of Dr George Wald, biological laboratories of the Harvard University, Cambridge, Mass. At these three centres, important investigations on the regeneration of visual purple, the physico-chemical basis of vision, factors affecting light and dark adaptation are being undertaken, and techniques are being developed to estimate the retinal responses.

The direct application of this work has been the measurement of the rate of dark adaptation as a means of assessing nutritional status with respect to vitamin

A. Professor P. C. Jeans making use of the Birch-Herschfeld photometer first used this technique for this purpose. The publication of Jeans' results caused a stir in nutrition circles in the United States. A vitamin A subnutrition of 20-79 per cent. in different economic groups of the population at Iowa and living on a diet which presumably included a good supply of milk and green vegetables, was very startling. Jeans, however, developed a more refined instrument the 'Biophotometer' and again justified his results. Studies undertaken at other centres essentially confirmed Jeans' technique and conclusions. Important among these are the studies of Dr Harold Jeghers, Evans Memorial Hospital, Boston; of Dr H. P. Getz, Medical School of the University of Wisconsin; of Dr Lydia Roberts, department of home economics, University of Chicago; and Dr Leela Boohar, nutrition section, Bureau of Home Economics, Department of Agriculture, Washington D.C., the last two being the most active ones for these investigations. Attempt is being made to follow the course of vitamin A deficiency in a number of human subjects living on controlled diets very low in vitamin A.

Recently in the laboratory of Professor Selig Hecht, the 'Visual Adaptameter' has been developed, which is regarded to be the most reliable instrument for the measurement of rate of dark adaptation in humans. It is now being tried in various laboratories. In Great Britain, Dr L. J. Harris and his colleagues have undertaken extensive investigations on different groups of the population in different parts of Britain with the dark adaptation technique. A vitamin A subnutrition of 25-35 per cent. appears to be common in most parts of the western countries.

Miscellaneous

A number of organic chemists have been actively engaged in revealing the nature of substances of biological significance. Their contribution has been an important factor in the development of the science of biochemistry. When Hans von Euler and his colleagues at Stockholm showed in 1928 that carotene was the precursor of vitamin A, Professor Paul Karrer at the Chemical Institute of the University of Zurich, took up the work on carotenoids from the point where Willstätter and Stoll had left it some years ago. In a series of most brilliant researches he established the chemical constitution of most of the known members of the carotenoid group including alpha and beta carotenes, lycopene, xanthophyll, zeaxanthin, bixin, crocetin and some of the bacterial pigments, rhodoviolascin,

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rhodopin, rhodopurpurin etc. Later, Professor Karrer also isolated vitamin A and established its chemical structure. Hardly less brilliant have been the researches of Professor R. Kuhn in this field. Working at the chemistry department of the Kaiser Wilhelm Institut für Medizinische Forschung, Heidelberg, he has established the chemical constitution of gamma carotene, kryptoxanthin, rubixanthin, rhodoxanthin, azafrin etc. Professor L. Zechmeister, Director, Chemical Institute of the University of Pecs, Hungary, has been another active investigator in this field. He did much of the early spade work on the chemistry of these pigments and established the constitution of capsanthin and capsorubin. More recently he has isolated many new members of this group, namely, lycophyll, lycoxanthin, petaloxanthin, and citraurin. In U. S. A. at the Division of Plant Biology, Carnegie Institution of Washington, Stanford University, California, Dr James H. C. Smith and Dr Harold Strain are interesting themselves in plant pigments. They have done lot of work on leaf xanthophylls and have shown the existence of many new pigments like isolutein, neoxanthin, violaxanthin and flavoxanthins. In addition to their work on carotenoids, Professor Richard Khun and his colleagues at Heidelberg, have undertaken lot of important work on the elucidation of the structure of flavines, including riboflavine, the growth promoting factor of the vitamin B-complex. The rat pellagra factor of vitamin B₆ was differentiated from the complex by Dr Paul György in this laboratory. Now Kuhn and his colleagues have isolated the substance and revealed its chemical nature. Work of outstanding importance on the chemistry of sterols in general, vitamin D and related compounds is being pursued by Professor Adolf Windaus at the Chemistry Laboratory of the University of Göttingen.

An important field of biochemistry is a study of the mechanism of biological oxidations or cellular respiration. Most brilliant investigator in this line is Dr Otto Heinrich Warburg. Now at the Kaiser Wilhelm Institut für Zellphysiologie, Dahlem-Berlin, he has established an active centre for the study of cellular metabolism and respiratory ferments. His work on the metabolism of tumours, cozymase, energy exchange in carbon dioxide assimilation is well-known. Professor H. von Euler, Biochemical Institute, University of Stockholm, has another active school for studies

on fermentation and on biological oxidations. Investigations on muscle metabolism has been the main interest of Professor O. Meyerhof and his colleagues first at the Kaiser Wilhelm Institut für Biologie, Berlin-Dehlem, and later at the Institute at Heidelberg. Closely allied to this work is that of Professor A. V. Hill at the University College, London. At the University of Munich, department of chemistry, the researches of Professor Heinrich Wieland have been most fruitful in this field.

Important investigations on biological oxidations are also emanating from the department of medical chemistry, University of Szeged, under Professor Albert Szent-Györgyi. Professor Szent Györgyi has been interested in oxidation-reduction systems for many years. His most important discovery has been the isolation of reducing substance, hexuronic acid, from plant and animal tissues, which he himself later identified as vitamin C or ascorbic acid. Lately he has isolated a crystalline flavone 'citrin' from lemon juice which he believes to be the substance responsible for decrease in capillary permeability. Scurvy is believed by his school to be due to the combined deficiency of citrin and ascorbic acid. They have shown the beneficial effect of citrin in a number of clinical conditions attended with spontaneous hæmorrhages.

Endocrinology is another field in which the biochemist has been very active. Many laboratories are engaged in research on hormones. With insulin, the internal secretion of the pancreatic gland, will inseparably remain associated the name of Sir Frederick Grant Banting. Some years ago the University of Toronto created the Banting-Best chair for medical research and founded the Banting Institute. This Institute is now an active centre for research on diabetes and related problems. At the Rochester University School of Medicine, Professor John R. Murlin has also been interested in the metabolism of the diabetic organism. Lately they have been studying the conditions and the forms of insulin which can be fed by the mouth.

Three laboratories are actively engaged on the isolation and the chemistry of the physiologically active compounds present in the adrenal cortex. Dr E. C. Kendall at the Mayo Clinic Rochester, Dr O. Wintersteiner at the department of biochemistry, College of Physicians and Surgeons, Columbia University, New York; and Professor T. Reichstein at the University of Zurich. They have isolated a number of closely

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related compounds each exhibiting cortin activity. These compounds however do not account for the full physiological activity of the gland extract. Non-crystalline fractions considerably more potent have been isolated by all the three investigators. This work requires arrangement for working with very large amount of the material, large scale extractions, distillations, low temperature precipitations and crystallisations. An excellent set-up for all these processes is to be seen in the laboratory of Dr E. C. Kendall. At the School of Hygiene, University of Toronto also large scale preparation of liver, cortical and pancreatic extracts are undertaken.

An important centre for investigations into the male sex hormone is the department of biochemistry, University of Chicago, under Professor F. C. Koch. Professor Koch has standardised the capon growth

technique for the assay of this hormone and is now engaged in the study of its metabolism. A study into the normal day to day excretion of androgens and estrogens by normal men and women has been followed.

The female sex hormone and the physiologically active substances present in the urine of pregnancy have been studied in a brilliant manner by Professor F. G. Marrian at the department of biochemistry, University of Toronto, and now by him at the department of medical chemistry, University of Edinburgh. Another important centre of active investigations on the sex hormones is the Kaiser Wilhelm Institut für Biochemie, Berlin-Dahlem, which has recently been equipped in a most thorough manner by its new director Professor A. Butenandt. Lastly may be mentioned the laboratory of Professor A. I. Virtanen, the Biochemical Research Institute, University of Helsinki, which has been most actively concerned with the problem of the fixation of atmospheric nitrogen and the metabolism of nitrogen fixing bacteria.

In the last December issue in the account of Professor Lawrence's work a few lines have been unfortunately placed wrongly. On page 341 the four lines at the top of the right column will come on page 342 after the second line from the top in the left column.

The Cyclotron

D. P. Ray Chaudhuri

Scottish Church College, Calcutta

THE cyclotron is the most powerful apparatus for attacking the 'nucleus' or the 'heart' of the atom. Before describing it, let us take a panoramic view of the march in the progress of our knowledge of matter and of processes used for splitting up matter, which has now culminated in the invention of the cyclotron.

Up to 1800:—It was believed that matter was composed of the five elements, earth, water, air, fire, and æther.

In 1801:—One of the elements, water, was decomposed into two gases, hydrogen and oxygen, by passage of electricity.

1801-1895:—All matter was proved to consist of 92 different elements.

In 1895:—Elements were definitely split up into 'atoms' of negative electricity and a positive core.

1895-1930:—All atoms were proved to consist of a positive core of mass A , charge Z , and with Z electrons going round the core in planetary orbits.

By 1932:—The core or the nucleus of the atom was proved to consist of protons and neutrons.

The attack on the nucleus or as the Americans say, *nucleus busting*, began from 1930.

By 1932, physicists had found out that all chemical and physical reactions like combustion, electron bombardment etc., affect only the outer shell of electrons, but leave the nucleus entirely unaffected. In fact, they had discovered that all the familiar chemical and physical properties can be traced to the outer shell of electrons only.

Thus if we wish to excite a sodium atom to emit D-lines, a phenomenon which is observed in the sodium lamps now used for street illumination, we have to shoot at the atom with at least 2.5 volt electrons i.e., we have to take a stream of electrons, say from a

glowing filament, make them pass through a potential fall of at least $2\frac{1}{2}$ volts, and if they are allowed to fall on sodium atoms, these will glow and give us the yellow light. To get ultraviolet light, like that from mercury-vapour, we require about 10-volt electrons. But if we wish to get X-rays, such as are used for photographing the interior of the human body, we require about 20,000 volt electrons; but for deep therapy, we may require 10^6 -volt electrons. When streams of such high voltage electrons fall on a metallic target, their energy is converted into X-rays.

But physicists found about 1920 that such high-energy electrons, or positively charged particles can do nothing to the nucleus. For they had ascertained that the nucleus has a very minute dimension of 10^{-13} cm, and the field near the nucleus is of the order of 10^{20} volts/cm, and to get near it, particles having the enormous energy of several million electron-volts are required. Thus arose the necessity of constructing "generators" which can give us about "million electron volts".

High Voltage Technique

We are every day using electricity, and let us see what a million volt generator means. We use 110—220 volts for our household work, and 6,000 volts for electric traction and for transmission. Nowadays, in many countries, electricity is generated sometimes at places very far from where it is consumed: say at the mouth of a coal-pit or at a hydro-electric station. It has to be transmitted over hundreds of miles. The loss by transmission varies inversely as the voltage; hence sometimes transmitting voltages as high as 250 kilovolts have been used. But these involve transmission difficulties;—high towers have to be erected and transmission lines have to be carried over properly designed insulators. In many Western countries such transmission lines are features of the country side. Even

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in a hundred thousand volt X-ray generator special precautions need be taken for insulation.

This shows the tremendous difficulty of constructing a million-volt direct current generator and still more of using it to accelerate 'charged particles' like protons, deuterons or alpha particles.

The apparatus which have been tried for the purpose are:

(i) The Cascade Transformer

This is one of the earliest types of high voltage generators, in which the primary of a transformer is connected to a tapping off the secondary of another ordinary transformer and so on. It has been developed by Lauritsen at Pasadena in 1928 for production of X-rays at 750 kV and extended later to 1MV. So far as the writer knows the greatest voltage reached upto now is 2 MV. The apparatus is large and costly and requires a special building to house it. Alternating currents up to 30 milliamps may be obtained which have to be rectified by an array of thermionic rectifiers.

(ii) The Resonance Generator

This ingenious apparatus is due to Sloan and has so far been applied only for X-ray production. A copper coil is hung from one end in an evacuated steel tank, about 4 ft. across, and is made to resonate with a 100 kW radio-frequency oscillator mounted above it. High frequency oscillations are induced in the coil and an alternating e.m.f. of 1 MV is developed at the free end of the coil, which carries a target. The target faces a hot filament in the wall of the tank. The apparatus is compact, but the power consumption is very large. There are only two at present in use in America.

(iii) The Cascade Generator or the Voltage Multiplier

This method has been developed independently by Cockcroft and Walton in the Cavendish Laboratory at Cambridge and by Bouwers in the Philips Laboratory at Eindhoven. The principle consists in charging a number of condensers in parallel and discharging them in series. An alternating potential of 200 kV or so is taken, multiplied many times and rectified. Mechanical switches cannot be used at such high voltages and thyratrons and diodes are used for the purpose. Bouwers has already got 1.5 MV from this arrange-

ment and contemplates 2 MV. The apparatus is rather large and expensive, but the performance is impressive. Its working is further dependent on climatic conditions and it should be housed in a large air-conditioned room. It has ample reserve power and costs little to run. From 600 kV ion tubes giving 1 milliamper positive ion current, Bouwers, Heyn and Kuntke produce neutrons equivalent in amount to that from 100 gm of radium. The Philips Laboratories are supplying it in the market under the name 'Neutron Generator.'

(iv) The Electrostatic Generator

Van de Graaf, Compton, Van Atta and others have made considerable progress in perfecting an electrostatic machine utilising the principles of electrostatic induction familiar to the student of science in the Wimshurst machine. Insulated belts carry a charge induced on them to a large well insulated hollow aluminium sphere, whose potential rises. The voltage limit is set by the ability of the surrounding medium in contact with the sphere to withstand the electric pressure. Van de Graaf's experimental model generated 1.5 MV with an output of 25 microamps, and had two spheres of 2 ft. diameter each. The Massachusetts Institute of Technology has built one giving 5 MV with a current of 2 mA working at atmospheric pressure.

Compact electrostatic generators have been built by Herb and others using air under pressure to increase breakdown voltage. Use of Freon gas (CCl_2F_2) is likely to help development greatly, as with this gas under pressure the breakdown voltage may be increased by a factor of 10. The apparatus is cheap, simple and robust. It has already been adopted for hospital use in some places in America to work X-ray tubes at 1 MV.

(v) The Cyclotron

By consensus of opinion the cyclotron is the most efficient 'generator' of high energy particles, and it has the further merit of avoiding all 'insulation difficulties.' It can also be worked in any room of modest dimensions.

The principle, at least on paper, is quite simple. Positively charged ions, say protons, deuterons or alpha-particles, are accelerated in hundreds of small steps of a few 10kV each. An alternating e.m.f. of this peak value is applied to two hollow D-shaped electrodes separated by a short distance. Ions are drawn out from a source at about the middle of these

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'dees' and with the help of a strong magnetic field they are made to travel in circular paths inside the dees. The ions that cross the electrodes when the potential difference is maximum, acquire an energy corresponding to this peak value. They now enter the second electrode, describe a semicircle and come to the gap between the two. If by now the e.m.f. has been reversed the ions will get another increment in energy equal to the first value. This goes on at each reversal and the energy of the ions gradually increases. They describe wider and wider circles till at last they are drawn off from their outermost circle by means of another electric field and become available for nuclear bombardment. (See Fig. 1).

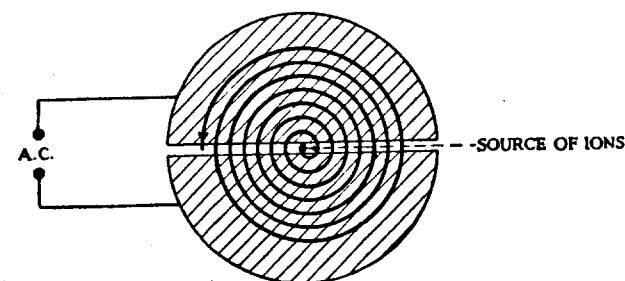


Fig. 1

Elementary Theory of the Cyclotron

To understand the working of a cyclotron better, let us consider a particle of mass m and charge e moving with a velocity v at right angles to the lines of force in a magnetic field of strength H . The particle will move in a circular path of radius r given by $Hev = \frac{mv^2}{r}$. The

time for a complete revolution is $T = \frac{2\pi r}{v} = \frac{2\pi m}{He}$. This depends neither on the velocity of the particle nor on the radius of the path and for particles of the same e/m the time to describe a complete circle thus remains the same so long as the magnetic field remains constant. For resonance between the applied electric field and the motion of the particle we must have T same for both, i.e., the alternating electric field must have a frequency $1/T$.

If the electric field is to be applied through a valve oscillator, the wavelength λ must be $= cT$ where c = velocity of light. Hence for resonance in a cyclotron we must have $T = \frac{\lambda}{c} = \frac{2\pi m}{He}$ or $\lambda H = 2\pi c \cdot \frac{m}{e}$. For protons $\lambda = 19.5$ m. when $H = 10000$ gauss; for deuterons and α -particles, which have the same value for $\frac{e}{m}$, $\lambda = 39$ m. with the above field.

For each passage from one electrode to the other the energy increases by $Ve = \frac{1}{2}mv^2$ where V is the potential difference across the electrodes at the time of passage. If this happens to be the peak value, the ion acquires the maximum energy in a smaller number of revolutions than otherwise. In all cases the radii of successive semicircles are to one another as square roots of natural numbers.

The energy E acquired in electron volts when the particle is accelerated to a radius ρ is given by $E = 4.8 \cdot 10^{-5} H^2 \rho^2$ for protons, and $2.4 \cdot 10^{-5} H^2 \rho^2$ for deuterons and α -particles. Here H is in gauss and ρ in cm.

It thus follows that in a cyclotron with useful radius $\rho = 38$ cm and $H = 15150$ gauss, one can obtain protons of energy $= 16$ MeV or deuterons of energy 8 MeV. For resonance the wavelength of the oscillator will be different in the two cases. For same λ and ρ , protons will have half the energy of the deuterons, but at the same time the strength of the magnetic field will have to be halved to get resonance.

As the energy depends on the product $H\rho$, it would appear that by increasing both H and ρ very high values of the energy can be built up. But there are two difficulties to remember. For resonance $H\lambda$ must also be constant. Increasing H means a shorter wavelength for the oscillator. The power required for the oscillator of an ordinary sized cyclotron is greater than that of most of the radio stations of the world. The technique of getting so much power out of a very short wave oscillator has not yet been developed.

The other difficulty arises from the relativity increase of mass of a particle with speed. For very high speeds the relation $H\rho = \frac{mv}{e}$ is not sufficiently accurate. It is to be replaced by $H = \frac{m}{e} \cdot \frac{v}{\sqrt{1-v^2/c^2}}$. At 10 MeV the mass of a proton increases by about 1%. The addition of a given energy now no longer causes an equal increase in velocity as when the velocity was small, and the particle soon falls out of phase with the alternating e.m.f. For protons this occurs at about 12 MeV, for deuterons at about 17 MeV and for α particles at about 34 MeV. At present these are the limiting energies which a cyclotron can deliver under the best circumstances. Even these values have not yet been reached.

The Electromagnet

We now give the reader some details of a cyclotron. The electromagnet should be capable of giving 15,000 to 20,000 gauss across a gap of about 3 to 4 inches and over as large an area as funds will permit. The

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pole faces of Lawrence's second cyclotron at Berkeley, California, which serves as the model for most cyclotrons of the world, have a diameter of 45 inches. The useful ρ value is about 38 cm. The field is about 18,000 gauss, the weight of iron in the electromagnet 65 tons and the weight of copper in the magnetising coils 9 tons. The power consumption is about 40 kW and is delivered to the coils from a generator at high amperage and low voltage. The coils are cooled in oil and an elaborate automatic device keeps the current in the coils steady to within a few hundredths of 1%, as with even as small a change as 0.1% in the magnetic field the intensity of the ion beam falls to one thousandth.

The Dees, Vacuum Chamber and Shims

The hollow semicircular electrodes have the shape of a pill box cut into two and look like the letter D. They are often referred to as the 'dees.' These are separated from each other by about an inch, are about 2 inches in height and the inner radius of the dees determines the effective ρ . The dees are enclosed in a cylindrical metal box whose top and bottom plates are made of iron to reduce the air gap of the electromagnet. This is called the vacuum chamber and is placed between the pole pieces of the electromagnet, leaving a small gap between the top and bottom plates and the pole faces. In these gaps are placed 'shims', which are thin iron rings whose dimensions are fixed by trial. Their function is to correct for the magnetic field and this must be done with the greatest care when high energies are to be reached. Exact calculation shows that the strength of the magnetic field at the middle point should be 0.9% greater than that for resonance and fall radially as $1.3 \times 10^{-2}(r/R)^2$ where r is the distance from the middle point and R the radius of the dees. A departure of 0.3% from radial symmetry reduces the strength of the ion beam to $\frac{1}{1000}$. The burden of bringing about this correction falls on the shims.

The dees are supported on glass insulators passing through the side of the vacuum chamber and are coupled to the oscillatory circuit by copper tubes passing through these glass insulators. A quadrant on a dee is cut off into a smaller radius. Opposite this occurs a curved deflecting plate which is charged to a high negative potential of 50,000 volts or so and serves to pull the ion beam out of the dees into the target.

Source for Ions

The vacuum chamber is filled with the experimental gas (hydrogen for protons, heavy hydrogen for deuterons and helium for alpha-particles) at a pressure of about 10^{-4} mm. of mercury. A larger gas pressure will give a larger ion current, but it must not be so high as to cause glow discharge between the dees. With increase of pres-

sure the number of collisions of ions with gas atoms increases. Now, a collision means a loss of energy on the part of the ion. Hence the maximum possible voltage is to be applied to the dees so that the number of revolutions and therewith the length of the path described by the ion to reach maximum energy diminishes.

To produce the ions most cyclotrons have near the middle of the dees a heated filament, electrons from which are accelerated down the space between the dees by a potential of about 1000 V applied between the filament and a surrounding shield. They ionise the gas and produce ions. The correct pressure is maintained by allowing gas to stream in and simultaneously pumping it out. Recently this form of ion source is being replaced by a capillary tube, which is mounted vertically at the centre of the dees with a small hole drilled through the capillary wall. This form of source gives a much stronger ion current even when other conditions remain the same and eliminates the undesirable heating effects from filament sources. The ion source being confined inside the capillary, the vacuum in the chamber can be improved and the energy distribution in the high voltage ion beam made much more uniform.

The Short Wave Oscillator

The alternating voltage is supplied to the dees by coupling them to a short wave oscillator. When the strength of the high energy ion current is studied in relation to its dependence on the voltage applied to the dees a very large increase of current strength is found to take place with increase in voltage. The energy distribution amongst the particles is also more favourable, a larger number of them having the maximum value (though the energy distribution depends also on the pressure inside the chamber and on the nature of the ion source). It is, therefore, necessary to apply as large a voltage difference between the dees as is possible. The oscillator must, therefore, be capable of supplying a considerable power, say from 30 to 50 kW.

Output from Cyclotron

We have already referred to Lawrence's second cyclotron. With $H = 15150$ gauss, $\rho = 38$ cm., voltage applied to dees = 90 kV, $\lambda = 26$ m, power supplied by oscillators = 25 kW, he gets alpha-particles of 16 MeV energy at 1 microampere (μA) and 8 MeV deuterons at 90 μA . This energy is acquired in 45 complete revolutions. This cyclotron has so far given 6.3 MeV protons, 10 MeV deuterons and 16 MeV alpha-particles.

Let us now compare the outputs of high energy particles from naturally radioactive substances and the cyclotron. One gram of radium emits 3.6×10^{10} alpha-

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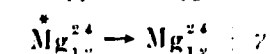
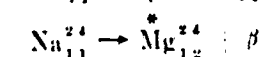
particles per second with energy equal to 4.8 MeV. Each particle carries a charge of $2 \times 1.6 \times 10^{-19}$ Coulombs. Hence the ion current from 1 gm of radium is equal to 0.012 μA . The cyclotron can give 1 μA of alpha-particles and protons and deuterons to about 100 μA . The alpha-particle output of a cyclotron is thus equal to that of 90 gm. of radium, which would cost about a crore of rupees. They are also more energetic, and while the natural alpha-particles can disintegrate nuclei of atomic number 20 (Ca), artificial alpha-particles can go up to 53 (I). There is no proton or deuteron emission in natural radioactivity. With these particles from the cyclotron it has been possible to transmute all elements in the periodic table, directly or indirectly.

As a product of many nuclear transformations, we get neutrons, e.g., in the classical case when beryllium is bombarded by alpha-particles from polonium. The neutrons, which are nuclear particles, carry no electric charge and have about the same mass as the proton. Owing to this absence of charge the repulsive electric field of the nucleus which acts against the entry of charged particles in the nucleus, has no action on the neutron, which can easily penetrate into a nucleus or come out of it, and hence they are extraordinarily active in promoting nuclear reactions. Even when not desired the cyclotron gives rise to a very large number of neutrons, principally in nuclear transformations taking place within the vacuum chamber. An intense neutron beam has strong biological action, similar to that produced by intense X-radiation. The neutron has a knack of knocking off protons from hydrogen-containing materials such as tissues in the human body, and giving a large part of its energy to the proton. The biological effect is due to the ionisation produced by these protons. Hence while working with a cyclotron one must protect oneself from irradiation by neutrons. This can be done by interposing a layer of water 50 to 100 cm thick between the worker and the cyclotron.

A mixture of radium and beryllium is a strong source of neutrons. 100 mg. of Ra+Be serves as a source of neutrons of sufficient intensity for most laboratory purposes. By bombarding beryllium with deuterons from the cyclotron we can get as much neutron intensity as is to be obtained from a mixture of 100 kg of radium with beryllium. The reaction occurs according to the scheme $Be_4^9 + H_2^2 \rightarrow Be_4^{10} + n_0^1$. In this respect the cyclotron is equivalent to 100 kg of

radium. Moreover, the cyclotron can give a sufficiently strong beam of 20 MeV neutrons, while the Ra+Be mixture gives 3 to 7 MeV and a very small amount of 14 MeV neutrons.

In biological action the usual neutron emission from a beryllium target of a cyclotron delivering 25 μA of 5.8 MeV deuterons is equivalent to gamma radiation from 100 gm. of radium. When sodium is bombarded with high speed deuterons, it is converted into a radioactive body emitting fast electrons and gamma rays, and has a half life of about 15 hrs. The reactions are: $Na_{11}^{23} + H_2^2 \rightarrow Na_{11}^{24} + H_1^1$



At the end of the reaction radio-sodium is converted into magnesium. The gamma rays are as penetrating as those from radium, and because of this, radio-sodium serves as a good substitute for radium in many cases. A day's bombardment of metallic sodium with 50 μA of 5 MeV deuterons gives more than 500 mgm equivalent of radio-sodium, i.e., an amount of radio-sodium having a gamma ray activity equivalent to that of 500 mgm of radium. This amount of radium costs about Rs. 60,000, while the cost of production of an equivalent amount of radio-sodium does not exceed Rs. 200 even when we include interest on capital outlay and the salaries of the staff. But against that we offset the fact that radium will last for 2,000 years, while sodium will disappear in a day or so.

Applications

The cyclotron is the only gun from which nuclear projectiles can be fired to break up the nucleus of any element on the periodic table, and of all the heavy and complicated tools used by physicists to probe into the sub-microscopic region of the atomic nucleus, this is the heaviest and the most complicated one. The impressive array of transformers, kenotrons and generators for the oscillator, the vacuum pumps, motor generator sets, water cooling pipes etc., contributes to the impression of complexity of the apparatus.

When the stream of fast particles from the cyclotron is allowed to fall on the target of an element, some of the nuclei may be directly hit and undergo transmutation. The incident particle is assumed to be absorbed by the nucleus and form what is called a 'compound nucleus.' This disintegrates with the

THE CYCLOTRON

emission of a nuclear particle and forms a different nucleus which may be stable or unstable. If unstable, it disintegrates with further emission of particles or gamma rays. This last phenomenon is known as 'induced radioactivity.' In many of the nuclear transmutations neutrons are emitted and these in their turn can be further used for nuclear bombardment.

Applications of Induced Radioactivity

Among the products of disintegration of nuclei by particles from the cyclotron are to be found hundreds of unstable elements which are isotopes of known stable elements. They decay with a period much shorter than radium and give off high energy electrons, positrons or gamma rays. The cyclotron far exceeds other types of apparatus in the amount of such radioactive material that can be produced. We have already seen the case of radio-sodium. Let us take another example. Radio-phosphorus is used in therapy and the activity required is about 20 millicuries. The concentration of the radioactive atoms to the inactive atoms must be large. With 8 MeV deuterons and a current of 70 μ A the cyclotron can produce in a day's work 10 millicuries of radio-phosphorus in a total quantity of 40 milligrams of ordinary phosphorus.

This synthesiser of elements has given us not only unknown isotopes of known elements, but also at least one unknown element itself. The element of atomic number 43, which is a homologue of rhenium, was synthesised before it was discovered in nature. The Berkeley cyclotron has synthesised it in 1937 out of molybdenum and deuteron and molybdenum and neutron. At least five isotopes of this element have been formed and some of them have life long enough to allow some of its chemical and nuclear properties to be studied, though the total quantity formed is no more than 10^{-10} gm.

Molecular Biology

Thanks to the cyclotron, nearly all the ordinary chemical elements can now be obtained in a radioactive form. They have exactly the same chemical properties as the inactive forms. The active modification accompanies the inactive form through every series of chemical processes, however complicated they are. But while the inactive species gets lost in the system and cannot be traced, just like a grain of sand in the

sea beach, the active atoms can always be recognised by their particular kind of activity, and thus the presence of a particular element at a place can be detected and its course followed through a series of changes. Such atoms, as it were, carry a label with them by means of which they can be easily identified and their concentration estimated with the aid of very simple machinery (a Geiger counter). Such 'tagged' atoms are being increasingly used to study biological processes, and a new science 'Molecular Biology' is being rapidly developed. Already it has some important results to its credit. To study the metabolism of phosphorus the active variety is mixed with the inactive one in a suitable proportion and administered to the subject in an assimilable form. The course followed by phosphorus can be traced by tracing the tagged atoms. It has thus been found that a large part of the phosphorus is incorporated in various compounds in the bones and muscles, from which it is gradually displaced. This shows that the mineral matter in the bone is in a dynamic state in which the atoms are being continually replaced. Examples of this kind can be multiplied, but consideration of space does not allow it.

Many other applications of induced radioactivity suggest themselves. If sodium chloride containing radio-sodium is swallowed, sufficient will find its way into the hand in ten minutes to affect a Geiger counter. Twenty seconds after intravenous injection in one hand its presence can be detected in the other. Such experiments point to the possibility of application of radio elements in the investigation of circulatory disorders.

Direct therapeutic effects of active variants of ordinary elements are the same as those of radium, and if there was no other result than the production of large amounts of equivalent radium, it would be one of the most important discoveries ever made.

Tagged atoms may also be used in chemistry to follow chemical elements through exchange reaction, catalyst poisoning, surface adsorption, etc. In metallurgy and physics of solids they may be used to study diffusion of atoms through single crystals and across and along crystal boundaries. Studies of this sort under various conditions of temperature and strain should clarify many of the problems that are now presented by the solid state and will lead to alloys with more desirable properties for all the various applications.

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Neutron and its Application

We cannot stop without talking about the importance of neutrons. The cyclotron is pre-eminent in the production of these particles, which are strongly absorbed by the light atoms such as constitute the human body. Their action is very similar to that of X-rays. The effect of X-rays is due to the ionisation produced by the photo-electrons liberated within the body by X-rays. The effect of neutrons is mainly due to the ionisation produced by protons liberated from the hydrogen atoms in the tissues by neutron impact. As the neutron has almost the same mass as the proton, it gives up at each encounter nearly half its energy to the proton. After 20 encounters, which will take place in about 10 cm. of water a neutron having an energy of ten-million volts will scarcely be left with an energy of $\frac{1}{16}$ volt. But the same neutron will pass through several feet of lead without much loss of energy. This is because the neutron is unaffected by the outer sheath of electrons, and can lose energy by encounter with the nucleus alone. Since lead is very heavy, the neutron loses very little energy when it encounters the nucleus. Hence we have the paradox that to protect a worker from the action of a neutron beam lead is useless, and we have to place a layer of water about 100 cm. thick between the neutron source and the worker.

Within the tissue the total ionisation as also the ionisation density along the tracks is greater for neutrons than for X-rays. It seems that biological effects on individual cells depend more on ionisation density than on the total number of ions. One might, therefore, expect that neutrons will be biologically more active than X-rays. The effect of neutrons in killing mice, *Drosophila* eggs, bacteria and fern spores, in producing chromosome abnormalities and in inhibiting growth in wheat seedlings has been compared with similar effects produced by X-rays and gamma-rays. The effects are in general qualitatively similar, but suggest that in most of these cases the biological effect per

ionisation in the tissue is greater for neutrons than for X-rays. In other fields, such as gene mutations in *Drosophila*, neutrons have been found to be less effective.

Treatment of cancer patients with neutrons have now begun in Berkeley. Though it is not known how successful it will be, encouraging therapeutic results have been obtained in other fields.

The Radiation Laboratory of the University of California has become a training school for cyclotron engineers, and many physicists and biologists from near and far have taken or are taking their lessons in cyclotron technique from Prof. Lawrence, who has been awarded the Nobel prize for 1939 for his invention. In many laboratories cyclotrons are already completed and in operation. Several prominent scientists have migrated to Berkeley to get first hand information about the cyclotron and have returned to their countries to make installations. Several so far installed can produce energies over 10 MeV. This is in excess of values possible with other types of high voltage apparatus. Berkeley still leads the world in having the biggest and most powerful cyclotron with a 60 inch chamber and an electromagnet weighing over 100 tons.

In the United States of America there are over 30 cyclotrons under construction or in action. In Europe, Copenhagen, Cambridge and Liverpool have one each in action, Paris, Zurich, Stockholm, Leningrad and Charkow one each under construction. In Japan there is one in action and one under construction. In Germany two have been planned. India perhaps cannot afford to have one, unless a philanthropic millionaire comes forward with offer of five lakhs of rupees for a cyclotron foundation, of which nearly two lakhs will be required for constructing the machine and three lakhs for an endowment to maintain the staff. But the sum is well worth spending, as thereby many tropical diseases from which India suffers, can be scientifically investigated.

Sir Alexander Cunningham

Bimala Churn Law

SIR Alexander Cunningham, the second son of Allan Cunningham, a Scotch poet, was born in Westminster on the 23rd January, 1814. He was educated at Christ's Hospital and after passing through the Military College at Addiscombe, he came out to India as second lieutenant in the Bengal Engineers in June, 1831. In 1834 he was appointed one of the aides-de-camp to the then Governor-General of India, Lord William Bentinck. He was afterwards sent out to Kashmir in 1839 on a special mission. While in Calcutta, he came in contact with James Prinsep, the famous Indologist who deciphered the Brahmi script completely, and the Kharosthi script partially. It was the inspiration of Prinsep which drew Cunningham to ancient Indian antiquities. In 1840, he was employed



Sir Alexander Cunningham

as an engineer to the king of Oudh. On the eve of the second Sikh War in 1846 he was sent on a political

mission through Kulu and Lahul into Ladakh. From 1847 to 1849 he was engaged as an engineer for fixing the boundaries of the North-West Frontier, and during the latter part of this period, he served in the Punjab Campaign including the battles of Chillianwalla and Gujrat. From 1833-1861 he held many posts in the P. W. D. In 1851, along with Lt. Maisiey he came to see the Buddhist monuments of Central India and wrote an elaborate account of them in his well-known book, *Bhilsa Topes or Buddhist Monuments of Central India*, published in 1854. From 1856-1858, he served as Chief Engineer of Burma, and from 1858-1861 of the North-West Provinces, i.e., the present United Provinces of Agra and Oudh.

After his military activities during which he was acquainted with many parts of India, he was appointed, on account of the interest he had shown in Indian antiquities, as an Archaeological Surveyor to the Government of India in 1861 and during the period, 1861-1865, he published Vols. I and II of the *Archaeological Survey Reports*. He left India in February, 1866, and while in London, he was appointed a Director of the Delhi and London Bank. On the 1st January, 1871, he returned to India as the Director-General of the Archaeological Survey and functioned in this capacity for 15 years, during which period he produced many volumes. After serving India for about 50 years he retired on the 30th September, 1885, in his seventy-second year with a pension. He was at first made C. S. I., then C. I. E., and after retirement K. C. I. E. He died on the 28th September, 1893, in London.

Cunningham was such a keen student of Indian antiquities and ancient Indian geography, that though towards the latter part of his life he was afflicted by a painful malady which confined him to bed, he never ceased to take a keen interest in his favourite study. His researches in ancient Indian geography, numismatics, coins and inscriptions are really very praiseworthy. We do not say that all his identifications are correct, but it must be admitted that by his preliminary

SIR ALEXANDER CUNNINGHAM

survey of the sites of antiquarian interest he has rendered invaluable service to the cause of Indian antiquity. As a pioneer among the workers in the field of archaeology and ancient Indian geography his name will be ever remembered.

With General Alexander Cunningham as the Director of Archaeology, the archaeological department in India was first started in 1862. His duty was to gather descriptions of note-worthy archaeological remains together with their history as far as available and to record traditions regarding them. Nine years afterwards his post was designated as the Director-General of Archaeological Survey of India. He was really the head of the survey in northern India as his office was not then extended to Madras and Bombay Presidencies. The twenty-three volumes of the Reports descriptive of his twenty-three years' touring abundantly prove his ability and industry in this field of investigation. They contain personal descriptions of his archaeological tours. These volumes which aim at exhaustiveness bring together the results of the survey of central and northern parts of India at which he and his assistants worked patiently and diligently for nearly quarter of a century.

When he was first appointed in 1862, the interest in ancient Indian geography was rather widespread. He devoted much of his time and energy to this subject and to the investigation into the holy places of the Buddhists mainly with the object of identifying them and collecting remains from those sites for display in museums. Cunningham was thus not only a great pioneer in the field archaeology, but also in ancient Indian geography.

We append here a list of his publications which form valuable contributions to the study of ancient Indian history and culture.

Books:

(1) *The Ancient Geography of India*. I. The Buddhist period including the campaigns of Alexander and the Travels of Hwen-Thsang. (London 1871). It is indeed a pioneer work and often consulted by scholars interested in the geography of ancient India.

(2) *Corpus Inscriptionum Indicarum*. Vol. I. Inscriptions of Asoka. (Calcutta 1877).

(3) *The Stupa of Bharhut, a Buddhist Monument*. (London 1879). Here the author has given an elaborate

description of the stupa, identification of its site, description of the pillars, railings, copings, etc. He has discussed the probable age of the stupa, and has given sculptural details e.g., objects of worship, decorative ornaments, human beings, superhuman beings, trees, fruits and many other miscellaneous objects. He has dealt with the Jataka scenes and inscriptions on the railings of the Bharhut stupa.

(4) *Book of Indian Eras* with tables for calculating dates. (Calcutta 1883).

(5) *Coins of Alexander's Successors in the East*. (London 1884).

(6) *Archaeological Survey of India*, Vols. 1, 2, 3, 5, 9, 10, 11, 14, 15, 16, 17, 20, 21. (Calcutta 1862-1885). The remaining vols. 4, 6, 7, 8, 12, 13, 18, 19, 22, 23, 24 were written by his assistants under his guidance.

(7) *Coins of Ancient India from the Earliest Times down to the 7th century A. D.* (London 1891).

(8) *Mahabodhi or the Great Buddhist Temple under the Bodhi Tree at Buddha Gaya*. (London 1892). The author has here given us a complete history of the Buddha Gaya temple and has dealt with the inscription on the Asokan railing.

(9) *Coins of the Indo-Scythians, Sakas and Kushans*. (London 1893).

(10) *Later Indo-Scythians*. (London 1893).

(11) *Coins of Mediaeval India*. (London 1894) from the 7th century down to the Muhammadan conquest.

(12) *The Bhilsa Topes or Buddhist monuments of Central India: comprising a brief historical sketch of the rise, progress and decline of Buddhism* (London 1854). This book consists of 368 pages together with 33 plates. Half of this book is devoted to a sketch of Buddhist history and about one fourth of it, to the donative inscriptions chiefly on the rails and pillars.

Papers:

The following are his contributions to the *Journal of the Asiatic Society of Bengal*:—

Notice of some counterfeit Bactrian coins. (ix. 393). Notes on Captain Hay's Bactrian Coins. (ix. 531). Description of, and Deductions from a consideration of some new Bactrian Coins. (ix. 867). Second notice of some forged coins of the Bactrians and Indo-Scythians. (ix. 1217). Abstract journal of the route to the sources of the Punjab rivers. (x. 105). Description of some ancient gems and seals from Bactria, the

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Punjab and India. (x, 147); A sketch of the second silver plate found at Badakshan. (x, 570), Notice of some unpublished coins of the Indo-Scythians. (xiv, 430), Journal of a trip through Kulu and Lahul, to the Chu Mureri Lake, in Ladak, during the months of August and September, 1846. (xvii, Pt. 1, 201), Memorandum detailing the boundary between the territories of Maharaja Gulab Singh and British India, as determined by the Commissioners P. A. Vans Agnew, Esqr. and Capt. A. Cunningham. (xvii, Pt. 1, 295), Verification of the Itinerary of Hwen Tshang through Ariana and India, with reference to Major Anderson's hypothesis of its modern compilation. (xvii, Pt. 1, 476), Proposed archaeological investigation. (xvii, Pt. 1, 535), Verification of the itinerary of the Chinese pilgrim, Hwen Tshang, through Afghanistan and India, during the first half of the seventh century of the Christian era. (xvii, Pt. II, 13), An essay on the Arian Order of Architecture, as exhibited in the Temples of Kashmir. (xvii, Pt. II, 241), Coins of Indian Buddhist Satraps, with Greek inscriptions. (xxiii, 679), Memorandum on the Irawadi river, with a monthly register of its rise and fall from 1856 to 1858, and a measurement of its minimum discharge. (xxix, 175), Remarks on the Bactro-Pali inscription from Taxila. (xxxii, 139, 172), Archaeological Survey Report for 1861-62. (xxxii, Supp. No. 1), Note on the Bactro-Pali inscription from Taxila. (xxxiii, 35), Remarks on the Date of Pehewa Inscriptions of Raja Bhoja. (xxxiii, 223), On the Pehoa inscription of Raja Bhoja. (xxxiii, 229), Archaeological Survey Report for 1863-64. (xxxiii, Supp. No. 1), On Antiquities of Bairat, etc. (Proc., 1865, 97), Coins of the nine Nagas, and of two other Dynasties of Narwar and Gwalior. (xxxix, pt. 1, 115), Memorandum on the Operations of the Archaeological Survey for season 1873-74. (Proc., 1874, 108), Notes on the gold coins found in the Ahin Posh Tope. (Proc., 1879, 205), Remarks on Bactrian and south Indian coins. (Proc., 1880, 117), Note on coin of Shams-ud-din Kaimurs.

(Proc., 1881, 158), Relics from ancient Persia in gold, silver and copper. (I, pt. 1, 151), Note on coin from Mahanada. (Proc. 1882, 104), Remarks on coins from Tomluk. (Proc., 1882, 113), On a gold Gupta coin sent by Mr H. Rivett Carnac. (Proc., 1883, 144), Relics from ancient Persia, in gold, silver, and copper. (III, pt. 1, 64, 258).

The following are his important papers in the J. R. A. S.:—

(1) Ruins of Sankassa 1843, 241. (2) Opening of Topes or Buddhist Monuments of Central India 1852, 108. (3) Ancient Inscription from Mathura, note, 1871, 193.

In the *Numismatic Chronicle* the following are his noteworthy contributions:—

(1) Coin of the Indian Prince Sophytes, a contemporary of Alexander the Great.

(2) Coins of Alexander's Successors in the East, the Greeks and Indo-Scythians—an important series of papers (N. S. Vol. viii, pp. 93-136, 181-213, and 257-83; Vol. ix, pp. 28-46, 121-53, 217-46 and 293-318; Vol. x, pp. 65-90, 205-36; Vol. xii, pp. 157-85, and Vol. xiii, pp. 187-219).

Cunningham had undoubtedly superhuman energy and indefatigable zeal. True that all his works have been supplemented or supplanted by the publications of his long line of successors. Yet it is undeniable that he has guided them all along the right path, even by his pitfalls. Here indeed lies the inestimable value of Cunningham's writings. It is to him that the world mainly owes a very comprehensive and at the same time a most realistic picture of ancient India. His sincerity, honesty of purpose, power of appreciation, and unparalleled devotion to duty, are truly reflected in the style, manner of presentation of facts, and elucidation of subject-matters.

Visit of Dr R. A. Millikan to India

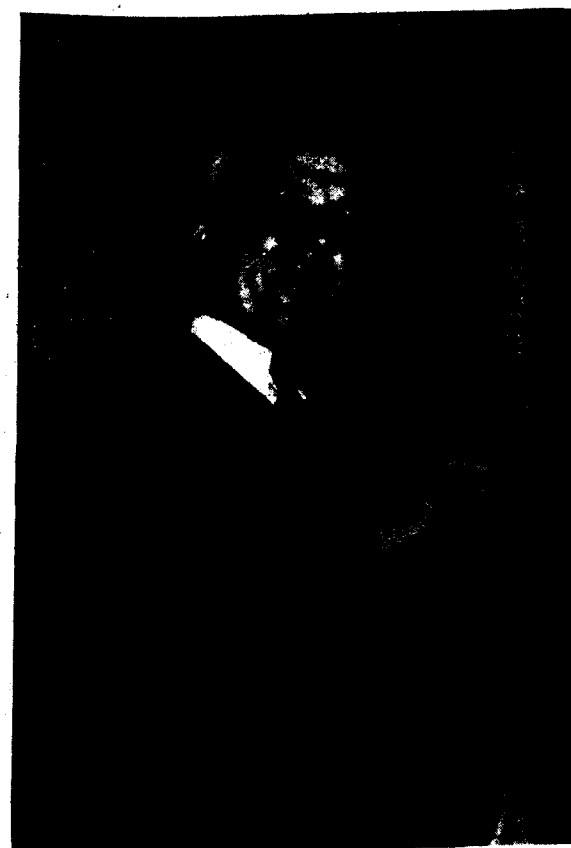
Dr and Mrs. Millikan with Drs. Neher and Pickering arrived in Calcutta by S. S. Erlenga from Rangoon on the 25th November last with the intention of measuring cosmic ray intensities in Indian latitudes. In India they will remain the guests of the Indian Meteorological Department. They were received at the Calcutta wharf on behalf of the Department by Drs S. K. Banerji and S. K. Pramanik, and on behalf of the Calcutta physicists by Profs. D. M. Bose and M. N. Saha. During

Institute. Dr Millikan addressed three large gatherings at Calcutta, at the University College of Science, the Indian Association for the Cultivation of Science and at the Bose Institute. The subjects for the three lectures were respectively, a scientist's philosophy, the organisation of the California Institute of Technology and his recent researches on cosmic rays. He was elected an honorary member of the Indian Physical Society and was awarded by the Indian Association the Joykissen Mookerji Gold Medal for his services to science. He and his companions were treated by the professors of the University College of Science to a dinner at Faculty Club of the University, which was attended by the Vice-Chancellor Hon'ble Mr Azizul Haque, Dr S. P. Mookerjee, Mr Subhas Chandra Bose and many other distinguished citizens of Calcutta.

The party left for Agra on the 5th December when the author of this note was kindly allowed by Dr Millikan to travel with them and be present at Agra and Gwalior where some of the experiments were carried out.

Balloons carrying electroscopes were let off from Gwalior and from Agra. In the next figure, Dr Neher is seen in the act of releasing one electroscope, the second figure shows the electroscope with its parachute being carried up in the air. The electroscope remains in flight for three hours after which a fuse is burnt and the electroscope descends rapidly to the ground being borne in a parachute. At the time of writing this note, one of the two electroscopes released from Gwalior has been recovered, the film inside of which showed that the electroscope reached a height of about 33 km. i.e., it penetrated almost 99 per cent. of the total mass of the earth's atmosphere.

Dr Millikan has recently showed that from the altitude-ionisation curve of the cosmic rays, one may obtain the total energy brought into the earth's atmosphere by cosmic particles. It is well known from the Lemaitre-Vallarta theory that cosmic rays which are charged particles are deflected by the earth's magnetic

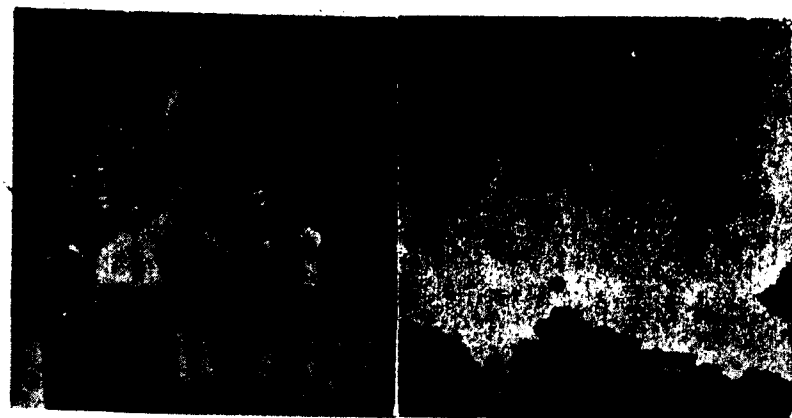


Dr R. A. Millikan speaking at the Indian Association for the Cultivation of Science.
(By courtesy of Hindusthan Standard)

their short stay at Calcutta Dr and Mrs Millikan were the guests of Lady Abala Bose at the Bose Research

VISIT OF DR R. A. MILLIKAN TO INDIA

field, and unless their energy exceeds a certain limit, depending upon the magnetic latitude, they will fail to reach the top of the atmosphere. The total cosmic ray intensity at any latitude, therefore represents the energy brought by cosmic rays having all energies



Dr Neher releasing an electroscope tied to a string of six balloons.

exceeding the minimum for the latitude. When we measure the total cosmic ray intensity for two stations, the difference between them gives us the total intensity of cosmic rays whose energy lies between two limits determined by the magnetic latitudes of the stations. If simultaneously observations are taken over a large number of stations, extending from the magnetic pole to the equator, one may obtain the intensity of cosmic rays for different energies and thus obtain the energy distribution curve for the incident cosmic rays.

The distribution curve has prominent peaks at certain energies which suggest, according to Dr Millikan, the annihilation of matter somewhere in space. The collapse of hydrogen nuclei will give rise to an emission of energy of about a billion electron volts. Similarly the collapse of the other nuclei like helium, boron, carbon, nitrogen etc., which are thought to be most frequent in the Cosmos would correspond roughly with energies of the order of 4×10^8 , 10×10^8 , 12×10^8 , 14×10^8 e.v. respectively. Millikan suspects that some of the peaks may coincide with these energies. In course of his lecture at the Bose Research Institute, Dr Millikan remarked that his colleague Dr Bowen had proved from an analysis of the spectra of Novae, which are thought to be stars in explosion that stellar

mass is composed preponderately of hydrogen, helium, carbon, nitrogen and oxygen, and then silicon. The intermediate elements occur in very minute quantities. In order to verify his ideas about the origin of cosmic rays, part of which at least may be due to annihilation of matter in space, the energy distribution curve must be determined with greater accuracy. Hence the present party intends to measure cosmic ray intensities at as many latitudes as possible, all taken at close intervals, since recent work has shown that the total cosmic energy incident at the same place fluctuates from year to year and from day to day.

Besides the work with electroscopes the party also intends to send up in balloons coincidence as well as single counters, by means of which it will be possible to study the variation of the vertical and the total intensity of cosmic rays, the variation of shower frequency with altitude and the East-West Effect. In these experiments, the counter pulses, the barometer and thermometer signals are made to actuate a short wave oscillator. The radio signals from the oscillator are picked up by a receiver on the ground and are recorded on a chronograph. The following figure shows Dr Pickering receiving such signals from coincidence



Dr Pickering receiving radio signals from coincidence counters which are up in the stratosphere.

From Agra, Dr Millikan proceeds to Peshwar, and thence to Madras which is nearly on the magnetic equator. His present views on cosmic rays have been published in a series of lectures delivered at the Cambridge University.

N. N. Dasgupta.

Nobel Prizes in Chemistry

Professor Richard Kuhn

Professor Richard Kuhn of the Kaiser Wilhelm Institut für Medizinische Forschung, Heidelberg, Germany, has been awarded the Nobel Prize in Chemistry for the year 1938 for his outstanding work on the carotenoids, flavins and vitamins B₂ and A.

Early in his career Kuhn was considered to be the most brilliant pupil of Richard Willstätter. He worked on enzymes and made very important contributions to our knowledge of the amylases and of peroxidase. During recent years Kuhn has been engaged in researches on natural pigments and has done brilliant work on the chemical constitution of kryptoxanthin, rhubixanthin, rhodoxanthin, saffron and azafrin. Mention should also be made of astacene, a pigment isolated from lobster.

The researches which brought Kuhn into the field of vitamins were connected with carotene, the familiar pigment of carrots. He fractionated carotene into α , β and γ -carotenes, and it was found that, of the three, β -carotene was the most potent as a precursor of vitamin A. In other words β -carotene was capable of replacing vitamin A in the diet, as it could be transformed into vitamin A in the body. He has later shown that carotene is not unique as a precursor of vitamin A, but that the pigment kryptoxanthin could also replace vitamin A in the diet, and in fact the vitamin A activity of yellow corn appears to be chiefly due to kryptoxanthin. His outstanding achievement

*Reuter informs from Stockholm in a telegram of December 7 last that the three German chemists have refused the Nobel prizes for 1938 and 1939 in chemistry. In accordance with a Reich State decree.

In 1936 the Nobel Committee awarded the Peace Prize of 1935 to Karl von Ossitsky, the leader of the anti-war movement in Germany. He was detained without trial by the Nazi Government and when the prize was awarded he was in sick bed in prison hospital. This award offended the Nazi Government and on January 30, 1937, a decree was promulgated which announced the award of three German National Scientific and Industrial Prizes, each of the value of R. M. 1,00,000 annually, and forbade people to accept the Nobel prizes.

in the year 1937 was the synthesis of vitamin A itself, which had been a trying problem to many leading scientists. The synthetic vitamin A was proved to be identical with the natural pure vitamin by feeding tests with rats.

The researches of Kuhn on vitamin B₂ and flavins are of epoch-making importance. The greenish fluorescence of whey, obtained after separating fat and casein from milk, has been long observed. But it was Kuhn who isolated from it the pigment concerned, which he called lactoflavin and which was found to be identical with vitamin B₂, as proved by growth promoting tests with rats. It is a new class of natural pigments for the first time recognised by Kuhn, and, since then, the same or similar pigments have been isolated from eggs, liver, kidney, malt, etc. Kuhn also accomplished the synthesis of lactoflavin and showed it to contain isoalloxazine and ribose residues. The lactoflavin is a yellow-orange compound giving a yellow aqueous solution with a greenish fluorescence. In combination with a protein it forms the 'yellow enzyme' of Warburg, concerned in tissue respiration.

Kuhn also recognised the existence of a fresh factor in the 'vitamin B-complex' and this factor, called vitamin B₆, has since been worked on by Kuhn, György and others. When the writer of this note met Prof. Kuhn at Heidelberg in January last, he saw a large quantity, nearly 10 grammes, of crystalline vitamin B₆, prepared by Prof. Kuhn in co-operation with the Badische-Anilin und Soda Fabrik of Germany. This vitamin has now been synthesised in Merck's laboratory in America.

Kuhn is a relatively young man and is at present engaged on even more interesting and original lines of biochemical enquiry.

B. C. Gupta.

Profs. Butenandt and Ruzicka

The Nobel prize in chemistry for the year 1939 has been awarded jointly to Professors A. Butenandt, Director of the Kaiser Wilhelm Institute of Biochemis-

NOBEL PRIZES IN CHEMISTRY

try at Berlin-Dahlem and L. Ruzicka, professor of organic chemistry, University of Zurich, for their brilliant contributions towards the discovery and artificial preparation of sex-hormones, which control the secondary sexual characters in males and females.

Professor A. Butenandt

It was in the year 1929 that Butenandt and Doisy succeeded, independently and almost simultaneously, in isolating the ovarian (follicular) hormone, 'Theelin,' $C_{18}H_{22}O_2$ (also known as oestrone) in crystalline condition, from the urine of pregnant women, and later from palm kernel. In 1934 he isolated, from corpus luteum, a crystalline female sex-hormone 'progesterone,' $C_{21}H_{30}O_2$, which helps in proliferation of the uterine mucosa necessary for the embedding and growth of the fertilised ovum. Butenandt, in the same year, confirmed its structure, by preparing this artificially from stigmasterol, the naturally occurring solid alcohol of soya bean.

Prof. Butenandt won world-wide recognition also through his researches on the discovery of the male sex-hormone 'androsterone,' $C_{19}H_{26}O_2$ (1931) and similar other physiologically active compounds obtained from male urine. Within three months after the isolation of another type of male hormone, 'testosterone,' by David and others from bull's testes (1935) (found to be 6 to 10 times as active as 'androsterone'), Butenandt prepared this synthetically from dehydro-iso-androsterol, which he could prepare from stigmasterol and thus confirmed its structure.

Recent works of Butenandt on the transition from androsterone to progesterone group (1939) (i.e., from male to female sex-hormone) and correlation of androsterone with the corticosterone group (crystalline substances which are reported to possess the biological activity of adrenal cortical extract) are not only of outstanding importance but also indicative of the dawn of a new era of biochemical discovery.

Works of Prof. Butenandt on the discovery of androsterone were reported from chemical laboratories

in Göttingen (1931). He was appointed professor of organic chemistry and technology in Danzig (1935) and was awarded the Emil Fischer medal by the city of Berlin (1935). He was then promoted to the post of the Director of the Institute of Organic Chemistry in the Technical University at Leipzig and afterwards appointed the Director of the Kaiser Wilhelm Institute of Biochemistry at Berlin-Dahlem. He has also been awarded the Rinecker gold medal by the University of Würzburg (1936) and the Scheele medal of the Chemical Society of Stockholm.

Professor L. Ruzicka

Since the discovery of the male sex-hormone, androsterone (1931), up to the beginning of 1933, only 25 mg. of the substance had been isolated and for this 50,000 litres of urine were required. This extremely laborious process of extraction of androsterone was done away with by the epoch making researches of Ruzicka and his assistants (Goldberg, Meyer, Brungger and Eichenberger) in 1934. He prepared it synthetically in the laboratory from epi-dihydrocholesterol (a stereo-isomer of the derivative of the animal sterol, cholesterol), which not only attracted scientists towards the artificial preparation of sex-hormones but also proved beyond doubt the correctness of the structure of androsterone as given by Butenandt in 1931.

In 1935 Ruzicka prepared a male hormone 'dehydro-iso-androsterone,' $C_{19}H_{24}O_2$, from cholesterol and succeeded in converting this, independently, to 'testosterone.' He has also prepared several physiologically active derivatives of androsterone and testosterone which are far more potent in their comb-growth activities than the original mother substances.

Apart from starting the new angle of vision (i.e., taking steric structure of the hormones into consideration) for artificial preparation of sex-hormones, works regarding the constitution of polyterpenes and polyterpinoids are also of outstanding importance.

The University of Basle has conferred the honorary doctorate on Prof. Ruzicka for his masterly works on sex hormones, sterols and steroids.

M. C. Nath

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Dr Millikan in India

DR. Robert Andrews Millikan, Director of the California Institute of Technology with two of his fellow workers Drs Neher and Pickering arrived in Calcutta on the 25th November last for the purpose of continuing their study of the intensity variation of cosmic rays at different latitudes in India. Professor Millikan is too well-known in the world of science for his experiments in connection with the precise determination of the elementary electric charge of the electron and the value of 'h,' the Planck's Constant which won for him the Nobel Prize in Physics in 1923, and his researches in connection with the region of the spectrum lying between the ultra-violet and the X-rays and the nature and origin of cosmic radiation. Dr. Millikan and his colleagues Dr G. E. Hale and Dr Noyce were instrumental in bringing together professors and men with sufficient money for starting the California Institute of Technology. This institute, as is well-known, has designed the 200 inch telescope which will be very useful in the study of the most distant parts of space hitherto unexplored and will enable astronomers to throw much light on the problems of the expanding universe. Many pupils of Dr. Millikan have won fame and renown in the domain of physics and mention may be made of Dr Anderson who was recently awarded the Nobel Prize for his discovery of 'positron,' the positive atom of electricity. We have published elsewhere in this issue a short account of his visit to our country.

Sir J. C. Bose Memorial Lecture

THE Bose Research Institute was founded on the 30th November, 1917, by Sir J. C. Bose. Every year on the anniversary day, Sir Jagadish gave an address reviewing the work carried out in the Institute during the past twelve months. After his death in 1937, the Governing Body of the Institute decided to institute a Sir J. C. Bose Memorial lecture to be delivered every year on the 30th November. Last year Dr Rabindra Nath Tagore was invited to deliver the first Sir J. C. Bose Memorial Lecture. This year Prof. Meghnad Saha, F.R.S. was invited to deliver the second Sir J. C. Bose Memorial Lecture. Prof. Saha chose for his subject "Worlds, Atoms and Nuclei" and delivered a fascinat-

ing lecture reviewing the topography and the nature of the physical world. The Director, Dr D. M. Bose, presented before the audience a short review of the scientific activities of the Institute carried out in the various departments during the past year, a summary of which is published elsewhere in the current issue of our journal (see p. 438).

Indian Historical Records Commission

THE sixteenth Indian Historical Records Commission was held in Calcutta on December 13 and 14, and was attended by distinguished scholars from all parts of the country. The proceedings were opened in the Darbhanga Hall of the Calcutta University by His Excellency Sir John Herbert, Governor of Bengal, and was presided over by the eminent historian Sir Jadunath Sarkar owing to the unavoidable absence of Sir Girija Sankar Bajpai, who was the President-elect for the session. In his address Sir Jadunath pointed out that in England all historical documents in the possession of the Government are thrown open to scholars if they are 70 years old but in India though scholars are crying for a long time for the same liberality in respect of documents 120 years old, the Government treats them as a miser's hoard to be kept buried in dark cells. Dr S. N. Sen, Secretary to the Historical Records Commission informed the house that the Political and External Affairs Department of the Government of India has at last agreed to relax the present restrictions in connection with throwing open their historical records to genuine research scholars and he had reasons to believe that the Department was prepared to go a long way in removing the grievances so eloquently voiced by Sir Jadunath Sarkar. It is earnestly to be hoped that students of history all over India would have the fullest facilities to make use of historical records in the archives of the Government.

Indian History Congress

THE necessity of co-ordinated efforts for the preparation of a comprehensive history of India was emphasised by Dr Ramesh Chandra Majumdar in his presidential address delivered at the last Indian History Congress at Calcutta held on December 15 last. In order to achieve this object and to direct properly the course of Indological studies the president recommended the

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formation of a permanent National Academy of Historical Studies whose activities would be of a more continuous character and not confined to annual sessions only. The President drew attention to the unfortunate and undesirable regional bias which has revealed itself in the recent historical writings of some Indian scholars and warned against this growing menace of provincial outlook in historical studies. He also deprecated the nationalist outlook in historical studies and the attempt of some Indian writers to maintain, without proper regard to historical evidence, that everything in our past was beyond criticism and contained all the elements of progress. Turning to the study of Indian history, the President remarked that though some progress has been made in recent years, Indian scholars have not yet engaged to any extent in the task of unravelling of the obscure period of the Indus valley civilization and filling in the wide gap in our knowledge of the period between the well-known epochs of the Rig-Vedic and the Puranic civilization. The growth of art or religion in India was evidently a very complex process and not one of simple evolution from Rig-Vedic times. Probably the Vedic and Indus valley civilizations flowed for a long time parallel to one another and later united to form the mighty stream of Hindu civilization, which took definite shape in the first millennium B.C. For a study of that period the archaeology department must come to the aid of Indologists and the activities of the department should be concentrated to the discovery and exploration of sites likely to yield materials for the study of history of this period. Dr Majumdar also drew attention to the importance of the study of Indian culture and civilization in central, eastern and south-eastern Asia.

Solving India's River Problems

HOW India's irrigation and allied problems are being solved in the various Irrigation Research Stations in the country are detailed in the Report of the Central Board of Irrigation in India for 1937-38 just published. At the Central Hydrodynamic Research Station at Khadakvasla, (Poona) studies of far-reaching importance are being made on models of the behaviour of rivers, both as regards changes in their natural courses and attacks on engineering structures. Experiments have been made to find out how cross flow above the barrage at Banbassa on the Sarda River could be prevented. The relevant factors have been studied and further experiments are to be continued to test the proposals theoretically worked out. Details connected with the construction of a railway bridge across the Brahmaputra River at Amingaoan where the river is about half a mile wide, have been worked out on models and a suitable alignment for the bridge has been proposed. Experiments are now in progress on the amount of scour that may be anticipated round the piers. On the large scale model of the Ganges

above the Hardinge Bridge, studies are being continued on the changes likely to occur in the river course during the next few years. Investigations have also been made on models of canal head regulators to find out how silt could be excluded.

A great deal of work on models was done at the Punjab Irrigation Research Institute as well but this formed only a part of the activities of the Institute. The main interest in the work undertaken by it appertains to land reclamation and the problems connected with sub soil water. The Punjab offers a vast field for these enquiries and definite advances have been made in ascertaining the causes of the rise of ground water and the methods of combating the evils attendant thereon. Further improvements have been made in the sodium carbonate treatment evolved by this Institute for the reduction of losses from canals by seepage. On models, investigations have been made on training works on the river Sutlej at Palla Headworks and on various weirs, under sluices, and canal falls. The relation between the yield and draw-down, yield and diameter and yield and shrouding in tube-wells, has also been studied in models and certain helpful conclusions have been reached.

At the Irrigation Research Division, Bombay, investigations have been carried out in land reclamation, land drainage and the effect of irrigation on different types of soil, while the main research activity in the United Provinces has been confirmed to the determination of losses from canals and means of preventing them. In Sind investigations in a variety of subjects have been carried out by the Development and Research Division, chief among which were the experiments to corroborate and enlarge the theories on silt. A study is proposed on the absorption and evaporation losses in water courses, passing through different typical soils in Sind, and preliminary arrangements have been completed for the necessary experiments.

The various investigations carried out, were reviewed by the Central Board of Irrigation and its Research Committee at their meetings, and, in addition there was considerable discussion about the effect of deforestation. The lack of forest cover, it was pointed out, not only caused increased flooding but meant the ruin of vast areas of land because of the removal of the top soil by flood water. To combat the evil, suitable machinery has yet to be developed by all Provincial and State Governments.

Micronutrients and Plants

RECENT experiments have shown that several elements, till lately considered inessential, must be present in traces in the soil for full and healthy growth of plants. It was known in the last century that potassium,

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calcium, magnesium, iron, sulphur, phosphorus and nitrogen are essential for plant growth. The last three enter into the composition of certain vital plant proteins, magnesium forms part of chlorophyll molecule and iron in small traces is necessary for building up of chlorophyll. A complete culture solution has been recently prepared by Shive and Tottingham with only three salts in solution viz., potassium hydrogen phosphate, calcium nitrate and magnesium sulphate with a trace of an iron salt. But attempts to grow plants in such solutions failed in the case of such common plants as flax and tobacco. For perfect growth the plants needed a trace of the element boron. This element has been found to be important micronutrient for a number of other plants like beans and citrus fruits like oranges or lemons. Effect of boron deficiency gives rise to various plant or fruit diseases and application of boric acid to the soil stops these difficulties. Other elements which act as micronutrients towards certain plants are iodine, manganese, copper and zinc. The last named is essential for grape fruits.

Contemporaries of the Mammoth

PROF. P. Kapterev has recently published an account, says *Russia to-day Press Service* of Sept. 13, 1939 of his experiments* with organisms contained in frozen soil in Siberia. Information regarding the flora associated with the mammoth has been known for years from the contents of the food canal of frozen animals. But it is now announced that plants and animals contemporaneous with the mammoth have been brought to life after lying in a state of suspended animation for at least twenty thousand years. The soil from which the organisms have been obtained were at a depth of 132 feet, far within the limit of the permanently frozen soil. In contemporary strata were discovered bones of mammoths, woolly rhinoceros, bison and musk-ox, indicating a period contemporary with the interglacial period which came between the last two Ice Ages. The soil samples placed in sterilized containers and in sterilized atmosphere yielded living organisms, which included several kind of soil bacteria including a distinctive nitrogen bacterium, fungi and water plants, the majority being closely related to present day forms. From another sample taken from a depth of 14 ft. and of later geological period, twenty different kinds of water plants, mosses, filaments of fungi and a crustacean were obtained, and placed in favourable laboratory conditions these organisms began to multiply rapidly. But this stratum is only about 3000 years old.

*A short account of the experiments has reached our hands and will appear in the coming issue of this journal.

Indian Science Congress

The 27th session of the Indian Science Congress will meet this year at Madras from the 2nd to the 8th January. There are this year thirteen sections. In the mathematics section Prof. A. C. Banerji of Allahabad will deliver his presidential address on 'The Development of Galactic Dynamics and some Allied Problems,' in the physics section Prof. K. S. Krishnan of Indian Association for the Cultivation of Science on 'The Diamagnetism of the Mobile Electrons in Aromatic Molecules,' in the chemistry section Dr S. Krishna of Forest Research Institute and College on 'The Role of Chemistry in Forestry,' in the geology section Prof. L. Rama Rao of Bangalore on 'Recent Advances in our knowledge of the Upper Cretaceous and Lower Eocene beds of India with Special Reference to the Cretaceous Eocene Boundary,' in the geography and geodesy section Dr Shibaprasad Chatterjee on 'The Place of Geography in National Planning,' in the botany section Prof. Y. Bharadwaja of Benares on 'Some aspects of the Study of the Myxophyceae,' in the zoology section Prof. B. K. Das of Hyderabad on 'Nature and Causes of Evolution and Adaptation of the Air-Breathing Fishes,' in the anthropology section Rao Bahadur K. N. Dikshit of Archaeological Survey on 'Scope of Prehistoric and Anthropological Work in India,' in the medical and veterinary research section Dr J. R. Haddow of Imperial Veterinary Research Institute on 'Development of Animal Husbandry in India,' in the agriculture section Rai Sahib Jai Chand Luthra of Punjab Agricultural College on 'Industrial Utilization of Agricultural Products in India,' in the physiology section Dr W. R. Aykroyd of Nutrition Research Laboratory on 'Rice,' in the psychology section Dr D. D. Shendarkar of Hyderabad (Dn.) on 'Psychology and Educational Research.'

A series of interesting discussions have also been arranged, and the following are some of the subjects: 'Recent Biological Control Work on Indian Insect Pests' (Sections of Entomology and Agriculture), 'Geography Syllabuses in the Universities' (Section of Geography and Geodesy), 'Types of Topography based on the Erosion of Rocks' (Sections of Geology and Geography and Geodesy), 'Nutrition of Cattle and the Fodder Problem in India in relation to the Human Food Problem' (Sections of Agriculture and Medical and Veterinary Research), 'Industrial Utilization of Agricultural Products in India' (Section of Agriculture), 'The Role of Science in National Plannings,' 'The Ice Age (Pleistocene) in India' (Sections of Geology, Physics, Geography and Geodesy Botany, Zoology, Entomology and Anthropology).

SCIENCE IN INDUSTRY

Power from the 'Valley of Hell'

IN northern Italy there is a valley which is known as the "Valley of Hell." It is so called for its great source of subterranean steam. Italy lacks in coal resources and oil reserves. So Italian engineers have now looked to this natural source of steam, which issues from the earth at a temperature of 220°F. Already 300 live steam wells have been sunk to provide steam for producing nearly 1,200,000 kWh of electrical energy daily. Some of the steam wells are 1000 ft. deep and required as much as a year to drill. Steam so obtained is used to produce steam from pure water, which in turn is used to drive turbines, since the steam from the wells are contaminated with chemicals. After proper condensation these chemicals are also recovered from the steam. More than 8,000,000 tons of chemicals: pure borax, carbonic acid, ammonia, boric acid, and other useful products are furnished as by-products in this steam power development.

—N. K. S. G.

Electrical Gauge for Water Levels

AN electrical gauge depending on the change of resistance caused by the fluctuations of the level of the water in the river has been devised in the Punjab Irrigation Research Institute and installed in the River Chenab at the Khanki Head. The contrivance enables the gauge in the river to be read off in the telephone hut which is about four hundred yards away from the gauge well. The apparatus is under observation and has so far worked satisfactorily.

Measuring Smoothness of Surfaces

A DEVICE sensitive to indicate the differences in thickness of a finger print on a piece of smooth glass has been developed in the G. E. C. Laboratory at Schenectady, U. S. A. The instrument is being used to determine the smoothness of metal or painted surfaces and indicate minute variations far beyond the human eye. Variations of as little as 1/10,000,000 inches are clearly indicated. The outward appearance of the apparatus is somewhat like that of a phonograph. The object to be tested is placed on a turntable and a sapphire-pointed stylus or needle passes over the material as it revolves.

Small mechanical impulses are created as the hard point rides over surface irregularities. These impulses are then converted to electrical impulses and after proper amplification graphically recorded. The stylus or needle is so sensitive that when it is placed on the revolving turntable, the invisible vibrations produced by a person whistling are shown on the recording meter. The surfaces of bearings and other moving parts of motors and other sensitive parts of instruments which are subject to wear may be tested for their smoothness by this instrument.

—N. K. S. G.

Fritted Metal Filters

FILTRATION of alkali hydroxides is a difficult problem. Pure nickel is the only material which is stable towards sodium and potassium hydroxides at any concentration and up to 500°C. So nickel filters have been prepared in Germany by sintering powdered nickel with heat. By a proper choice of size, form, and surface of the powered particles, as well as the temperature, pressure, and duration of sintering, filters of different porosities have been prepared. Where an especially high porosity is desired, the metal powder is mixed with a solution of foaming agent and worked to a froth, which is then dried and sintered.

—N. K. S. G.

Cattle Feed from Molasses

BAGO-MOLASSES feeding trials have resulted in satisfactory progress in the general condition, health and milk yield of cows and steady increase in the weight of heifers. Bago-molasses have also proved to be an economic substitute for part of daily rations to dairy cows, heifers and bullocks.

The importance of the use of molasses in India arises from the scarcity of fodder and the possibility of export specially to Britain. £4,000,000 worth of cattle feeds were exported from this country to Britain in 1938. No reliable figure of the extent to which molasses can replace other feeds is available from the experiments carried on by the workers in different countries. Besides, it was necessary to study the use of molasses as cattle food under Indian conditions; and with this object the Imperial Council of Agricultural Research sanctioned the scheme.

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The programme of work consisted in designing, installing and testing machinery and appliances to be used for making cattle feed; and preparing cattle feeds of different compositions and carrying out feeding trials to assess the value of the feeds. Preliminary equipment having been provided, feeds were prepared containing bagasse screenings, oil cakes (ground nut, linseed or mustard) and molasses in the proportion of 2, 3, 4 respectively. About 1,500 maunds were sent out during 1936 and 1937 to ten animal nutrition centres.

One maund of Bago-molasses was substituted for Re. 0-11-4 worth of ration during working days and Re. 0-14-8 of wheat bran (2/3 maund) during idle days for bullocks at Patna; Re. 0-13-8 of standard mixture (1/3 maund) at Bangalore; Re. 0-8-0 of wheat bran (3/10 maund) for milk and young stock at Naini and Re. 0-10-0 of standard mixture (1/5 maund) for milk cows and Re. 0-9-7 of the mixture for dry cows and Re. 0-12-0 for hill-plough bullocks at Mukteswar. Cost of Bago-molasses (including raw materials at the present rate) at present works out at Re. 0-7-9 approximately per maund. Employment of machinery for the various processes is likely to reduce the cost to Re. 0-6-6 per maund of feed.

Artificial Lightning Strokes

WESTINGHOUSE Co. of U. S. A. has perfected a method by means of which an artificial discharge can be produced which like natural lightning is able to set fire to materials on its path. Known as "hot" lightning this form of discharge is now used by Westinghouse for the routine testing of all high tension power transformers. The tests are carried at 1500 kV and 80,000 amp. In the previous methods of creating discharge flashes, the heat generated was intense, but did not last long enough so as to set fire. In the "hot" lightning stroke, a low-amperage, long-duration stroke follows the main and "leader" lightning discharge, as in the case of natural lightning. The after-stroke of "hot" lightning generates temperatures only half as high as the main stroke, but the duration is between 100 and 1000 times as long. The protracted charge is produced by means of additional condensers or by a transformer from which the charge is passed through a series of resistance inductance coils in oil and permitted to follow the initial high current discharge relatively slowly. Demonstrations of "hot" lightning shown by Westinghouse engineers include the fusing of sand in a fibre tube, setting fire to cotton cloth, and burning holes through copper sheets varying from 1/32 to 1/16 inch thick.

—N. K. S. G.

New Use of Bagasse

A PLASTIC compound made from the lignin and cellulose of sugarcane bagasse has been manufactured by chemists of the United States Department of Agriculture. The first method is by hydrolysis with acid. Plastics made from the compound, while not so strong as some synthetic plastics now in use, are quite moisture resistant. The second method is hydrolysis in the presence of aniline, a coal tar derivative. Products of this method have resisted bending pressures up to 9000 lbs. per sq. in. They can be used as table tops and building panels. Treating the bagasse with sodium hydroxide and furfural is the third method and the plastics obtained from this method acquires qualities midway between the other two.

Alternative Fuels for Motor Vehicles

DUE to the strict rationing of petroleum for public and private uses during war, the engineers in England are looking for other alternative fuels. The alternative fuels actually available fall into three groups: liquid fuel such as heavy oils, paraffin, benzene, and methylated spirit; solid fuels in the form of coke, coal or charcoal; and gaseous fuels in the form of coal gas, blast furnace gas, or butane. Since all sorts of liquid fuels are imported in England from outside the first group automatically drops out. But England has got ample stock of coal. So it has been suggested that producer gas driven engines be substituted for fuel oil engines. Actually automobiles are being designed and running on producer gas. The existing petroleum driven cars can be converted into a producer gas driven one by a slight change in the engine and by attaching a portable producer gas plant to it. Different designers are working and perfecting it. Already Brush Engineering Co. Ltd., are manufacturing gas producers named "Brush-Koela" producer plants which can be used to drive all types of internal combustion engines and all classes of motor vehicles.

In England coal gas was used in the last war also for road transport. The gas was carried in collapsible containers on the roof of the vehicles under low pressure. This type of cars are already showing their appearance. But the disadvantages of this type of low pressure gas is that the capacity is so low that the range of operation rarely exceeds 20 miles. To increase the range high pressure gas cylinders are being used, but this again increases the cost of the charging plant. In order that sufficient gas may be carried to give a reasonable radius of action, the gas has to be at a very considerable pressure, a pressure in the neighbourhood of 3000 lb. per square inch being used. The cylinder must be light if the dead weight is not to be excessive. There are few charging plants available in England for this

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type of cars also. These two types of gas automobiles have the advantage over gas producer in that they do not occupy valuable car space, and so will find their use in light type of cars.

Next the use of storage batteries for driving the heavy types of lorries is being advocated. Apart from the above ways described above, there is another way which though not practicable at present may, in future, solve not only the fuel problem of England, but that of the whole world with respect to efficient generation of energy. The present methods of converting the energy stored in fuels to available energy has a maximum overall thermal efficiency of 30 to 35 per cent. That means, 30 to 35 per cent of the total energy liberated by the combination of fuel with oxygen is only useful, the rest being lost to us. But if it were possible to convert the energy liberated by the combination of carbon of the fuel and the atmospheric oxygen directly into electrical energy in a fuel cell electrochemically, the overall efficiency would have been cent per cent. With such a successful fuel cell, besides the enormous drop in the cost of power, there would have been no smoke nuisance. But all schemes so far proposed and tried have been fruitless. But with continued research we can hope to use commercially such a method in near future.

—N. K. S. G.

Television and its Future

At the beginning of civilization man was subjected to certain limitations. His reach was limited to the length of his arm, his spoken words to the carrying

power of his voice, and his vision was restricted to the limited circle surrounding him. One by one, these limitations have been removed. Electricity has enabled him to control power and direct activities miles away, telephone and radio have carried his voice around the world, and now television is breaking the bonds of the third limitation, i.e., enabling him for the first time to see events occurring beyond his horizon at the very instant they happen. The future of television is tremendous. Gradually the difficulties that seemed insuperable are being overcome through continued research. Already transmissions on a smaller scale are being effected successfully in America, and the American experts are of opinion that within 6 to 8 years, the system will be so perfected, that just like radio receivers television receivers will be standard equipment in millions of homes.

The principle of working of television is as follows. The scene to be televised is photographed, or rather "viewed," to use a more nearly accurate term, by the television camera. The television camera lens focuses the scene or picture on a plate mounted in an evacuated tube, called the camera tube. The resultant latent image is photoelectrical; i.e., the vacuum-sealed plate is a sheet of mica coated with millions of tiny drops of silver, which are sensitive to light. These drops of silver acquire electric charges when the camera lens focuses light on the plate. An electron beam moves across the plate at high velocity removing the electric charges from the plate. These charges then pass into the transmitting equipment and are finally radiated in much the same manner as in normal radio broadcasting.

—N. K. S. G.

Modern Boilers and Their Developments

N. K. Sen Gupta

College of Engineering and Technology, Jadavpur.

When James Watt sat in front of the mythical teakettle and conceived the idea of utilising the power of steam, he started something so vast, and so tremendous in its import for the human race that could poor Watt have foreseen the full consequences of his discovery, he might well have put the lid back on the kettle, made a cup of tea, and let it go at that.

Whether he actually ever sat in front of a teakettle is not known; probably he did not, though it is popular history, because the origin of the idea of using steam power is lost to antiquity. We find the first record of the steam engine in Hero's engine, described by Hero, the younger, and dated about 120 B.C., Porta De Cause, and Branca in the period between 1600 and 1629 sug-

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gested crude schemes for utilising the power of steam but it was not until 1663 that Edward Somerset, an English nobleman, actually built a steam engine. Then came Samuel Moreland, Papin, Savory, Newcomen and finally James Watt. What actually happened was that a model of a Newcomen engine was given to Watt for repair and he, being an ingenious young man, soon became aware of its numerous deficiencies which led him to device a better one.

Steam is only a medium for the conversion of the thermal energy, stored in fuels, to mechanical and electrical energy; and the mechanism consists of two essential parts, one the steam generator or boiler, where water receives the heat of combustion of the fuel and is converted to steam, and the other the prime mover which transforms the energy from the steam to mechanical or electrical form. In order to increase the overall thermal efficiency, radical changes have been made in both the fields, as for instance Watt's steam engine has been replaced by turbine in modern big power plants. But this article will deal with boiler developments only.

The changes in the field of steam generation is radical and startling. During the past twenty years boiler pressures have increased from 350 to 2500 pounds per square inch, rates of evaporation per boiler from 150,000 to 1,000,000 pounds per hour, and total steam temperature from 600° to 1,000°F. Side by side corresponding progress has been made in the conditioning of boiler feed water. The complexity of a modern boiler has been increased much by its associated equipments. To quote one authority, "A modern boiler is a 'fearsome' thing, something which must have its origin in some diabolical scheme to confound the human race in its efforts towards greater power."

What are the advantages of so much abnormal increase of temperature, pressure, and capacity? From the standpoint of pure thermodynamics the conversion of heat energy in steam to mechanical energy in a prime mover follows Carnot's cycle and the efficiency of conversion is according to the formula $\frac{Q(T_2 - T_1)}{T_2}$ where Q is the quantity of heat per unit weight of steam, T_2 is the temperature of steam, and T_1 that of the cooling water or refrigerator, as it is thermodynamically called. So it is apparent that by increasing T_2 , both the values

of Q and $\frac{T_2 - T_1}{T_2}$ increase, with consequent increase of efficiency. Moreover the effect of moisture in the steam is deleterious to turbine blading, so for straight power generation high temperature is more important due to the necessity of keeping moisture at the turbine exhaust within 10 to 12 per cent. In order to obtain

high temperature the boiling point of water is increased by increasing the superimposed pressure on it, and then superheating the steam so obtained. In modern power plants steam is bled at definite pressures from different points of a turbine, either for heating purposes or for by-product power generation. Where steam is needed at definite pressures, more than a few degrees of superheat is superfluous. With exhaust conditions fixed in this way by-product power generation in usable quantities require higher pressure rather than higher temperature.

The present temperature limits are fixed entirely by metallurgical considerations and the use of still higher temperatures is dependant upon the researches of the metallurgists in the development of the steel alloys capable of withstanding higher temperatures and pressures. At temperature of 900° to 1,000°F. the metal in contact with steam is red hot and is subject to the action, which is called creep, that is, permanent elongation of the metal with time. Many excellent researches have been done and more is being done on the creep properties of different types of steel and while progress is slow, steels are being produced, which are capable of being used at temperatures in the range between 900° and 1,000°F. with good results.

Apart from the thermal economy of high pressures, the question of pressure is equally important. It has a definite bearing on the size of the equipments used, particularly in turbines, where size is very important in determining cost. One pound of steam at 0°F. and at an absolute pressure of 2,000 pounds per sq. in. occupies a space of less than 0.2 cubic feet, whereas at a pressure of 200 pounds per sq. in. the same pound of steam will occupy a volume of 2.3 cubic feet, and at 20 pounds per sq. in. 20 cubic feet. From this it is quite obvious that pressure has a great deal to do with the size of the steam passages in a turbine or engine and hence with the cost. Moreover, the volume per unit weight of steam being less with increase of pressure, the volume or floor-space of the boiler proper need not be increased with increasing capacity. As for example, a boiler installed in 1936 in the Rouge plant of the Ford Motor Co., U. S. A., produces a million pounds of steam per hour at 1340 pounds pressure and 910°F., and occupies the floor space in which formerly stood a boiler producing 200,000 pounds steam per hour at 240 pounds. Thus five times the steam is being produced at approximately five times the pressure in the same floor space.

The abnormal high capacity of the boilers owes its origin to ever increasing demand for power. Just as in the case of other industries where the cost of manufacture decreases with bigger output, so also in the case of power generation the cost of power per unit is less when the production is increased. The efficiency increases

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with increase of load factor. So the trend is nowadays towards the erection of a central power station and to distribute the power so generated to different consumers. In 1918 when the typical large boiler house contained long rows of boilers, it was stated in a lecture that "one boiler in every five or six should be spared to provide for cleaning and repair." But today due to the perfection of the automatic controlling equipments for boilers and stokers, etc., the breakdown and consequent repairs have been almost eliminated, and so it is now quite possible to run a big power house with a single boiler.

But with centralisation of power generation, much complexity has been introduced into the steam generation systems. For, a difference in efficiency of a few per cent in the case of a small generating unit makes comparatively little difference in the total cost of operation, but the same percentage in the case of large unit runs to many thousands of rupees annually as savings or loss.

Continual replacement of smaller units by bigger ones are going on, but military considerations may limit the extent to which centralisation can be carried. Actually there has been a case in England whereby a public utility company had to change their site twice for vehement protest from the locality, who objected to have an object of air raid in their vicinity.

Watt's boiler was in reality a steam kettle with much water space, and working at a pressure of 5 to 6 pounds per sq. in. As the necessity for more and more steam increased, the heating space was increased by adding a few tubes through which either water or hot flue gas was allowed to pass. Thus during the period between 1780 and 1800 Trevithick invented the Cornish fire-tube boiler, cylindrical in shape, and John Blakey patented the first water-tube boiler in the year 1766. The first sectional water-tube boiler with well-defined circulation was built by Joseph Eve in 1825, but early developments were slow. By rapid advances the pressure rose from 5 to a range of 20-25 pounds, and then to 50 pounds per sq. in. and gradually the Lancashire and other cylindrical boilers and other water-tube boilers came into existence. Even in those early days of 1827, Jacob Perkins, an American by birth, designed and operated boilers at pressures as high as 1600 pounds per sq. in. He also constructed engines operating at 800 pounds per sq. in. pressure, but since he was a century ahead of his time, he met with little sympathy or support.

A modern steam generator is essentially a water-tube boiler, containing a very little space for water compared to its steaming capacity, and its adjustment to varying conditions of load is brought about by automatic

control apparatus regulating the fuel, water, and air supplies. Drum sizes have been much reduced, indeed, some modern boilers have only sufficient water space to run only a couple of minutes at normal capacity. So feed water control and regulation and instantaneous control of combustion are of utmost importance from the standpoint of boiler safety. The drums and tube joints are made by fusion welding methods. The tubes connecting the drums, etc., are bent, since scale formation in a modern boiler is almost nil, and since bent tubes provide for expansion and contraction at high temperature without undue strain on joints and boiler parts. Also with bent tubes the distribution of the heat absorbing surface is more easier and effective. The number of drums vary from two to ten. A modern boiler comprises mainly of the following parts: suitable furnace with stokers or proper arrangement for fuel feeding and removal of the ash and fly ash separator where needed; economizer, air pre-heater, superheater, desuperheater, reheater, steam drier, and washer, feed water regulators and other auxiliary automatic control apparatus, etc.

Furnace:—In order to decrease space and increase the capacity, modern furnaces are designed for heat release of 20,000 to 84,000 B. t. u. per cubic feet per hour. With solid refractory walls heat release is generally not over 12,000 to 15,000 B. t. u. per hour per cubic feet. In order to receive such an enormous heat release without any damage to the furnace walls, and without any heat loss to the surroundings, water-cooled and steam-cooled furnaces have been designed. Water-cooled furnaces, are surrounded by tubes through which water from the water drum circulates to the steam drum thus absorbing the heat from the furnace in its passage. Steam-cooled walls are those where steam from the drum passes through the tube walls, which functions as a superheater or a low pressure steam is passed through the tubes, where they function as a reheater.

Solid fuels are introduced into the furnace on travelling grate stokers, which are of many types, such as overfeed, underfeed, pneumatic spreader stokers, named according to the manner and mechanism of the feed. But most of the modern boilers are fired with any of the three, pulverized coal, gas, and oil. Report from three principal boiler manufacturers show that out of 335 boilers installed between the years 1932 and 1937 with 100,000 pounds per hour capacity and above, 182 were pulverized coal fired, 67 were stoker fired, 60 were fired with gas or oil, and 26 were fired with mixed fuel.

Where formerly 40 to 50 pounds of coal per square foot of stoker grate surface was considered maximum, today as much as 85 pounds per sq. ft. can be burnt. This increase was brought about largely by better control of air distribution through the fuel bed. On travelling grate stokers, the combustion is progressive with the ash going over the end of the stoker to the

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ash pit for removal, without any interruption to the boiler service. For use with low-fusion-ash coal, water-cooled stokers have been developed which are giving good performance.

In the case of pulverised coal firing two types of furnaces are in general use, one the so-called dry-bottom type which disposes off the ash in dry granular form and the other the wet-bottom furnace in which the temperature is kept high enough to liquify the ash and then tap it from the bottom of the furnace. The latter type which is called slag-tap furnace has some advantages in that it entrains a certain amount of fly-ash that would escape from the boiler with a dry-bottom furnace, but it has also limitations as regards the rating at which boilers can be operated. From the standpoint of health and sanitation, powdered coal fired furnaces are also provided with Cottrell electrostatic precipitators in order to free the flue gas as completely as possible from fly-ash. Other forms of fly-ash separators, such as screens, baffle traps, cyclone collectors, rotating centrifugal separators, are also being used.

Economiser, Air-preheater, Superheater, and Reheater: For every fall of 30°F. in stack gas temperature one per cent of the fuel cost is saved, and the temperature of the flue gas as it leaves the boiler proper ranges from 50° to 100°F. higher than the saturated steam temperature generated by the boiler itself. So the importance of the economiser and preheater can be imagined. They reduce the flue temperature by 250° to 300°F.

In modern boilers feed water is heated by the steam bled from the turbine at as many as five points, which then passes through the economiser, where it is further heated, and thence to the water drum. The circulation then divides, a part of the water going to the water walls, and the remainder through the boiler section; the steam generated rises to the steam drum, where separation from water takes place, then the steam is passed through the superheater to the high pressure turbine from which it exhausts at medium pressure and with very little superheat. This exhaust steam is led through reheater (which in fact is nothing but a superheater) where it is reheated, or in fact superheated, to a temperature that will enable it to expand through the low pressure turbine without excessive moisture being formed.

The burning fuel in the furnace is supplied with hot combustion air from the preheater and gives up much of its heat by radiation to water walls or steam walls; the hot gases then by convection carry the remainder of the heat from the furnace, and passes over super-

heater and in turn over economiser and preheater, whence they leave for the fly-ash collector and then to the stack.

For the enormous amount of heat released per unit volume of the boiler furnace, air preheat is very essential and in the case of pulverised coal both the primary and secondary air needed are heated up to 350° to 400°F. Many steam generating units in operation today have greater surface in the economiser than they have in all of the rest of the boiler, ranging in a particular installation as high as 67.5 per cent, average being 40 to 50 per cent. With increase of steam temperature, superheater area has also increased and in part they have been placed inside the furnaces. On the average they occupy from 15 to 40 per cent of the total heating area. Water walls occupy from 5 to 20 per cent of the total. Side by side heating area in the boiler proper has been reduced, being as low a figure as of 7 per cent of the total in a particular installation. Boiler surface proper will decrease still further with more and more increase of pressure, for the latent heat of steam decreases with increase of pressure. Thus in a steam generator operating at the critical pressure, where the latent heat is zero the boiler section will disappear completely, leaving only two sections, an economiser and a superheater.

De-superheater, Steam drier and Washer: The above are also integral parts of a modern plant. It must be realised that with hundreds of thousands of pounds of steam delivered by a boiler, even a fraction of a part per million of contaminating solids in the steam, in form of entrainment, may deposit many pounds of solids in the superheater as well as in the pipe lines and turbines. So various arrangements for washing and scrubbing the steam are made. De-superheaters are also required to take care of the temporary unbalance in operating conditions which provide protection against excessive high temperatures.

Feed water treatment and control: The old time lime-soda or zeolite process of water softening do not suffice for the modern plant. Just like air conditioning, boiler water is now also conditioned with respect to different salt contents and pH or acidity, so that there may be absolutely no scale formation, no corrosion, and no embrittlement of the heating surfaces. The residual calcium, after preliminary treatment with zeolite or lime-soda, is further precipitated by treatment with sodium orthophosphate, frequently mixed up with organic materials such as tannin, etc. Many other organic base exchangers have been developed and continued research is being carried on in this line. With phosphate conditioning, the scale problem, which was due to calcium and magnesium salts, appeared to have been completely solved, but with a steady increase in boiler pressure and rate of heat input, a new type of

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scale was found to be formed. This is essentially a sodium aluminium silicate, corresponding in some cases with the formula $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2 \cdot 2\text{H}_2\text{O}$, and is so hard that a turbine cutter will slide over their surface. This difficulty has also been conquered by substantial elimination of alumina or nearly complete removal of silica from the original feed water.

Of all the methods for conditioning feed water to prevent corrosion, deaeration, the use of chemical scavengers, such as sodium sulphite or ferrous hydroxide or some organic materials, for the residual oxygen after deaeration, and close control of alkalinity, is the best at present. The technique of deaeration has been perfected to such an extent that water containing as little as 0.005 parts per million of oxygen can be prepared. And this oxygen is further removed by chemical scavengers added. Controlled alkalinity keeps the oxide coating on the steel in the most protected state.

It has been believed that intergranular cracking and subsequent failure can be prevented by keeping a definite ratio of sodium sulphate to total alkalinity. But very recent investigations have shown that sodium sulphate has little to do in causing embrittlement. In 1934 it was found that caustic soda, long regarded as the primary cause of embrittlement, did not produce intergranular cracking when pure. A year later the answer to this riddle has been discovered in silica, which, when present only in very small amounts changed the general surface attack of caustic on steel into selective corrosion. And side by side laboratory tests showed that sodium sulphate has little effect in preventing cracking. Instead it was discovered that lignin derivatives from sulphate waste liquor and certain tannins were the most effective inhibitors of intergranular corrosion by solution of caustic soda containing silica usually present in feed water up to a temperature of 480°F. At higher pressures and temperatures this combination failed but maintaining a ratio between Na_2O_3 and silica at 0.6 seems so far to afford protection.

Continuous carryover of droplets of water has been recognised as a mechanical problem and has been largely solved by steam washers etc., but foaming is a problem of water conditioning. The development of foam is attributed to suspended solids, dissolved solids, alkalinity, and contamination with oil containing saponifiable materials. Various antifoam compounds are available, but none is quite satisfactory. It is only controlled to some extent by keeping down the alkalinity and other materials in the feed water.

From the above descriptions it will be clear that the control of a modern power plant is almost a super-

human affair. Control arrangements must be very sensitive, and indeed, it is due to the degree of perfection of control mechanisms that such high pressures, temperatures, and capacities have been made possible. The net result is that the overall thermal efficiency has increased from 10,000 to 11,000 B.t.u. per kilowatt hour.

There are now some unconventional or unorthodox types of boilers, in which the designers have abandoned the common course and adopted quite new ideas. First, of all comes the mercury boiler, experiments with which are being carried on by G. E. C. This is in fact a binary system, i.e., a system using two fluids or two vapours. The mercury vapour generated in a special boiler is sent through a mercury vapour turbine from which it exhausts into what may be called a condenser boiler. Water in this second boiler is converted into steam by the latent heat of condensation of mercury, and this steam is also used in turbines. Overall efficiency is from 8,500 to 9,500 B.t.u. per kW hr. Advantages of mercury is that its boiling point being high, higher initial temperature is obtained without substantial increase in pressure. Thus with steam at the critical pressure of 3226 pounds per sq. in. the temperature is 706°F. but mercury at that temperature has only a gauge pressure of 5 pounds per sq. inch. But the weight of mercury being 13.6 times the weight of water the total weight of boiler is very big.

"Atmos" boiler consists of rotating boiler tubes with provision for most intimate forced contact between water and boiler surface. The heat transfer co-efficient is thus enormously increased. There is also arrangement of plenty of surface through which the steam might separate itself from water, and also arrangement for artificial separation through centrifugal force.

In 1922 Mark Benson in England produced a boiler with the sensational working pressure of 3200 pounds per sq. in. Since this is the critical pressure for steam his boiler is without drums or steam spaces and consists only of an economiser section which heated the water to a temperature of 706°F. When it attains this temperature the water turns into steam without any addition of heat, and passes to the superheater section.

"Schmidt-Hartmann" boiler practically consists of two boilers operating at two different pressures. The boiler operating at higher pressure is filled with distilled water, which never leaves it except through unavoidable leakage. This water is converted to steam and then condensed in coils immersed in water contained in a low pressure boiler, the condensate returning to the high pressure boiler automatically. So the distilled water serves merely as a heat transferring device and protects the surfaces of the high pressure boiler from scale or corrosion.

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The "Loeffler" boiler has adopted the principle of generating steam by blowing a very highly superheated steam into water. Saturated steam thus produced is passed through superheater coils, and one-third of the steam is sent to the prime mover and the remaining two-thirds is forced by means of a pump back into the saturated steam drum for production of steam. The pump consumes about 2 to 3 per cent of the total boiler power. Two large units of this type have been recently built in Brimsdown power station in England, each having a rated evaporation of 210,000 pounds per hour, when running at 2000 pounds per sq. in. and 940°F. Overall thermal efficiency attained at Brimsdown is 30 per cent.

Another radically different type is the "Velox" boiler, in which heated air for combustion is forced at a pressure of 15 to 30 lb. sq. in. A continuous combustion gas turbine, which is operated by the hot flue gases, forces the combustion air at a velocity of near about 650 ft. per second. Some of the water from the drum is also forced by a pump through coils, over which the hot gases flow, returning the steam generated to the drum again. Thus enormous rates of heat release is attained, in some cases as high as 900,000 B.t.u. per

cubic foot per hour. A boiler efficiency of 92 to 95 per cent is claimed.

Another recent development of great importance is the so-called "steamotive," which is a small, compact, highly efficient, steam electric generating plant, adoptable for either stationary or mobile purposes. This is a forced circulation type of boiler under completely automatic control, operating at high pressure and temperature. This development is of particular importance as it provides a steam driven power source capable of competing with internal combustion engines in the fields. The boiler efficiency is of the order of 85 per cent.

Whether these new units point the way to the pattern of boilers which will be used in the future, or whether the present day conventional types will survive, it is difficult to say, but all of them today represent boiler developments. One healthy point and encouraging part of the present-day development is that scarcely two boilers installed at the present time are alike. It may happen that the whole problem of evaporating water at high pressure and temperature, with its present-day complex equipments will be fully dispensed with in favour of much simpler methods. Continuous combustion gas turbine (described on p. 171 in the last September issue of SCIENCE AND CULTURE), Dr Abbot's Solar flash boiler and fuel cells are indications on this side.

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Treatment of Infected Wounds with Urea

UREA was so long regarded as a waste end-product of protein metabolism. Spiro (*Z. Physiol. Chem.*, 30, 182, 1900) and Ramsden (*Jour. Physiol.*, 20, 28, 1902) independently showed that urea was a good solvent for proteins. Wilson (*Jour. Path. Bact.* 11, 394, 1907) observed that in 8-25 per cent urea solution no bacteria could grow and stronger solution of urea was bactericidal. Symmers and Kirk (*Lancet*, 2, 1237, 1915) availed of these properties of urea in the treatment of wounds. Wound surface covered with pus and dead tissues is a good medium for the growth of bacteria. If this pus and dead tissues are dissolved by urea, bacteria will not get a nidus for their growth and the wound will heal. Recently the urea treatment of wounds have been revived by Robinson (*Amer. Jour. Surg.*, 33, 192, 1936); Muldavin and Holtzman (*I.* 549, 1938), and Holder and McKay (*Ann. Surg.* July 94, 1939). They have treated most successfully superficial and deep abscesses, infected and traumatic wounds of all kinds, cellulitis, septic wounds due to burns, carbuncles, varicose ulcers, empyema etc. The technique is very simple. The wound is first washed with a saturated aqueous solution of urea so as to remove the pus and dead tissues. Excess water is removed by sterile absorbent cotton. Urea crystals are then applied over the wound surface. The crystals are kept in contact with the wound by a waxed paper. The wound is then bandaged as usual. Wounds heal within a very short time. Urea treatment should be advocated for the following reasons: (i) it is cheap costing twelve annas per pound, (ii) it rapidly deodorises foul smelling wounds, (iii) it does not irritate the wound, (iv) it is not toxic and it is effective also in cases in which other treatments have been unsuccessful.

—S. B.

Tuberculosis and Pregnancy

THERE is a difference of opinion whether a tuberculous woman should be pregnant or not. From statistics we see that death rate in tuberculous woman is the same no matter whether they are pregnant or not. In a tuberculous woman after delivery it is usually seen that the disease flares up. This is due to the fact that the enlarged uterus carrying the foetus presses over the

diaphragm like a splint and thus diminishes the thoracic cavity. The lungs are compressed. There is a lessened circulation and as a result less toxin is absorbed in the blood. Soon after delivery this support for the diaphragm is lost and the lungs expand as a result. Due to increased circulation more tuberculous toxin is absorbed and the condition of the patient becomes worse. If after delivery gas is introduced into the peritoneal cavity or artificial pneumothorax is performed, these cases do not relapse. Barnes (*Lancet.*, 2, 976, 1939) reports a case in which after delivery air was introduced into the peritoneal cavity immediately after the delivery of the placenta in a tuberculous woman. The patient was saved from an acute flare up of the disease. The pneumoperitoneum was followed by the routine treatment of tuberculosis in the usual way by injections of gold and calcium preparations. In the case reported artificial pneumothorax was not possible because both the lungs were affected.

—S. B.

Magnesium and Anæmia

HENRIQUES and Orskov (*Arch. f. Physiol.*, 82, 86, 1939) observed that newly formed red blood cells have an increased magnesium content. Greenberg and Schmidt (*Physiol. Rev.*, 15, 297, 1935) state that during anæmia magnesium content of the red blood cells rises from 5.4-7.8 mg. per cent to 15 mg. per cent. Anæmia was produced by bleeding or by injection of phenyl hydrazine in dogs and rabbits. While these animals were recovering, there was a considerable rise of magnesium in the red cells as they were relatively more numerous during this stage. Bang and Orskov (*Jour. Clin. Invest.*, 18, 497) have observed that in pernicious anæmia high magnesium values are found during relapse in the majority of the cases examined. A decrease in the values takes place during remission after treatment with liver extract.

—S. B.

Rural Medical Relief

A SCHEME has been proposed by the Bengal Provincial Branch of the Indian Medical Association for providing suitable medical relief in the rural areas. The whole rural medical relief and public health scheme as described below will be under the Director of Public

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Health. The District Health Officers will be under the Director of Public Health, as far as supervision and control are concerned. The Assistant Surgeons should have purely government duties being in charge of jails, sub-jails, medical care of police, medico-legal duties of sub-divisional and sadar hospitals. It has been proposed that the posts of the Surgeon-General and that of the Civil Surgeons may be abolished, and the offices of the Surgeon-General and that of the Director of Public Health should be amalgamated.

The primary object of the scheme is to improve the public health of the population. This is only possible by giving preventive aid. No preventive scheme is successful unless it is supported by a systematic curative campaign, to eliminate infective foci as effectively as possible. So there should be a combination of the two aspects—preventive and curative—to make the scheme popular, economical and useful. There should be a complete abolition of diarchy in the administration and the two schemes should be incorporated into one and placed under one and the same administration. It is an undisputed fact that allopathic system is the only system competent to undertake the scheme of preventive medicine. So the scheme is only meant for the allopathic system with the proviso that standardized indigenous drugs should be made use of as far as possible, and there should be an Indian Pharmacopoeia for cheapness and efficiency.

As regards the control of the scheme, the District Boards are only to pay their respective contributions, the ultimate control should be with the Director of Public Health.

For well-co-ordinated relief works, development of roads and lines of communication should also be incorporated in the scheme. In inaccessible and distant areas where regular medical aid is difficult to be given, travelling dispensaries would be useful. There should be in each district a *District Sanitary Board* whose function will be chiefly advisory. The members of the Legislative Assembly of the district should be ex-officio members of the Board. 75 per cent of the seats will be for medical men and engineers and others interested in public health will also be included in the Board.

Each primary unit is to be constituted of an approximate population of a Union Board area of about 40,000 people and the supervision of medical as well as public health work is to be undertaken by local advisory committees. The staff for the work will consist of (i) a subsidised practitioner, (ii) a whole time non-medical health assistant with public health training, (iii) a part-time trained dai, (iv) one servant.

The idea behind the scheme is that in course of time, these units will develop into cottage hospitals for isolation and treatment of communicable diseases with the co-operation of the government and the Local and District Boards.

It is suggested that the public will contribute a quarter, Local and District Boards a second quarter and the government the remaining half of the expenditure. The routine administration of these units will be supervised by Assistant Health Officers in charge of Sub-Divisions under whom there will be a small staff of 1 non-practising doctor, 2 sanitary inspectors (non-medical), and 1 servant. This party will constitute a mobile squad for relieving and doing epidemic works. During non-epidemic season, they will do public health work. A group of units will get a lady health officer and there will be a clinical laboratory in the district which will examine free of charge all materials of communicable diseases.

A separate scheme for medical relief in the urban areas is under preparation.

Study of Health Problems in Japan

FOR the study of health problems, the Koshu Eisei In or the Institute of Public Health under the control of the Ministry of Health, has been inaugurated with money donated by the Rockefeller Foundation of the United States. The donation amounted to three and a half million yen for building and equipment. The Japanese government supplied the land and is responsible for the upkeep of the Institute. At present the yearly budget for the Institute is Y 350,000 but it is hoped that this figure will be increased in future.

The building of the Institute is done in neo-gothic style and has in all ten stories, two basements, five floors and three floors in the tower. The floor space of the Institute is 45,000 tsubo (a tsubo being 6 feet square). The purpose of the Institute is to educate public health officers who are already in service or who are intending to become health officers. Three major courses are offered in the Institute, the educational department of which is under direction of Dr Reizo Nobechi. They are the medical, the pharmacological and the veterinary courses to prepare health officers, doctors, pharmacists and veterinary doctors. The first two, which are one-year courses, are now in progress and will be held annually.

Apart from the educational section there is the research section under the directorship of Professor H. Hayashi, who is also the director of the complete institution. The research department has eight departments which work on different health problems. The departments include the department of physiological hygiene

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under Professor Ichikawa; the department of vital statistics under Professor Kawakami; the department of epidemiology under Professor Nobechi; the department of hygiene and veterinary medicine under Dr Ikeda; the department of child hygiene under Professor Saito; the department of industrial hygiene under Prof. Akatsuka; the department of building sanitation under Professor Hirayama, and the department of sanitary engineering under Professor Hirose. There is also a department for the study of nutrition problems.

The Institute of Public Health has many interesting equipments among which is a research room for the study of artificial climate, or air conditioning. With this machine the temperature in the two rooms attached to the large room where the machinery is installed can be varied from 50 degrees centigrade to 40 degrees centigrade. Between these degrees the machine can manufacture any kind of temperature and any kind of humidity. Above 20 degrees centigrade the humidity causes the

effect of heat to be more intensive, whereas below 20 the humidity intensifies the cold. Therefore the actual temperature of the room is not so important as the percentage of humidity. This piece of equipment cost about Y 100,000. There is also a research room for the study of the effect of sound. There are two rooms in one of which all sounds are instantly absorbed, as in a thick forest, and another where every sound is resonated. Then there is the research room for the study of physiological effects of elimination. At present the problem of the rather high percentage of near sightedness among the school children is one of the most important problems. The feeding of infants and their proper diet is another subject which is being studied at the Institute.

The staff at the Institute consists of seven professors, nine assistant professors, 24 assistants, two experts and many technicians. Co-operative institutions of the Institute for Public Health are the Institute for Infectious Diseases, the Institute for Nutrition, the Institute of Physical Culture and the Government Hygiene Institute.

Nobel Prize in Medicine

Prof. Carneille Heymans

Prof. Carneille Heymans, professor of pharmacology in the University of Ghent, Belgium, has been awarded the Nobel prize for physiology and medicine for 1938. Professor Heymans has earned world-wide eminence amongst physiologists and pharmacologists for his ingenious technique of cross-circulation experiments, which has opened up a new line of investigation regarding the complicated sensory mechanisms for the reflex control of blood in the body, a vital process for the maintenance of life. The intricate mechanisms through which the body automatically adapts itself to environmental changes both physical and psychological, had baffled the physiologists, who for many years have been striving to unveil this hidden mystery of the human body. Thanks to their untiring efforts, the role of the vagus, the sympathetic and the vasomotor centre in the control of blood pressure have long since been discovered, but it was left to Heymans to bring to light the most important and delicate mechanism of control through the 'Carotid Sinus'. The term 'Carotid Sinus' (Sinus Caroticus) is applied to a dilatation normally present at the bifurcation of the

common carotid artery and the credit for its discovery goes to H. E. Hering and F. Koch of Germany. The Spanish anatomist, de Castro, also made many important contributions towards the histology and anatomy of the 'Carotid Sinus' but it was the work of Heymans and his colleagues which showed, for the first time and with convincing experimental evidence, the important part which the 'Carotid Sinus' plays in the maintenance of the normal circulation, the respiration and the rate and output of the heart knowledge which is of supreme importance to clinicians and cardiologists. Prof. Heymans is also responsible for many other important advances in physiology and pharmacology, largely concerned with the control of circulation. A prolific writer, Prof. Heymans has published a large number of research investigations which are characterised by sound experimental technique and clarity of expression, and are models to follow by research workers in the fields of physiology and pharmacology. His book 'Le Sinus Carotidien' (Paris, 1933), in collaboration with his colleagues, Bouchaert and Regniers, is an excellent treatise dealing with the work which brought him the Nobel Prize.

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Son of an illustrious physiologist who had occupied the same chair as he is now occupying in Ghent, Prof. Heymans had the opportunity of receiving early training in experimental technique from his father, J. Heymans and there are many joint papers in which both the father and the son collaborated. In a comparatively small laboratory, Prof. J. Heymans worked on his hobby "the physiology of circulation" and it remained for his son to bring into reality the discoveries which he anticipated.

Prof. Gerhard Domagk

The Nobel prize in physiology and medicine for the year 1939 has been awarded to Prof. Gerhard Domagk, Pathologist to the Medical Biological Research Laboratories of Bayer-Meister-Lucius Company at Elberfeld, Wuppertal. Prof. Domagk has opened a new vista in chemotherapy and the most coveted honour has been bestowed on deserving shoulders. Domagk, who incidentally came into the lime-light only a few years ago, has brought about a revolution in the medical world by his remarkable discovery of a chemotherapeutic remedy for bacterial infections. For years together, since the discovery of Salvarsan by Paul Ehrlich in 1906, research workers have been engaged in the search for remedies which will kill bacteria in the body. A number of useful remedies for protozoal infections were elaborated but no success was attained with regard to this class of infecting organisms. The first significant attempt in this direction was made by Levy and Morgenroth (1918) who observed that ethyl hydrocupreine (optochin), a derivative of cinchona alkaloids, was of some value in protecting mice infected with pneumococci. Later Heidelberger and Jacobs (1918) tried to enhance the bactericidal properties of the quinoline group by linking the azo compound with the hydrocuprein derivatives. These effects did not attain much success and no compounds could be synthesised which would exhibit bactericidal property without being toxic to the organism.

In view of the persistent failures of many workers to find a suitable compound, the quest was practically given up and it came to be assumed that the bacterial infections were beyond the reach of chemotherapy. In 1935, Prof. Domagk described the remedial effect of a red dye named 'Prontosil', an amide of chrysoidine, on streptococcal infections in mice. The red dye was actually prepared by two chemists, Klarer and Meitzsch in 1932 under the direction of Domagk but it remained for Domagk to show that mice infected with virulent strains

of streptococci survived when this dye was injected. He further observed that scrapings from infected peritoneum taken 48 hours after induced infections in laboratory animals were free from streptococci in treated mice whereas they remained virulent and viable in untreated 'control' cases. Confirmatory laboratory reports were soon published by a host of workers in Germany, France, America and England. Levaditti and Vaisman (1935) obtained very interesting data which supported in the main all the conclusions arrived at by Domagk and later Colebrook in Great Britain found definite clinical evidence of the usefulness of the remedy. Domagk himself gave a fair trial to his drug 'Prontosil' in many clinical cases. His daughter was once suffering from a needle prick and the streptococcal infection therefrom assumed an alarming character. When surgical intervention by repeated incisions failed to give any relief, Domagk gave 'Prontosil' by mouth and rectum to his daughter. Fortunately this checked the infection and the daughter's life was saved.

Since then, a large number of similar compounds have been synthesised and efforts are still being made to discover newer compounds which will be even stronger than the original dye discovered by Domagk. A certain amount of success has already been achieved and who knows what the future has in its stores! Perhaps some day workers will be able to find some remedy for organisms smaller than bacteria e.g., virus infections. Thus, Domagk's initial discovery has paved the path towards wonderful possibilities in a line which was almost thought to be a closed field. Domagk's work has undoubtedly rendered a great service to the cause of suffering humanity.

A man of charming manners, Prof. Domagk is extremely courteous to those who visit his laboratories. The writer had the privilege of spending a short time in the summer of 1937 in the Elberfeld Laboratories of Bayer Company and through the courtesy of Prof. Schuleman, the discoverer of the well-known synthetic antimalarial drugs, Atebrin and Plasmochin, had the opportunity of visiting Prof. Domagk in his laboratories. A thorough and methodical worker, who is also scrupulously clean in his technique, is difficult to meet. Domagk's laboratory is sure to attract the attention of all visitors. Prof. Domagk believes that in order to achieve success in the field of chemotherapy and applied research a close collaboration with chemists is essential. He has himself developed a wonderful 'team work' amongst chemists and medical men, a thing we in India should learn to follow.

B. Mukerji.

Mineral Springs and Medicinal Muds*

P. K. Ghosh

Geological Survey of India, Calcutta.

Waters of mineral springs as compared with the rain water as also the normal potable water-supply of cities contain a larger amount of dissolved mineral matter and sometimes gases, due to the perceptible presence of which, they acquire a distinct mineral taste. They derive their constituents from the rocks and minerals through which they percolate, as well as from the gaseous emanations of molten rocks underground. They often issue hot, the temperature being sometimes as high as the boiling point of water.

Some of the dissolved constituents impart a definite therapeutical value to these waters which are then known as medicinal waters. These waters, seem to be more potent at the site than when bottled and transported. Medicinal waters or medicinal springs have been divided into several groups of which the following may be mentioned:—

- (1) Carbonated waters, rich in CO₂ and poor in solids, e.g., Nauheim water;
- (2) Alkaline water with carbonates and bi-carbonates of alkali metals preponderating, e.g., Vichy and Carlsbad;
- (3) Salt springs with high NaCl-content and an appreciable amount of potash, e.g., Apenta waters of Hungary. Many of the German spas are of this type, e.g., Harzburg, Homburg, Wiesbaden, etc.
- (4) Barium springs as those of Llangamarch;
- (5) Bromide and iodide waters as of Woodhall Spa;
- (6) Aperient waters in which the sulphates predominate, e.g., Friedrichshall in Germany;
- (7) Chalybeate springs with iron predominating, e.g., Marien Bad and Turnbridge Wells;
- (8) Sulphur springs, highly charged with H₂S gas, e.g., Strathpeffer, Harrogate, Aix-la-Chapelle;
- (9) Arsenical springs, e.g., La Bourboule, Levico, etc.
- (10) Radioactive springs with water rich in radon, a gaseous disintegration product of radium, and which itself is radioactive. Many of the continental springs,

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e.g., Bad Gastein, Kreznach and others are said to have superior radioactive values and their therapeutical properties are ascribed to this fact.

Springs falling under most of these categories are known to occur in India.

The medicinal waters mentioned above are not all potable; some of them are suitable for baths only, and some are used as sprays. The presence of radon and arsenic impart definite therapeutic virtues not only to the water but also to the atmosphere that comes in contact with it. The famous spas of the world owe their value a great deal to such an atmosphere and due to which the physician finds his patients responding to spa-treatment more quickly than in the case of home-treatment. The social atmosphere as well as the lack of the day-to-day worries of life no doubt play a part in these cures.

A course at a spa corrects metabolic errors engendered by a sedentary life. Rheumatism and gout, as is well-known, respond to spa-treatment. For gout, certain natural waters seem to have a specific effect. Astonishing results have been achieved recently at some of the European spas in the treatment of tropical diseases, malaria, yellow fever, dysentery. At La Bourboule, thousands of French soldiers were cured of malaria during the war. Among them were many cases which resisted quinine treatment, but yielded to a combined treatment with quinine and arsenical waters of La Bourboule. It is claimed that Vichy, Harrogate and Bath have offered considerable relief in cases of tropical liver, and the suggestion is put forward by eminent hydrologists that spa-treatment is most valuable as a prophylactic measure in helping to keep people who are compelled to live in the tropics in a healthy condition. Asthmatic patients have received considerable relief from arsenical waters used as sprays. High blood-pressure, pelvic disorders of women, gall-bladder, inflammation and gall-stones, certain nervous disorders, obesity, anaemia and endemic or cystic goitre are among some of the complaints that are said to yield to spa-treatment. In general its tonic effect is undisputed.

Dr F. Howard Humphris, in a paper read at the Harrogate Congress (*Journal of State Medicine*, 1935, pp. 476-480), distinguishes natural radioactive water-therapy as 'mild radium Therapy' as opposed to radium Therapy used for an altogether different purpose, and

mentions the following diseases in which mild radium therapy has been found beneficial:—

- (1) In gout and goutiness. In rheumatism especially those of infectious origin, and characterised by pain.
- (2) In certain gynaecological conditions, notably pelvic pain and congestion and salpingitis, and for the cure of sterility.
- (3) In the alleviation and the prevention of post-operative peritoneal adhesions.
- (4) In dermatology, such skin affections as psoriasis, mycosis, fungoides, eczema and lichen.
- (5) In diseases of the respiratory organs and upper air-passages, chronic catarrhal conditions and affections of the sinuses.
- (6) In tending towards revitalising diseased or ageing tissues.

Dr Mutch pointed out (*Lancet* 11, 1013, 1931), 'In cases of serious increase of blood-pressure and arteriosclerosis, the effect of radium emanation and water drinking is very marked and favourable'. A. P. Luff remarks, "An artificially prepared mineral water, although identical in chemical composition with the natural one, does not possess the same therapeutic effects, since it is lacking in the property of radioactivity." D'Arsenaval, the celebrated French master, gave the mild radium therapy treatment his blessings in a communication to the Academie des Sciences. F. Howard Humphris advocates artificially activating the natural mineral waters of the British Isles (by artificially introducing radium emanation in them), as the British waters compare unfavourably with some of the famous continental springs in this respect. Of the several disadvantages that the British spas suffer from, the lack of mild radium therapy is the greatest. Professor Dawson Turner observes, "The mineral waters artificially activated are of value in the treatment of chronic inflammatory processes and residues of the same," and that "in therapeutic doses they are quite harmless;" further that, "specific urate-dissolving powers are to be found in the activated water." The value therefore of natural radioactive water is obvious.

Reports of the spa-hospitals agree that the immediate results of treatment are highly satisfactory. On an average eighty to ninety per cent of the cases admitted at Bath, Buxton and Harrogate are recorded on discharge as "cured or greatly improved." The reports from Wiesbaden (in Germany) and Piestany (formerly in Czecho-Slovakia) for 1930, are as follows:—

Spas	No. of cases	Cure %	Full work %	Partial work %	Unable to work %
Wiesbaden	667	12	70	4	4
		Cured %	Improved %	Unchanged %	
Piestany	265	26.5	71	2.5	

ity of the improvement is lacking, but indirect evidence is derived from the fact that more patients are being sent to these hospitals by approved societies and that the latter express satisfaction with the results, and that financial support is given to these institutions by working men's associations, public assistance committees, co-operative societies, insurance companies and large employers of labour. These presumably find it to their interest to continue their subscription.

In certain continental countries, notably in Germany and Austria, the spa-treatment of insured persons has been firmly established for many years. It comes under the heading of general treatment and may be claimed by the insured as a right. Two insurance societies in Austria sent 8,000 cases to spa establishments in 1933. On the continent where spa-treatment is highly organised and its value fully recognised, it has been shown to be of real economic value both to the individual and to the community. There can be no doubt that during the last few years a vivid change has taken place in the medical and the lay mind of the value of physical methods in the treatment of a wide range of chronic diseases. At the chief spas facilities already exist for such treatment. In Soviet Russia, all the "cure" places were taken over by the State in 1919, and are now run for the benefit of the proletariat. The State makes it a point to send its industrial workers to spas for a thorough overhaul from time to time. In France, the Ministry of Mines has charge of the storage and conservation of existing springs and the prospecting for new sources. The spas have no subsidy from the State. In Germany and America many of the famous spas are owned and managed by the respective governments.

Among Asiatic countries, Japan has followed the lead of the West in the good work of developing her medicinal springs. There are now over 1,000 spas in Japan receiving 20,000,000 visitors annually. The Medical School of Kyushu Imperial University persuaded the Government to establish a Hydrological Institute and Spa Hospital under the management of the University in the vicinity of Beppu, the largest hot spring district of Japan, in 1931. The objects and scope of the Institute are the study of the theory and practice of Medical hydrology, as well as treatment of patients with various diseases. The equipment of the Institute is similar to that of European spas consisting of baths of various types, e.g., carbon dioxide, electric, hot air and kinetic baths, aeration, dry or wet sand, colon lavage, cold hydro-therapy, mud treatments, etc.

There are also departments for auxiliary physical methods, wards for patients and laboratory facilities. The Institute is comprised of five departments, medical, surgical, gynaecological, dermato-urological and one for fundamental medical examination, into which are admitted those requiring preventive treatment.

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The charges for accommodation range from three to ten shillings per diem, with a scale of charges for board, consultation and treatment. It is evident that in this country as in Europe spa treatment and the spa habit are no longer regarded as being only a hobby of the rich or the crank, but have become part of the medical courses of the universities, with support from the State. It is thus difficult to resist the conclusion that the ownership of the spa industry is, viewed in its widest aspect, a paying proposition.

Mention may be made here also of mineral muds, used for either purely medicinal purposes, as in the treatment of arthritis, gout, skin diseases etc., or for cosmetic purposes. Both forms are sold only for application externally, some of them being employed for their radioactive elements.

The following is a brief description of the types of mineral muds used in Balneo therapeutics:—

(1) *Natural Mineral Muds.* Type A. In this type reactions take place between the substances of which they are composed. These reactions arise from certain geographical, climatic and biological conditions of the mud deposits in question. The most important reactions are the changes produced by the organic substances on sulphides and sulphates. Examples of these are Limans of Odessa, the muds of the banks on the open sea at Wilhelmshaven, on the Russian bank of the Baltic Sea, on the shores of the South Russian Salt Lakes and on the lower shores of the Danube in Rumania. Fresh water muds from Balaton in Hungary, from the North Russian Lakes, and from Gytija in Scandinavia, may be mentioned in this connection.

Type B. Muds are of origin similar to A, but saturated with mineral water. These muds are enriched by the peculiar properties of the mineral waters with which they have been in direct contact. Part of their efficacy springs from the reaction of the substances contained in the water, or from a modification of the reaction which normally takes place in the mud when not saturated with the mineral water. The microflora and organic matter of the mud take part in these reactions, thus influencing the reactions and composition of the mud. Other important factors are the chemical composition, temperature and manner of saturation of the water. The following examples of this type may be given; the pond mud of Trencianke Teplice, saturated with warm sulphur springs; the river mud of Dax, saturated with the water of hot sulphate springs; river mud of Abano saturated

with hot salt sulphate water, river mud of Csaszar Bath in Budapest saturated with hot sulphur water, Piestany (in Hungary) mud sedimented in hot sulphur springs and Kolop (also in Hungary) mud produced by the maceration of clay like sediments by cold sulphur springs.

(2) *Artificial Mineral Muds.* Produced by the addition of water to pulverised earth or rocks of certain types. Belonging to this group are Eifelango in Germany consisting of volcanic tuff and diatomaceous earth, Teufelsbad pyritic sand, Isla and Tersana muds also come in this group.

Among the cosmetic muds used by beauty specialists, mention may be made of so-called Nile mud.

In India some 300 mineral springs are known to exist, while of these 70 are of reported medicinal value. Several are associated with places of pilgrimage. So far very little systematic scientific investigation of their properties has been made, apart from a few in Bihar and Bombay. In view of the fact that in every country where the mineral waters and muds have been exploited, their extended application has proved of value both economically and nationally, it seems timely that a thorough examination of such resources in India should be made.

It is well-known that India consumes a large quantity of medicinal table waters imported from abroad. It is not unlikely that some of our spring waters may prove to be of equal value; as a matter of fact the waters of the Sitakund Spring were bottled for sale in the past. Some idea of the extent to which reputed waters are sold may be obtained from the world consumption figures of the following; St. Galmier Water, 100 million litres annually, Appollonaris Water 37 million bottles!

A thorough investigation of Indian waters and muds may reveal the existence of radioactive waters suitable for spas. Some of the Indian waters e.g., Rajgir and Bombay are known to be radioactive and there is no reason to suppose that others of even greater radioactive potentiality do not exist. It has been shown in Europe and Japan that spas for middle and working class people are also in the long run a sound economic proposition.

It is not difficult to imagine that in a country like India, where skin disease, rheumatism, malaria and other ills amenable to spa-treatment are widely prevalent, the discovery of medicinal springs, if such exist, in suitable circumstances would be of considerable importance to the public health. One reason why one may anticipate the popularity of such spas is that the bath and pilgrimage habit are already well established among the population.

RESEARCH NOTES

Protoplasmic Elasticity

Many authors have compared protoplasm to non-living colloidal systems in which the electric charge of the colloidal particles is of first significance in preventing the precipitation of the particles. Therefore to maintain the stability of the system the valence of introduced cations should largely determine the effects of such ions in dispersing or aggregating the colloids. The effect of sodium and of calcium on protoplasm is a controversial subject but Seifriz maintains that consensus of opinion appears to indicate that in general sodium disperses and calcium aggregates. Heilbrum on the other hand maintains that sodium and potassium increase the viscosity of the main mass of protoplasm whereas calcium and magnesium decrease the viscosity. Other investigators, like Northen, indicate that protoplasm is not a simple colloidal system and he has deduced that protoplasm has a net-like ultramicroscopic structure and it is probable that the network results from the combination of proteins with lipoids and carbohydrates and many inorganic ions are tied up to the network and occupy key positions as magnesium does in the chlorophyll molecule. The network is a labile structure and unlike non-living system it responds to different stimulants of injury, anaesthetics and temperature. If such is the system then chemical properties of an ion will be of more importance in altering the structure than the valence of the ion. A further contribution to this view has recently been made by the recent investigations of Henery T. Northen and Rebecca T. Northen on the effects of cations and anions on protoplasmic elasticity (*Plant Physiol*, 14, 539, 1939). He worked on spirogyra filaments and found that univalent cations of lithium and calcium decreased protoplasmic elasticity, while sodium and potassium increased it. Of the divalent cations, chemically related calcium, strontium, and barium decreased elasticity whereas chemically related beryllium, magnesium, zinc, cadmium and mercury increased it. The closely related

anions, bromide, chloride, and iodide had little effect on elasticity; the sulphate, phosphate, fluoride and chromate ions caused an increase and the arsenate and nitrate ions a decrease. They concluded that the effect of an ion in decreasing protoplasmic elasticity is due to its chemical activity rather than to its valence. The studies of the effects of cations and anions lend more support to an ultramicroscopic network structure for protoplasm than to a suspension of hydrophobic and hydrophilic colloids whose stability is determined in part by the charge of the suspended particles.

B. K. K.

Some Factors Determining Brain Wave Frequencies

Some recent electro-encephalographic investigations have been directed towards the understanding of the physico-chemical factors responsible for electrical oscillations of the cortical neurones giving rise to characteristic brain rhythms. It has been shown by Hoagland, Rubin and Cameron (*Amer. J. Physiol.*, 120, 559, 1937) and Gibbs, Gibbs and Lennox (*Arch. Neurol and Psychiat*, 39, 298, 1938) that during hypoglycemia cortical potentials change markedly and that they return to normal when the blood sugar content is again raised. From these and other studies it is becoming evident that there is a definite relationship between carbohydrate metabolism of the brain cells and the brain rhythm—whatever other factors may be existent upon which the latter may be further dependent. Most of the experiments to deprive the brain of glucose through insulin administration have been so far done with an intact liver. But it is possible that many substances are converted by that organ into carbohydrate and passed into the blood stream as glucose, thus vitiating such experiments. So Madduck, Hawkins and Holmes of Harvard (*Amer. J. Physiol.*, 125, 551, 1939) after preliminary occlusion of the inferior vena cava removed under ether not only the liver but the abdominal viscera of their animals

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by Mann's method to block the supply of glucose to the brain. The animals lived for 24 to 36 hours. Blood was drawn from the carotid artery for occasional sugar estimation and cortical potentials were led off the dura. Injections of different substances were made into the ear vein or cannulated jugular or femoral. It was found that with the diminution of blood sugar in 2 to 4 hours from 109 mgm. per 100 cc. to 32 mgm. per 100 cc., the cortical frequencies became progressively slower dropping from 5 to 7 per second with fine 60 p.s. frequencies superimposed upon them to smooth 1 to 2 p.s. frequencies, and these became increasingly larger in size until at 23 mgm. per 100 cc. all waves disappeared and the record was flat and the breathing ceased. But the waves returned to normal again with the injection of glucose, mannose and maltose along with a short administration of artificial breathing. The following substances could not bring the waves back to normal under any circumstances: fructose, galactose, hexose diphosphate (with or without adenylic acid), glyceric aldehyde, succinate, fumarate, pyruvate, glutamate and mixtures of glyceric aldehyde and glutamate and of glutamate and pyruvate. Others have shown however that all these substances are metabolized by isolated brain tissue. The effect of glycogen was not tested. Control experiments revealed that in hypoglycemia elevation of the blood pressure alone which was usually 70-90 mm. of mercury in an eviscerated, hepatectomized animal induced no improvement in the cortical potentials. Under the conditions of these experiments, considerable doses of sodium malonate injected intravenously had but slight and transitory effect on brain potentials. The authors conclude that "the chemical reactions necessary to permit the normal functioning of the cortical cells do not involve merely the combustion of the known products of carbohydrate breakdown. Some critical reaction occurring earlier in the metabolic chain and probably involving the intact glucose molecule may be essential."

Hoagland, Rubin and Cameron (*J. Neurophysiol.*, 2, 170, 1939) in order to check the dependence of the relative frequency of brain potentials on the rate of respiration of brain cells of intact human beings administered to 4 patients dinitrophenol by mouth, 4 mg. per kg. of body weight, and took their brain wave records. Dinitrophenol is considered as an effective metabolic stimulant in respiring cell systems *in vitro*, as well as in intact mammals (Dodds, *Lancet*,

226, 1048, 1934). It was found that the brain wave frequencies from occiput and vertex were significantly increased over normal in the first two or three hours following dinitrophenol medication. After this period the frequencies fell though up to the 4th day residual effects persisted, but in a week the frequencies came back to pre-experimental level.

B. K. B.

Individual Difference in Dark Adaptation

Gross deficiency in vitamin A produces marked differences in dark adaptation. Convincing data on this subject have been advanced by several workers. Excluding deficiency in vitamin A, no physiological factor is generally held to be responsible for individual variations in dark adaptation. It has been claimed that a small deficiency even in apparently healthy individuals will produce some slowing in the process of dark adaptation.

L. R. Phillips (*Proc. Roy. Soc.*, 127, 405, 1939), describe experiments designed to determine the influence which the diameter of the pupil, colouring, visual acuity and age might exercise on the dark adaptation of individuals, after the variations due to deficiency in vitamin A had been eliminated as far as possible. The experiments were divided into two parts. In the first, male observers, of much the same age, and approximately emmetropic, were dosed with vitamin A for some days previous to the determination of dark adaptation. In the second, observers of both sexes, of widely different ages, were tested without previous dosage, but with chances of serious vitamin A deficiency reduced by the choice of suitable observers. To avoid effect of exposure to strong daylight, the examinations were conducted after dark in the evenings of the winter months from December to March.

From the result of the experiment which has been described in detail the author concludes that comparatively large pupil in the light produces a retardation of dark adaptations, and comparatively large pupil diameter in the dark tends to decrease perception times. Heavy pigmentation of the retina favours more rapid dark adaptation.

Retardation of dark adaptation with age has been found to be partly due to small pupil diameter in the dark and partly due to changes in the retina with increasing age.

These findings will afford a valuable guide to those who utilise the dark adaptation test as a routine method for measuring vitamin A deficiency.

H. N. B.

SCIENCE &
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PROCEEDINGS AND PUBLICATIONS

National Academy of Sciences, India

(Allahabad, 27th November, 1939)

R. C. CHATTERJI: Annotated list of the Helminths recorded from domesticated animals of Burma, Part II—Cestoda.

M. ZIAUD-DIN: Tables of symmetric functions for statistical purposes.

RAM KUMAR SAKSENA: The nutrition of some species of the genus *Pythium* in synthetic liquid media.

SIKHIBHUSHAN DUTT: A new series of extremely sensitive reagents for the detection and estimation of ferrous iron in traces.

JAGAT NARAIN TAYAL AND SIKHIBHUSHAN DUTT: Chemical Examination of the Leaves of *Nepeta Ruderalis* Hamilt: composition of the essential oil.

Royal Asiatic Society of Bengal

(Calcutta, 4th December, 1939)

BAINI PRASHAD: *Tabaqat-i-Akbari*, (Eng. Trans.) Vol. III.

GHULAM MUSTAFA MALIK: The food of the mountain barbel *Oreinus McClelland*, and its probable bearing on the introduction of brown trout in Himalayan streams.

GHULAM MUSTAFA MALIK: Cases of mortality of brown trout *Salmo trutta fario* Linn. in the hatcheries of the Hazara District, N. W. F. Province.

CHINTAHARAN CHAKRAVARTI: Sanskrit works of Sahib Kaula.

Indian Chemical Society

(Calcutta, September, 1939, *J. I. C. S.*, 16, 423-480, 1939)

SHARIFUDDIN WARSII AND SALIMUZZAMAN SIDDIQUI: The constituents of *Didymocarpus Pedicellata*.

Part III. Isolation of a sesquiterpene and two polyterpene products and examination of the fatty matter.

K. P. BASU AND M. C. MALAKAR: Calorific values of Indian foodstuffs.

PANCHANAN NEOGI AND KANAI LAL MANDOL: Co-ordinated copper compounds with propylene-diamine.

N. L. VIDYARTHI AND C. J. DASA RAO: Fatty acids and glycerides of the fat from the seeds of *Garcinia Indica* (kokum butter).

N. L. VIDYARTHI AND M. VENKATESH MALLYA: Fatty acids and glycerides of the oil from Sapota seeds (*Achras Sapota*).

K. P. BASU AND K. GUPTA: The role of vitamins and calcium in the diet in the utilisation of proteins.

PHULDEO SAHAY VARMA, N. B. PAREKH AND V. K. SUBRAMANIAM: Halogenation Part XXI. Direct replacement of aromatic sulphonic groups by chlorine and bromine atoms.

N. R. DHAR AND E. V. SESHACHARYULU: New aspects of nitrogen fixation and conservation in the soil. Part III. Influence of light on bacterial numbers and nitrogen fixation.

PHULDEO SAHAY VARMA AND (MISS) K. M. YASHODA: A note on the iodination of a few halogenated phenols.

N. L. VIDYARTHI AND M. VENKATESH MALLYA: A note on the occurrence of an isomer of ricinoleic acid in the fatty oil from the seeds of *Vernonia Anthelmenitica*.

(Calcutta, November, 1939, *Ind. & News Ed.*, 2, 139-186, 1939)

S. S. BHATNAGAR, K. G. MATHUR AND ROMESH CHANDRA: Activation of hematite.

K. L. ROY, D. LAHIRI AND B. C. GUHA: Studies on Indian Coals, Part IV.

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JANG BAHADUR JHA: The testing of ghée by means of fluorescence analysis in ultraviolet light.

A. NAGARAJA RAO AND S. N. GUNDU RAO: Activated carbons from bagasse and other Indian raw materials.

NITYA GOPAL CHATTERJEE: A new process for the extraction of castor seed or cakes with industrial alcohol.

H. K. SEN: Shellac in moulding and varnishing industries.

National Institute of Sciences of India
(Calcutta, December 1939, *Trans. Nat. Inst. Sc. Ind.* 2, 39-68, 1939)

B. N. DESAI AND P. M. BAEVE: Changes brought in colloids by dialysis.

RESEARCH WORK IN INDIA

Madras University

The work in the zoological laboratory of the university is mainly marine biological. Plankton of the Madras coast was investigated by one of the earlier students and a fair amount of information of the microplankton and the maxima of the various groups of planktonic animals is now available. The *Hydro- and Scypho-medusae*, the *Actinaria*, and *Ceriantharia* and *Decapod* larvae occurring in the plankton have been investigated and the results published.

A study of the anatomy of the polychaete worm *Morphysa*, the molluscs *Kalinga ornata* and *Stiliger gopalai* and the Echinoid *Salmacis bicolor* has been made. Details of the early development of *Mesopodopsis orientalis* have been published. Developmental studies have been given equal attention and the life histories of several fishes have been made known.

Cytology forms an important aspect of the work in the laboratory and several contributions have already appeared on oogenesis and yolk formation, secretory phenomena in types of gland cells.

Growth studies on a few sedentary organisms in the Harbour have been completed and the results are in course of publication. A thorough study of the brackish water fauna of Madras has been made and the results published. Incidentally a fair amount of

information regarding the breeding period of several marine animals has been collected.

Work on plankton, spermatogenesis, fauna of the sandy beach and animal communities of the level sea bottom off the Madras coast are in progress.

The Laboratory has an impressive record of published work to its credit.

Bose Research Institute*

The scientific activities of the Institute are carried out in the following departments: plant physiology and genetics, bio- and agricultural chemistry, zoology, anthropology and experimental and theoretical physics.

Plant Physiology and Genetics: The investigations carried out in the department of plant physiology and genetics have been partly on problems of pure theoretical interest and partly on those which can have possible economic applications. Some of these investigations have been undertaken in collaboration with the department of bio-chemistry. A series of investigations on the effect of auxin treatment on plants have been carried out during the course of the past year. Very significant results have been obtained by the treatment of the stems of Balsam plants with lanoline pastes containing B indole acetic acid. Interesting results have also been obtained on the root formation in mango plants under such treatment. Extensive and detailed investigations have been made on the physiology and development of tropical fruits like mango and guava, in which the physio-chemical changes accompanying the metabolic changes in the fruit development at various stages from early growth to maturity and ripening have been investigated. The influence of different concentration of ethylene vapour as a stimulant to early ripening is being studied. These investigations are expected to give valuable information on the problem of fruit storage in the Tropics.

Certain investigations on problems connected with the physiology and anatomy of jute plants have been undertaken. At present attention is confined to the study of the rate of growth of jute plants, estimation of the carbohydrate and nitrogenous substances available in them at various stages of growth, together

*Adapted from the Director's Report presented by Dr D. M. Bose at the 22nd anniversary meeting held on 30th November last.

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with their transport, and also the development of fibre in the capsularis variety. Certain interesting results have already been obtained in this investigation. The study of the effect of Colchicine on plant chromosome have been commenced. The effect of such treatment on Jute seedlings is under investigation. The other plant on which this treatment is being carried out is Allium (onion). The formation of polyploid cells with increased chromosome numbers has been observed. Cytogenetical study of different useful Indian plants are being undertaken, including those on Jute, Neem, Indian Almond, Mango and Strawberries.

Bio- and Agricultural Chemistry: Investigations on the nutritional value and vitamin content of various Indian food stuffs are being continued. We have commenced chemical and mechanical analysis of soils from different localities round about Falta and also from different parts of Bengal, with a view to correlate the paddy yield on some of these soils with their compositions, and to determine the geographical distribution of different types of soil in Bengal.

Investigations on the bio-chemical processes occurring in plant tissues have been commenced. The mechanism of the synthesis of amino acids in plants is being studied. Attempts are being made to purify the enzymes responsible for those reactions, in order to study their chemical nature. The role of C₄-dicarboxylic acids in plant respiration is being studied. Preparation of a cell-free phosphatase from vegetable tissues and its occurrence at different stages of germination is being investigated. Attempts are being made to synthesize in vitro various phosphoric esters by vegetable enzymes. Another interesting line of investigation undertaken is the study of the metabolic changes in Filarial tissues with special reference to carbohydrates and proteins.

Zoology: Observations are in progress on the habits of fishes, their food, and the surroundings in which they can thrive easily.

Anthropology: Our research worker in anthropology has recently returned from Germany after one year's fruitful study in the Kaiser Wilhelm Institute for Anthropology in Berlin under Prof. Eugen Fisher, the subject of his investigation being anthropometric measurement on twins. He proposes to carry on similar investigations in this country. We have written to the Census Commissioner for facility to

carry on such investigation during the next Census operation in 1941. Blood group investigations are also being continued in selected areas.

Physics: Investigations both in theoretical and experimental physics were successfully undertaken last year. In experimental physics investigations have been carried out on the study of the dispersion of ultrasonic waves in water and other liquids. Certain theoretical investigations on the problem of sound absorption in liquids have been carried out. A theory has been worked out, to account for the rather obscure phenomena of the origin of colour shown by paramagnetic salts and solutions, which appear to give a satisfactory account of the whole subject. Experimental investigation of absorption by the halogen compounds of the transition elements in the vapour state is being continued and these investigations will give additional material for testing the validity of the proposed theory.

Certain important investigations have been carried out on the theory and properties of mesotrons. Other investigations on relativistic statistical mechanics and the study of matter at high temperature and pressure, also the theory of conduction and absorption in stellar matter are being carried out.

Cosmic Ray Investigation: The investigation of various aspects of the cosmic ray problem is being carried out by the Wilson Chamber, by the proportional counter tube, and by the photographic plate method. The photographic plate method has already yielded very interesting results on nuclear disintegration by ionising and non-ionising cosmic rays. We have, for the first time I believe, obtained definite evidence of tracks due to mesotrons on photographic plates, and there appears to be some indication of a couple of end tracks of mesotrons with which are associated emission track of electrons, similar to those photographed by Maier Leibnitz in a Wilson Chamber. Recently we have sent photographic plates to Sandakphu covered either by thick lead sheets or by water; this will enable us to distinguish the effects produced in photographic emulsion by non-ionising particles like neutrons and neutretos, and ionising particles like protons and mesotrons.

Theoretical interpretation of recent experiments on hard cosmic ray showers by means of counter tubes has been undertaken. A series of investigations on artificial radio-activity has been carried on. Amongst the problems which are being investigated

at present are the determination of neutron resonance levels in Vanadium, chemical isolation of radioactive isotopes of Cobalt, etc. The study of the β -ray spectra of the radioactive isomers of Bromine is being undertaken. For satisfactory progress in such investigations, the strength of the neutron source has to be considerably increased. We are undertaking the construction of an apparatus for the copious supply of neutron produced by the bombardment of a heavy ice target by heavy hydrogen.

α -particle disintegration of fluorine and other elements are being studied. The energy spectra of the negative and positive electrons and γ -radiation emitted by the end products of such nuclear disintegration are being studied by Wilson Cloud Chamber and by other methods.

Theoretical interpretation of the origin of the β and γ -ray spectra of radio-active Arsenic has been given in a recent paper.

Seminar and Symposium: A physics seminar, in co-operation with the Physics and Applied Mathematics Department of the University College of Science, has been started since July 1938. A four days Symposium was held during the last Easter week, on the properties of the Mesotron as revealed by cosmic ray investigations. Many interested workers from other University centres took part in it.

Guest-Worker: The Sir J. C. Bose Research Fellow of the Calcutta University in bio-physics, Dr. B. K. Bagchi, is carrying on investigation in the Bose Institute on human electro-encephalography, i.e., the recording of electrical potentials from intact human brains, under various psychological and physiological conditions—this being the first project of its kind in India.

Sir J. C. Bose Research Scholarship in bio-physics: The Governing Body of the Bose Institute

have accepted the offer of Lady Bose to administer the corpus of the Sir J. C. Bose Research Scholarship Fund for Presidency College students. Two research scholarships in Bio-physics will be tenable in the Bose Institute for qualified students of Bengali Hindu origin who have pursued higher studies in those subjects in the Presidency College, Calcutta.

Visitors: Dr R. A. Millikan of the California Institute of Technology with his two fellow workers Drs Neher and Pickering arrived in Calcutta on the 25th November last and were the guests of the Director during their brief stay in Calcutta. We took the opportunity of arranging a meeting of our physics seminar before which Dr Neher and Pickering gave reports of their measurements of cosmic ray intensities at different latitudes by the balloon ascent method. Before a meeting of the Indian Physical Society held in this hall, we had the opportunity of hearing from Dr Millikan a very instructive historical survey of the cosmic ray investigations which concluded with a discussion of the problems which will be investigated in India. We have sent one of our research workers who will be attached to Dr Millikan's party at Agra. He will have the opportunity of learning the technique of the balloon flight investigations. Due to the large land area and favourable wind directions, India offers a very suitable field for investigations of latitude and altitude variation of cosmic ray intensities. Such work can be undertaken with the co-operation of the Meteorological Department when the technique has been mastered.

The object of the Institute has been to utilise the best technical methods of physical and chemical investigations for applications to the study of various bio-physical phenomena with a view to their use in agriculture and medicine. The research staff is at present engaged in perfecting such methods of experimental and theoretical investigations and in training workers in their use. The aim in view is to make co-operative research possible in this country, in which scientific institutions, industrial organisations and the Government can contribute their respective shares.

BOOK REVIEW

ANCIENT JAPAN IN THE LIGHT OF ANTHROPOLOGY—
by Ryuzo Torii, (*Kokusai Bunka Shinkokai or
The Society for International Cultural Relations,
Tokyo, 1937*). Pp. 22 and 14 plates.

According to Dr Torii, the ancestors of the Ainu were the original inhabitants of Japan. They were followed by the "Japanese proper." The culture of the former was characterized by axes, chisels, scrapers, arrow-heads and spearheads of stone, bone-combs, bone and stone necklaces, shell-bracelets, earthen images, hand-made pottery with coiled or geometric decorative patterns, the use of vermilion (ochre?) for decoration, pit and cave-dwelling. In contrast to this the culture of the "Japanese proper" had the following elements, megalithic monuments, burial of chiefs under tumuli, burial of their attendants after voluntary sacrifice in a circle round the tumulus of the chief, wheel-made pottery with huge handles and coiled decorative patterns, clan-organization, clan-gods, shamanism, iron-smelting, absence of casting, use of mirrors, crude and unglazed porcelain, horses, agriculture, weaving. Sometimes the two cultures overlapped one another in point of time.

Dr Torii is of opinion that the Stone Age was immediately followed by the Iron Age in Japan. Bronze articles were used for ritual purposes, and not for ordinary use. They thus do not warrant the presumption of a Bronze Age. He notes certain cultural elements introduced from China and Indo-China, particularly in connection with agriculture and ceremonialism.

From the summary presented above, it is clear that Japan had a phase of late neolithic and early metal age culture, which evidently deserve very careful study. We hope the universities of Japan will take up the work of scientific excavation in order to throw more light on this obscure phase of Japan's ancient history.

N. K. B.

HUMAN ELEMENTS IN CERAMIC ART—by Kikusaburo Fukui (*Kokusai Bunka Shinkokai or The Society for International Cultural Relations, Tokyo, 1936*). Pp. 16 and 20 plates.

This is the record of a lecture delivered by the Director of The Society for International Cultural Relations to the Tokyo Women's Club in November, 1934. Mr Fukui is a lover of ceramics, and it is his idea that the character of ceramic art in Japan not only indicates her artistic ability, but also serves as an index to her deeper national culture. Japan absorbed Buddhism, Confucianism and Christianity from other lands, but gave a new shape to each according to her own genius. It has been the same with ceramic art. The latter was introduced into Japan from China and Korea; but, in Japan, it has taken a new shape and has continued to develop along original lines. Mr Fukui fondly hopes that Japan will rise to be the home of a new synthetic culture produced out of Eastern and Western elements, which will ultimately create a new era in world history.

We may not share the mystical faith of the author in the future of Japan; but must thank him for the numerous illustrations in his pamphlet depicting the various stages of porcelain manufacture.

N. K. B.

FOLK-CRAFTS IN JAPAN—by Soetsu Yanagi (*Kokusai Bunka Shinkokai or The Society for International Cultural Relations, Tokyo, 1936*). Pp. 55 including 19 plates.

In this delightful essay, Mr. Yanagi makes a strong appeal for the proper appreciation of what he calls the "People's Art." Rural folk in Japan build their houses and roads, wooden boxes and apparel of daily wear in a beautiful fashion. The form and decoration generally conform to long established traditions; but they display a degree of refinement and a sense of restrained beauty which hardly falls short of the standards set up by famous masters. Mr Yanagi adds to the pamphlet a collection of plates to illustrate

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the work of many "nameless artists," and these compel us to join him in his enthusiasm.

The writer seems to put lesser value on individualism than the habitual art-critic; but we must not forget that the traditional forms of beauty current among the rural craftsmen of Japan must have been once, at least, created by some gifted person in the past. Other craftsmen may have added to it or improved upon it in course of time; until a particular form became the joint creation of an age or a folk and not so much of an individual. But this process should not lead us to underestimate the first man's gift.

The specimens of art illustrated show that many of these were the products of professional men, however "nameless" they may have been. They were not obviously the creation of ordinary folk, except such examples as plates I to IV, VII and XVIII. In India, our folk-arts have been otherwise. In one class of pictures, the original creation was by some professional and genuine artist, who was as "nameless" as in Japan. These were then copied time after time by less skilled and even amateur hands until they came to cover and beautify almost every peasant's house in the village. The drawings in the booklet under review show that in many cases the execution was by untrained people while the composition and colour scheme was from more sophisticated hands. There was a second class, however, which was entirely the creation of amateur people, who were, nevertheless, inspired by a deep and true sense of beauty. Such example are unfortunately absent in Mr Yanagi's plates. The examples, which have been illustrated, are too well-executed to have been turned out by ordinary people. They are evidently not the work of folk-artists, as we understand it in India, but of professional artists, who lived in rural surroundings and who accidentally happened to have become "nameless."

We would request the author to tell us something of how rural folk in Japan try to beautify their life without the aid of professional craftsmen.

N. K. B.

FUNDAMENTALS OF JAPANESE ARCHITECTURE—by Bruno Taut. (*Kokusai Bunka Shinkokai or The Society for International Cultural Relations*, Tokyo, 1937). Pp. 21 and 12 plates.

Dr Bruno Taut is a practising architect who has been in Japan since 1933. Formerly he lived in Magdeburg and Berlin as an active city engineer. The present pamphlet records his lecture delivered to the Poers' Club in 1935.

In it, he has tried to give us a brief review of the fundamentals of Japanese architecture. Many foreign critics consider the Nikko style as most characteristic of Japan. It is an extravagantly ornate style in which fundamental architectonic lines are sacrificed to secondary embellishment. Dr Taut considers it to be unrepresentative of the 'true spirit' of Japan; which, according to him, is best represented in the Ise shrines with their simple logical lines and forms. In them nothing is retained which does not conform to the "integral architectonic character." He also considers the Katsuro Palace, built in the same spirit, as a thing of "eternal beauty," "a completely isolated miracle in the civilized world."

For some time past, Japan has been aimlessly imitating fashionable forms of Western architecture. In order to rescue her from the drift, it has been natural for Dr Taut to characterize certain elements of ancient Japanese architecture as truly national and some as un-national. His motivation is clear, and his treatment of history has consequently been subjective in character.

But can we not develop a completely objective point of view in connection with the history of art? Is it not possible to view the human spirit as setting up different standards of beauty under different mental conditions without committing ourselves to particular likes and dislikes?

If that were possible, we believe, the historian would be able to present a truer picture of the course of changes in history. History itself would then appear as a running stream rather than as a number of cut and dried beads hanging together on a string, some of which we characterize as good and some as bad.

N. K. B.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

The Nuclear Mass and Radio-activity of ${}^3_1\text{H}$

It has been recently observed by Alvarez and Cornog¹ that a radiation of short range is emitted by ${}^3_1\text{H}$. Since the radiation is of short range, it is most likely that ${}^3_1\text{H}$ emits β -rays and is converted into ${}^3_2\text{He}$ which has been shown by the same authors to be stable. If one examines, however, the mass data given by Livingston and Bethe,² the results mentioned above seem to be anomalous, because the masses of ${}^3_1\text{H}$ and ${}^3_2\text{He}$ are almost equal, being 3.01705 and 3.01707 respectively. The object of this note is to point out that such an anomaly is only apparent and arises only because the masses of atoms and not of nuclei, are given by Livingston and Bethe. If we consider the actual nuclear masses, it can be shown that ${}^3_1\text{H}$ can emit β -rays of small energies and can thereby be transformed into ${}^3_2\text{He}$.

Now the mass of ${}^3_1\text{H}$ has been derived^{3,4} from the reaction ${}^3_1\text{H} + {}^3_1\text{H} = {}^3_2\text{He} + {}^4_2\text{He} + Q$ (1) where Q the energy release = 3.98 ± 0.02 MeV. If one uses the usual masses of ${}^3_1\text{H}$ and ${}^3_2\text{He}$ atoms in equation (1), one gets the mass of the ${}^3_1\text{H}$ atom. The mass of the nucleus is obtained by subtracting the electron-mass from this mass. Thus the mass of the ${}^3_1\text{H}$ nucleus = $3.01706 - .00054 = 3.01652$.

The mass of ${}^3_2\text{He}$ has been determined recently by Bonner⁵ from the reaction ${}^3_1\text{H} + {}^3_1\text{H} = {}^3_2\text{He} + {}^4_2\text{He} + Q_1$ (2), the value of Q_1 given by him being 3.36 ± 0.2 MeV. Using the masses of deuteron, proton and neutron, we get from (2) the mass of ${}^3_2\text{He}$ nucleus, which is equal to 3.01585. Thus, ${}^3_1\text{H} - {}^3_2\text{He} = 3.01652 - 3.01585 = .00067 > \text{electron mass}$.

Hence we see that ${}^3_1\text{H}$ can emit one electron with small kinetic energy and can itself be transformed into ${}^3_2\text{He}$ and, therefore the radiation from ${}^3_1\text{H}$ observed by Alvarez and Cornog probably consists of β -rays.

Our thanks are due to Prof. M. N. Saha, F.R.S., for kindly pointing out the utility of using the actual nuclear masses in the calculations in nuclear reactions.

Palit Laboratory of Physics
University College of Science
Calcutta, 6-12-39.

S. C. Sirkar
K. C. Mukherji

¹ *Phys. Rev.*, 56, 613, 1939.

² *Rev. of Mod. Phys.* 9, 373, 1937.

³ Oliphant, Kempton and Rutherford, *Proc. Roy. Soc., A*, 149, 406, 1935.

⁴ *Phys. Rev.*, 52, 685, 1937.

Errors of Observation in Physical Measurements

Sixteen years ago in the course of an investigation of Upper Air Relationships¹ I had occasion to examine the question of correlation between errors of observation. In this connexion I found that precise knowledge regarding the standard error of even simple length measurements were completely lacking. In recent years the statistical theory of errors has received some attention; but the actual nature of errors of observation in physical measurements has not yet been properly studied.

This question is, however, becoming of increasing importance in view of the fact that in recent years results of even certain precision physical measurements performed independently by different observers have shown significant differences among themselves. The situation may be stated a little more precisely. If m_1 be the mean value of a set of n_1 measurements of any physical quantity carried out by one observer, m_2 the mean value of a similar set of n_2 measurements of the same physical quantity carried out independently by a second observer, and s_1 and s_2 the respective observed standard deviations, then the corresponding standard

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error* of m_1 and m_2 are given by e_1 and e_2 respectively, where $e_1 = \frac{(s_1)}{\sqrt{(n_1)}}$ and $e_2 = \frac{(s_2)}{\sqrt{(n_2)}}$. If $d = (m_1 - m_2)$ be the difference between the mean values based on the two independent sets of observations, the probable error of d is given by the well-known formula $\sqrt{(e_1^2 + e_2^2)}$. Dividing " d " by this probable error we get the 'deviation' in terms of standard errors the probability of occurrence of which can be easily obtained from tables of the probability integral.† If the deviation is large and the probability of occurrence is small, the difference $d = m_1 - m_2$ between the two results must be treated as significant.

Such significant differences may arise from a variety of causes. There may be of course systematic differences in physical conditions under which the observations were made. Assuming, however, that such differences in physical conditions have been eliminated, if the significant differences are still found to persist, as they appear to do in many cases, it becomes necessary to study more closely the nature of "errors of observations."

Eight or nine years ago I collected some material for this purpose. The length of several brass rods (or rather of the distance between two fine marks on each rod) of various sizes were measured a large number times (of the order of 500 or more) by different observers. Originally it was the intention to study the relation between the mean value (m) and the corresponding standard deviation (s), in particular, to test whether the standard deviation was independent of the mean value, that is, whether the error of measurement remained sensibly constant for different values of the length measured, or whether s/m , that is, the proportional error was constant, or whether any other empirical relationship could be traced between s and m .

The preliminary examination of the material, however, clearly showed that, under the conditions of these particular experiments, the errors deviated very markedly from the normal (Gauss-Laplacian) distribution. There was unmistakable evidence of a particular kind of bias. Each observer tended to conform much more closely to particular values of the observations than one would expect from normal theory. Further

*It will be remembered that the "probable errors" e_1 and e_2 are given by $0.6745 (e_1)$ and $0.6745 (e_2)$ respectively. In modern statistical practice "standard errors" are usually used instead of "probable errors."

†That is, on the assumption that s_1 and s_2 are the "true" values of the respective standard deviations, which is more or less justified when n_1 and n_2 are both large.

examination showed that something like the following was probably happening: An observer gets scale readings of the two end-points (or marks on the brass rod) as say 4.36 cm. and 2.31 cm. which yield an observation of 2.05 cm. for the length. This knowledge sets up a bias (of which the observer is usually unconscious) in favour of the particular length 2.05 cm. Subsequently, for example, if the observer gets a reading of say 13.23 cm. for one end-point, there is a tendency for him to register the reading for the other end-point by (unconsciously) adding 2.05 cm. to 13.23 cm. and getting 15.28 cm. or some reading very near this value.

As already stated, the readings for the same observer naturally clustered round the biased value far more closely than one would expect from the normal theory, so that the calculated standard errors were small. Consequently the mean values obtained by different observers in most cases differed very significantly which, of course, merely showed the presence of marked "personal equations."

A possible way of eliminating the above kind of bias suggested to me by making use of non-uniform scales in place of ordinary standard scales. A number of non-uniform scales were constructed in the laboratory, the necessary apparatus for which was borrowed from the Bengal Engineering College, Shibpur, through the courtesy of Prof. Amaresh Chakravarti. In the non-uniform scales the centimetre and millimetre marks were varied at random but the variations were kept so small that they could not be at once detected by merely looking at the scale. Preliminary experiments with these non-uniform scales along with an ordinary uniform scale were started some time ago under the general supervision of Subhendu Sekhar Bose. These experiments also showed that a marked bias was set up when working with the uniform scale.

In view of the intrinsic interest of the problem we started a new series of observations in April, 1939 under the supervision of Mr Susobhan Datta, M.Sc., P.R.S. A preliminary analysis of the material has confirmed the emergence of biased values when using the uniform scale. The use of non-uniform scales, of course, together with calibration tables, on the other hand, gives better results; so that we reach the apparently paradoxical conclusion, namely, that non-uniform or 'inaccurate' scales give more reliable results than uniform or accurate scales. The preliminary analysis also definitely indicates that the distribution of errors, even when measurements are made with non-uniform scales with a view to eliminate personal bias, shows marked skewness indicating a significant deviation from the normal Gauss-Laplacian curve.

The material collected so far is being analysed in detail and will be published in due course. Experimental

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work is also proceeding and arrangements have been made to study in the same way results of observations with more precise measuring instruments of different types. After clearing up some of the obscure points discussed above, we also hope to be able to go back to our original problem, namely, the study of the relation, if any, between the size of the object and the standard error of the measurements.

Statistical Laboratory
Presidency College
Calcutta, 27-11-39.

P. C. Mahalanobis.

Memoirs of the Indian Meteorological Department, Vol. XXIV, Part II, 1923.

A New Series of Extremely Sensitive Reagents for the Detection and Estimation of Ferrous Iron in Traces

Isonitroso-thio-barbituric acid was discovered by Lal and Dutt in 1937, while working on a theory of colour on the basis of molecular strain advanced by Dutt, with special reference to isonitroso compounds. Subsequently in 1938, many other aromatic substituted derivatives of isonitroso-thio barbituric acid were discovered and their interesting properties studied exhaustively from the point of view of colour in relation to chemical constitution.

About a month ago, it was discovered sheerly through an accident that isonitroso-thio-barbituric acid forms an intensely blue coloured precipitate with ferrous iron, the sensitiveness of the reaction being maintained even at tremendous dilution of the ferrous salt. This led to the present investigation with the results given in detail in the present paper, which is going to be published elsewhere.

The following substances have been found to be suitable for use as extremely sensitive reagents for the detection and estimation of ferrous iron in traces, the order of their sensitiveness being given in figures within brackets:

- (i) Isonitroso-thio-barbituric acid (23.6).

- (ii) Isonitroso-1:3-diphenylthio-barbituric acid (26).
- (iii) Isonitroso-1:3-di-o-tolylthio-barbituric acid (28).
- (iv) Isonitroso-1:3-di-m-tolylthio-barbituric acid (31.2).
- (v) Isonitroso-1:3-di-p-tolylthio-barbituric acid (28).
- (vi) Isonitroso-1:3-di-o-xylylthio-barbituric acid (29).
- (vii) Isonitroso-1:3-di-o-anisidylthio-barbituric acid (35).
- (viii) Isonitroso-1:3-di-p-phenetidylthio-barbituric acid (32).

The figures of relative sensitiveness that have been given above within brackets have been arrived at by comparison within strictly comparable and standard conditions, with the help of a Helige's 3 stage immersion colorimeter.

All the reagents mentioned above can also be utilised for the detection and estimation of ferric iron, when ferrous iron is absent from solution, by first reducing the ferric salt to the ferrous state and then applying the reagents. In a mixture of ferrous and ferric salts, the ferrous salt may first be estimated colorimetrically, and then the total iron by complete reduction. From the difference in the two results, the amount of ferric iron present may easily be calculated.

For the reduction of ferric salts to the ferrous state, zinc-copper couple, aluminium-mercury couple, palladium-ised barium sulphate and electrolytic reduction can be profitably utilised. Photo-reduction of ferric salts by ammonium oxalate in presence of sunlight has also given very good results.

Any of the reagents mentioned above is capable of estimating one part of ferrous iron in three million parts of water and of detecting one part of iron in 5.5 million parts of the same solvent.

Chemical Laboratory,
Allahabad University,
Allahabad, 1-12-39.

Sikhibhusan Dutt

The Deccan Traps An Episode of the Tertiary Era

Prof. B. Sahni's General Presidential Address
at the Indian Science Congress, Madras

When a man of science accepts the position of honour in which I find myself this evening it is usually understood that he undertakes, among other things, to engage a large public audience, having the most varied pursuits in life, on some topic of general scientific interest. At the same time he is expected to have at least something to say that he can claim as his own and, what is more, to say it in plain language. Such a man, I assure you, is a man to be sympathized with, for he is shouldering a heavy task.

A World of Fragments.

The student of science lives in a world of fragments. Nothing in that vast array of visible things that we call Nature appears to our restricted vision as a complete picture. True Artist that He is, the Creator never reveals the whole of His design at once. Like the child with a Jigsaw puzzle we try to piece together the fragments of the picture.

We have our moods, too, like the child. Sometimes we gaze wistfully at fragments of the universe far beyond our reach. Sometimes we are bent upon a quest of the minute: a sort of splitting process that is awe-inspiring in its endlessness, for as we probe deeper and deeper it unfolds to our wondering eyes systems within systems, worlds within worlds. Sometimes, again, we are engaged in the reverse process: of building up fragments into what we like to think is a plausible whole. Not that we ever get at the real and complete whole; nor ever shall. For none of us has even a fraction of all the pieces, and each has his own way of putting together what little he has.

To the onlooker, who alone holds the key, the seriousness with which we go about our little attempts must seem pitiable. For after all there can be only one real solution, one Truth. Some of us may boast that we have got at that one Truth: we only delude ourselves. None the less, curiosity lures us on, for there are few pursuits so absorbing as this study of fragments that we call Science.

Yes, this is real Science, the Science of the original scientists, the seekers after Truth.

At times, in our search for the Truth, we come upon things we can make use of in a worldly way. And we know that some of these things we can use, as we like, for good or for evil. But if we are mere seekers after Truth, we care no more about them but turn them over to others: and out of this comes much that is good and noble and beautiful. But sometimes, alas, as we see to-day, Greed comes to conflict with Truth; and the passion to rule harnesses Science to ignore ends. For all that science may have done to civilize him man, it seems, can still be no less of a brute than he was. In the lurid light of happenings we see that civilization is not the same thing as culture.

But this is a sad digression which I had not intended for this occasion. My object this evening is to spend a brief hour with you in the contemplation of Nature.

The Eocene Age: A 'Dawn of the New.'

Less than six months ago the British Association for the Advancement of Science met under the presidency of a renowned scientist. In his address at Dundee Sir Albert Seward gave a vivid account of the way in which, by a study of fragments, such as samples of rocks and of the remains of plants preserved in them as fossils, he was able to visualize a scene in the west of Scotland at the dawn of the Tertiary era. As a pupil I feel tempted to follow his example, and to attempt a reconstruction of an Indian scene at about the same period of the earth's history.

But I would ask you to bear with me if I seem at times to be telling a fairy tale. For at this distance of time we can only see a dim outline of the world as it was, and the exact language of science is ill-suited to the description of visions.

Competent authorities place the dawn of the Tertiary era between sixty and seventy million years ago. It is the birth of a new era in a very real sense. Stupendous forces, surging in the womb of the earth, had already caused gigantic rifts in the crust, and these rifts are gaping out into oceans. From smaller fissures in the crust, molten rock is now pouring forth in repeated

floods of lava which will cover millions of square miles of land and sea. Vast areas are being converted into desert by showers of volcanic ash. A new type of landscape develops, with high volcanic plateaus as a dominant feature. The face of the earth is rapidly changing. She puts on a more modern garb of vegetation; the land, lakes and rivers become peopled by creatures more familiar to us. Still there is no sign of man. But the stage is being set for his arrival. For this critical period foreshadows the birth, out of the sea, of the mightiest mountains of the world; and the heaving bosom of the earth, somewhere to the north of India, is to be the cradle of man.

Such was the Eocene age: it was literally a 'dawn of the new.'

Early History of the Deccan.

To arrive at our early Tertiary scene in India we can either work backwards from the present, or approach it from a still earlier past and try to appreciate the setting in which that scene was laid. I prefer the latter course, although for a few moments it will take us far behind the period with which we are specially concerned. For we shall have to go back to a time, at least three hundred million years ago, when neither the Atlantic nor the Indian Oceans were yet born.

Opinion is by no means agreed even upon the broad distribution of land and sea prior to the Tertiary era. But according to a theory now generally associated with the name of Professor Wegener, who died a hero's death in Greenland a few years ago in the pursuit of Science, all the land areas of the globe were once directly united together into one world continent. The two Americas lay much further to the east, while Europe and Africa lay further west, than as present. Greenland, Ireland and the British Isles were all much closer together and were wedged in between Canada and Scandinavia. South America fitted into the great angle in the west coast of the African continent. Australia and Antarctica lay close up against the south-eastern coast of Africa, with the southern tip of India in contact with Madagascar and wedged in between the African and Australian blocks. At this remote period the South Pole was somewhere in Cape Colony.

At intervals during a period of several hundred millions of years disruptive forces of unthinkable magnitude have caused ever widening fissures in the crust. The Great Rift Valley of Africa is believed to be one of the youngest of these fissures, still in the

making. The Red Sea rift has now become two hundred miles wide; the Atlantic rift is already an ocean. And thus, like icebergs breaking off by the formation of crevasses from the snout of a glacier, or from the edge of an ice-sheet that has spread out to sea, the continental blocks are supposed to have drifted away into their present positions. But these continental movements have not been all movements of separation. They have also brought into contact with each other land blocks formerly sundered by the ocean.

Here in Madras we stand at the eastern edge of one of these blocks which, according to Wegener, has drifted—and perhaps is still drifting—north-eastwards from its former position in the southern hemisphere. To the north of it formerly lay the great Tethys Sea which once separated it from the main Asiatic mass. The Asiatic block, in turn, has moved south-west, towards India. As the two great land masses approached each other, narrowing down the width of the intervening sea, parts of the ocean floor were caught up as between the jaws of a gigantic vice, and they have been squeezed, crumpled and uplifted into the chain of the Himalayas.

A Primeval Landscape.

By far the greater part of the Indian peninsula is made up of rocks that have solidified from a molten state. But the igneous activity which these rocks indicate took place in distinct periods separated from each other by a span of time of which no adequate estimate is yet possible.

The eastern and southern portion of the peninsula (shown red in geological maps) forms one of the most ancient land surfaces of the globe. Parts of it are believed to belong to the primeval crust of our planet as it first cooled and condensed from a gaseous or liquid mass.

From time to time other molten rocks from the interior have burst through the crust and solidified in the cracks, forming thick sheets of walls cutting across the older rocks. The early convulsions of the earth while she was young are still recorded in the complex folds into which these archaic rocks have been thrown. Over large areas the original rocks have been fractured by earth movements or so badly crushed and altered that we can no longer tell their mode of origin.

This was the kind of primitive landscape on which, long afterwards, life first originated (in water) and on which the stratified crust of the earth was laid down.

With the passage of time the greater part of this crust has worn away, and the old surface has again been laid bare. But portions of the strata still remain, protected in deep trough-like hollows in the old river basins, the Mahanadi, the Godavari and the Nerbada, and in a string of outlying patches along the east coast, from Trichinopoly as far as Cuttack. These deposits were laid down chiefly in lakes and rivers, but partly also in shallow seas that flooded the land from the north and east. The wealth of evidence these strata contain tells of great changes of climate and of a long succession of floras and faunas that lived on the vast southern continent of which India once formed an integral part.

Except for these temporary incursions of the sea the plateau of the Deccan has remained a land area, so far as we know, ever since the original crust was formed.

We have seen that the eastern and southern parts of the peninsula are composed mostly of rocks of great antiquity. Similar rocks, in fact, form the foundations of all the continental blocks, the eroded tops of the ancient mountains often projecting through rocks of more recent date. The Nilgiris, and the Palni and Annamalai Hills, are composed of large dome-like masses of semi-molten rocks which have heaved up by the overlying crust and have later been exposed by the denuding action of rain and rivers. These primeval hills usually have rounded, undulating outlines. Occasionally an isolated dome rises suddenly out of the alluvial plain. There it stands, like a petrified sentinel of the hoary past, with his face obliterated and his feet buried in the dust of ages.

Through untold aeons of Time Nature has carved this ancient surface into fantastic shapes. Great masses of rock sometimes lie uneasily perched one on top of another in threatening piles, like dilapidated towers. Vast areas are strewn with enormous weathered blocks lying in utter confusion, as if a great city, where only giants must have lived, had been laid in ruins. Occasionally a huge sphere of granite lies precariously poised on the rounded back of a hill as if one could, with a mere push, send it hurtling down the hill-side. A later day has seen the handiwork of man superimposed upon Nature's in sculptured epics like those at Mahabalipuram—unsurpassed in the grandeur of their conception or in the depth of devotion that inspired them.

The Deccan Trap Country.

Very different is the landscape in the central and western parts of the Deccan, coloured green, by con-

vention, in all geological maps. This is much younger ground, for as we step over from the red part of the map to the green we traverse, at a single bound a vast span of geological time: in most places the newer rocks rest directly upon the eroded surface of the old foundations. Abruptly we are transported into a new era of the earth's history. In fact we have arrived at the dawn of the Tertiary. After a long period of quiescence the volcanic energy pent up in the interior of the earth is now bursting forth in floods of lava on a scale never witnessed before or since.

Delegates to this Congress who have travelled here from the north by way of Bombay or Nagpur must have noticed the long, low, flat-topped hills which dominate the scenery over the greater part of the country drained by the Nerbada and Tapi and by the upper reaches of the Godavari and Krishna rivers. The same type of scenery extends into Kathiawar and Cutch, and for at least two hundred miles north of the Nerbada. Crossing the Western Ghats from Bombay to Poona the railway climbs up through gorges cut through a series of terraces at different levels, like the remnants of a gigantic staircase. These terraces are the exposed surfaces of successive sheets of lava which were poured out at intervals, during a period that must have extended through many thousands of years, and which on the west coast were piled up to a thickness of six to ten thousand feet.

The Deccan before the Eruptive Period.

With the fragmentary data at hand let us try to picture the geography of the Deccan during the Cretaceous epoch which preceded this era of fire and devastation. The south-east coast is flooded by a shallow sea, teeming with life, from Trichinopoly as far as Pondicherry. The same sea stretches north-eastwards into what is now the province of Assam, for similar types of fossil shells have been found in the two regions. Near Utatur we may pick up fossil timber, riddled with holes made by extinct types of wood-boring molluscs. The shells of the creatures still lie in their burrows, petrified within the wood: the logs must have drifted down an east-flowing river into an estuary or lagoon a hundred and fifty miles south of Madras.

The northern sea has also overflowed the land, in the region of the lower Nerbada. But the fauna here is very different, because the barrier of the plateau cuts it off from the southern sea. The northern fauna is more allied to the European—in fact the same ocean

stretches on one side into Europe and on the other as far as Tibet and China.

But of our western coast at this period there is no evidence; either India has not yet split away from Africa; or, what seems more likely, it has brought away with it a large tract of land which lies to the west. By the sinking of this tract the gulf between India and Africa will widen out into the Arabian Sea, isolating our triangular island of the Deccan which, like a gigantic raft that has been cut adrift, will continue on its long journey to the north-east.

Amongst the denizens of the land, dinosaurs abound in the forests of the Central Provinces. Many of them belong to types peculiar to India but, strangely enough, they have their nearest relatives among the dinosaurs of Madagascar and South America: there must still be some land connexion left that allowed these reptiles to intermigrate. But they are rapidly running out their race. The last of the Indian dinosaurs lie buried in the Lameta beds near Jabalpur and at the village of Pisdura near Warora, to the south-east of Wardha.

The Dawn of the Tertiary Era.

We are now approaching the end of the Mesozoic era. The old southern continent is breaking up. The gulfs widen. The same sea that washes the northern shores of the Deccan receives the rivers that drain parts of Egypt, France, Belgium and England. It also laps the shores of Mexico in the far west. In the far east, it sweeps southwards, past Borneo. This is the equatorial ocean of the time, the birth-place of the great mountain ranges of the world in the era that is to come.

It is over such a scene as this that the Tertiary era dawns, with the lurid light of volcanic outbursts. There are, indeed, no volcanoes in the familiar, Vesuvian, sense. The lava wells up quietly through fissures in the earth. But these fissures are hundreds of yards wide and stretch for miles across the country, with crooked cracks branching off to right and left, all brimming with the fiery liquid. In the Rajpipla hills near Broach, in Cutch, Kathiawar and other parts of Western India, some of these old fissures can still be recognized, with the lava solidified inside them in the form of walls of dykes.

The Deccan lavas, being rich in iron, are of a specially fluid kind that takes long to set. They flow almost like water, filling up hollows in the land and

spreading rapidly in horizontal sheets, covering miles of country before they harden into the basalt or 'trap' rock that is familiar to us. In its devastating march the 'fiery deluge' bakes up the soil and consumes all surface vegetation. The very earth is on fire.

Pools and tarns begin to seethe as the lava flows over them. Here and there a stream is dammed up and collects its waters in a temporary lake till it finds or makes a new channel, or the lake itself is covered up by another eruption. The bigger rivers, not so easily blocked, manage to keep their old course, gradually cutting their way through any lava flows that might cross their path. But the eruptions continue from time to time, and from place to place over an enormous area, originally perhaps half a million square miles, from Rajahmundry to Cutch and from near Dharwar almost as far as Jhansi; piling sheet upon sheet of molten rock and loading the old foundations under a plateau thousands of feet thick. Even after the continuous erosion of millions of years the Deccan traps still cover an area of 200,000 square miles, and you can travel all the way from Nagpur to Bombay, a distance of five hundred miles, without ever stepping off the volcanic rocks. Their abrupt ending along the west coast, where they are thickest and form the great scarp of the Western Ghats, leaves us no real measure of their original extension into the tract of land that foundered into the Arabian Sea.

It is difficult to tell where, in the enormous area of the Deccan traps, this igneous activity first began. The traps of the Nagpur-Chhindwara region were certainly among the earliest to be poured out and, so far as we know at present, the highest flow of the series is to be seen on Malabar Hill and at Worli in Bombay. It appears the vulcanicity began in the eastern parts of the Deccan and gradually spread to the west.

The lava flows vary in thickness from a few feet to as much as a hundred. As one flow overlaps another, it seals up the old fissures, and any later eruptions have to force their way up through the entire pile. There is a tremendous outburst. A fresh crack has been rent open, or an old one has split wider. The yawning mouth of Hell roars with thunder, and hurls fire and smoke and ashes miles up into the sky, as if spitting curses on Heaven itself.

The ash comes down again, raining upon the lava still hot round the fissures, perhaps raising a mound here and there; or it extends the desolate waste by burying under its weight any fresh vegetation farther

afield. Beds of volcanic ash abound in many parts of western India, specially round Poona and Mahabaleswar. There must be an eruptive centre in the vicinity.

If a lake or river happens to be near by, the ash settles down on the water, forming a sort of volcanic sediment in which the creatures living there find a speedy grave.

But it is an immortal grave. For, through a process that is still largely a mystery to us, the bodies of these plants and animals become imperishably preserved. Particle for particle, cell for cell, the plant tissues are replaced by silica derived from the ash, or from a lava flow that may have overwhelmed the lake; and in the end we are left with an exact replica of the original in hard, indestructible silica.

This is not a mere cast or an impression of the external features of the plant, but a petrification in the strict sense, which you may cut into thin sections and of which you may examine under the microscope the minutest details of the anatomy. The preservation of the tissues is sometimes so perfect, and the resemblance with the tissues of modern plants is so complete, that while engrossed in their investigation in the laboratory we are apt to forget that we are dealing with forms of plant life that existed fifty or sixty million years ago.

Partly with the heat of the lava, but largely through the action of percolating minerals, the entire bed of the lake becomes hardened into a rock that rings under the hammer like a piece of steel. Embedded in the mud and silt are also the remains of any land plants, or the bones of animals living on the banks, that may have been carried down by a stream. Thus we may have a whole flora and fauna sealed up in a bed of volcanic ash, or in lake and river deposits interbedded between sheets of lava.

Life in the Deccan Trap Period.

After what I have said it will be easy for you to picture the conditions in the Deccan trap period, and realize how valuable for the historian of plant and animal life must be the documents preserved in these intertrappean beds. They have their value, too, in the study of rocks, for the state of evolution of a flora or a fauna gives a measure of geological age more trustworthy than any yet discovered.

The age of the Deccan traps has now been a matter of discussion among geologists for over seventy years. The main point at issue was whether the volcanic period began during the decline of the Mesozoic era or at the dawn of the Tertiary. To most of you, the wranglings of geologists over the age of a stratum

may seem rather futile and meaningless. But apart from its scientific interest, a precise knowledge of the positions of strata in the geological time scale is of value in the exploitation of the mineral wealth of the earth.

We shall revert a little later to the question of the age of the Deccan lavas, for on this question the flora of the intertrappean beds gives evidence which, I venture to believe, is decisive. First let us examine a few selected specimens from this remarkable museum of plant antiquities.

By far the greater part of our knowledge of this flora is based upon collections made in the Nagpur and Chhindwara districts. This is a fortunate fact because here, as we have seen, some of the lowest beds of the series are exposed. According to Sir L. Leigh Fermor these are the oldest beds in the whole series, so that if we could fix the age of the fossils preserved in them we should know when the volcanic activity began. From here we have a great variety of spores, seeds and fruits; abundant remains of water-ferns and other aquatic weeds; different species of the lowly fungus order, sometimes found within the tissues of other plants which they have reduced to decay, as well as numerous kinds of petrified timbers, including palm stems in bewildering variety and number. Associated with these plant remains are the relics of animals that lived at the same time: the shells of many types of freshwater snails, the scales and bones of different kinds of fish, the wings of insects, and the skeletons of many other creatures of land and water. All these relics lie buried in a common grave.

Some of the earliest plant collections were made about ninety to a hundred years ago, chiefly by Christian missionaries, medical men and military officers in the service of the East India Company. Among these men the name of Stephen Hislop will always stand out prominently. It is a pity that this valuable material was not described in Hislop's day, for some of his most interesting specimens, mentioned in his published letters, can no longer be traced. I owe to the kindness of Mr. W. N. Edwards of the British Museum the loan of what remains in London of the Hislop collection. The rapid sketch I am about to attempt is based partly on this material, but mostly on specimens collected in recent years by members of the Geological Survey of India, by Professors K. P. Rode, S. P. Agharkar and P. Parija, by Mr. V. N. Shukla and myself. In the investigation of this material several workers have taken part and it is a pleasure to acknowledge the assistance I have received from the late Pro-

fessor B. P. Srivastava, Mr. H. S. Rao and Mr. K. N. Kaul.

The intertrappean plants of the important area near Rajahmundry, which must have lived in the brackish waters of an estuary, are being investigated by Professor L. Rama Rao and his associates at Bangalore. These Rajahmundry beds are also low down in the series, and the plants probably lived at about the same time as those of Nagpur-Chhindwara.

Among the commonest of fossils in the Deccan beds are some extinct species of stone worts known under the expressive name *Gyrogonites*, derived from their tiny spirally twisted fruits. The great majority of species of this genus, described from France, England and other countries, are of early Tertiary age, and it is interesting that some of these are identical with our Deccan forms.

Some microscopic branched filaments, no doubt belonging to fungi, are seen attached to reproductive organs of two different kinds. One form, with more or less spherical closed bodies of a dark colour, recalling the fruit bodies of modern mildews of the family Perisporiaceae, has been described as a new species, *Perisporiacites varians*. The other has flaskshaped bodies, and for this the genus *Palaeosordaria* has been created. Very little is known of the fossil history of the Perisporiaceae and Sordariaceae, but the few previous records, whatever their worth, are all from rocks of Tertiary age. The Deccan fungi were discovered in certain lake-muds at Sausar, midway between Nagpur and Chhindwara.

In the same lake deposits were found, in great abundance the remains of *Azolla*, a familiar genus of small floating water-ferns which even to-day cover stagnant pools in many parts of the world. The extinct species from Sausar, which has been named *A. intertrappea*, is geologically the oldest known form of the genus: a striking example of the tenacity with which even highly specialized forms of life can persist through the ages. The preservation is so perfect that most of the details of the anatomy, specially of the reproductive bodies which are highly characteristic of the genus, have been studied. Some hollow spherical bodies, associated with the *Azolla*, no doubt belong to an unknown genus of water-ferns, probably related to the modern *Salvinia*; the provisional name *Massulites* has been given to them. The spongy mass of which the body is composed contains small spores embedded in it much in the same manner as in *Salvinia*. Among many types of free-lying spores seen in the same rocks are two which deserve special mention. They are of

two very different sizes, but they resemble each other so much in certain peculiar features that they appear to be the megaspores and microspores of one and the same species, most probably another water-fern. The interesting point about them is the close resemblance they show, both in their structure and in their mode of germination, to the two kinds of spores, large and small, of the rare genus *Rognellidium*, which to-day is confined to South America. So far as I know, the water-ferns are unknown from rocks older than the Tertiaries.

In the Hislop collection at the British Museum there are a number of seed-bearing cones; some of them were found embedded in volcanic ash. The new name *Takliostrobus* has been given to one of them after Takli, a suburb of Nagpur, where it was discovered. Another has been named *Indostrobus*; a third was referred to the old genus *Pityostrobus*. All these cones have peculiar features of their own but the fact that in all of them the scales bear a pair of elongated seeds on the upper surface indicates that they were distantly related to our modern pines and deodars.

Of the several kinds of seeds found at Sausar there is one intriguing type. *Sausarospermum*, remarkable for its several antique features. It recalls the seeds of certain fern-like plants from the coal measure of Europe, but it is hardly conceivable that there is any real affinity between them; at present it is best to reserve opinion on this matter. The name *Viracarpus* has been given to a cylindrical fruit, derived from a number of small flowers densely crowded on a thick axis. This is from the Hislop collection and it may be the very specimen which he mentions in his writings as a mulberry-like fruit, though unfortunately it has never been described. The resemblance to a mulberry is purely superficial, for each flower produced a group of six seeds. It is impossible to say anything yet about the affinities, except that the nearest resemblance that I have so far been able to trace is with the fruits of certain palm-like plants of the family Cyclanthaceae now confined to tropical America.

A very interesting fruit, *Enigmocarpus*, was first discovered by Professor Rode near his home at Mohgaon Kalan, east of Chhindwara. The name is eloquent of our ignorance concerning its affinities, but the structure is perfectly preserved. It is an elliptical 8-chambered fruit about the size of a large pistachio nut, with numerous dicotyledonous seeds in each chamber, attached on a central column from which the eight partitions radiate. The wall of the fruit is thick and spongy; the fruit was no doubt dispersed by water.

To let out the ripe seeds the fruit wall bursts lengthwise, neatly, down the middle of each chamber.

Among Hislop's specimens are two species of cardamoms, both very like the small green kind that we commonly offer, with other spices, to guests in our homes. One of the specimens was so deceptive that a friend actually tried to peel it, till he discovered that it was petrified. In one broken specimen the seeds are exposed, showing their characteristic wrinkled surface.

The other monocotyledonous fruits all belong to palms: some have been described under the general name *Palmocarpus* which may include fruits belonging to widely different kinds of palms. One was named *Tricoccytes* because its supposed resemblance (which has proved deceptive) with the fruits of the Euphorbia family. It has three large chambers, each occupied by an equally large oblong seed. The fibrous fruit wall is thick and adapted for dispersal by water. It seems to have been divided up into a number of longitudinal chambers separated by partitions of hard tissue. The 'chambers' may have been quite empty, or filled with a loose spongy tissue which acted as a float. The surface was covered by a thin, smooth, watertight rind. The whole fruit was about the size of a walnut, which it superficially resembled also in having a curious beak-like point.

But the most interesting of the Deccan palm fruits is one which Hislop writes he had found, but of which we have not been able to trace the original specimen. It is the fossil genus *Nipadites*, so-called because of its resemblance with the fruit of the modern stemless palm *Nipa fruticans*, which forms dense clumps to day in many tropical estuaries, and is common in the Sundarbans. Eighty years after Hislop's discovery was announced Professor Rode found another specimen at Mohgaon Kalan. This specimen shows all the characters of the modern genus, so we need have no hesitation in calling it a *Nipa*, although the species is different. The fruits of *Nipa* are by far the commonest fossils in the London Clay, which everybody agrees was deposited in the Eocene period; they have also been found in the Eocene of Belgium, and of the Paris basin, in fact, in the very grounds of the old Trocadero, now dismantled; also in the Mississippi basin in southern Russia, in Egypt and in far-off Borneo. These fossil records of a brackish-water plant help us to draw at least roughly the coastline of the old Tethys sea, which must have swept the northern shores of the Deccan not far from where Chhindwara now stands. This important genus is scarcely known from rocks older than the Eocene.

It is interesting to see this evidence of brackish-water conditions in the Deccan supported by the fossil remains of aquatic animals. Dr. Hora describes several kinds of fossil scales belonging to types of fish which ordinarily inhabit fresh waters near the sea shore but are capable of descending to the mouths of rivers. It is interesting, too, that on the whole the evidence of the fish-remains from the Deccan beds, first emphasized by Sir Arthur Smith Woodward over thirty years ago, and now confirmed by Dr. Hora, is in favour of an Eocene age; and Professor Bonnema wrote to me that the same is the case with the remains of some small crustaceans which show a treacherous resemblance to the seeds of plants.

But we must return to the palms, for these are by far the most important constituent of the intertrappean flora, and no doubt must have dominated the vegetation of those days. As a rule we only find bits of petrified stems which, for lack of a proper system of classification, we lump together under the artificial genus *Palmoxylon*; although among them there must certainly be many distinct genera that we could easily recognize, if we only knew the flowers or fruits. Sometimes we come across entire trunks, or large portions of them, with the thick mantle of roots still attached round the base. At the Nagpur museum there is a fine specimen, probably discovered at Saugor in Central India well over a hundred years ago; and in 1934 I was able to unearth from the dust and oblivion of the vaults of a Bombay museum a heap of petrified palm stems, some of which were certainly collected at Saugor before the year 1857. It is this very collection that H. J. Carter mentions in a paper of that date, but which had apparently been lost. Luckily, silicified plants do not deteriorate with age: they are immortal, as I have explained already; but alas, most of the labels are gone, except those that were painted on the specimens.

By their sheer number and amazing variety these palms of the volcanic period compel the attention of geologists, because from all accounts it appears that this family of plants, although it first arose in the Cretaceous period, did not rise to any prominence till after the Mesozoic era had begun.

The Age of the Deccan Lavas.

I have tried to put before you, as briefly as I can, what we know to-day of the fossil flora of the north-eastern part of the Deccan. For deciding the question of the age of the Deccan traps it is perhaps unfortunate that so many of the plants are new to science and confined to this country; but, of course, they have an

interest of their own. For the rest, you will have noticed that from what we know of the geological history of the stoneworts, the fungi, the water-ferns and particularly of the palms, which formed such a vast proportion of the flora, everything seems to point to a Tertiary age. What is more, the fishes and the crustaceans, too, seem to fall into line with the plants.

So much for the Nagpur-Chhindwara traps which, according to the geologists of the Indian Survey, are the oldest in the whole series. For all we know, the Chhindwara traps may have flowed out into an arm of the northern sea which was not far off. The lavas of the east coast, too, seem to be equally old. Professor Rama Rao and his colleagues, Messrs. Narayan Rao and Sripada Rao, have quite recently found stoneworts and other algae of early Tertiary age in the estuarine beds of Rajahmundry, at the head of the Godavari delta.

It is curious that no intertrappean beds at all have been discovered in the middle part of the series, which we cross as we travel towards the west coast. Not until we actually reach Bombay Island, where the highest members of the series are exposed, do we again come upon any sedimentary beds. It may be that during the middle part of the volcanic period the lavas were poured out in such rapid succession that no time was allowed for any plants or animals to colonize the desolate surface. Still, I think, a search ought to be made for traces of fossils along planes between the lava flows, *e.g.*, at Matheran, Poona and elsewhere.

In the highest intertrappean beds, namely those at Malabar Hill and Worli, plenty of organic remains have been collected, including a multitude of skeletons of a pigmy species of frogs. I have not seen any plants from here and cannot say whether these beds are much younger (geologically speaking) than those of the Central Provinces. But this seems to me unlikely, because we are told that near Surat and Broach the highest traps are covered by marine beds of definitely known Eocene age. If this is true, then here, at least, the volcanic activity must have already come to a stop before the sea began to encroach upon the land in early Tertiary times. According to Professor V. S. Dubey the radio-active content of some of the traps in western India also indicates an early Tertiary age.

Thus the chances are that the whole of this imposing thickness of thousands of feet of igneous rock was poured out within the relatively short interval of the Eocene period. Quite probably this terrible drama of fire and thunder was only a brief episode of the very earliest part of the Eocene. The thickness of a stratum

is by itself no measure of time. For after all it would not take long for a lava flow a hundred feet thick to be poured out like a flood from a fissure volcano, once it came to business. It is the deposition of the relatively thin sedimentary beds during the quiet interval that must have taken up most of the time of the Deccan trap period.

The conclusion that the Deccan traps were poured out at the dawn of the Tertiary era and not at the close of the Mesozoic, brings them into line with other vast outpourings of Eocene lavas: for example, those that now cover at least 200,000 square miles of the north-western United States and the equally widespread lavas of the old Thulean continent that once united the western Isles of Scotland with Iceland, Greenland and other arctic lands.

Before I close I ought to say that this idea of the Tertiary age of the Deccan traps is by no means a new one. Indeed, it is over a hundred years old, for it was first put forward, so far as I know, by Malcolmson in 1937; and it was repeatedly expressed by Hislop and others in the middle of last century. In later years the question has also been discussed and rediscussed by so many, and from so many different angles, that we could hardly see the wood for the trees. But the pioneers were right, as they so often are. They saw things more clearly because they worked with a clear state and, as we all know, a clear state is a very useful thing.

But the pioneer geologists were right also for another reason. They did not despise the mute but eloquent testimony of the plants that suffered the fiercest ordeals of the dawn of the Tertiary era. For, as the first flashes from the fissure volcanoes flared up on the eastern horizon, the stalwart Palm said to the little *Asolla*:

This lurid light is not a sunset glow—
It is the herald of a morn.

Conclusion.

We have now seen the contrast between the red part of the map and the green. Between the two lies the fact that this was the dawn of a new era: for, look at the number of Eocene genera of plants and animals that survive to this day.

A vista of time stretching back through well-nigh two thousand millions of years. But man, a recent creature of the earth, has united them in one poem of duty to his Creator: if the foundation rocks of the south have given us Mahabalipuram and the Seven Pagodas, the Deccan traps have given us Ajanta and Ellora.

Short Life Sketches of the General President and the Sectional Presidents

Birbal Sahni General President

Professor Birbal Sahni comes of a cultured family of the Punjab and was born at Bhera, Punjab, on November 14, 1891. He is the third son of Professor Ruchi Ram Sahni, a distinguished Professor of Chemistry and a pioneer educationist of the Punjab. Professor Ruchi Ram always took keen interest in the advancement of scientific knowledge in this country and through his example Birbal at a very tender age acquired taste for science. In later life he came under the inspiring guidance of Professor Sir A. C. Seward at Cambridge.

Professor Birbal received his early education at Lahore and in 1911 he joined the University of Cambridge, where he became a foundation scholar and later a life member of the Emmanuel Emmanuel College. His original researches won for him the degree of doctor of science of the University of London and of Cambridge.

He returned to India in 1919 as a professor of botany in the Benares Hindu University and a year later joined the Punjab University in the same capacity. Since July 1921 he has been the professor of botany in the University of Lucknow.

In 1929 he was awarded the Sc.D. degree of the Cambridge University—the first Indian to obtain the distinction. He has been specially interested in palaeobotany, *i.e.*, the study of fossil plants now extinct. Besides his outstanding researches in palaeobotany he has published a large number of original papers on a wide range of subjects.

Professor Sahni is connected with a large number of scientific bodies, Indian and foreign. He is one of

the founders and an ex-president of the Indian Botanical Society. He was president of the section of botany in 1921, of geology in 1926 and of botany in 1938 of the Indian Science Congress. He is a fellow of the Royal Asiatic Society of Bengal, vice-president of the Indian Academy of Sciences and National Institute of Sciences, a former Vice-president and now foreign secretary of the National Academy of Sciences, United Provinces. He was vice-president of the palaeobotany section at the 5th International Botanical Congress, held in Amsterdam in 1935 and was awarded the Barclay medal of the Asiatic Society of Bengal for research in biological science in 1936. Dr. Sahni is the Dean of the Faculty of Science, Lucknow University. He was India's delegate to the third centenary celebrations of the National History Museum in Paris in 1935 and represented his university at the International Botanical Congress, Amsterdam, the same year.

Professor Sahni was elected a Fellow of the Royal Society of London in the year 1936.

A. C. Banerji President, Mathematics Section

Professor A. C. Banerji was born on September 23, 1891, at Bhagalpur, Bihar. He received his early

education in Government Zila School, Bhagalpur and graduated from the Presidency College, Calcutta in 1911. He took his M.Sc. degree in mixed mathematics. With a government scholarship from Bihar he joined Clare College, Cambridge, in 1915, and became the Foundation Scholar of the College.

He became wrangler in 1918. At Clare College he was the president of the debating society

for two terms in 1918-19. On his return was appointed a professor of mathematics in Muir Central College, Allahabad, in July 1920, and in 1921 he was appointed to act in the Indian Educational Service as the senior reader of mathematics in the Allahabad University. In 1930 he was appointed to the professorship of mathematics of the University. He was the president of Secondary Educational Conference U. P. in 1933. He was the first secretary of the National Academy of Sciences, Allahabad; and for two years was its vice-president. He is also a fellow of the Royal Astronomical Society and the National Institute of Sciences. He has published a number of research papers in hydrodynamics, nuclear physics, wave mechanics, relativity, galactic dynamics, and astronomy. Professor Banerji has also written and published about two dozen popular articles on scientific and educational matters both in English and Bengali.

K. S. Krishnan

President, Physics Section

Professor K. S. Krishnan is a very distinguished pupil of Sir C. V. Raman, and he had his early research training under him in the laboratories of the Indian Association for the Cultivation of Science, Calcutta. He stayed in the Association for nearly five years from November 1923 to December 1928, and collaborated



with Sir C. V. Raman in much of the work on light - scattering and allied phenomena done during this period, and in the discovery of the Raman Effect. At the end of 1928 Dr Krishnan moved to Dacca, to take up a Readership in Physics at the Dacca University, and while there he started

his well-known researches on magne-crystallic action. In 1933, when Sir C. V. Raman left Calcutta for Bangalore, Dr Krishnan was called to the newly founded Research Professorship in physics, at the Science Association, the Professorship which he is holding now.

1936 Professor Krishnan was invited to the International conference on Photoluminescence held at Warsaw. In 1937 he made an extended tour in Europe, and gave lectures at the Royal Institution in London, at the Cavendish Laboratory in Cambridge and in some of the continental universities, and he was awarded the university medal at Liege. He again visited Europe early this year, at the invitation of the International Institute for Intellectual Co-operation, to attend a conference on Magnetism arranged by the Institute at Strasbourg.

S. Krishna

President, Chemistry Section

Dr S. Krishna obtained his D.Sc. from London University and is the Forest Biochemical at the Forest Research Institute and College at Dehra Dun, U. P.

L. Rama Rao

President, Geology Section

Born in 1896, Professor L. Rama Rao graduated in 1917 from Central College, Bangalore winning the Madras University prize in geology. He was appointed demonstrator in geology in the Central College in 1918 and was made a professor in 1932. He was elected



fellow of the Geological Society of London in 1929. He is a fellow of the National Institute of Sciences and the Indian Academy of Sciences. He started in 1922 a detailed survey and investigation of the Upper Cretaceous rocks found along the east coast in South India in the Trichinopoly, Pondichery, and Rajahmundry areas, in which work he has been actively engaged all these years and has published a number of papers. In the course of this work, several interesting observations and valuable discoveries have been made, which have added considerably to our knowledge of these rocks, and have opened out new fields of research.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

FEBRUARY 1940

VOL. V NO. 8

A Scientist's Philosophy

A CORRECT philosophy is like the Law of Gravitation in that it withstands all the assaults of time, but it is also like that law in that new and more refined observations, as well as more minute and painstaking analysis, may be expected to bring refinements and extension rather than replacement. For at least since the advent about 300 years ago of the method of science, we have very seldom been obliged to throw away what we thought we had learned and to start all over again. Our progress has been rather by the method of accretion—by adding bit by bit to the knowledge already acquired, by modifying it and giving it new form but retaining the old substance—in a word by the evolutionary process. This is only saying that the old knowledge, in so far as it is real knowledge, is always incorporated into the new philosophy. I think it may be seriously questioned whether revolution and violence have not in general destroyed rather built up, retarded rather than accelerated progress. So much for a general point of view as to procedure, now as to my own philosophy which is what this lecture is about.

In contributing my bit to a volume called *Living Philosophies* (published by Simon and Schuster, New York) some years ago, I saw then, just as I see now, the three great discoveries and influences which have underlain the progress of mankind as, (1) The discovery of the Golden Rule or, more broadly, of the altruistic ideal; (2) The discovery of the ideal of natural law or of the scientific method of approach to

knowledge; (3) The discovery of the idea of continuous, age-long growth or evolution.

Let me amplify and refine and extend somewhat these ideas as they seem to me to apply to the present. The discovery of the golden rule finds its beginnings in what Breasted calls "the Dawn of Conscience," i.e., in the development of a sense of duty or responsibility to something more significant, more fundamental, more enduring than oneself—the devotion to which justifies unselfishness. Where and how this altruistic idea developed we can only conjecture. Perhaps it is an outgrowth of mother love found in all mammals and birds but apparently not in fishes, for beneath the surface of the sea there seems to be no heart, no pity. This altruistic idea, then that underlies the word "ought" is the common element in all the great religions. It seems to be *the one essential thing in religion* and I am going to call it religion's contribution to the progress of mankind. It springs from the feeling or the conviction that there is something more important even than the life of the individual, something that justifies his devotion and if need be, his self-sacrifice even of life itself. This attitude is at the base of all *personal morality*—the willingness to listen with Socrates to "the inner voice." It is clearly a matter primarily of the emotions and the will.

This attitude or feeling of good-will or unselfishness is clearly absolutely essential to human progress; for, obviously, without the willingness of the individual to

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subordinate his impulses and desires to what he regards as "the common good", i.e., to something outside himself, organized human society at once becomes impossible and reduces to "the jungle." But though this altruistic or love-your-neighbour attitude is necessary to human progress, it is not sufficient despite the fact that the religious leader is prone to assert that it is. For head as well as heart is necessary for social well-being and increasingly so as society becomes more complex. Indeed the sincere and devoted fanatic, who always does and insists on doing what he thinks is right, has often been a terrible world scourge; for social morality has actually little if anything to do with individual morality. It is *social results* alone that we are here concerned with, *not attitudes*. The pious religionist who, following what he thinks his god's command, bathes with thousands of others in plague-infested water, is doing his best but with what social consequences?

It was here that the second discovery—that of the scientific method—made its stupendous contribution to human progress. Though adumbrated in Greek times, it essentially came into being in a large way about three hundred years ago. It starts with two fundamental assumptions, (i) that nature acts consistently, not capriciously, as all the preceding animistic philosophies, ancient and modern, had assumed; and (ii) that man, by sufficiently intensive study, is capable of understanding, to some extent at least her processes and of turning them to his own social needs.

These two ideas, the uniformity or orderliness of nature and man's capacity to understand her, were almost unknown in ancient time. The Greek gods who controlled natural events were capricious human beings and the Jehovah of the Hebrews slew or spared according as he was angry or otherwise. Of course those philosophies were fatalistic. Three blind fates sat down in deep and dark inferno and wove out the fates of men. Man himself had no understanding of or control over nature. His only hope was by magic, incantations and sacrifices to get a "stand in" with the gods.

We have now had three hundred years of testing of the foregoing assumptions that underlies modern science, first and most elaborately in the field of physics where man's recent conquest of the "thunderbolts of Jove" which through all the ages had been the dread and terror of mankind, resulting in the in-

auguration of the marvellous age of electricity in which we live, has convinced even the man in the street that science holds the key to human progress. But we have had similar testing of these scientific assumptions in the field of astronomy, then in chemistry, in engineering, in geology, in biology and much more recently and less completely, in economics and the social sciences with results so uniformly consistent as to justify the assertion that the scientific method, with its uniform technique of hypothesis, careful analysis, prediction and experimental test and verification, whether it be by the laboratory method or by statistical or historical studies, is the only method by which definite, dependable, practical knowledge has been obtained.

Further these results fully justify the assertion that in all the fields in which the scientific method has been applied *there already exists a core of well established, non-controversial fact and law; and that human progress must henceforth be made, primarily if not exclusively, by standing on this core of the already known, and slowly gathering into it by the continuous use of the same method, more and more from the surrounding zones of the controversial and the unknown.* The procedures and the attitudes are essentially the same in the social as in the natural sciences but the techniques are different. In the former we are able in our laboratories to separate and isolate the various factors and obtain controlled conditions. In economics and the social sciences long and elaborate statistical studies must be made in order to isolate the factors and thus obtain the controlled conditions. For example, we are just beginning to have, available through such bodies as the National Bureau of Economic Research, a large amount of such definite dependable statistical knowledge in economics to which practically all economists agree.

While the first of my three elements in human progress, unselfishness, stems from the emotions and the will where lies indeed the seat of all action, the second is the child of man's intellect alone. The first leads him to do right *as he sees* it, the second gives him knowledge of what *is* socially right—a purely scientific problem on which he is slowly making progress. It is true to be sure, that the definite knowledge of which he is already in possession is vastly greater than what he has thus far been willing to use, since we see him every day under the lure of the demagogue and the sincere but ignorant rabble-rouser, advocating and voting for the use of both physical and economic perpetual motion machines, or for emotional

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panaceas like extreme nationalism or the Marxian class war which both experience and careful analysis have shown to represent fundamental fallacies.

My third great element in human progress involves both the intellect and the emotions. The facts of evolution have been demonstrated intellectually but nothing so stirs the soul of man to wonder and to reverence as the contemplation of the extraordinary orderliness and unity of nature more and more clearly revealed as man's studies go deeper and deeper, and above all, the inescapable evidence that he finds, not of random and unprogressive change, but of definitely directed movement toward the age-long development of higher and higher forms culminating in man himself. Most scientists will, I think, join with Einstein in his combination of emotion and intellect when he says, "Enough for me to contemplate the mystery of conscious life perpetuating itself through all eternity, to reflect upon the marvellous structure of the universe which we can dimly perceive, and to strive humbly to understand even an infinitesimal part of the intelligence manifested in nature." I myself need no better definition of God than that.

May I now add one new political element to my social philosophy which is inspired by recent world events and is essentially a corollary to the second of the foregoing elements in human progress, i.e., the scientific approach to knowledge. The most important social question that faces the civilized world today is, "Can free representative government survive anywhere in the face of the reactionary influences that are now pushing the whole world back toward the despotisms from which it began to free itself three hundred years ago, when the method of modern science first began to let in the light, to free the spirit of man and to destroy the authoritarianism of both church and State which had kept mankind in ignorance and bondage through most of recorded history?" These reactionary forces mask under the names of communism, national socialism, liberalism, even democracy; but while the hands are Esau's, the voice is Jacob's. The suppression of the freedom of the individual to speak, to write, even to think reveals in every case the deception. This alone tells the story of whether a given country, no matter what label it carries on its flag, has actually turned the clock of progress back or not. No other criterion is needed.

By this test, we in the United States and you in most of the other democracies, are still free, but the reactionary influences are rolling in waves from Russia, from Germany, from Italy, from Japan. Will they engulf us? New moves toward socialism and collectivism are reported in the papers every day. If recent history means anything, these are only the vanguard of despotisms, as one can see by observing what the countries which profess them have become; for what does the name Nazism mean but national socialism and what does the Russian tyranny call itself if not a socialistic State? If Longfellow were alive, he would write more anxiously than he did seventy-five years ago about our great experiment in democracy in the United States.

"Humanity with all its fears,
With all its hopes of future years,
Is hanging breathless on thy fate."

For communism, fascism, nazism, totalitarianism in all its forms, mean simply despotism and *despotism means eternal war*. That is where we are headed unless through the public school, which in my country now reaches practically the whole of the oncoming generation, and through the press which now reaches a large part of the present population, and through all other available agencies, we can so educate our people, while we still have the ballot, to use that ballot to preserve our liberties. It all comes back to you and me—the voters. If we have rotten governments, it is because we, by our ballot, put corrupt men into control. If we have an insidious and disgraceful patronage system as we have in the United States, which corrupts the public and private morals of the nation and renders us callous to the wholesale use of public funds for political purposes, it is because we, the voters, tolerate it. If we have stupid, incompetent, untrained, unscientific men in office, it is because our ballots put them there. The only possible hope for the preservation of our democratic liberties obviously lies in the development of an educated, intelligent, scientifically-minded, objective electorate. That is what in the last analysis our schools and colleges primarily exist for and the most direct and effective approach to the problem of rational, objective, intelligent living is through the spread throughout our whole populations of an increased familiarity with the way in which modern science had developed. It is here that the problems of obtaining real, dependable, unprejudiced, workable knowledge as a guide to conduct in place of hunch,

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superstition, prejudice and emotion has come most near to a solution. If our educational institutions of all types can rise to their responsibilities and do their jobs rightly, our democracies can be saved. If they cannot do it, we are doomed. I for one am going to assume that they can do just that if each of us, as yet free citizens can be awakened to the danger that is before us and the direction in which we are going and

become inspired to do his part in ourselves voting and in educating our fellows in the real responsibilities of democracy. Eternal vigilance is indeed the price of liberty *

*This lecture was delivered by Dr R. A. Millikan on November 27, 1939 to the students and teachers of the University College of Science, Calcutta. We are thankful to Dr Millikan for having kindly permitted us to print it in SCIENCE AND CULTURE.

Scientific Work and the Public

Fortunately, much has been done in recent years to "infiltrate" the doings of science into the reading of the general public. An increasing number of scientists are sharing with the rank and file the results of their labours, even at the risk that inadequate statements may be circulated by the press at the expense of a certain prestige among colleagues who fail to understand the need for popularization of science. There is indeed a need for far more popularization of science in still plainer language—not for the unintelligent but for the vast majority of intelligent people who make up the nation but to whom scientific terminology is as non-understandable as is the vocabulary of the medical profession to the architect or the engineer. Science, which depends for its existence upon public good will and, in the end, public financial support can well afford to keep the world constantly informed of its achievements other than in technical language. Perhaps the day will come when every editor of a scientific journal shall request in addition to the technical manuscript a paraphrased summary in ordinary English recounting the significant results of

each piece of research. This might incidentally help a scientific worker to evaluate the significance of his own contribution to the society in which he dwells.

Through a new emphasis in educational curricula and a further and more extensive popularization of science among peace-loving nations, one might expect that economic and political differences would become more easily adjusted. Nations would unite in the conquest of the frontiers of knowledge. One is indeed a pessimist to think that the present accomplishments of science are other than the beginning of a national prosperity such as civilization has yet to see. Such new trends of emphasis together with a more direct impact of science upon governments could accomplish much in the next two decades. Many of the problems of science today cannot be solved except through the co-operation of workers in various fields of science, and there are many scientific problems which must wait for solution upon international co-operation alone.

—The Scientific Monthly.

Work of the Archaeological Survey of India

(Continued from the last issue)

Conservation Work of the Department

IN reviewing the conservation work of the department, Sir Leonard starts by paying a tribute to the archaeological department for what it has done and is doing for the preservation of the invaluable monuments of India's past. But this compliment is immediately followed by the observation that it has been a serious error on the part of the department to spend money in the manner it has done for the conservation of excavated remains. According to him this has been carried in some cases to such absurd length that even scientific aims have been defeated by the prevention of further digging, and the conservation of later buildings has effectually sealed up no less rich lower and older levels. In some cases, he further adds that deceptive work of reconstruction has been done in an enthusiasm for restoration. All this has happened because officers of the department have been content to follow blindly the general rule to conserve in all cases instead of judging each case on its own merits. But in condemning the department in such sweeping terms, Woolley forgets that the department has also to respond to the public demand that the antiquities should not be allowed to rot, and the public should have some idea of what they looked like when complete. On this point, we are afraid that Woolley has condemned the department without caring to ascertain facts, and his opinion is often self-contradictory.

Faulty Excavation Work

Regarding the work of excavation done by the department, Sir Leonard discovers not only a lack of judgment in drawing up a programme of research but also condemns the quality of the excavation work done.

Due to the present policy of dispersing the available funds into small grants for work on a large number of sites, the work on some of the sites has to be entrusted to men who are not supposed to be qualified for it, and have not the background of scholarship or any experience in field work. The result in

such cases is deplorable; valuable evidences are destroyed and what survives the workman's pickaxe is not properly understood. The criticisms do not stop here but extend to some of the most important excavations conducted by superior officers of the department, at Harappa, Paharpur, Sarnath, Nagarjunkonda etc. According to Woolley, works in these sites have been done in amateurish fashion by persons without adequate training and experience. These remarks cannot be overlooked as they bring the charge of incompetence even against the topmost officials of the department and certainly calls for an explanation from the Director-General of Archaeology.

Probably a reply to this criticism is found in a later observation by Woolley where he finds that the officers of the Archaeological Survey are not grouped on professional basis like Excavators, Epigraphists, and Inspectors, but every one is expected to be an expert on every subject. Probably Sir Leonard Woolley is not aware that this practice which is derived from traditions of the Indian Civil Service, dominates sometimes even the scientific services and is probably largely responsible for the kind of mistakes referred to. If his plans of creating posts on professional basis are adopted, the quality of work will certainly improve.

The Museum Policy

The policy of maintaining local museums on excavated sites has, according to Woolley, proved to be a failure in this country, as owing to the inaccessibility of some of them, they cannot serve any educational purpose to the public. Even at the great and sensational sites of Mohenjo-daro and Harappa, the annual number of visitors do not exceed one thousand* and the number decreases yearly. At Nagarjunkonda, a place 'almost inaccessible' according to the Director-General, a museum building is being erected at a cost of nearly Rs. 27,000 to house a collection of magnificent stone sculptures of a type which is not represented in any museum in India. The excavation

*We are not told how these figures were obtained, but our impression is that the figures are wrong.

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and sculptures have been open to view for several years but the number of visitors that it attracts may be estimated from the fact that within the last two years, apart from the officers of the department, Sir Leonard was the only person to visit the site. Probably this is due to the fact that there was hitherto no road but Woolley has condemned the department without caring to ascertain all the facts; the Madras Government, before building a road made it a condition that the wonderful finds must remain there. Another point is the feeling of the Andhras, who are very touchy about such relics leaving their province and going to Madras, Calcutta or Delhi.

Any museum in a central place whether controlled by the department or by a provincial government or by a university or such other bodies, is by its position alone infinitely more suited to serve as an educational centre than would be a museum on an archaeological site, and Sir Leonard emphasizes that the department should, through such institutions, use for the general benefit all valuable materials collected, while the local museum should only be a work room and a clearing house while excavations are in progress.

Of the local museums at Sarnath, Taxila, Nalanda, Mohenjo-daro, Harappa and Nagarjunkonda, he advises the closing down of all except two, viz., Taxila and Sarnath, which will remain highly specialised. He advises the establishment of a central national museum on a suitable site at Delhi which should house a general collection of Indian antiquities. This and the archaeological section of the Indian Museum at Calcutta may then represent Indian archaeology in general. But would local or provincial sentiment agree to valuable antiquities being removed?

Co-operation of Various Authorities

Between the Government and the provincial, municipal, university and State museums there should be, according to Woolley, close co-operation. Sets of unique objects may be lent for short periods to provincial museums, temporary exhibitions of which would have considerable educational value. A closer co-operation with universities and educational institutions in the country has also been recommended, but Woolley has forgotten to note, probably due to the secluded way in which his movements were regulated, that a certain amount of co-operation has always existed, though pro-

bably this can be further improved. Senior officers of the department may be officially attached to such institutions as part-time lecturers. This would not only widen the department's sphere of influence but may actively help to discover and develop talent in possible recruits for the service.

Popularization of Archaeological Work

Most of the valuable work which has been done by the archaeological department lies buried in learned volumes excepting for a small number of guide books for monuments and museums. We quite agree with Woolley that the most effective way of encouraging public interest in archaeology in this country and abroad would be to arrange for the publication of small well-illustrated books which will summarise the results and bring to the ordinary reader up-to-date knowledge regarding the discoveries and the problems of Indian archaeology. An example is provided by Woolley's own story of excavation in the *Ur of the Chaldees*. If books of a similar character can be written on the Indus Valley culture, on the Buddhist monasteries of northwest India, on Taxila, Nalanda and other similar subjects, they would be very welcome and would help to broaden the basis of education. It is not quite right to say that works of this nature have not been attempted. The story of the Indus Valley Civilization was first published by Sir John Marshall in the *Illustrated London News* and evoked widespread interest. "SCIENCE AND CULTURE" has published an article on James Prinsep, the decipherer of the Brahmi script. The same journal and the *Indian Art and Letters* have recently published popular articles on the Indus Valley Civilisation. Recently in Sir John Cumming's "*Revealing India's Past*" (India Society, London) a semipopular account of the work on Indian archaeology has been given. We hope Woolley had time to examine Sir John Marshall's guides to the Museums at Taxila, Sanchi and Sarnath. But we admit that these are not sufficient and Woolley's suggestions should be acted upon. But there is no reason why the officers of the department should be blamed for not doing such work. They are, according to Woolley's finding, over-worked, and there are plenty of Indian scholars outside the department who can undertake to do this work.

Learned Memoirs by the Department

Regarding the annual *Reports* and *Memoirs* of the department, Woolley has made sweeping comments condemning them all summarily as indigestible and

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esoteric. We had to rub our eyes in wonder when we read these passages. Sir Leonard Woolley is well-known as a very careful excavator, (he is the official excavator of the British Museum) as a writer of popular books, an expert in ancient pottery, but we are not aware whether he has carried out decipherment of any inscription, cleared up any knotty point on chronology or tried to solve a problem on development of art, or style in architecture by a learned discussion of all available material. We are not even aware whether he has that background or knowledge of Indian archaeology which alone can entitle him to the position of a Jove speaking from above the clouds with the thundering voice which he has unfortunately assumed on this occasion. We are afraid he has not, and decency required that before he passed such a sweeping remark on *Memoirs* which have been written by such great authorities as Sir John Marshall, L. ü ders, Vogel, Foucher, Sten Konow, R. D. Banerjee, R. P. Chanda, D. R. Bhandarkar, H. P. Sastri, Sir A. Stein, Du Roiselle and other well-known authorities, he should have taken the trouble of ascertaining their contents. We are sorry to note in this connection that like all experts, Woolley has overrated the importance of the subject in which he is a specialist and underrated that of others. He has justly complained against the neglect of potteries by the department, but has grossly underestimated the importance of the reading of inscriptions and of coins. Anybody who is familiar with the development of our knowledge of India's past within the last 100 years knows fully well that whatever little knowledge we have of the past of India up to the time of Asoka has entirely been obtained from the careful study of inscriptions and coins. They have given us the names of kings, nay even of dynasties, which disappeared without leaving any echo in tradition or legend, and have enabled Indologists to throw light on many epoch-making events and human movements of earlier times. If Sir Leonard Woolley, instead of confining his movements solely to the Olympian heights as he did in course of his Indian tour, cared to exchange views with professors of universities and other workers on India's past, he could not have pronounced such fantastic opinions on the *Memoirs* published by the department!

Necessity of Stabilising the Budget

In discussing the financial needs of the department Sir Leonard finds fault with the present budget-

ary arrangements which treats one of the primary duties of the department, viz., excavation as a luxury, the fixed charges being considered first and only the residue being spared for excavation work. But when finding fault with the department for a lack of any coherent plan of excavation work he forgets (though he himself admits it elsewhere) that this was rendered impossible mainly because of the financial stringency imposed by the Government and of the budgetary policy which does not allow the department to plan any excavations even a year ahead of the programme and so encourage taking up field work. Moreover the grant has to be spent within the limits of the financial year in order to avoid its resumption by the Treasury. The result has been that the department could not formulate a programme of excavation more than twelve months ahead and there was always a tendency to spend the little residue in a haphazard fashion without any regard for probable returns. Sir Leonard proposes that the budget for all departments except excavation should be stabilised, while the excavation fund ought to take the form of an endowment giving to the Director a fixed income on which he can draw as required and the balance in hand at the close of the financial year may be credited to the next year. The direct contribution of the Government to this fund should be fixed and calculated on the basis of what is required for a reasonable excavation programme and should be guaranteed at least for a number of years independent of whatever balance the Director may be holding in reserve. Another most useful suggestion is the creation of travelling scholarships which would enable officers of the department to have some firsthand knowledge of foreign methods and ideas.

These recommendations are very sound, and we are quite sure that the department must have made similar representations to the Government. But it is not possible for them to get the fixed rules of the Government changed. Lapse of grant unless it is spent within the course of one revolution of the earth is, like the proverbial law of the Medes and Persians, a fixed custom with the Government of this country and is responsible for a good deal of inefficiency which characterises all public works under the Government in this country.

Recruitment and Reorganization

On the question of selecting and training of officers, Sir Leonard proposes certain readjustment and redistribution and implementing of the existing staff.

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The retirements and retrenchments in 1931 caused gaps in the cadre of officers which could not be filled up properly. He considers an increase of staff as obviously essential for the sake of efficiency.

The present organization of duties within the department, according to Woolley, makes impossible demands upon officers and expects the same man to pass through the *Avatars* of conservator, explorer and museum manager, may be, all in course of one single revolution of the earth. The proposed reorganization would be based on specialisation within the department and practical differentiation of conservation, exploration and museum management and would thus bring the efficiency of recruits within the bounds of possibility. The scheme provides for the additional appointments of two Circle Superintendents, two Assistant Superintendents, two Field-Directors, two Assistant Archaeologists, two Proto-historian Superintendents, one Assistant Superintendent for Epigraphy and one assistant for physical anthropology and four student apprentices. As for the existing arrangements for training recruits, the existing state of affairs is so deplorable in his opinion that there is no chance of securing proper training within the department. To quote Sir Leonard's own words, "In museum work, as in excavation, and in conservation in some of its aspects, the staff of the archaeological department are insufficiently trained by precept and by experience; they are not themselves adequate to their task and naturally they are unable to train up their successors to any higher standard than their own and the quality of the department is likely to deteriorate progressively. Outside help is necessary if any good is to come of the Department's work." He accordingly recommends that an European advisor in archaeology be appointed for five years who would be able to help the Director-General by his advice and the whole staff would be so trained by precept and example within this short period that it would be capable of doing its own work on its own initiative.

We are afraid that we cannot agree with the recommendation for importing an European advisor in archaeology. Such a person, however eminent he may be, can be expert only in one or a few branches mentioned by Woolley, for it is next to impossibility to expect that the brain-stuff of experts on ten different subjects can be found boiled in one

pot. In the case of a person like Sir John Marshall, who probably alone amongst living Indologists possesses the necessary qualification, it was acquired after a whole life-period spent on such work. In our opinion, young Indian officers recruited for the posts recommended by Sir Leonard Woolley should undergo a preliminary training in this country on certain lines, just to get a personal contact with Indian problems. They should then be sent to foreign experts, say to the British Museum, if it is museum training; to Italy, if it is conservation work; to Iraq, Egypt, Palestine or Asia Minor to be attached to excavating or exploring parties, if it is excavation work. We are quite sure that such a system would produce far better results than the importation of a single super-expert from Europe on a fancy salary.

Conclusion

We have finished our observations on the recommendations of Sir Leonard Woolley regarding the work and organization of the Archaeological Survey of India. The recommendations which he has made regarding museum management, utilisation of museums by the public for educational purpose, for training officers of the department in specialized jobs, for long period budget provision, and for proper choice of sites for excavations and for co-operation between the department and educational institutions are very sound, and should be given immediate effect. But these suggestions are neither new nor original; long before Sir Leonard Woolley visited Indian soil, some of these suggestions had been made, *particularly through the columns of Science and Culture*.^{*} As usual they fell on barren grounds, but now that a super-expert from abroad has repeated them, they will probably be acceptable to the Government of India. His attacks on the work of the department, excepting those relating to excavation and exploration, are largely unjustified and irrelevant, probably due to his ignorance of Indian archaeology, and of the methods and practices of service followed by the Government of India.

We cannot finish this article without calling attention to certain very peculiar features of Sir Leonard Woolley's visit. He was asked to visit India at the instance of some high god of the administrative machinery of India, and while on Indian soil, he was tossed on at an Olympic height between the Viceroy and Governors. Excepting on one or two

SCIENCE AND CULTURE. 1. 61, 439, 1935-36; 3. 129, 1937-38.

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occasions, he was very rarely allowed to come into contact with Indian scholars, and representatives of enlightened public opinion. Whatever the high officials may think, such practice must be condemned by all shades of public opinion in India. We welcome advice from European scholars and experts, but they should sit on the same table with Indian scholars and experts and discuss their observations and recommendations in a friendly and absolutely unbiassed spirit.

Finally we cannot but deplore the policy of the Government of India in reference to scientific services and departments. They are almost all of them without exception miserably under-staffed, receive very

small grants for carrying out programmes of work which are entirely beyond them and still at the very first opportunity when there is any question of reduction of expenditure, they are the first to be selected for retrenchment both in personnel and grants. Moreover the Government from time to time invite such super-experts as Sir Leonard Woolley who are not properly acquainted with developments or conditions in India, to review and pronounce judgment on the works of such departments and services, and the result naturally are reports like the one we have commented upon in fair detail in our two issues. Surely such wastage of public funds cannot be defended and we would again suggest that time has come when India should have an authoritative and fully representative Research Council to advise in reference to such activities. We hope to deal with this question in greater detail in a later issue.

Emphasising the Value of Science

The education of public opinion is a long and tedious process. But the patient and persistent efforts of a united scientific body towards this end should be fruitful of results in due time. If a little more than two decades is needed to train for military purposes a new generation, then the same amount of time spent in an organized efforts for education in scientific intelligence would work wonders. So often has the teaching of history, literature and allied subjects so glorified the results of military achievement that rising generations learn too easily to place undue emphasis on this phase of social progress. When scientific achievements and the men who have pushed back the barriers of knowledge have been given an equal emphasis a far greater proportion of hero-worshippers among our youth will find their heroes in science.

One cannot but wonder that the teaching of science in our schools and colleges may have been guided all too much by emphasis upon the technicalities of the subject rather than by the experience and methods of science as applied to clear thinking and to developing a true basis for a sense of values. When one finds a science requirement in the curriculum irritating to a pupil who makes use of radio, automobile airplane and many other devices of science and engineering, one wonders where the fault lies. From such reports that come in from overseas one would think that the Union of Soviet Republics was far more progressive in the scientific education of youth than is the United States of America.

—The Scientific Monthly.

The Massachusetts Institute of Technology

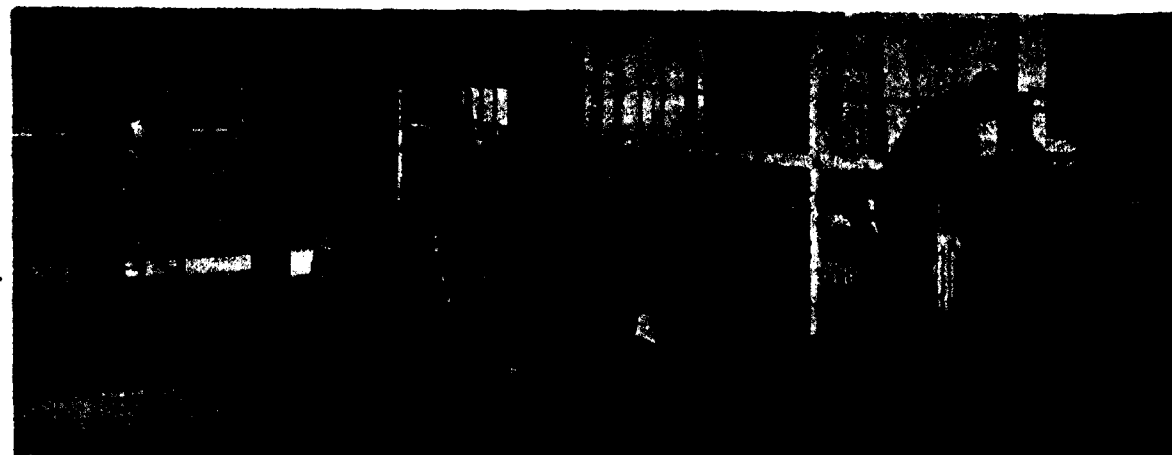
At the dawn of an era in which science was destined to play an important role in the advancement of human welfare, William Burton Rogers (1804-1882), geologist and natural philosopher of the University of Virginia conceived the idea of the establishment of a great Institute of Technology. He spent nearly a decade prior to the American Civil War in planning and working out the details, and ultimately selected Boston as the most suitable site for the institution.

Aim and Scope

The institution came into being by the grant of a Charter by the Commonwealth of Massachusetts on April 10th, 1861, "for the purpose of instituting and maintaining a society of arts, a museum of arts, and

outgrown its original local aspect and has become national and international in character. Recently a survey of the licence plates of the cars parked in its compound showed that out of forty-eight States of U. S. A. forty-seven were represented there, besides there are a large number of students from 37 foreign countries scattered all over the world.

At present the Institute is organised under four separate Schools: the School of Science, the School of Engineering, the School of Agriculture, and the Graduate School, which together offer over 900 subjects of instruction. It has been a pioneer institution in making laboratory method of instruction as an indispensable educational technique. Today its labora-



The Department of Civil and Sanitary Engineering laboratory of Structural Analysis. A suspension bridge model under study.

a school of industrial science; and aiding by suitable means the advancement, development and practical application of science in connection with arts, agriculture, manufacture and commerce." Guided by such high ideals the Institution was started with 15 students in rented rooms in Boston. Its growth was rapid: today it has a student body of 2800, a staff of over 500, a plant and endowment representing an investment of nearly Rs. 145,000,000 and a living alumni body of 32000 in 82 countries. The Institution has

atories are one of the best equipped in the world. A friend of mine from Scotland, who has come here to study automobile engineering once remarked; "The biggest technical college in Glasgow can be housed in one corner of M. I. T." The Institution virtually created the profession of chemical engineering; its courses in electrical and aeronautical engineering were probably the first in the world. It was also the first technological Institution to recognise and provide for the important place of economics in the training

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of engineers, and in collaboration with a sister institution it first established the systematic training in public health.

In recent years there has been a trend at the Institute towards greater flexibility in the curriculum and more individual treatment of the students. The number of courses has been increased until there are over forty regular courses of study, arranged to meet the growing requirements of the industries and to fulfil the needs of students of diverse interests. Moreover the authority to make substitutions, which resides in departmental heads and the Petitions Committee, renders it possible to alter any of these to suit special cases. In addition there is the possibility, in the courses in general engineering and general science, of arranging special schedules at will for those who are planning unusual objectives.

Present Location

In 1916, the Institute moved to its completely new site on the Cambridge side of river Charles. Here on a tract of eighty acres extending along the river are the seventeen educational buildings, laboratories, students' union, gymnasium, playing fields, sailing pavilion and boat-house. Old historic Boston, famous for its great libraries, art and science museums, and music enables students to profit from the manifold cultural opportunities; whereas Cambridge being the third biggest manufacturing city in New England affords ample opportunities to supplement their work by visits and other profitable contacts with manufacture and commerce.

Teachers and the Taught

More important than its unsurpassed buildings, laboratories and equipment is the Institute's teaching and research staff. The mere fact that there is a staff member for approximately every six students ensures individual attention and high standard of teaching. There are professors who are famous all over the world for their original scientific contributions, who have close associations with the leading manufacturing concerns of the country and who are regarded as authorities in their own fields. There is a complete informality between the teachers and the taught, which brings students more in contact with professors, and creates an atmosphere of freedom and friendship so congenial to work in. The president of the Institute invites all

students from the foreign countries and the members of the staff once every term for tea. The heads of the departments in turn occasionally invite students and the members of the staff of their departments for tea. The professors take a great deal of interest in foreign students and often call them to their houses. Once every week at the end of seminar classes light tea is served when students and teachers get opportunities of meeting each other. There are very often departmental picnic parties in which professors mix with students freely and take part in sports and other frivolities.

New Entrants

The entering student receives in many ways a friendly introduction to Institute life, both curricular and extracurricular; every effort is made to familiarise him at the start with all those activities and facilities that one can find at the Institute. At the Freshman* camp, for example, which he may attend on voluntary basis the weekend before the Institution opens, the freshman becomes acquainted with a large number of his classmates in an informal and intimate way. In the first week of the beginning of the session a lecture is given on the use of library and how to get the maximum advantage out of it. Also in the first week a free dinner is given to the new entrants at which the president presides and explains the diverse activities of the Institution.

Method of Teaching

Instruction in technology consists of a co-ordinated programme of recitations, lectures, consultations, seminars, library works, library research and original research. During the first two years subjects of study consist of such fundamentals as physics, chemistry, mathematics and English. It is not until the third year that students in different courses find their paths diverging, but even then due emphasis is laid on the fundamental sciences and design. Wherever possible more emphasis is laid on solving problems, which not only clears up some of the hazy ideas of students but also gives an insight into the practical problems to be found in every day industrial life. It is in this aspect and in the system of examination that the American system of education differs widely from the British, the former being more realistic and practical than the

*In American institutions first year college students are known as freshman, second year students as sophomore, third year students as juniors, fourth year students as seniors and then afterwards as graduates.

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latter. The British system lays more emphasis on abstract theory whereas the American system supplements theory with problems. In the American system of examination a student is judged from his day-to-day work. Every week in the undergraduate subjects students are assigned a certain number of problems for home work and then once in every week there is a class test. At the end of term there is a final test. But the final rating of a student depends mostly on the marks obtained in his home work and weekly quizzes of which a systematic record is kept by the instructor in charge of the subject, and partly on the marks obtained in the final examination. In most of the graduate subjects there is no final test and students are graded by the impression that they create on their teachers by their work throughout the session. In most of the examinations students are allowed to use books and notes, the aim of these examinations being not to lay an unnecessary burden on students memory but to test whether they can make an effective use of the fundamentals mastered while studying the subjects. There is a registration officer in each department who is virtually in charge of the studies of the students in his department. He guides students in the selection of their programme of study at the Institute and looks after their day-to-day progress, his office combines in him



A Differential Analyzer.

the duties of parents, a guide and a teacher. In the laboratory courses no formal assignment is made for the experiments; students make their own selection in consultation with the instructor from a large number of experiments which can be set up in the laboratory in that particular subject. Due emphasis is given on the use of library books, for example, in the department of electrical engineering every graduate student has to write a seminar paper on the subject which he

likes most and thus a test is made how far he can dig up the subject matter. This paper he has to present orally before the class; but before doing that he has to discuss the subject matter with the professor-in-charge and give a preliminary oral demonstration before him. If his presentation is not good he is given several rehearsals, a record is made of his speech and then played again before him so that he may know his own defects by hearing his own words. Besides the department provides a number of colloquia each year treating the economic as well as the technical aspect of various important subjects, which are led by the experts invited from the leading industrial organisations of the country. A happy co-operation in academical and industrial training is to be found in the co-operative courses in electrical engineering, mechanical engine-



The glistening steel building housing the Institute's high-voltage electrostatic generator. This equipment together with the cyclotron now building provides unexcelled facilities for high-voltage research.

ering and marine transportation and at practice schools of city planning and chemical engineering, when students spend a part of their educational programme alternately at the factory plant and at the Institute. Until recently no distinction was made between foreign students and Americans in giving co-operative courses; but after the economic collapse of 1929 foreigners are more or less excluded from these co-operative courses.

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Research

Research work is the heart of all the Institute's activities in which members of the staff and students participate alike. The professors working in close co-operation with some of the leading industrial organisations and the Government get some of their problems from these sources. The students have to take research work not only for their doctor's degree but the presentation of a thesis is compulsory for master's as well as bachelor's degrees. Among the Institute's recent notable achievements in research may be mentioned the development of high-speed photography, which enables pictures to be taken at an exposure of two millionths of a second; the building of differential analyser for aiding scientists and engineers to solve mechanically laborious mathematical problems involving many unknown quantities with a precision and



Magnet developed by Institute metallurgists which produces a field of at least 100,000 gauss, the highest permanent field ever attained. The magnet will be used to study the behaviour of matter at temperatures below one degree absolute.

rapidity that staggers imagination; the development of 1.5 million X-ray generator which produces greater intensity of rays than all the available radium in the world and which is to be used for cancer treatment at the Huntington Memorial Hospital, Boston;

the development of a seismograph which responds to earth displacements of less than a millionth of an inch; the development of magnet which produces a field of at least 100,000 gauss, the highest permanent field ever attained; the construction and design of Wright Brothers' wind tunnel in which wind can be forced to move at a velocity of 400 miles an hour for the study of problems in aeronautics; and the development of a new system of blind-landing for the aeroplanes.

Student Aid and Prizes

Among the resources for financial aid to students are the Technology Loan Fund available for under-



Within the Wright Brothers Memorial Wind Tunnel, showing the vanes guiding the air stream around one of the corners.

graduate and graduate students, Freshman competitive and other scholarships open to students entering from secondary schools, undergraduate scholarship aid to upper class men and graduate scholarships. The extent of these resources is indicated by the fact that, since its establishment in 1930, over 1750 men have borrowed more than Rs. 3,300,000 from the Technology Loan Fund; that during 1938-39 Rs. 300,000 and Rs. 330,000 were available for undergraduate and graduate scholarships respectively. And it is satisfactory to note that the award to scholarships to students is based on their financial condition and educational merits, no discrimination at all is made even if the student comes from a foreign country.

Placement

Finally the most unique organisation in M.I.T. is the placement bureau to aid its students in getting employment as they approach the end of their educational career. A series of lectures are given to seniors and graduates by competent men to acquaint them

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with industrial opportunities and to outline the principles to be observed in seeking employment. To the Institute come employment officers of many industrial organisations to interview students with proper qualifications and thus it helps seniors and alumni in seeking jobs for which they are particularly fitted and it



Within the Wright Brothers Memorial Wind Tunnel the variable pitch propeller which is designed to produce an air velocity as great as 400 miles per hour in the tunnel.

also aids industry in selecting men for positions requiring engineering and scientific education. This service is rendered free.

Finance

Coming to the economic side of the Institute, the following figures will tell their own story:

	1937-38	per cent. of Total
Income from students ...	\$ 1,505,400	50 p.c.
Income from investments ...	\$ 1,284,300	43 p.c.
Income from other sources ...	\$ 218,800	7 p.c.
	\$ 3,008,500	100 p.c.
Academic expenses ...	\$ 2,035,900	67 p.c.
Administration expenses ...	\$ 323,500	11 p.c.
Plant expenses ...	\$ 337,600	11 p.c.
Miscellaneous expenses ...	\$ 319,900	11 p.c.
	\$ 3,016,900	100 p.c.

The Institute received as gift from the late George Eastman, who under the pseudo-name of Mr Smith gave more than Rs. 58,000,000. He was not a Technology graduate but he became interested in its work as once he wrote, "I have great deal of confidence in the material you turn out at your Institute."

Uptil last year the tuition fee charged from a student for the two regular terms of 15 weeks each was 500 dollars but now it has been increased to 600 dollars; in spite of this, the popularity of the Institute is so great that the number of applications for admission is increasing year after year. The average expenses of a student besides tuition are about Rs. 200 per month.

The housing facilities of the students at the Institute have been carefully planned and organised. The undergraduate houses have a capacity of 625; the graduate house provides accommodation for about 400 students, besides the Institute recognises 24 national fraternities, which have their houses situated on private property in Cambridge, Boston and Brooklin and care for approximately 600 students.

Extracurricular Activities

To complement and aid its educational activities the Institute provides extensive opportunities for students to join in those extracurricular pursuits—athletic, literary, dramatic and social—which further the development of character and personality. These enterprises are administered by the students themselves, under a well-organised system of student government. There are four self-supporting undergraduate publications; the *Tech*, a biweekly newspaper; *The Tech Engineering News*, a monthly technical journal; *The Technique*, the year book and *Voo Doo*, a comic magazine. Its sailing club is the best in the country and its nautical association offers every interested student an opportunity to learn sailing.

B. D. Toshniwal.

Indian History Congress

Proceedings of the Third Session at Calcutta

INDIA has a chequered past. Often in the days of yore learned men would assemble in some notable site to listen to *Itivrittam narendranam rishinancha mahatmanam* (stories of kings and high-souled sages). It is, therefore, an ancient institution which was sought to be revived on June 8, 1935, when a number of historians gathered in the city of Poona to inaugurate a History Congress with a somewhat limited scope which in three years developed into a body whose horizon was no longer bounded by the limits of the Modern Period but included within its orb all periods of Indian History, Ancient, Mediaeval as well as Modern. This transformation took place at the Second Session of the Congress at Allahabad.

The Third Session of the Indian History Congress was held in Calcutta in the university premises from December 15 to 17, 1939, at the invitation of Calcutta University.

Dr R. C. Majumdar, M.A., Ph.D., Vice-Chancellor of the University of Dacca, was the General President of the Session which was inaugurated by His Excellency the Governor of Bengal and Chancellor of the University on December 15. The Hon'ble the Vice-Chancellor of Calcutta University welcomed the delegates as Chairman of the Reception Committee. The Hon'ble Chief Minister of Bengal, who holds the portfolio of Education, opened the Historical Exhibition in connection with the Congress on December 15 in the afternoon.

In inaugurating the Congress His Excellency Sir John Arthur Herbert pointed out that the assembly represented a long and distinguished tradition of historical scholarship, and as the events of today were not and never could be dissociated from the past, the historian would be of inestimable help even to people who were concerned primarily with day to day events.

The President of the Session emphasized* the necessity of a public forum for discussing all historical

*See also pp. 417-8 of the last January issue of this journal.

cal problems. He put in a plea for widening the scope of historical studies and indicated the lines on which future investigation, in the subject, ought to proceed.

The work of the Congress was divided into five sections—Archaic and Cultural, Ancient Imperial, Early Mediaeval, Moghul (including the early Maratha-Sikh period) and Modern (including the later Maratha-Sikh history). The number of papers read before these five sections were 21, 34, 27, 26 and 35 respectively or 143 in all. The meetings were so arranged that all the delegates could listen to the Presidential Addresses in the various sections by turns. A panel of secretaries saw to the smooth and uninterrupted working of the sections.

Dr A. S. Altekar, M.A., LL.B., D.Litt., of Benares Hindu University, presided over the Archaic and Cultural Section of the Congress and his address was on the *Reconstruction of the Pre-Bharata War History*. A resolution from the Chair was adopted by the section requesting the Government of India to reconsider their decision to stop further excavation work by the Archaeological Survey on account of the financial stringency due to war and inviting the co-operation of the Indian universities and other learned bodies in this matter. The papers read before the section dealt with the historical and cultural aspects of the remote past of India and helped to throw some further light on the subject.

Prof. K. A. Nilkanta Sastri, M.A., of Madras University, presided over the Ancient Imperial Section and dealt in his address with the conception of Empire in Ancient India. Most of the papers of the section were interesting and provoked much discussion. Mr P. Acharyya, in his paper suggested that the famous inscription of Bhatta Bhavadeva did not originally belong to the Bhuwaneswar Temple and Prof. B. M. Barua agreed with him. Dr B. R. Chatterji's paper on Jayavarman VII of Cambodia was welcomed by Dr R. C. Majumdar who requested the author to bring out a revised and up-to-date edition of his *Indian*

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Cultural Influence in Cambodia. Mr B. V. Krishna Rao's theory that the original home of the Chalukyas was in Andhradesa was supported by Dr N. Venkataramanayya but was opposed by Dr D. C. Sarkar. Mr D. N. Mukherji's theory of the contemporaneity of the early Guptas with Kanishka was controverted by Dr R. C. Majumdar and Prof. H. C. Raychaudhuri. The latter also found it difficult to accept Mr B. N. Puri's contention that Kanishka of the Ara inscription is to be identified with his namesake of the earlier records. Of special interest was Mr Y. M. Deshpande's paper on a copper plate of Vakataka Vindhyasakti which excited a valuable debate in which Dr R. C. Majumdar, Prof. V. V. Mirashi, Dr D. C. Sarkar, Rao Bahadur K. N. Dikshit and Prof. H. C. Raychaudhuri took part. Dr D. C. Sarkar in his criticism of the paper argued that if the grant was a genuine one (to which view Dr Majumdar, Prof. Mirashi and Rao Bahadur K. N. Dikshit inclined), the Pravarasena mentioned in it should be identified with Pravasesena I and Vindhyasakti should be taken as a later prince different from the founder of the Vakataka dynasty. Dr U. N. Ghoshal's interpretation about the head-offering motif in an ancient Bengal sculpture was criticised by Mr S. K. Saraswati who suggested that the figure may be a representation of hair-offering. Mr K. P. Chattopadhyaya's theory about cross-cousin marriage and matrilinear succession among the Satavahanas was not accepted by Prof. H. C. Raychaudhuri. Dr D. C. Sarkar held that the auspicious symbol at the beginning of Hindu inscriptions was pronounced as *Om Siddhih* and the *Pranava* was responsible for Al-Biruni's wrong interpretation of the symbol as *Om*. Prof. Mirashi however thought that the symbol indicated *siddham*, while Mr K. P. Mitra found in it nothing but a developed form of *svastika*. Dr D. C. Sarkar in reply pointed out that the symbol is followed by *siddhih* in the grant of Ranabhanja's 58th year and that *siddham* and the *svastika* occur side by side in the Nasik cave inscriptions. In addition to the above, there were other papers which excited much interest.

Dr M. Nazim, M.A., Ph.D. (Cantab), Superintendent, Central Circle, Archaeological Survey of India, presided over the Early Mediaeval Section. He gave a brief outline of the efforts made by individual scholars to elucidate the history of Mediaeval India. Mr N. B. Ray argued that the infant placed on the Delhi throne after the death of Muhammad bin Tugh-

luq was a pretender of unknown origin but Dr N. Venkataramanayya and Mr R. K. Chaube were inclined to take him as the actual son of the late Sultan, while Dr K. R. Qanungo agreed that the case was suspicious. Dr B. B. Majumdar pointed out the similarity of views between Chaitanya and his reforming contemporaries like Ramananda and Nanak. Dr Qanungo observed that such similarity should not be taken to indicate mutual influence. Dr N. C. Banerji's paper on the Life and Times of Alauddin Khilji was supplemented by interesting details from Amir Khusru by Dr Qanungo. Dr H. C. Ray's paper on the Word *Turuska* in Tummana Haihaya Records was discussed by Prof. H. C. Raychaudhuri and Dr Qanungo. Mr S. N. Dhar explained the causes of Dahir's defeats by the Arabs, repudiating the current theory that the Buddhists acted treacherously towards the Hindu King. Dr Qanungo agreed with him while Dr S. K. Banerji stressed on the economic factors which played a leading part in bringing the Arabs upon Sind. Dr Qanungo in his paper argued that Amir Khusru's work on Dewal Rani could not be accepted as a true historic account of a contemporary episode and that the figure of the heroine was more or less a romantic picture. Mr Shriram Sharma and Dr B. P. Saksena on the contrary maintained that the poem has a real historical basis.

Dr Tarachand, M.A., D.Phil. (Oxon.), Principal, Kayastha Pathshala, Allahabad, presided over the Moghul Section and delivered an address on Indian Culture under the Moghuls. The papers were subdivided into two classes dealing with Moghul history and early-Maratha-Sikh history respectively. In the first division, there was a discussion on Rai Bahadur Dr S. K. Bhuyan's paper on Swargadeo Rudra Singh, King of Assam (1696-1714), Mr S. H. Askari expressing doubts about the projects of Rudra Singh. In the second division a lively debate took place on Mr V. D. Rao's generalisations from Maratha bardic literature in which Profs. Kale, Puntambekar, Shriram Sharma and Banhatti took part.

Rao Saheb C. S. Srinivasachari, M.A., of Annamalai University, presided over the Modern Section and delivered an address on the Study of Modern Indian History. Prof. Spear in his paper emphasised Ellenborough's high-handedness and the differences between him and Bentinck. The President and Dr N. L. Chatterji took part in the discussion, the former suggesting that the atmosphere of Madras was responsible for Bentinck's failure as governor there. Prof. Spear in his reply emphasised Bentinck's youthfulness and inexperience in his Madras days and

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pointed out that the English government could not do without Ellenborough because of his political influence though his hustling manners were universally known. Prof. S. N. Bannerji traced the beginning of an Asiatic foreign policy by the British Indian government to the Durrani menace and Wellesley's attempts to meet it. Dr K. K. Dutt in this connection drew attention to Dr N. K. Sinha's paper on the Durrani menace in the *Indian Historical Quarterly*, 1934. Mr R. C. Banerji's thesis about the Company's patronage of Indian religions in the shape of State contributions towards expenses and military guards in honour of processions was supported and supplemented by the President and Dr A. P. Dasgupta from Madras and Rajshahi records respectively. Mr H. R. Ghoshal's paper on Bengal's opium trade led to a discussion in the course of which Dr Bisweswar Prasad suggested that the opium trade had much to do with British annexations.

In addition to the papers mentioned above, all of which provoked some discussion, there was a large number of suggestive and informative contributions in every section a full account of which will appear in the *Proceedings* of the Third Session. The academic side of the Congress was further enriched by an interesting illustrated lecture by Rao Bahadur K. N. Dikshit, M.A., Director-General of Archaeological Survey, on Prehistoric India on December 15. Next morning the delegates had the opportunity of attending the annual meeting of the Numismatic Society for which facilities were provided by the Reception Committee of the History Congress. The discovery of a very large hoard of Satavahana coins was announced at the meeting.

The Calcutta Session owed much of its success to the large number of distinguished scholars who assembled from the various parts of India. The actual number of delegates came up to the big total of 185, about half of them officially representing the different governments, States, universities, research societies and other institutions. The donations to the Reception

Committee included a princely one of Rs. 1,000 from Dr B. C. Law, M.A., Ph.D. and generous grants of Rs. 1,000 and Rs. 750 from the Bengal Government and Calcutta University respectively.

The social side of the Congress received as much attention as its academic activities. The Hon'ble the Vice-Chancellor of Calcutta University gave a dinner to the delegates and members of the Congress on December 16, and another was given by Dr N. N. Law, M.A., Ph.D., editor of the *Indian Historical Quarterly*, the next night. The University of Calcutta entertained the Congress at lunch on December 16 and Dr S. C. Law, M.A., Ph.D., F.N.I., F.Z.S., was at home to its members on the same afternoon in his beautiful aviary, a few miles out of town. On December 17, the Reception Committee arranged for a steamer party. The Arts Faculty Club of the University organised a Musical Soiree on December 15 and the Sanskrit Sahitya Parishad staged two dramatic pieces on the evening of December 17.

The session was wound up on December 18 by an excursion to Tribeni and its neighbourhood, the trip being ably managed by the University History Union. The party after visiting Belur Math was given a reception in the Public Library at Uttarpara by the local gentry led by Mr D. N. Mukherji, M.L.A. At Serampur College, the visitors were shown round by Rev. J. A. Rawson, Acting Principal. At Chandernagore, Mr. Harihar Seth with his usual liberality entertained the whole party at lunch. After visiting the local Catholic Church, the party proceeded via Hooghly College, the Imambara and the Portuguese Church at Bandel to Tribeni where the visitors saw the Zafar Shah Mosque, the *ghats* of Raja Mukundadeva of Orissa and the other sights. The Mahasayas of Bansberia entertained the delegates and the students at tea in the afternoon.

On behalf of Panjab University, Prof. J. F. Bruce invited the Congress to hold its next session at Lahore and the invitation was accepted with thanks.

Mineral Production in India During 1938

THE total value of ores, minerals, and metals produced in India during 1938 is estimated by the Geological Survey of India at about Rs. 34,13,95,000 as against Rs. 30,49,43,000 in 1937.* This represents an increase of nearly 12 per cent and is largely due to the record production of coal—28,343,000 tons valued at Rs. 10,64,24,000 which exceeds the production of the previous year by over 35 per cent.

Of the other minerals, ores and metals, the production of steel has gone up slightly; pig iron production is also better, but with the fall in price there has been a decline in the production of manganese. Gold output is steady, petroleum has improved and so have building materials and salt, but mica has fallen appreciably and so has copper. Ferro-manganese has more than doubled in value, while in ilmenite, with increasing production, India is leading. Chromite has fallen in value, but monazite, gypsum and steatite have improved. Diamonds, graphite and felspar have improved as against barytes, bauxite, asbestos and tungsten-ore which have declined in value. In bauxite the fall in value is entirely due to the fall in price and not to any fall in quantity. The total values of apatite, beryl, garnet and sapphire production have all fallen greatly.

Occurrence is reported of antimony-ore (zinckenite) in Chitral; explorations are being continued for the discovery of tungsten-ore.

Almost the whole of iron ore production of India is smelted for the production in India of pig iron and steel and, with manganese ore, in preparing ferro-manganese.

That increased interest in mining is being shown in India will be evident from the fact that the number of mineral concessions granted was 468 in prospecting licences, 137 in mining leases and 36 in quarry leases, or 641 in all, against 291 in prospecting licences, 57 in mining leases and 25 in quarry leases, or 373 in all, in 1937.

The following is a tabular statement showing total value of minerals, ores and metals for which returns of production in India are available.

Minerals, ores and metals	1937	1938	Variation per cent
	Rupees	Rupees	
1. Coal	7,81,02,439	10,64,23,835	+ 36.2

*See SCIENCE AND CULTURE, 4, 488, 1939.

2. Steel*	6,68,63,554	6,96,52,932	+ 4.2
3. Manganese-ore (a)	4,29,53,068	3,92,94,763	- 8.5
4. Iron (Pig iron (b)	2,82,78,201	3,44,16,000	+ 21.7
5. Gold	3,03,95,871	3,04,75,397	- 0.3
6. Petroleum	1,37,06,864	1,65,43,142	+ 20.7
7. Mica (b)	1,43,60,036	1,13,25,346	- 21.1
8. Building materials	97,07,817	1,12,65,392	+ 16.2
9. Salt	81,47,365	95,18,383	+ 16.8
10. Copper	61,67,490	44,02,580	- 28.6
11. Ferro-manganese*	10,69,453	24,63,590	+ 130.3
12. Ilmenite	11,26,329	15,46,436	+ 37.3
13. Saltpetre (b)	11,17,844	11,68,446	+ 4.5
14. Kaynite, etc.			
15. Chromite	8,35,589	6,82,502	- 22.4
16. Clays	3,25,578	3,76,270	+ 15.5
17. Monazite	1,40,365	2,33,700	+ 66.4
18. Gypsum	1,18,543	1,71,903	+ 45.1
19. Steatite	1,55,221	1,68,580	+ 8.6
20. Magnesite	1,63,938	1,60,593	- 2.0
21. Fuller's earth	75,017	78,958	+ 5.2
22. Diamonds	54,979	68,813	+ 25.1
23. Zircon	39,036	40,737	+ 4.3
24. Silver	32,343	31,222	- 3.4
25. Barytes	1,49,260	29,312	- 80.3
26. Ochres	28,193	28,865	+ 2.3
27. Bauxite	61,839	25,540	- 59.1
28. Graphite	16,302	20,691	+ 26.9
29. Iron-ore (Agaria)	1,062	12,600	+ 1093.9
30. Tungsten-ore	24,500	9,600	- 60.8
31. Asbestos	6,022	4,482	- 25.6
32. Felspar	3,390	4,335	+ 27.8
33. Baryl	1,969	1,597	- 18.8
34. Garnet sand	1,656	600	- 63.7
35. Bentonite	900	330	- 63.3
36. Corundum	—	250	+ 100.0
37. Sapphire	550	150	- 72.7
38. Apatite	1,660	119	- 92.8
39. Copper-ore	—	101	—
40. Aquamarine	—	14	+ 100.0
41. Tantalite	301	—	- 100.0
Totals	30,49,43,161	34,13,94,710	+ 11.9

* (a) Export f.o.b. values. (b) Export values underestimated.

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Report on the Work of the Education Department of the High Commissioner of India, 1937-38.

THE number of Indian students pursuing courses of study or training in Great Britain constitutes the largest single national group representing nearly 70 p.c. of the total from the whole of the British Empire. Recent years have witnessed a gradual increase in the number of Indian students in Great Britain. The High Commissioner has estimated that Indian parents are spending nearly 70 lakhs of rupees annually for the education and training of these students. It is really a matter of important national concern that India should derive real benefit commensurable with the huge drainage of money and the actual results obtained ought to be seriously scrutinised. Unfortunately every year the High Commissioner complains that young Indians with little idea of the exact purpose in mind or incapable of being benefitted by the proposed course of study or training abroad come to Great Britain and drift from the course of study to another or are obliged to return to India with no qualification for employment of any kind. To avoid such bitter disappointment and undue wastage, parents and guardians should, before sending their sons or wards abroad, seriously consider and consult with educational authorities in India and in Great Britain as to whether their children are suited for the proposed courses of study abroad with any real advantage and benefit. Only in the case of post-graduate students who have proved their merit and capacity in India, and are fitted for pursuing specialised courses of study which are not available in India, proceeding abroad for further studies may be justified. They will have to spend a comparatively short time abroad and the money spent on their education is likely to be of benefit to India. The invidious distinction made by the Government and other agencies between persons holding a British university degree, whatever may be its real worth, and those holding Indian university degrees, has led, to a small extent, to the unreasonable craze for the former. Instances are not rare where second or third year persons in virtue of their British qualifications have been given preference to really meritorious persons possessing Indian qualifications. Until there is a complete change in this attitude the large efflux of mediocre Indian

students to British universities with the consequential heavy drainage of India's money will not be properly checked. The High Commissioner's report also shows that in spite of warnings about undue overcrowding in the legal profession in India, the number of Indian students pursuing full time courses in the various Inns of court and of those called to the Bar, do not show any tendency to decline.

During the year under review, a few firms and railway organisations offered suitable practical training facilities to a number of Indian students. It is a long standing grievance that British organisations do not generally offer requisite training facilities to Indian students. Matters may be easily mended by the Government of India, if they make it a condition, while placing their large contracts with the different British firms, that a certain number of Indians must be offered adequate training facilities in them. This method has been advantageously followed by some other countries while dealing with the more advanced and industrialised countries, but the Government of India has not moved its little finger to remove these difficulties and disabilities of Indian students.

Motion of the Galactic System and Sources of Stellar Energy

THE last August issue of the *Journal of the Franklin Institute* has published two valuable summaries of the present available data regarding the motion of the galactic system among the nebulae and the sources of stellar energy. The first article is written by Dr E. Hubble of the Mount Wilson Observatory, Pasadena. With respect to the extra galactic nebulae as frame of reference, it is now known that the galactic system is moving with a speed of the order of 100-200 kilometres per second in the direction of the northern galactic latitudes. The sun is rotating about the centre of the galaxy with a speed of the order of 275 kilometres per second in the galactic direction, latitude 0°, longitude 55°. The resultant is a speed of the order of 300 kilometres per second in the direction, latitude 35° north, longitude 55°.

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Prof. H. N. Russell, director of the Princeton University Observatory has discussed about the possible sources of stellar energy. Starting with the known fact that reactions which form the sources of stellar energy must be accompanied by a loss of mass, Prof. Russell gives a summary of the recent work of H. A. Bethe who has shown how the impact of four protons, that is, hydrogen atoms, on a carbon atom, the latter acting as a catalyst, may produce a helium atom. The diminution of mass involved in the process of conversion may supply the sun's energy if its temperature is of the order of 18-21 million degrees centigrade, that of Sirius at 22 million and that of γ cygni at 30 million. These temperatures are in agreement with previous astrophysical observations.

Blood Group Tests of Paternity

FOR sometime past attempts have been made in Great Britain to introduce blood tests as evidence of paternity in bastardy cases. Lord Merthyr introduced a bill in the House of Lords in December, 1938, which sought to enable Law Courts to order blood-group tests to be made in bastardy cases. The House of Lords Select Committee, to which the bill was referred to consist of Lord Strathcona (Chairman), Lord Dawson of Penn and the Bishop of Salisbury and others. The Committee recently gave its unanimous opinion that the qualities of blood underlying blood-grouping and the laws of inheritance governing the transmission of these qualities from parents to children are accepted by such a consensus of scientific opinion that it is desirable in the interests of justice for this knowledge to be applicable to affiliation cases and it has recommended that the bill be passed into law.

The tests will prevent injustice at least in a number of cases by excluding paternity. The Committee records that the risk of error in making blood-tests have been reduced to negligible proportions and there is an overwhelming preponderance of opinion among medical and legal witnesses in favour of the use of blood-tests as evidence in affiliation cases. By the way, it may be mentioned that further refinements in the use of blood groups as a test of paternity were indicated by V. Friesenrich of Copenhagen at the last International Congress of Genetics held in Edinburgh immediately before the outbreak of war. He reported the division of A group into three varieties; A_1 is dominant over A_2 and A_3 and A_2 over A_3 , A_3 is quite rare. The distinction between A_1 and A_2 is already employed medico-legally on the Continent, thereby increasing the proportion of cases in which false accusations of paternity can be disproved.

Plants used in Prospecting for Mineral Wealth.

THE *Science News Letter* has published an account of how botany may presently come to the aid of geology in prospecting for new mineral wealth. Two Swedish scientists Drs Nils Brundin and Sven Palmquist, have proposed a new method of detecting the presence of minerals under the earth in any particular area, by testing leaves and twigs collected from deep-rooted trees and shrubs grown in that area. The method depends on the fact that all substances in the ground dissolve at least to a slight extent in soil water and are taken up with the water by the plant roots and concentrated in the leaves and young twigs. The plant material is reduced to ash and placed in a carbon arc. A spectroscopic examination of the light will then reveal the presence of and even give some indication of the relative abundance of elements present in the plant. The method is not of course well adapted to prospecting for common materials like iron or aluminium, compounds of which are extensively present in all soils. But it may prove to be really useful in the search for such rare metals like nickel or molybdenum, which are only very 'spottily' distributed and rather difficult to locate by methods now in use.

Soil water at lower levels travel considerable distances so that the minerals detected in the plants may not lie directly beneath them. For exact location of the ore bearing bed of rock, the geologist however, would have to trace to its source the water that brought the traces of mineral elements to the trees.

Shipbuilding Industry in India.

A RECENT press report states that the Scindia Steam Navigation Company is contemplating to build a ship-building industry in India. In this connection a site for shipbuilding yard in Calcutta was inspected by Sir Ramaswamy Mudaliar, Commerce Member of the Government of India and Mr Walchand Hirachand, Chairman of the Scindia Steam Navigation Company. Proper attention has not been paid up till now to the vast possibilities of the shipbuilding industry in India. A very small share of India's shipping* is now in Indian hands but as Indians will gradually acquire an increasing share in the country's shipping they will be able and it will be also necessary for them to support a national ship-building industry. Calcutta being the biggest Eastern port in the British Empire would be an ideal site for it. Even now a large number of ships have their minor repairs done in Calcutta and if facilities were available, major repairs could be undertaken here. Such activities being considerably restricted in European countries at present due to war condition, India should not fail to avail of this opportunity.

*See SCIENCE AND CULTURE, 5, 67, 1939.

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Skilled and cheap labour as also raw materials like steel plates, metal forgings, iron castings, timber, etc., are available here at a suitable rate. Undoubtedly technical difficulties will have to be overcome at the outset and it may be necessary to utilise foreign experts but Indians can be quickly trained for this purpose and our engineering institutions may undertake to train up full-fledged marine engineers and naval architects in due course. For designing the hull or propelling machinery, foreign help would be necessary in the initial stages, and the well-known Japanese methods may be advantageously followed. Even a few years ago Japan used to place orders for her ships with British and other European firms on the definite understanding that working drawings of the hulls and machineries would have to be supplied to the buyers of the ships. These enabled them to build sister ships of similar design locally and in a short time Japan became independent of other nations in this respect.

India with her vast coast line and big inland rivers will always have a great demand for ships and a well developed shipping industry is a feasible proposition only if Government help and enough capital are forthcoming. Though not at all economical, Indian shipping concerns are at present faced to charter old ships under foreign flags to carry on coastal shipping. Indian ship-building industry will largely remove this difficulty even though it may restrict its activities in building small ships to meet the coastal requirement for the present.

Science Congress Meeting at Madras

THE Indian Science Congress concluded its 27th session at Madras this year in the first week of January under the presidency of Prof. Birbal Sahni, Sc.D., F.R.S., and was attended by a fairly large number of delegates from all parts of India. The University of Madras and the Local Reception Committee deserve warmest congratulations for having so ably organised the session. Professor Sahni's reconstruction of a scene during the Tertiary period in the Deccan traps illustrated with excellent slides and photographs and laboratory specimens of fossilised plants (the full text of the Presidential address appeared in the last January issue of our journal) was a splendid introduction to the proceedings of the Congress. Some of the other presidential addresses (a few abstracts of these are published in this issue as a supplement and the remainder will be published in the March issue) at the sections gave surveys of the investigations in the respective fields and

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these proved particularly interesting to those who, being primarily interested in other sections, could find some time to attend these. The joint discussions were largely attended but, due to a very heavy programme, some times the discussions had to be concluded hurriedly leaving the speakers at a disadvantage. It is to be hoped that select discussions on important popular subjects should be so arranged that the speakers may have time to dwell on their points at reasonable length. The spirit of these discussions, which incidentally aim at co-ordination of works, cannot be fostered properly if time is to be made in a single day for many other things.

There were four popular evening lectures, summaries of which will be published in the coming issues of this journal. Dr J. C. Ghosh spoke on 'Need of National Planning with reference to Key Industries,' Dr D. N. Majumdar on 'Marriage and Sex life in Cis-Himalayan Region,' Dr J. B. Grant on 'The Future of University Social Sciences Seen through Public Health' (see Medicine and Public Health section of this issue) and Sir C. V. Raman on 'Cyclotron.' Sir C. V. Raman also delivered an interesting address on "Ultrasonics."

This year the total number of papers in all the 13 sections was 678, and as in the previous years the number of papers in the chemistry section was the largest being 187.

The National Institute of Sciences of India held its annual meeting on January 2 and re-elected Bt.-Col. R. N. Chopra as the President for the next term. The Indian Statistical Conference also opened its session at Madras and held its concluding sittings at Mysore. Ten other learned societies also held their annual meetings during the Congress.

The General Committee made certain important decisions regarding the re-grouping of the sections. From next year the Mathematics Section will be renamed Section of Mathematics and Statistics, the Section of Psychology will include Educational Sciences and a new section on Engineering is added bringing the total number of sections to fourteen. As a move towards better realisation of social implications of science a small committee has been formed this year which will select subjects for joint discussions.

As usual there was a number of excursions and the social side of the meeting received due attention at the various luncheons and other parties organised during the session. At the invitation of Benares Hindu University the next session of the Congress will be held at Benares, and Sir Ardeshir R. Dalal, Director of Tata

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Sons, Limited, has been elected President for the next session. Sir Ardeshir is a leading industrialist of the country with very broad vision and the Indian Science Congress is fortunate in having him as its pilot for the next session.

Announcements

AT the 27th meeting of the general committee of the Indian Science Congress Association, held at Madras, Sir A. R. Dalal, Kt. M.A. (Cantab), Managing Director of Messrs Tata Iron and Steel Company, Limited has been elected General President for the next session. The Executive Committee for the next session has been constituted with Prof. B. Sahni (President); Sir A. R. Dalal (President-elect); Prof. S. K. Mitra and Principal P. Parija (General Secretaries); Prof. J. N. Mukherjee (Treasurer); Prof. S. N. Bose, Prof. H. Chaudhuri, Prof. K. S. Krishnan, Prof. P. C. Mitter, Dr B. Prasad, Prof. J. N. Ray and Mr. W. D. West (members).

The following are elected Sectional Presidents:— Prof. K. Anand Rao (Mathematics and Statistics); Prof. P. N. Ghosh (Physics); Dr Mata Prasad (Chemistry); Dr M. R. Sahni (Geology); Dr. Sri Ranjan (Botany); Dr A. Subba Rao (Zoology); Rai Saheb Y. Ramachandra Rao (Entomology); Mr T. C. Das

(Anthropology); Dr A. C. Ukil (Medical and Veterinary Research); Mr K. Ramiah (Agriculture); Dr B. B. Dikshit (Physiology); Dr I. Latiff (Psychology and Educational Science) and Sir M. Visvesvaraya (Engineering).

HIS Majesty the King has been graciously pleased to approve the recommendations made by the Council of the Royal Society for the award of the following two royal medals for the current year, one to Prof. P. A. M. Dirac, F.R.S., for the leading part he has taken in the development of new quantum mechanics, and the second to Prof. D. Keilin, F.R.S., for his contributions to bio-chemistry and entomology.

The following awards of medals have been made by the president and Council of the Royal Society: Copby medal to Prof. T. H. Morgan, of the California Institute of Technology for his establishment of the modern science of genetics, Davy medal to Prof. J. W. McBain, F.R.S., professor of chemistry in Stanford University for his work in the study of colloidal electrolyte; Hughes medal to Prof. G. P. Thomson, F.R.S. of the Imperial College of Science and Technology, for his discoveries in connection with the diffraction of electrons by matter.

MR K. N. Kaul of the University of Lucknow, who worked under Prof. B. Sahni has been appointed assistant for India at the Royal Botanic Gardens at Kew.

Industrial Research in the United States

A generation or two ago the word science became so highly respected that it was applied to all sorts of things, whether or not they had any relation to scientific work. Even athletes, such as boxers, who had certain characteristics were said to be scientific. More recently research has come to wear the purple. In our universities it is rolled unctuously on the tongues of those who have seen it only from afar. It is honoured in industry finance and government. There is no other pillar of fire to guide us out of the night.

For 30 years the centre of gravity of scientific research has drifted from our universities toward our industries, and now the current is becoming strong toward governmental agencies. All these trends arouse reflections. At the moment, however, we may review the magnitude of industrial research.

In 1938 there were 1,769 industrial research laboratories in the United States employing about 30,000 persons. The estimated annual expenditure of these laboratories is \$ 100,000,000 with a wide margin of un-

certainty. The chemical industries employ more scientists and pay more for research than any other industries, the electric and communication industries coming second. Together these two industries account for nearly half of industrial research.

Without any basis for comparison, the persons employed in industrial research and the expenditures for it appear enormous. But only about one per cent of manufacturing corporations maintain research laboratories and only one sixth of one per cent of the value of their products is spent for research. In a sense, research is a sort of insurance. Considered from that point of view, the expenditures for it seem extremely small. Enormously more is spent for fire and other insurance; enormously more is spent for insuring a continuing supply of raw materials. Much more is spent for accounting and legal advice. Much more is spent even in preparing for governmental agencies the numerous reports required of corporations.

—The Scientific Monthly.

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Steam Locomotive Developments.

SEVERAL interesting developments into the future possibilities of steam locomotives are under way on the French National Railways. They embody experiments with some of the most recent developments in steam engineering.

First comes the streamlined four cylinder compound locomotive with the Velox boiler. This boiler runs on the principle of pressure combustion of gas or oil, giving a high flue gas velocity with consequent high rate of heat transfer. The blower which provides the full combustion pressure is coupled with a combustion gas turbine, driven by the flue gas after they have passed over the superheater. The main feature of the boiler is first the rapidity with which steam can be raised with safety, a time of 15 minutes sufficing to get a full heat at 290 lb per sq. in. starting from cold, and secondly the high boiler efficiency, being about 83 to 86 per cent. under different loads.

The second locomotive consists of a coal-burning water-tube boiler operating at a pressure of 870 lb. per sq. in. Steam at 870 lb pressure is fed to the cylinders and exhausted into the atmosphere in the usual way.

The third one is a stream lined, non-condensing turbo-mechanical locomotive. It has the normal type of fire-tube boiler working at the high pressure of 365 lb per sq. in. A double shaft turbine is attached to each driving axle through an elastic coupling with double reduction gearing. One half of the turbine is for forward motion and the other half for backward motion. At the top speed of 10,000 revolutions per minute each half has an output of 1,000 h.p.

Another scheme has been proposed in order to do away altogether with connecting and coupling rods attached to the wheels. This consists of a 16 cylinder vee steam engine, mounted well forward, and with a crankshaft arrangement longitudinally down the locomotive and driving the axles through worm-gearing carried in roller bearings. The torque is to be transmitted to the wheels through individual axle drive. The proposed rotational speed of the engine is 1,000 revolutions per minute. The boiler is to be of normal type with a working pressure of about 290 lb. per sq. in. —N. K. S. G.

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Production of Fuel Oil by Hydrogenation of Tar.

THE results of the experiments conducted on a semi technical-scale plant for the production of motor spirits, aviation spirit, Diesel oil, and other products by the hydrogenation of tar have been published by the Department of Scientific and Industrial Research, (London), under the name of "The hydrogenation cracking of tars." The plant was of a capacity of treating 200 to 400 gallons of tar per day. The raw materials consist of hydrogen and low-temperature tar, to which is added a controlled proportion of "recycle oil" which is the residue of the hydrogenation product after removal of the motor spirit. From the mixing tank the tar and the oil are pumped at a pressure of 200 atmosphere into a high pressure pipe line, where they are mixed with hydrogen and passed through the heat interchanger and preheater to the converter. The converter is a vertical cylinder of forged steel, inside of which is concentrically suspended the reaction chamber which is made of chrome nickel steel. The reaction chamber is filled up with a granular catalyst consisting of molybdenum disulphide supported on silica gel. The reaction temperature is 500°C. The products leaving the converter pass through the heat interchanger, and a water-cooled condenser, to a high pressure separator, where the residual gas is separated. The liquid products then pass to a low pressure separator where the dissolved gas is also removed. Then the liquid is passed to a still for the removal of motor spirit by distillation. The residue in the still (usually boiling above 170°C.) form the "recycle oil." The residual gas consisting of about 90 per cent. hydrogen is reused after proper scrubbing.

The operation of the plant has been very satisfactory and the data obtained will be of much value for running a big scale plant.

—N. K. S. G.

Air-conditioning in Indian Gold Mines

WITH increasing depth the rock temperature also increases and so the air in the lower levels being hot the works become difficult. So in order to make working easier Ooregun Gold Mining Co. of India Ltd. has installed air-conditioning equipments in their mines

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"acquaintance." He should know them well, should be able to design them and arrange them in the proper sequence and position so as to build a plant. The Industrial Chemist emphasises the chemical side of an industry whereas a Chemical Engineer looks more to the physical and mathematical side.

A Chemical Engineer's Position in Industries.

On a Chemical Engineer employed in a factory rests the responsibility of maintaining a high level of operating efficiency. Groggins classifies the essential requirements of the sound economical operation as follows:

- Determination of the best production method and site for the plant;
- Selection of the best type and most economical size of equipment;
- Attainment of highest practicable yields;
- Continuity of operation and maximum productivity per unit time;
- Purchase of raw materials at favourable prices;
- Minimum of overhead expenses.

It is the duty of the Chemical Engineer to look after the first four items. His position is not that of a chemical analyst, but that of a superintendent of a part or whole of the plant.

In several industries two departments—chemical and mechanical—work side by side, and very often these two do not work in co-operation. A Chemical Engineer at the head of both the departments can direct both of them and help to increase the efficiency of the plant.

India has started taking active interest in planned industrialization and several new industries are to be started. The location and design of plants can be best done by a well-trained Chemical Engineer. With some aptitude for law he is also very suitable for handling patents and patent law.

It is high time we realized the importance of the manufacture of equipment in our country, for no nation can progress industrially unless it manufactures its own capital goods. Equipment used in many chemical industries is easier to make because of the relatively small number of mechanically moving parts. With proper co-operation a chemical, mechanical and an electrical engineer together with a metallurgist can design completely many of the chemical plants that are being imported into this country. Unless machinery-producing industries are set going, India will continue to remain in a helpless state.

Need of Planned Research for Industry *

Bt. Col. R. N. Chopra

Director, School of Tropical Medicine, Calcutta.

The National Institute of Sciences of India was founded to fill an urgent need keenly felt by scientific workers all over India for a body which could co-ordinate the work of various scientific societies, institutions and Government scientific departments and services throughout the country. With this end in view the Organizing Committee of the Institute laid down the main items of its programme as follows:—

- The promotion of natural knowledge in India including its practical application to problems of national welfare.
- To effect co-ordination between scientific academies, societies, institutions, and Government scientific departments and services.

- To act as a body of scientists of eminence for the promotion and safeguarding of the interests of scientists in India and to represent internationally the scientific work of India.
- To act through properly constituted National Committees in which other academies and societies will be associated, as the National Research Council of India, for undertaking such scientific work of national and international importance as the Council may be called upon to perform by the public and by Government.

*Adapted from Bt. Col. R. N. Chopra's Presidential Address before the National Institute of Sciences of India at Madras on January 2, 1940.

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- To publish such proceedings, journals, memoirs and transactions, and other publications as may be found desirable.

Since its foundation in 1935 the Council of the Institute has left no stone unturned to further this programme, but financial and other difficulties have been a serious hindrance in the full performance of some of its activities. The publications and meetings of the Institute have been arranged with a view to bringing to the notice of the authorities and the general public the very important and pressing question of exploring and developing the material wealth of this vast sub-continent and for harnessing the scientific resources for their proper exploitation. India has fortunately been richly endowed by nature with all that any country can possibly need. While primarily an agricultural country, with extensive agricultural and forest lands capable of yielding almost all kinds of foodstuffs, timber and other economic products, it also has very rich resources of various minerals on which depends the highly industrialized life of the present times. Its power resources in the way of coal and water power are also very extensive, but have not been adequately developed. According to Sir M. Visvesvaraya only 2% of the hydroelectric resources of India have so far been developed. In those respects India can rightly be designated as one of a triumvirate with the United States of America and the Russian Socialist Federated Soviet Republic, the only two other countries of the world which have almost unlimited agricultural, mineral and power resources. As compared to the other two units of this triumvirate, however, those resources in India have for want of a systematic policy of industrialization not been developed, and naturally, therefore, India stands very low in the list of industrialized countries of the present day. This unfortunate position of India is intimately connected with the lack of proper organization and development of scientific and technical education and research in the country and the lack of an industrial policy. A very serious situation has suddenly arisen as a result of the war which Germany has forced on the world and the repercussions of which are already materially influencing life in every country. Its direct effects on India are already becoming a source of great concern both for the authorities and the public at large, as we are dependent for the great majority of manufactured commodities on imports from foreign countries. This has been brought home to me very forcibly in connection with the drug industry, which seemed to be apparently making a headway, but the outbreak of war has brought to the fore the very serious problem of the supply of the basic materials for the manufacture of medicinal preparations practically all of which were being imported from foreign countries. This is a situation which no self-respecting country

should face with equanimity. It would not, therefore, be out of place if I may briefly review the situation to-day and indicate the urgent necessity for the proper planning and organization of scientific research as this alone will make it possible for India to assume its proper place in the comity of nations, and be as independent as possible of imports from other countries of even the daily necessities of life.

Education on Western lines was introduced into India within comparatively recent times and it is, therefore, remarkable that its progress in the country has been so rapid. The first universities in this country were founded at Calcutta, Bombay and Madras in 1857, but these and others founded in the latter half of the 19th century were only universities of an affiliating type and their energies were mainly directed towards examining students for various examinations and degrees, rather than serving as centres of teaching or research. With the passing of the University Act of 1904, however, most of the universities instituted courses for advanced studies and special Honours courses in scientific subjects and, by the appointment of professors and lecturers and the extension of libraries and laboratories materially advanced the cause of scientific teaching and original research in the country. A start had been made in regard to scientific education in the latter half of the 19th century, but this teaching was mainly confined to preliminary studies rather than more advanced teaching on research. The major part of advances to our knowledge in the scientific sphere in India up to the beginning of the 20th century was due to the scientific departments of the Government and work of independent workers who devoted their spare time and energies to studies in subjects which interested them. In a number of cases such devotion to research was looked down upon, and I cannot do better than cite the classical example of Sir Ronald Ross who was actually rebuked for devoting all his spare time to the study of mosquitoes; this incidentally resulted in the discovery of the very important role played by mosquitoes in the spread of Malaria.

University education since this period has progressed at a remarkably rapid rate, but the reorganization of the secondary school system to guarantee a sound basic education and primary scientific training, and the reorganization of the University studies with a view to ensuring a sound knowledge of the fundamental sciences to serve as a foundation for advanced study and research are still urgent desiderata.

In the recently reorganized teaching universities in addition to their capacity for imparting training in various scientific subjects, research qualifications in the case of the professors and lecturers were rightly regarded as requisites for appointment and promotion, but Prof. Saha rightly pointed out the defects of the present-day

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situation when he remarked that 'owing to intrigues by vested interests, and defects in the constitution, these ideals are being lost sight of, nay even abandoned in many of the universities, and some of them are being reconverted to the high school stage from which they were rescued by the reforms of 1921-22'.

After the World War of 1914-18 greater attention was paid to the reorganization, on a more extensive basis, of the various Government scientific departments and research institutions, and a number of special research institutions were founded. Unfortunately the Board of Scientific Advice, which the Government of India had established in 1902 for the co-ordination of scientific work carried out by its official agencies, was closed down in 1924, and though proposals for the foundation of a National Research Council to replace this Board have been under consideration for several years, the scheme has not hitherto materialized. The Indian Research Fund Association which was founded in 1911 for the prosecution and assistance of research in connection with the causation, mode of spread and prevention of diseases in India has been carrying on a very useful work, but for want of funds its activities have been greatly restricted since 1931. The Imperial Council of Agricultural Research constituted in 1929 and the Indian Central Cotton Committee and the Indian Central Jute Committee, have done very valuable service in arranging agricultural, technological and economic research in connection with agriculture, in effecting the improvement of various types of crops, and in studying the factors connected with the marketing of the products, but even here lack of funds has been a serious hindrance in the way of progress. Though a number of official organizations exist for the development of Medical and Agricultural Research, there are no institutions worth the name for the advancement of Industrial Research. Various private bequests resulting in the Indian Association for the Cultivation of Science, Calcutta, the Tata bequest resulting in the foundation of the Indian Institute of Science at Bangalore, Sir Tarak Nath Palit, Sir Rash Behary Ghosh and Khaira bequests leading to the establishment of the University College of Science at Calcutta, the Bose Research Institute, Calcutta, founded and endowed by Sir Jagadish Bose, Rai Bahadur Lakshminarain bequest to the University of Nagpur, the Maharaja of Jeypore bequest leading to the foundation of the Science Departments of the Andhra University, contributions from the Rockefeller Foundation towards the All-India Institute of Hygiene and Public Health and the Attock Oil Company bequests to the Punjab University are responsible for the creation of a number of important agencies. For the advancement of higher teaching and research in various sciences. The facilities for teaching and research in various sciences in the vast sub-

continent of India are still very limited, and it is a matter of real pride that in spite of these handicaps Indian students of science have during this short period of a little over a quarter of a century, justified their capacity for original investigation. In the words of the late Lord Rutherford 'India is now taking an honourable part and an ever increasing share in the advance of knowledge in pure science. As Prof. Saha, however, very cogently pointed out, the time has now come not only to strengthen the scientific surveys and the research atmosphere of the universities, but we ought to enter on a third phase, namely, scientific research should now be applied for solving the industrial problems of the country.'

Lord Rutherford in his Presidential Address, already referred to, gave a very valuable summary of the organization of industrial research in Great Britain, and, though great differences exist between agricultural and industrial conditions in Great Britain and India, it would be of value to give here a brief summary of how the British Government have contributed to the promotion and organization of industrial and agricultural research in the period since the World War of 1914-18.

Prior to the World War progress in industry depended, in the main, on the brilliant contributions of individual workers, rather than on any systematic attack by scientific methods on the problems of industry. The World War, however, brought the industrialists and the men of science into closer contact to their mutual benefit. The Government also recognized that a more systematic application of science and research over a broader field was essential in the national interest, and in 1915 a special Department of Scientific and Industrial Research was founded. This was followed by the Medical Research Council in 1920 and the Agricultural Research Council in 1931. In fact the establishment of the Department of Scientific and Industrial Research marked the first organized measure taken in Great Britain for helping industry through the application of science. Several new organizations controlled and financed by this Department were set up to deal with the scientific aspects of the use of fuel, of the storage and transport of food, of buildings, roads, etc., and the famous National Physical and Chemical Research Laboratories at Teddington were developed under the aegis of this Department. As a result very important national organizations have been built up for the investigation and application of science to various problems connected with the daily life of the people and the nation's industry as a whole. In the British organizations there is no political atmosphere, but of course the responsibility for allocating the necessary funds ultimately rests with the Government. The planning of the programmes of research, however, rests with research councils or committees who are not themselves State servants but distinguished representatives of pure science and industry, this work being

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mainly in the hands of the Advisory Council of the Department of Scientific and Industrial Research. Similar research organizations under the control of Research Councils or corresponding bodies, which have been set up in Canada, Australia, New Zealand and South Africa, are responsible for the rapid scientific and industrial developments in these dominions.

The late Lord Rutherford in discussing the development of industrial research in Great Britain remarked

'Even in a large country like India, where the resources and needs of the different Provinces are very varied, it seems to me essential for efficiency that the organization of research should be on national rather than on provincial lines. The setting up of separate research establishments for similar purposes in the various provinces cannot but lead to much overlapping of work and waste of effort and money. Such a central organization of research does not necessarily mean that the scientific work should all be concentrated in a single laboratory. If research work is to be of real and lasting value it must be carried out in the interests of the country as a whole and not of any particular province or area. As was well summed up in a leader in *Nature*, 'This necessitates careful planning and co-ordination of various schemes for research in all branches of science, whether pure or applied. In formulating the future policy, India should profit by the experience of Canada and Australia where the working of the scientific departments of the State or Provincial Governments *vis-a-vis* those of the Central or Federal Government has shown that the research organizations of the country should be truly national and responsible to the Federal Government alone. The detailed planning of research must be in the hands of those with the necessary specialized knowledge, and they must be able to act without suspicion of political or racial influence.' In other words, a plea is made for the foundation of a National Research Council in India on the lines of the body which ever since its constitution has been rendering such useful service in Great Britain. The Council should not only define the policy but act as an expert advisory body for planning and co-ordinating all scientific research in the country. The planning of scientific policy and co-ordination of research should be so arranged as to preclude duplication and avoid wastage of talent and available funds, but without in any way restricting the normal work of the universities, scientific departments and institutions, or in any way curbing individual initiative which is always so essential for high class research. Such an authoritative body should also be able to help in bringing about the necessary reforms in the existing system of scientific education. The Council should be liberally

endowed so as to be independent of annual appropriations for carrying out all its programme of work.

Pure scientific research is as essential as that specifically devoted to the attainment of any industrial object. While industrial research is confined specifically to investigations which have a direct bearing on the development of any industry, it would be a truism to assert that discoveries made in the domain of pure science may and often find application in industries at a later date, and that industrial application, though its precise form cannot always be foreseen at the time, has come to be an expected incident in the after life of the discovery. This principle is fully accepted in the highly organized machinery for industrial research in the United States of America, and as a result a great deal of importance is attached to researches in pure sciences. The connection of such researches with any of the industries is often not obvious, but all the same they are encouraged in the hope that they may provide the raw material for industrial research, and further owing to the interdependence of different investigations, progress in any one science may have a very marked bearing on the development of others. Industrial research work in the United States of America, according to Flemming, has developed along certain definite stages

- (a) Industrial research applied to the elimination of manufacturing troubles.
- (b) Research having some new and specific commercial object.
- (c) Research in pure science with no specific commercial application in view.
- (d) Research applied to public service.
- (e) Research for the purpose of establishing standard methods of testing and standard specifications connected with the purchase of raw materials.

Research laboratories in the States are attached to or supported by manufacturing corporations, associations of manufacturers, universities and colleges, national institutions, commercial laboratories and scientific societies.

Apart from numerous endowments and appropriations made for research to various universities, colleges and Government departments, there are in the States a large number of funds that have been established for the endowment of scientific research alone. Though a number of them are for the promotion of industrial research, others were founded for providing the necessary funds for medical, astronomical and general research in other sciences. In 1917 a National Research Council was appointed by the National Academy of Sciences at the request of the President of the United States. This Council includes the most prominent research men in the States and all departments of research are fully represented. Its object is to co-ordinate the Scientific

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research work of the country in order to secure efficiency in the solution of the problems of war and peace, and this Council has rendered possible the nationalization of research in the country. Selection and training of research men have also been given special attention to, and it has been found that 'while full credit should be given to the genius who can often achieve so much with very limited facilities, it is a fallacy to assume that research work of great value cannot be carried out by men of more than average attainments. This is illustrated by the success achieved in many of the laboratories in the States, where, with suitable organization, important investigations both directly connected with industry and in pure science have been successfully dealt with by men of no more than average ability working under competent direction.

Industry has rightly been styled as the basis of national prosperity, and it is, therefore, necessary that every resource should be used to facilitate its progress. In this connection research is of the utmost importance and it must be regarded as an indispensable weapon with which to develop industries of any country and to cope with international competition.

The National Planning Committee which has been working in Bombay for the past several months is collecting detailed data in regard to industrialization of the country in all its aspects and other national problems, and it is hoped that its work would prove valuable in laying down the lines for future development in the country.

I have given you a bird's-eye view of the organization and development of scientific research and studies in India up to the present day, and of the lines followed in Great Britain for the organization and development of scientific research, both pure and applied, the latter with particular reference to the needs of industry and the life of the people. I have also incidentally referred to the development of similar machineries in Canada, Australia, New Zealand and South Africa, and, finally, to the highly organized system in the United States. On the analogy of these great industrial countries, I give below the outlines of a scheme for developing a similar organization in India to plan and co-ordinate research

so as to avoid wastage both of talent and funds, preclude duplication, employ the available scientific personnel to the best advantage, and, finally, to arrange for the training of a much larger number of research personnel to supply the needs of the developing industry.

Starting from the top I consider it absolutely essential that there should be a separate department of the Central Government corresponding to the Department of Industrial and Scientific Research in Great Britain. It should be staffed by scientists with administrative experience and not by civilian administrators; and this I consider to be the absolute *sine-qua-non* of the whole scheme. Civilian administrators, though they are admirably suited to carry on the civil and military side of the Government, have unfortunately seldom realized the exact needs of Science in the country, and as a result the progress of Science in India has been materially slowed down, if not actually hindered. The Department should have an Advisory Council, the National Research Council, constituted on the lines of the Research Councils of other countries for planning and co-ordinating research, to promote and develop not only scientific but industrial research in the country, and finally for devising ways and means to make India independent, so far as possible, of foreign imports by a well-planned survey and development of its economic resources. It is only then that it would be possible for this country to assume its right place among the industrially developed countries of the world. With a view to harnessing Science in the service of Industry, the proposed Department and its Advisory Council will also have to explore ways and means for extending the existing machinery of scientific education in the country, from the school to the university stage, develop applied scientific training and research, and finally to see that research, whether in pure or applied sciences, is undertaken with a definite end in view and not only as a means for self-glorification.

I have only given the broad outline of the scheme, as I am of the opinion that its details can only be evolved after careful consideration of the *pros* and *cons* by an expert committee on which all elements of science and industry in the country are fully represented. Let us hope that this scheme will commend itself to the Government and that steps will be taken at a very early date to bring into being such an agency; this alone will enable the country to steer a safe course in the face of the Armageddon which is now threatening the world.

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Nicotinic acid and delirium tremens

DELIRIUM TREMENS usually occurs in subjects of chronic alcoholism. This disease was so long considered to be due to the toxic effects of alcohol addiction. Strauss (*Amer. J. Med. Sci.*, 189, 378, 1935) and Spies and De Wolf (*Amer. J. Med. Sci.*, 186, 521, 1933) showed that alcoholic polyneuritis and alcoholic pellagra could be cured if proper food rich in "vitamin B" was consumed even if the consumption of alcohol remained unchanged. Goodhart and Joliffe (*J. Amer. Med. Ass.*, 110, 414, 1938) successfully treated alcoholic polyneuritis with thiamin. These results led Mainser and Krause (*Brit. Med. J.*, 2, 331, 1939) to treat a case of delirium tremens associated with severe gastrointestinal manifestation and acute inflammation of the mouth and tongue with thiamin and nicotinic acid. Large doses of thiamin were without any effect. After administration of 0.5 gm. of nicotinic acid the case improved within twelve hours. All the symptoms disappeared and the patient became a normal individual. Insufficient supply of nicotinic acid in the food is therefore considered to be an important factor in the onset of delirium tremens.

S. B.

Synthetic Oestrogens

THE naturally occurring oestrogens are oil-soluble sterols all containing a phenanthrene ring. It was thought that the phenanthrene ring was essential for their oestrogenic properties. Much simpler compounds having oestrogenic properties have been recently discovered. These are, (1) diethyl stilboestrol (Dodds, covered. These are, (1) diethyl stilboestrol (Dodds, Lawson, and Noble, *Lancet*, 1, 1389, 1938), (2) 4:4'-dihydroxy- γ : δ -diphenyl- β : δ hexadiene (Dodds, Goldberg, Lawson, and Robinson, *Nature*, 142, 34, 1938) and (3) 4:4'-dihydroxy- γ : δ -diphenyl-n-hexane (hexoestrol) (Campbell, Dodds and Lawson, *Nature*, 142, 1121, 1938). Chief advantages of these compounds over natural oestrogens are that they are as active per mouth as by injection and they are very cheap. Recently, Campbell, Dodds, and Lawson have studied the biological effects of the synthetic oestrogen hexoestrol (*Lancet*, 2, 312, 1939). It sensitises the uterus of ovariectomised rabbits to the action of progesterone. It causes growth of the nipples and development of the mammary tissues

in male guineapigs. It prevents implantation in rats when administered per mouth, during the three days after mating. Its prolonged use in male rats is followed by reduction of body weights and atrophy of the gonads. Immature rat-uterus increases in weight after its use. A positive oestrus vaginal smear is obtained in ovariectomised adult rats after its administration. Hexoestrol is as potent as stilboestrol but it is found to be more active than stilboestrol when assayed by injection into ovariectomised rats.

S. B.

Anti-tumorigenic Action of Progesterone

LIPSCHUTZ and Vargas showed that uterine and extra-uterine tumours can be produced in guineapigs by subcutaneous injection of follicular hormone. (*Lancet*, 1, 1313, 1939). They also observed that the tumorigenic action of oestrone is more marked in castrated than in noncastrated females. This non-tumorigenic action of the ovary might be due to the luteal hormone. This has recently been corroborated by Lipschutz, Murillo and Vargas (*Lancet*, 2, 420, 1939). They injected 80 μ g. of oestradiol benzoate into castrated female guineapigs thrice a week for ninety days. All of them developed uterine or extrauterine tumours. Five castrated female guineapigs were also injected with similar quantities of oestradiol benzoate. After thirty days 80 μ g of oestradiol benzoate was supplemented by injections of 12 g. of progesterone. After ninety days no tumours were observed in any of the animals. Development of uterine tumours may therefore be due to a disturbance in the normal balance between follicular and luteal hormones.

S. B.

Haemoglobin Solution as a Substitute for Blood

A 5 per cent. haemoglobin-Ringer's solution is capable of maintaining normal tissue oxygenation and normal colloidal osmotic pressure of blood, in acute blood loss. This has been confirmed on animals by perfusion experiments, and on several human patients suffering from acute blood loss. No ill effects are obtained in any of these cases. (O'Shaughnessy, *Lancet*, 2, 1068, 1939).

S. B.

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This reorientation of the definition and scope of the Social Sciences now leads to consideration of Public Health.

Public Health

Public Health is the science and art of social utilisation of scientific knowledge for medical protection by maintaining health, preventing disease, and curing disease through organised community efforts for (a) the hygiene of the environment, (b) the control of community infections, (c) the education of the individual in principles of personal hygiene, (d) the organisation of medical and nursing service for the early diagnosis and preventive treatment of disease, and (e) the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health. As such, public health becomes social medicine and is primarily a field of social activity, applying practically every basic science directed towards a comprehensive programme of community service.

One's specific query in public health is two-fold in terms of the opening quotation and the definition of *THE* problem. On the one hand, to what extent are tools available and utilised through public health for the maintenance of mankind at his optimum physiological level and on the other what are the reasons and obstacles in the way of full utilisation. The present tools of public health have originated from the medical knowledge derived chiefly from biology. This knowledge has already passed through two chapters during the scientific period of the past three hundred years; and, now is on the entrance of the third and probably final chapter required for a comprehensive understanding of man. The first two chapters have covered the morphological and cellular-chemical or in other words gross understanding of man. The new chapter is bio-physical upon which even the recent significant chemical advances in endocrinology await final explanation. The bulk of required knowledge lies ahead. The existent understanding of man lacks almost entirely in two fields most required for any optimum physiological level. These are eugenics and medical psychology, including mental hygiene, in which utilisable knowledge may be said to be only emergent. The eventual goal when reached must provide tools for prevention of mental disturbances to an even greater extent than organic disease is preventable today. However, the available medical knowledge provides considerable tools particularly in preventing organic disease.

To what extent is mankind utilising then the even incomplete tools already available? The answer is

'inefficiently' for mankind as a whole and very inadequately even in the most advanced communities. It would be a digression to diverge into technical details in support of this statement except in relation to defects in social applications. Consequently reference only is made to the reports published within the past five years in England and the United States—the two countries possessing as extensive a medical organisation as is to be found: *The British Health Services—PEP Report* and, the *Report of the Committee on Costs of Medical Care*.

Two categories of causes are revealed when one comes to analysis of the broad reasons of non-utilisation—medical and non-medical. The non-medical causes become proportionately more important as medical tools reduce "excess" mortality, although as will be noted the two are very inter-dependent upon one another. The death rate in India and England respectively is 25 and 12. If the yardstick of deaths per thousand of population per annum is used, it may be stated that rates above an arbitrary 15 may be considered 'excess' and that their reduction is proportionate to the extent and standard of community organisation for medical protection. Reduction beyond 15 may be as much due to general social-economic improvement as to specific medical measures. The most sweeping generalisation, probably to give recognition to the latter phenomenon, is made by Bernal as follows:

"It is probable that an overwhelming majority of diseases that occur throughout the world are due directly or indirectly to the lack of primary necessities, generally food, and many of the remainder are attributable to bad working conditions. In other words, men are really murdered by the system they live under, or to put it in a more positive form, the adequate supply of primary necessities would give some twenty to thirty years of added life on the average to each person in the world. This may sound extreme, but it merely reflects the fact that no one draws plain inferences from the difference between the Englishman's expectation of life of fifty-five years and the Indian's of twenty-six".

What is the significance and the implication of this non-utilisation of available tools, particularly the non-medical social-economic? It may be permissible to summarise one's personal experience of nearly twenty years as a university teacher of public health to answer this question.

The chief problem in university teaching of the social sciences is to provide students with adequate opportunity for self-participative instruction in general principles of the subject in question. The principles in this instance are those concerned with the maintenance of health through organised community effort. In

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countries like China, where the bulk of this experience was derived, the major problem is rural-agricultural. It did not take long to realise that independent vertical effort limited to medical alone was incomplete and insufficient if the student was to be provided with any realistic opportunity in participating in community organisation demonstrating the successful solution of the problem of maintenance of health and avoidance of disease with available tools of science. Ignorance, poverty, lack of transportation proved to be more serious factors than many endemic diseases in high death and morbidity rates. In turn it was found that preventable disease was a similarly serious obstacle to successful development of education, agriculture, co-operatives and communications. The next step was automatic, i.e., to provide a joint community field for university departments of public health, education, economics, agriculture, government engineering and sociology to experiment and exemplify their principles.

This evolution to provide adequate practice opportunity for the student ramified into ancillary problems of suitable facilities in research that also required a new orientation entirely. Successful *METHODOLOGY* for community utilisation of knowledge within economic practicability is as difficult a field of investigation and development as any glassware research within academic walls. The view point usual to scientists is so conditioned within narrow limits that it is difficult for them to consider as scientific any work in social fields. *THIS FAILURE TO ESTABLISH SCIENTIFIC METHODOLOGY IN DETERMINING TOOLS FOR COMMUNITY WELFARE IS ONE OF THE CHIEF FACTORS RESPONSIBLE FOR THE PRESENT SOCIAL LAG THROUGHOUT THE WORLD.* The belated recognition of responsibility in this direction is the reason for the action of the three internationally recognised scientific bodies referred to above. But the proposals now laid down are so incomplete in proposing any specific means of solution of the problem towards which they are directed that they must prove ineffective unless implemented. Natural science may and should take cognizance of the importance of social lag and the necessity for steps to correct it but solution of the problem is the responsibility of the social sciences within whose province rests the utilisation of knowledge and tools made available by the natural sciences. And, the solution depends chiefly upon Methodology just as much as in the case of the re-emergence of the natural sciences in the Renaissance through the development of scientific experimental methodology. The inductive approach is as essential to progress in the one branch of university investigation as the other. The present non-scientific nature of the social sciences is proportionate to their failure to use inductive methods in their

efforts at extending knowledge. The development of methodology in the social is much more difficult for reasons obvious to all than in the natural sciences and it calls for a generally higher level of synthetic ability than required by research in the latter. This statement may be so without the experience of most that it requires illustration for clarification. An example from public health may be useful.

The a b c of the scientific experimental method is 'observation of natural phenomena and their confirmation through controlled experimentation'. Most practice in health administration today is still empirical. Fifty years ago in the early days of bacteriology it was a natural unproved assumption that inanimate objects associated with an infectious patient should be dangerous. Expensive community machinery was developed upon this assumption to provide for terminal fumigation and is still undertaken blindly in many parts of the world. However, Chapin through extending the experimental method to verify this practice was able to prove the innocuousness of fomites in most infectious diseases. The result has been simplification of disease control methods and release of only too scanty funds for more effective purposes. Those interested in medical examples where inductive experiment in the development of effective community control methods that necessitated extension back for their solution to additions of basic knowledge in physics should consult the literature of the past fifteen years on yellow fever. This is cited as an illustration of the interdependence of progress in human welfare on co-ordination of both the natural and social science branches of knowledge. So much for an example that may be termed more biological than social. An opportunity for the latter offers at our doors here.

The present outstanding medical problem in India is that of extending medical knowledge for actual utilisation by the villager. Three methods are empirically being initiated *a priori*. The urgency for successful solution of the problem is nationally recognised. But so far there has been no consideration to solve it scientifically as there would be if there were a similar significant problem in any industrial field that involved the natural sciences, or even in any medical field if the problem was one arising out of its occurrence in individuals rather than in the herd. Why in one and not in the other? It would seem that the benefits arising from a successful solution of the problem in question would be so enormous that the matter would command universal interest and support. The cost of setting up experiments in statistically significant populations of each proposed method with staff of the same standard as would be assigned to a comparable problem in physics would be negligible in national terms. Five to ten years would permit of conclusions that would save crores in stopping the continued undertaking of demonstrated ineffective

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methods. Or, as is more than probable, the conclusion might well indicate all three of the present proposals as inadequate and suggest an entirely new solution which might become the eventual policy to be adopted. But because the problem involved is not one concerned with the necessity of additional or new knowledge in one of the natural sciences but is concerned with finding efficient method of social application and utilisation, there seems to be some inexplicable mental block which precludes consideration of the problem in the scientific manner that responsible individuals would immediately utilise were it a much less important problem of determining the vector in a new disease or a new drug to cure a specific disease. It is not only the difficulties that are undoubtedly more in one than the other in applying inductive methodology but there is some psychological blind-spot through previous conditioning of mentality that seems to obstruct rational or scientific approach if the problem is social.

Public Health as a social field lags greatly in either methods or their community utilisation in applying available knowledge for the maintenance of health and the prevention of disease. There are ancillary reasons for this lag but the most important has been the failure to develop knowledge of methods of application by experimental methods. While the development of knowledge is not a privilege limited to any single social agency, the university is the one agency best organised for this function. Consequently any blame for failure in this direction rests with that agency most suited to produce results.

The failure cited in public health is exemplifiable to a greater or lesser degree in each of the social sciences. As would be expected this degree is in general proportionate to the difficulty of providing the subject with controlled experimental conditions. Political science is probably the greatest offender and education the least. But education even is glaringly deficient in particularly countries of low economic standards in its failure to develop not so much education *per se* as the methods by which the latter can be effectively utilised not only to remove illiteracy but to prepare for intelligent citizenship-participation in democracy. Social welfare measures can be successful only in proportion to the degree of popular response and intelligent participation. Hence, the fundamental nature of the right kind of education. Examination of the major social problems now confronting the world indicates that failure of removal in any of the four groups of physical environmental, population, social organisational and social-economic, with the exception of the last, is not due to absence of knowledge of their cause and preventability as to practicable

community methods for their removal, which in final analysis depend upon education.

Public Health has been used as an example of a university 'social science' deficient in its task of obtaining optimum utilisation of the scientific knowledge from which it is derived because of failure to develop knowledge of methods of utilisation through the same inductive methods through which its basic biological knowledge has been derived. It has been implied that scientific experimentation in the social sciences requires community fields controlled as much as possible in a comparable manner to the laboratories of the natural scientists. But, there is an additional essential to be borne in mind for optimum results in the social fields. This is their mutual inter-dependence upon each other for their individual progress. Results in any single field in the utilisation of available knowledge must go hand in hand with simultaneous utilisation in all social fields. The more scientific and specialised the more differentiated must social organisation become and the more individuals themselves have to assume responsibilities for the technical well-being of the State as a whole. Science is rapidly transforming communities from 'unicellular' self-contained organisms into 'multi-cellular' bodies with evolution of differentiated 'organs' having specific social functions but increasingly inter-dependent as differentiation progresses with the advance of science. Sociology may well become a science some day when there is sufficient knowledge of herd laws to differentiate a physiology of society as a whole after scientific knowledge has replaced empirical methodology of application in political science, economics and other social fields. The corollary implies the substitution of the welfare for the profit motive now underlying support to much of research motive in the natural sciences as has been brought out by Bernal.

This discussion would be subject to the criticism of merely another instance of hypothesis based upon verbiage if it stopped here. Attention has been drawn to the major problem in the social lag of the university social sciences as exemplified by public health. A specific recommendation as to the solution of the problem is now submitted through describing a university experiment in developing inductive methodology for the correlated application of science to the community life in China that was suspended by the 'China Incident.'

'Reconstruction' has become a catch-phrase particularly in Asiatic countries, especially China and India. The conclusions of the experience in public health referred to above was shared in China by workers in other social fields. The chief conclusion reached was the inability to secure 'reconstruction' without first reconstructing education from the village to the university. Although there are different levels of education

MEDICINE AND PUBLIC HEALTH

with separate functions they are inseparable. It was found that university education presented three social problems for solution: practicable methods; organisation for extending methods; and trained personnel. Attention must be called particularly to the last on account of the general failure to appreciate its importance, particularly in countries of low economic standards desirous of utilising science. The cash resources available for buying the application of knowledge is everywhere insufficient; and, dependence upon this source of employment of modern knowledge produces practically no results. The statement commonly accepted that for economic reasons it is not practicable to control malaria in rural Asia is based upon this fallacy that malaria is controllable only through cash purchase of application of control measures. This statement falls to the ground wherever material resources in kind are utilised to apply knowledge of control measures. The chief factor involved is labour. Asia is surfeit with unemployed labour in the villages that can be co-ordinated to specific ends upon fulfilment of one condition—education of the right kind that activates individuals to utilization of benefits from science obtainable through collective action. Application of this principle has been shown to be one of the major factors contributing to whatever success in the various social fields that has been obtained in Soviet Russia. Experience taught this in China. Its appreciation seems absent in any major application in India. Application implies the essential 'reconstructed' education that in turn depends chiefly upon new methodology. Development of methodology demands the highest type of synthetic ability and the unhurried leisureliness of university research. In turn, any plan for extension of methodology calls for trained personnel of a 'reconstructed' pattern that in the first instance becomes a problem of the university to produce. It has not been possible up to the present day in India to ascertain any interest of the monastic universities in the solution of the realities of the problem being discussed; i.e., the social lag in this country.

This appreciation of responsibility by university leaders in China resulted in the formation of a 'University Council of Social Sciences' in which political science (government); economics; education; agriculture; medicine (public health); engineering; and sociology were represented. Principles were postulated in defining their common problem as well as those common to its solution. The latter for instance were:

"In the first place, each social field of reconstruction should be based upon the actual needs of the rural population of China; and its field operation should be the primary ecological unit of the Chinese society, that is, the village. Secondly, each social field of

reconstruction should ultimately be self-supporting. In other words, the population of the primary ecological unit, or of the larger national economic unit, should, in the last analysis, be able to bear the cost of reconstruction. Third, each social field of reconstruction should be an organic part of the social organisation or the community life of the village, growing out spontaneously of its own needs and interests. Fourth, there should be a correlated approach of all social fields to the reconstructional process in every ecological unit rather than isolated development of individual fields in any particular unit. Lastly, the initiative and leadership of each social field should come from the locality as far as possible."

In judging the success of each social field in reconstruction, these five principles may be used as criteria. Take co-operation for example. If the co-operative programme does not fulfil the vital economic needs of the village, or if the cost of co-operative organisation cannot be hoped to be paid ultimately by the village population, or if the co-operative society is not created out of spontaneous interests of the village, or if the leadership and initiative of the co-operative programme do not come from the locality, or if the co-operative programme cannot be correlated or integrated with other social programmes in the village such as agricultural extension, public health or village education, such a co-operative programme can hardly be successful.

The Council as the official organ of the represented universities secured government assent both national and provincial (Shantung) for the responsibility of nominating the officials to govern a district of ten million population. At the same time, it created an Institute as its organ for teaching and research. The staff were concurrently the officials. Each faculty adopted to any degree hitherto lacking the 'clerkship' system of medical instruction whereby the final undergraduate year was spent entirely by the student in self-instruction in his field of study under supervision of the same teachers who had taught theory of practice. Needless to point out that self instruction initially was more essential for the teacher than the student. The professor of agricultural extension found that, while principles learnt in America might hold, he had to revise both methodology and content to obtain concrete results. His initial contributions to the 'People's Weekly' were meaningless to the farmer under Chinese conditions made literate through the 'reconstructed' educational methods of the College of Education. The initial urgency of teaching responsibility made the student the taskmaster of the instructor. This pressure accelerated appreciation in individual fields of the mutual interdependence referred to above. This appreciation extended to the instructional field in the

MEDICINE AND PUBLIC HEALTH

development of a common introductory social-economic course for students from all faculties. Co-ordination to assure maximum integration both in the development of methods as well as their extension was provided through each department of the Institute having a technical advisory board with representation from the corresponding administrative provincial bureau and national ministry and there was recognition from the Ministry of Education. Programmes were planned in terms of the estimated number of students, graduate and undergraduate. For example, the requirements of graduate training for administration in social medicine is one hsien (average 400,000 population) per two students and one sub-station (average 20,000 population) per each undergraduate student. In planning and financing departmental programmes the existing government policy and regulations in terms of training requirements were first determined. This permitted decision of the degree to which the government programme had to be either technically reoriented or supplemented in terms of Council requirements, which in turn permitted definition of personnel and financial needs. Requirements in excess of government facilities constituted the Council's responsibility in providing both personnel and funds.

Following decision of programme there was consideration of research projects. The work of Council departments was so organised as to permit senior personnel to have at least one-fourth to one-third of their time free from routines in order to engage in work of academic interest. Research projects might be either "technical" or administrative. Technical projects however had to be in the fields of application, leaving basic research for the academic campus. Investigation in administration was directed towards the most efficient organised community effort to bridge the gap between available knowledge and its utilisation under practicable

economic conditions. Research projects constituted legitimate charge on the Council budget.

The War interrupted this experiment in extensification of university organisation as the area in question was one of the first regions to be occupied by the Japanese but it is hoped the interruption is only a suspension. The nucleus of the Institute is carrying on as 'refugees' in Kweichow province where the work has been resumed on a modified scale with the Institute serving more provincial than the former national scope.

It is Julian Huxley who has pointed out that the understanding and controlling of man's social environment requires development in three inter-related ways: formulating methods; able brains attacking its fundamental problems and discovering its principles; and third, practical outlets in application through social experiment comparable to those in the natural sciences. This whole problem is one deserving the major attention of the social sciences of the universities within the three of the defined functions of extending knowledge. In fact, much of any acuteness of the problem of social life is due to failure of the universities in this direction.

The "tools of progress" referred to by your president last year are largely a product of the universities of Europe. Why should not the tools of utilisation be the significant contribution of the universities of Asia to the world society of tomorrow? It should be within the scope and interest of this Congress to initiate India's development towards solving this university responsibility. Naturally each university social discipline has its individual responsibility to proceed as rapidly as possible in adopting and utilising the inductive method for extending knowledge but, as pointed out, the problem of controlling man's social environment is so complex that it will be solved only through co-ordinated effort as requires the leadership of an organisation such as the Science Congress.

RESEARCH NOTES

Age and Vitamin A—Requirement

From the histological changes in the tooth formation of rats, it has been observed by Irving and Richards (*Nature*, 144, 908, 1939), that small doses of vitamin A which are adequate to maintain rats free from vitamin A deficiency at an early age are not sufficient for the purpose as they grow older. The deep orange pigment in the enamel of the teeth is gradually lost accompanied by pathological changes such as ketorosis of the stomach. The results of these observations reveal the fact that the requirement of the animals for vitamin A increases with age not only for tooth formation but also for the prevention of pathological changes characteristic of vitamin A deficiency. This is somewhat in contrast to the general notion that the requirement of vitamin A is relatively greater during the growing period.

B. G.

Benzedrine and Brain Metabolism

Among certain amines studied for the treatment of narcolepsy, benzedrine seems to be the most effective. The toxic effect of other amines is probably due to the liberation of corresponding aldehydes which are highly toxic to respiratory processes in brain. Mann and Quastel (*Nature*, 144, 943, 1939) have recently shown that benzedrine stimulates the oxygen uptake of brain tissue *in vitro* and is capable of maintaining normal respiration of brain even when administered in conjunction with other amines.

B. G.

Inhibitory Factor in the Oxidation of Vitamin C

It has been known that blood can prevent oxidation of ascorbic acid by atmospheric oxygen. The protective action may be due to the inhibition of the oxidation of ascorbic acid either by proteins, amino acids and salts, as suggested by Kellie and Zilva, Barron

et al and Stotz *et al* or by thiol derivatives like glutathione which can prevent oxidation. Recent work of Mystkowski and Lasocka (*Biochem. J.* 33, 1460, 1939), shows that though a small inhibitory effect can be observed with proteins and amino acids like glycine, leucine and aspartic acid, it is the chloride ion present in blood and in tissues, which is responsible for preventing the oxidation of ascorbic acid. This finding seems to support the view that sodium chloride, when added to fresh vegetables during the process of boiling and cooking, can prevent the oxidation of ascorbic acid even by air and heat (Hygaard and Rasmussen, *Nature*, 142, 293, 1938).

B. G.

Synthesis of Vitamin B—Complex By the Sheep

McElroy and Goss (*J. Biol. Chem.* 130, 437, 1939) report the result of their investigation on the nature of the different members of the vitamin B complex which may be synthesised in the rumen of the sheep. Four mature grade Dorset Horn ewes were fed for 30 days on a purified ration consisting of washed casein 5 per cent, washed sardine meal 6.7, glucose 11.0, corn starch 10.6, mineral mixture 3, and dried plain beet pulp 63.7 per cent.

The ewes were slaughtered 14 hours after the last feeding and the rumen and reticulum contents immediately preserved in the cold in 50 per cent ethyl alcohol, which were subsequently dried in glass dishes at room temperature from 48 to 72 hours and then finely ground in preparation for biological assay. The mixed rumen and reticulum contents assayed were a composite sample made up of equal weights of dry material from each of the four sheep.

The authors find that the thiamine content of dried, mixed sheep rumen and reticulum contents as synthesised by the sheep is > 5 micrograms per gram. So also riboflavin is > 20 micrograms per gram. Pantothenic acid was found to be 5 chick units and

RESEARCH NOTES

vitamin B₆ between 6 to 10 micrograms per gram of dried, mixed sheep rumen and reticulum contents.

H. N. B.

Better Bengal Rain Forecast

A method has been suggested for a more detailed and precise forecast of rain-fall and its distribution over south Bengal during the nor' wester season by Mr A. K. Roy in the India Meteorological Department Scientific Notes Vol. VIII No. 83, published recently.

Data for six seasons from 1929 to 1934 have been examined, based on barometric pressures at Barisal, Calcutta and Berhampore observatories. The days were classified into four main classes:—

- (1) Pressure at both Barisal and Berhampore greater than Calcutta pressure.
- (2) Barisal pressure greater than Calcutta pressure, but Berhampore pressure equal to or less than Calcutta pressure.
- (3) Barisal pressure equal to Calcutta pressure.
- (4) Barisal pressure less than Calcutta pressure.

After classification of these main classes into sub-classes and the analysis of the data, it was found that the conditions are most favourable for rainfall when morning pressures at both Barisal and Berhampore are higher than the pressure at Calcutta, that is, on

days of class (1), and, further, the chances of rain are greater, the greater the positive difference between the pressures at Berhampore and Calcutta.

Also, the average of total rainfall in south Bengal per day on which rainfall occurs at one or more stations is greater and the distribution of rainfall is more wide-spread on days of class (1) than on days of other classes.

On the average, the maximum amount of rainfall with the most wide-spread distribution occurs on days on which pressure at Berhampore exceeds that at Calcutta by .03" or more, with Barisal registering higher pressure than Calcutta. The chances of three or more stations in south Bengal getting rain on any one day decrease progressively as we pass on from class (1) to the other classes. Thus, while 81 per cent of days under class (1) turn out to be rainy, taking the rainfall at three or more stations in South Bengal out of the 15 considered in the paper as the criterion, the rainy days coming under classes (3) and (4) are restricted to only 19 and 5 per cent. cases respectively.

In the light of the results brought out by the above analysis, a convention has been suggested at the end of the paper, which can, with advantage, be adopted as an auxiliary to the synoptic map for a more detailed and precise forecast of rainfall and its distribution over south Bengal during the nor' wester season, mid-March to mid-May.

ERRATUM

On page 7 of Prof. B. Sahni's presidential address at the Indian Science Congress, 1940, published as a supplement to our last January issue read the line just above the heading 'The Age of Deccan Laras' at the foot of the right column as till after the Tertiary era had begun for, Mesozoic era.

UNIVERSITY AND ACADEMY NEWS

PROCEEDINGS AND PUBLICATIONS

Entomological Society of India

(Bengal Branch, Calcutta, 29th November, 1939)

D. N. ROY: Life history and sex-ratio of *Chrysomia rufifacies*.

Royal Asiatic Society of Bengal

(Calcutta, 1st January, 1940)

K. P. CHATTOPADHYAY: Satakarni succession and marriage rules.

PERCY BROWN: A note on (a) Two old Japanese 'How-to-Draw' books, and (b) An old Japanese book on repeating patterns for textiles such as brocades, etc.

EILEEN W. E. MACFARLANE: Mother and child combinations of blood groups and blood types in Calcutta.

J. N. MUKHERJEE: A note on solubility and dissociation constant of stearic acid.

Indian Chemical Society

(Calcutta, October, 1939, J.I.C.S., 16, 481-556, 1939)

JATINDRA CHANDRA PAL and B. C. GUHA: Combined ascorbic acid in plant foodstuffs. Part I.

PRATUL NATH SEN-GUPTA and B. C. GUHA: Combined ascorbic acid in plant foodstuffs. Part II.

BAIDYANATH GHOSH and B. C. GUHA: Concentration of ascorbigen from cabbage.

K. C. SAHA: Distribution of free and total ascorbic acid in the liver and muscle of Bengal freshwater fish.

PHULDEO SAHAY VARMA, K. S. VENKAT RAMAN and (Miss) K. M. YASHODA: Condensation of arsenic chloride with dialkyl aromatic amines.

SHARIFUDDIN WARSII and SALIMUZZAMAN SIDDIQUI: The constitution of *Didymocarpus pedicellata*. Part IV. Isolation of two new colouring matters and their relationship to pedicin.

MUHAMMAD QUDRAT-I-KHUDA and AMALENDU KUMAR RAY: Chemistry of spiro-compounds. Part I. Preparation of *cyclo-pentane-spiro-cyclopentanone* and *cyclo-hexane-spiro cyclo-heptanone*.

MUHAMMAD QUDRAT-I-KHUDA and ASUTOSH MUKHERJEE: Chemistry of spiro-compounds. Part II. Synthesis of *cyclo-pentane-spiro-cyclo-pentanone*.

M. S. TELANG and V. V. NADKARNY: Kinetics of the reaction between potassium persulphate and the alkyl iodides. Part I. Influence of solvents, acids and salts.

K. P. BASU and K. GUPTA: Biological value of the proteins of some species of Bengal fish by the nitrogen balance and growth methods.

PRATUL NATH SEN-GUPTA and B. C. GUHA: The estimation of vitamin C in food-stuffs.

M. P. SHAH and V. B. THOSAR: A note on the action of nitrosyl chloride on monobromomalonamides.

(Calcutta, November, 1939, J.I.C.S., 16, 557-615, 1939)

N. R. DHAR and E. V. SESHACHARYULU: Nitrogen fixation in soil not wholly a bacterial process.

S. MUKHERJEE and N. P. DATTA: Electrochemical properties of stearic acid hydrosol. Part I.

N. P. DATTA: Electrochemical properties of stearic acid hydrosol. Part II.

MUHAMMAD QUDRAT-I-KHUDA, ASUTOSH MUKHERJEE and SUBASH KUMAR GHOSH: Studies on the essential oil from the rhizome of *Acorus calamus*. Part I. Isolation and examination of calamol.

B. CHATTERJEE: The electrochemical properties of colloidal silicic acid. Part I. Interaction with bases, Part II. Interaction with neutral salts.

Botanical Society of Bengal

(Calcutta 26th September, 1939)

D. CHATTERJEE: The Endemic Flora of India.

(Calcutta, 9th December, 1939).

S. N. BAL: Ipecacuanha.

BOOK REVIEW

and expressive movements by a distinguished neurologist connected with one of the leading hospital of nervous diseases in London.

A deaf-mute patient, who had successfully replaced verbalization from speech by finger-talk, lost this power of expression as a result of a small vascular lesion in the left cerebral hemisphere of his brain. A study of this case led the author to enquire into the methods whereby deaf-mutes communicate their wishes and interchange ideas with one another. As a result of his research the author found "that there exists among the deaf and dumb a general system of speech which is independent of racial and linguistic barriers and which is largely instinctive in its nature." The author discusses gesture and speech from the standpoint of philology and phonetics and also gives a brief account of the neurology of gestures. As a result of a detailed comparison he concludes that there exists a striking similarity between the system of gestures by the deaf-mutes and the sign-talk practised by certain aboriginal communities. The functions of gesture, its role as an embellishment of articulate speech and as a substitute, and finally as the precursor of speech are considered in a number of well written chapters, and it is concluded that "gesture, like speech, may therefore be regarded as a dynamic and living subject which has not achieved finality in respect of development."

B. P.

A COURSE OF PHYSICS—by Henry A. Perkins, Sc.D.
Professor of Physics, Trinity College, Hartford
(Bleckie & Son Ltd.). Pp. 820. Price 15 sh.

This book is mainly intended for the student reading the intermediate course and is written in a clear and lucid style. The author has written the book in such a clear way that the students of average intelligence can understand the various topics dealt with without any assistance. The author has covered a large ground in this book and discussed the fundamental concepts of physics in such a way as to pave the way for more difficult modern ideas. The book has been divided into six parts, viz., mechanics, heat, wave motion and sound, light, electricity and magnetism and corpuscular physics. In the part on electricity the motion of electrons and protons is introduced from the very beginning and a fuller discussion of atomic structure and allied phenomena is discussed at a later stage. Although the aim of the author was to bring the book up to date yet he has not omitted the most important classical portions which would give the student a substantial grasp of the general principles of physical phenomena and in this connection the mathematical analysis given for such topics would be of considerable help to young learners. A large number of problems are included in the book and the writer has also given at the end of each chapter supplementary references for an earnest and advanced student who wants to get more information regarding these topics. The book may be read with profit by the students who are even preparing for the graduate course, and we wish a wide circulation of the book amongst the teachers in physics in general.

S. K. A.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

Peculiar Behaviour of a Banana plant grown at the Royal Botanic Garden, Calcutta.

Freaks of nature both in plant and animal are by no means less common. A dwarf papaya fruit inside a full size papaya, an orange inside an orange, or a dwarf

a merry gold developing from the axil of a petal, extension of floral axis through a flower, much branched date palms, production of several flowering inflorescences on a much branched flowering stalk of banana (fig. 2) and similar other various unusual developments form the subject of plant abnormalities mentioned in quite a large

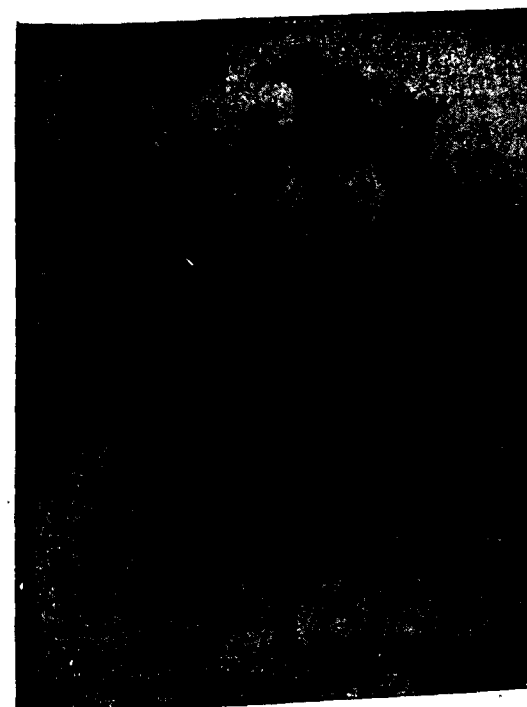


Fig. 1. Abnormal flowers of a *Nymphaea* species found growing in a village, Midnapur, Bengal—showing about a dozen flowers developed from the axil of petals of full-grown flower.

shaddock inside a shaddock (*Citrus decumana*), fasciated branches, double fruits, quadruple mango, tomato, brinjal and others, green roses—one to as many as 12 full fledged lily flowers (as recently reported from the village Cichra in the district of Midnapore (fig. 1) or a java flower or



Fig. 2. Abnormal inflorescence of a banana plant (*Musa sapientum* var. *paradisiaca*) grown in a village of 24-Parganas, Bengal.

number of literature. The writer in a paper on "Observations on some plant abnormalities in Bengal," published in *Current Science* (3, 189-193, 1934), dealt with some

LETTERS TO THE EDITOR

of them. Although monstrosities in the plant kingdom have been observed by many of us yet when such phenomenon actually occurs in nature it does not fail to create interest amongst us. There has been an instance of banana plant fruiting sometimes ago at the Royal Botanic Garden, Calcutta, with two bunches of fully developed fruits bursting out more or less vertically from the main



Fig. 3. Two fully developed bunches of banana in a plant grown at the Royal Botanic Garden, Calcutta, some time ago.

axis of the plant below the crown of leaves (fig. 3). It would have been quite a profitable business if by horticultural manipulation several fully developed bunches of banana can be produced in all the good varieties of banana plants cultivated in the gardens. But to make nature yield to human needs is not always an easy job.

Herbarium,
Royal Botanic Garden,
Calcutta, 1-12-1939.

K. Biswas.

The Chelation of Benzidine with Cupric Salts.

Cupric salts react with benzidine to form a series of intensely coloured co-ordinated compounds. Though the co-ordination valency of copper is usually four in

the most stable chelate diamino cupric salts it is observed in the present case that not more than one molecule of benzidine enters into combination with a molecule of the cupric salt, that is, the co-ordination number in the copper compound of benzidine is two. In the analogous case of *ortho*-phenylene diamino compound, however, a biscompound is found to be formed with cupric chloride. The precipitate which benzidine gives with Cu shows remarkable variation of colour with the change of the anion. Cl produces deep violet, SO₄ deep brown. Br deep red, NO₃ greyish black and CH₃COO brownish black substances. The complex salts are insoluble in water and sufficiently stable in air so that copper can be estimated gravimetrically as its benzidine compound from neutral solutions.

Department of Chemistry,
Presidency College,
Calcutta, 11-12-1939.

Kanai Lal Mandal.

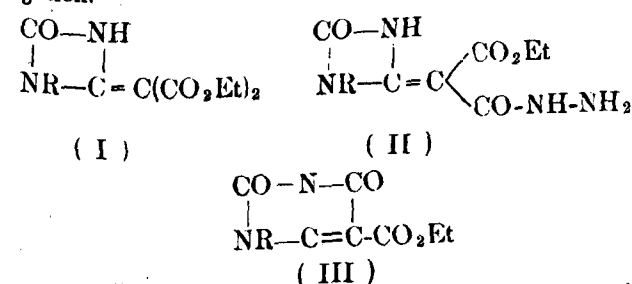
Synthesis of some Four-membered Heterocyclic Compounds

It is recognised that the closure of a four-membered heterocyclic ring from an open-chain molecule is, in general, one of the most difficult operations in ring-formation. Ingold and Piggott¹ obtained 1:3-dimethindiazine rings which are generally unstable. Senior and Shephard² obtained methylene diphenylcarbamide which is hydrolysed by boiling water.

It has been observed³ that thioacetocarbamic acid derivatives are characterised by their pronounced reactivity towards hydrazines and diamines and as such are of considerable value for synthetic purposes. The general mechanism of these reactions is that sulphuretted hydrogen is first eliminated and then ring-closure is effected by the elimination of either alcohol or water. Dicarbethoxythioaceto-carbamic acid has now been similarly found to react readily with an aromatic amine to yield a four membered heterocyclic compound (I) (m.p. 75°, R = Ph; m.p. 62°, R = *p*-tolyl) with alternate carbon and nitrogen atoms. It is readily soluble in alkali, and decolourises bromine yielding a colourless bromo-derivative (m.p. 120-121°; R = Ph). It is easily decomposed by acid or alkali, the aromatic amine being one of the degradation products. With hydrazine hydrate the compound (I, R = Ph) yields the monohydrazide (II), which melts at 171° with instantaneous formation of a solid (m.p. 252-253° decomp). The constitution of the latter compound is under investigation. The compound (II, R = Ph) forms the usual benzylidene (m.p. 209-210° decomp) and phenylthiosemicarbazide (m.p. 188-189° decomp.) derivatives with benzaldehyde and phenyl isothiocyanate respectively.

LETTERS TO THE EDITOR

When treated with alcoholic ammonia, the compound (I) yields (III) (m.p. 90-91°, R = *p*-tolyl) with the elimination of a molecule of alcohol. It is readily soluble in dilute hydrochloric acid and insoluble in alkali. Further properties of (III) are under investigation.



A detailed account of this investigation will be published elsewhere in due course.

The author's grateful thanks are due to Prof. P. C. Guha for his kind interest in this investigation.

Tejendra Nath Ghosh

Department of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, 2-1-40.

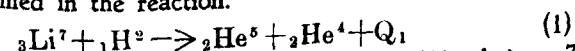
¹ J. Chem. Soc., 121, 2794, 1922.

² Ibid., 95, 504, 1909.

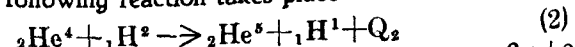
³ Ghosh, J. Ind. Chem. Soc., 63, 86, 1936; 15, 89, 1938.

The Mass of the Stable He⁵ Nucleus.

It was first pointed out by Williams, Shepherd and Haxby¹ that He⁵ nucleus is unstable and it exists only long enough to give a definite energy to the α -particle formed in the reaction.



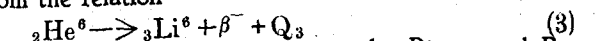
the range of ${}^5_2\text{He}^4$ observed in (1) being 7.1 cms. The mass of ${}^5_2\text{He}^5$ calculated by them from the observed value of Q_1 is 5.0137, which is greater than the combined mass of ${}^4_2\text{He}^4$ and a neutron. On the other hand, Joliot and Zlotowski² observed later on some long proton tracks by bombarding heavy paraffin with α -particles and explained their origin by assuming that the following reaction takes place:



The value of Q_2 observed by them being -0.1 ± 0.3 MeV, the mass calculated by them is 5.0106. It has been pointed out by Bethe³ that this mass makes ${}^5_2\text{He}^5$ unstable against neutron emission although it is a known fact that ${}^5_2\text{He}^5$ is actually stable against neutron emission.⁴ There is thus some controversy regarding the formation of a stable ${}^5_2\text{He}^5$ nucleus.

and it is possible to show that the mass of a stable ${}^5_2\text{He}^5$ nucleus must lie between definite limiting values in order that this nucleus itself and also the nucleus ${}^5_2\text{He}^5$ may be stable against neutron emission, provided that we take into consideration the most accurate nuclear masses and not the atomic masses. The mass of ${}^5_2\text{He}^5$ nucleus as obtained from the reaction (2) after substituting the values of the nuclear masses is $4.00281 + 2.01419 - (1.00759 + 0.000107) = 5.00952$.

Similarly the mass of ${}^5_2\text{He}^5$ nucleus can be obtained from the relation

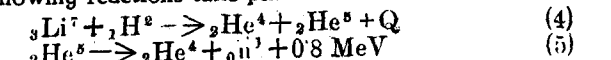


where the energy-release as given by Bjerger and Brostrom⁵ is 0.00397 M.U. With the most accurate value of mass of ${}^6_3\text{Li}^6$ nucleus the mass of the ${}^5_2\text{He}^5$ nucleus is $(6.01682 - 3 \times 0.00054) + 0.00397 + 0.00054 = 6.01971$.

This is greater than the combined mass of ${}^5_2\text{He}^5$ as given by Joliot and Zlotowski and a neutron by 0.00126. If ${}^5_2\text{He}^5$ with the mass 5.00952 be stable, ${}^5_2\text{He}^5$ with the mass 6.01971 becomes unstable against neutron emission.

It can be seen however from the above facts that both ${}^5_2\text{He}^5$ and ${}^5_2\text{He}^6$ will be stable if the mass of the ${}^5_2\text{He}^5$ nucleus is greater than 5.01074 and is less than 5.01174. Hence the nucleus formed in the reaction studied by Joliot and Zlotowski is probably stable with a mass lying between the above values.

Staub and Stephens⁶ have observed that neutrons with maximum energy of 0.8 MeV come out when ${}^7_3\text{Li}^7$ is bombarded by deuterons. According to them the following reactions take place:



From (5) the mass of ${}^5_2\text{He}^5$ comes out to be 5.0128. Probably this is an excited state of ${}^5_2\text{He}^5$. Tyrrell and others⁷ have calculated the energy difference ${}^2\text{S} - {}^2\text{P}$ to be 1 MeV. This along with the above value of the mass of the nucleus in ${}^2\text{P}$ state gives the mass of the ${}^2\text{S}$ which is 5.01172. This makes ${}^5_2\text{He}^5$ just stable against neutron emission. Perhaps the energy difference ${}^2\text{S} - {}^2\text{P}$ is still larger.

Palit Laboratory of Physics,
University College of Science,
Calcutta, 6-1-1940.

S. C. Sirkar
R. N. Rai

¹ Williams, Shepherd and Haxby, *Phys. Rev.*, 51, 888, 1937; 52, 390, 1937.

² Joliot and Zlotowski, *Jour. de Physique*, 9, 403, 1938.

³ Bethe, *Phys. Rev.*, 55, 434, 1939.

⁴ Bjerger and Brostrom, *Math. Fysiske Medd., Danske Vid. Selsk.*, 16, 1938-39.

⁵ loc. cit.

⁶ Staub and Stephens, *Phys. Rev.*, 55, 845, 1939.

⁷ Tyrrell, Carroll and Margenau, *Phys. Rev.*, 55, 790, 1939.

LETTERS TO THE EDITOR

Studies on the effect of Phage on Motile Organisms

The nature and biological significance of the action of bacteriophage have provoked much speculation but the nature of biochemical changes taking place throughout the action of phage has not yet been definitely established. d'Herelle¹, the original worker, showed with ultra-microscopic examinations that the phage element is an obligatory parasite which gets adsorbed on the bacterial wall after which it gradually penetrates inside, multiplies and forms a colony of 15 to 25 elements therein; the bacterial cell swells up and then bursts liberating the newly formed ultra-microbes. Andrews and Elford's² work has thrown some light on this phenomenon. They have observed that a specific phage added in excess to *B. coli* can within a few minutes so affect the organisms, that they are rendered incapable of propagation, that is, it apparently kills them. Recently Eisenberg³ has taken photomicrographs of phage corpuscles and has thus proved their particulate nature as well as some stages of the phage lysis of bacteria. The experiments of Elford, Andrews and Tang⁴, McIntosh and Selbie⁵, Northrop⁶ and Wyckoff⁷ with ultracentrifugal methods also tend to show the particulate nature of the phage elements. It is a well-known fact that the bacteriophage element turns the turbid broth cultures clear and limpid and multiplies through this process but as yet we do not know the intermediate stages of phage adsorption and other phases of the phage-bacterial conflict and the resulting changes of the cellular constituents of the bacteria. In the following experiments it has been found in the case of *B. coli* that shortly after bacteriophage is added to the motile organism the motility ceases though the flagella still remains.

Equal volumes of a 24 hours' culture of *B. coli* and Coliphage (10⁷ corpuscles per c.c. with d'Herelle's counting method) were mixed and incubated at 37°C. Loopfuls were withdrawn at specified times and the motility was observed with the hanging drop technique using 0.1% aqueous solution of neutral red as the staining agent with oblique illumination. As regards flagella staining Shunk's modification of Loeffler's method was followed.

Time (in mins)	Motility	Flagella
10	Positive	Present
20	"	"
25	Feeble	"
30	Negative	"
45	"	"

Time (in mins)	Motility	Flagella
60	Negative	Present
90	"	"
110	"	"
120	"	"
160	"	Disruption of the bacterial cell; No. of viable bacteria per loopful diminishes.
180	"	Progressive disruption continues.

From the above it can be concluded that soon after the phage corpuscle is fixed on the bacterial cell some functional change takes place inside the cell-wall whereby the flagellar activity stops. It would appear that the primary action of phage on flagellated organisms is to render them non-motile, although the flagella still remains intact. This occurs considerably before the disruption of the cell takes place.

My best thanks are due to Prof. Dr B. C. Guha and Mr P. B. Sen for their kind advice.

Applied Chemistry Dept.,
University College of Science and
Technology,
92, Upper Circular Road,
Calcutta, 11-1-40. D. K. Roy.

- ¹ *Bacteriophage and its Behaviour.*
- ² *Brit. J. Exp. Path.* 13, 13, 1932.
- ³ *Ibid.* 19, 338, 1938.
- ⁴ *Ibid.* 17, 51, 1936.
- ⁵ *Ibid.* 18, 162, 1937.
- ⁶ *J. Gen. Physiol.* 21, 335, 1938.
- ⁷ *Ibid.* 21, 367, 1938.

The Fluorescence of Organic Compounds by X-Rays

The excitation of fluorescent light in the visible region from Barium platinocyanide ($\text{Ba Pt (CN)}_4 \cdot 4\text{H}_2\text{O}$) by the irradiation of X-rays was first noticed by Rontgen himself at the time when he discovered X-rays. Though fluorescence of inorganic substances like NaCl, KCl, CaCO_3 etc. in spite of being stimulated by X-rays is not so striking, calcium tungstate, soda glass, lead and lithium glass, glass impregnated with manganese dioxide, minerals like wellenite (a silicate of zinc), zinc blende (zinc sulphide) and zunzite (a lithium felspar) afford striking and beautiful examples of the fluorescing ability of X-rays. Recently we have observed that many organic compounds such as benzene, naphthalene, anthracene, camphor, etc. (Table I) produce strong fluorescent spectra in the visible region when irradiated by X-rays. So far as we are aware, no such

LETTERS TO THE EDITOR

fluorescence of the organic substances has been observed before.

Preliminary observations on the positions of these luminous bands have been made by a direct vision spectroscope provided with a wavelength scale. It may be mentioned here that the list is not at all complete. Further investigations are being continued in this direction.

Substance	Position of the luminous band in $\mu\mu$	Nature of the compound	Remarks
Benzene C_6H_6	Single band from 450-500		The band is very weak
Naphthalene C_{10}H_8	Single band from 450-500	Containing two condensed benzene nuclei	The band is very weak
Anthracene $\text{C}_{14}\text{H}_{10}$	Spectrum extending from 500 to 552 with a black part at 525	Containing three condensed benzene nuclei	Strong; The band 530 to 552 is more intense than the band on the shorter wavelength side
Diphenyl $\text{C}_6\text{H}_5 \cdot \text{C}_6\text{H}_5$	One diffuse band extending from 430 to 555 with two black regions at 450 and 485	Two benzene nuclei directly united	Bands are weak
α -Naphthol	Single band from 440 to 500	Naphthalene derivative	Band is very weak. colour of the fluorescence is bluish violet
Alizarin $\text{C}_{14}\text{H}_8\text{O}_4$	does not fluoresce	Anthracene derivative	

Substance	Position of the luminous band in $\mu\mu$	Nature of the compound	Remarks
Phenanthrene	Spectrum extending from 430 to 575 with black regions at 450, 485 and 515	Isomeric with anthracene	Strong; Colour of fluorescence — is bluish violet, the black region at 450 is prominent
Fluorene $\text{C}_{14}\text{H}_{12}$	Spectrum extending from 430 to 580 with black regions at 450, 485 and 525	Diphenylene-methane	Strong; Colour of fluorescence is bluish violet
Carbazole	Spectrum extending from 435 to 560 with black regions at 452 and 410	Imide of diphenyl	Strong; Spectrum on the short wavelength side having a sharp end
Camphor $\text{C}_{15}\text{H}_{16}\text{O}$	Spectrum extending from 500-570		Medium strong

It is interesting to note that most of the above substances develop fluorescence under ultraviolet radiation. The positions of the luminous bands (from X-rays) are found to be almost the same as those excited by ultraviolet light.

We have also observed that the luminous fluorescent band of barium platinocyanide stimulated by X-rays extends from red to violet. The fluorescence of many organic compounds such as anthracene, phenanthrene, carbazole, is very strong.

Khaira Laboratory of Physics
92, Upper Circular Road,
Calcutta, 15-1-1940.

B. B. Ray
K. Das Gupta
H. Bose
S. R. Das

February 1940
Vol. V No. 8

Lindblad, in his earlier investigations, has assumed that the configuration from which spiral arms emanate consists of a spheroidal galaxy of stars of uniform density having a small condensed nucleus at the centre. Any tidal action will produce perturbations and he has worked out the condition necessary for the spiral formation. He has found that if the mass of the nucleus is small, there is a considerable possibility for the formation of spiral arms.

Spectrographical determinations reveal a fairly uniform angular speed of rotation in the central part of a nebular configuration, whereas in the outer less dense region, the angular velocity is far less than in the central part. The rapid decrease in the speed of rotation as we proceed outwards from the central part may produce instability and ultimately may cause the formation of the spiral structure. According to Lindblad, for the formation of the observed spiral arms, a high degree of flattening corresponding to the meridional eccentricity of 0.96 at least, is required. He has shown that in the outer regions of a nebular configuration there would be a distinct tendency towards matter being formed into a local condensation. Lindblad also suggests that as a result of an encounter between two such condensations near the edge of a system, one of the condensations may be ejected and depart in a spiral orbit from the central system.

Banerji, Nizamuddin, and Bhatnagar have worked out the case of a rotating spheroidal central mass of finite dimensions and of uniform density surrounded by a spheroidal structure of rotating compressible gas of variable density. The size of the central mass is taken to be small compared to that of the structure of the outer boundary. They have found that for the spiral formation, the equatorial diameter of the central nucleus in the case of our Galactic system cannot be greater than 35 par secs, and in the case of Andromeda nebula, it cannot be greater than 600 par secs.

Banerji has also investigated the condition for the formation of spiral arms in the equatorial plane of a rotating gaseous configuration of uniform density which surrounds the spheroidal homogeneous mass of incompressible material of relatively small size. It is evident that the density of the gaseous structure can only be uniform if the angular velocity is variable and satisfies a certain relation. It is found that at a sufficient distance from the centre of the configuration, in the equatorial plane, the angular velocity will be of the form $D_0 + \frac{D_1}{\omega^2}$

where D_0 and D_1 are constants. The condition for spiral formation has been obtained in a suitable form.

Concerning the origin of the solar system, the Planetesimal Theory of Chamberlin and Moulton and

the Tidal Theory of Jeans and Jefferys possess certain district advantages, but they are also open to certain grave objections. It appears to be highly improbable, if not impossible, that so much angular momentum as is found in the planets can be put into the ejected matter from the sun during its encounter with another star. The above two theories do not also give any satisfactory explanation for the formation and arrangement of satellites.

Russell has also discussed a number of new lines of attack on the problem. He examines the theory that our Sun might have been a member of the binary star having a companion much smaller than itself which had been revolving round the Sun and that a collision between this companion and a passing star broke the former into fragments from which the present planets were formed. Prof. Russell abandoned this hypothesis in view of the fact that it is not possible to explain satisfactorily how the companion of the Sun was got rid of and the terrestrial planets were ultimately formed. Lyttleton has attempted to show that "a binary system can be disrupted by means of the close approach of one component of another star of average mass and velocity (at infinity) and that all these stars can subsequently escape from each other." He also maintains that "the mechanism which effects this disruption also produces the planets, and the later encounters between pairs of planets while in the liquid state give promise of an explanation of the formation of Satellites." On the other hand, Luyten and Hill point that the two colliding stars retain about 94 per cent. of the length of the planetary ribbon and so only 6 per cent. of the length of the filament become available for possible capture by the Sun and subsequent formation into planets; so it is rather improbable that this mechanism can be responsible for generating the planetary system of the Sun. Luyten has also suggested that in order that the Sun could capture a part of the filament between the companion and the intruding star, the Sun must have been running parallel to the filament for some time and must itself have suffered a close approach or collision with the intruder. If the intruder is more massive, the Sun will be captured by the intruder. P. L. Bhatnagar has shown mathematically that if there is a collision between the Sun's companion and a passing star, the distance between the Sun and its companion would be so much reduced that a second collision between the components of the binary system cannot be avoided. The theory of formation of planets, therefore becomes too complicated to be developed mathematically on definite lines. It is a useful suggestion to work out the theory that our Sun was perhaps the intruding star which collided with a component of a binary star, and between the Sun and this component a planetary ribbon was formed which ultimately disintegrated into planets and satellites.

Chemistry

The Role of Chemistry in Forestry

—S. Krishna

The vast forest wealth of India is, at the present time, being only partially utilised for the industrial development of the country, even though the economic possibilities of this source of national wealth are great. With the demand for rapid industrial development, the products of Indian forests deserve greater attention since they form the raw material for many of the existing or the future industries, and there is no reason why the forest products should not attain an importance of the first rank if proper care and attention were to be devoted to it by foresters (as producers) and greater interest to it by industrialists (as consumers). This address brings out prominently the economic value of many of the forest products and shows what part chemistry plays in developing and exploiting them.

Forestry can roughly be divided into three main sections (a) production, (b) conservation and (c) utilisation. Chemistry plays an important part in all the three sections. It is well known that forests exert a moderate influence on climate and help conservation of soil. The soil and the plant that grows upon it are so intimately bound together that any disturbance in the one reflects on the other, with the result that in any effort to raise a forest the soil cannot be neglected. Hence, to raise a forest has to seek aid of chemistry in correctly understanding the relation of plant growth and soil and on this understanding depend the silvicultural operations which have to be employed to raise forests on scientific lines. The study of soils is, therefore, of utmost importance to scientific silviculture. It is not in the direction of soil studies only that chemistry has been of value. It has also been of help in placing in the hands of silviculturists substances, both natural and synthetic that promote growth in plants. The discovery of auxins and identification of one of them with indole acetic acid has been of considerable value and economic importance.

Conservation of forests is an important at its production and many of the silvicultural operations, such as fire protection, prevention of overcutting and erosion etc. are normally directed towards that end. If these are not carefully attended to, the forests degenerate and in some cases totally disappear. Over and above these is the menace of insect pests and if that is not stopped or carefully controlled, the forests may disappear as rapidly as by the combination of agencies such as overcutting,

fire, grazing, erosion etc. A single epidemic of sal (*Shorea robusta*) bores, for example, has been known to cause damage estimated at several lakhs of rupees. To check the inroads of such pests many measures (silvicultural, prophylactic, biological control and chemical control) are adopted. It is for the chemical control that the services of chemistry are needed and chemistry has given to entomologists several chemicals both natural and synthetic that attract, repel or kill lower forms of life and thus arrest damage to plants.

Botanical identification of plants is a preliminary essential to any scheme of utilisation of forest product. This the botanist does by basing his observations on morphological characters, without taking into account some of the characteristic chemical constituents. Many cases could be cited, for example, those of *Artemisia maritima*, *Cymbopogon martini*, eucalyptus, camphor tree etc., to show that differentiation in the species can also depend upon the chemical constituents which botanists have in all cases ignored. Close co-operation of chemistry and botany, it is pleaded, is likely to yield valuable results. Chemistry finds the widest application in forest utilisation. Through the study of wood structure and wood constituents it has been found possible to utilise timber to the best advantage. The process of natural seasoning of timber, for example, has been very much quickened by kiln seasoning and this period has still further been shortened by exposure to ultra short waves. Although seasoning imparts to timber considerable immunity to fungus and insect attack, it cannot protect it under all conditions of use. Certain timbers possess natural immunity while other are more vulnerable and, generally speaking, sapwood is much less resistant to insect and fungus attack than heartwood and softwoods lesser than hardwoods. In order to make available softwoods and sapwood for economic uses, the chemist has devoted a great deal of attention to finding chemicals which, when impregnated into the wood, would impart to it a certain amount of immunity against insect and fungus attack and thus prolong its economic life. Thus woods which, hitherto, have been considered inferior or useless are now being used for a variety of purposes. Chemist has further extended the use of inferior woods by discovering the excellent cementing properties of casein cements by the use of which, it is now possible to manufacture laminated woods with a core of inferior and facing of more expensive and decorative woods. Thus at a small expense of costly woods extensive use has been found for cheaper woods. Chemistry has found further use for soft woods by discovering methods of converting them into paper pulp and to sugar.

Apart from timber, which is the major produce, forests yield a large number of other materials, commonly designated as Minor Forest Products. These include flowers, fruits, leaves, barks, roots, herbs, bamboos, grasses, flosses, fibres, gums, resins and a host of other products of vegetable and animal origin, yielding a large proportion of the forest revenue. The revenue to the Government from royalty from this source in 1937-38 was Rs. 119 lakhs, grasses contributing Rs. 70.66 lakhs, bamboos and other M.F.P. over 48 lakhs. The market value of these latter products is estimated to be nearly 3 crores. This source of revenue could be substantially increased if the forest officers were to devote greater attention towards making fuller use of the minor products. In case, where this has been done, their efforts have yielded very encouraging results. For example, Baluchistan forests which were being run at a deficit for over 30 years have only recently, on account of the sale of ephedra, become solvent, making a surplus of Rs. 20,000. It is true that many of the minor products occur scattered in forests and the cost of collection is excessive but it will perhaps pay to work them on "cottage industry" scale rather than the "factory scale."

The two items, amongst the M. F. P. which yield the highest revenue are grasses and bamboos. Both of these have been utilised for the production of better grades of paper and have thus made India partially self sufficient with respect to this commodity. Another minor product which has gone a long way to meet the demand of the country is turpentine, from the oleo-resin of *Pinus longifolia*. The turpentine from this source, however, is not as rich in the pinene content as the turpentine from other species of pines such as *P. excelsa*, *P. khasya* and *P. merkusii*, all of which are found in abundance, though in areas where transport is costly. When these sources are tapped, it would give the country a large surplus of turpentine, rich in pinene content, for conversion into camphor which, at present, is wholly imported (worth 25 lakhs per annum) from foreign countries. Import of camphor into India is likely to increase with the growth of camphor consuming industries and it is, therefore, necessary to search all possible sources of camphor, both natural and synthetic. To establish this industry, it would be necessary to carry out very careful investigations without which the success may not be stable. Many an industry in India, has failed because of incomplete chemical, commercial and agricultural investigations and to illustrate the points the case of thymol industry is cited. Thymol was successfully manufactured in India, during the war of 1914 but the industry was killed as it failed to stand the foreign competition, on account of the poor quality of the Indian ajowan seeds (*Carum copticum*) contain 0.75% of thymol compared to 3% or over in seeds cultivated in foreign countries. Need for scientific cultivation is, therefore, obvious. The above remarks apply equally well to *Vetiveria zizanioides* (khas) oil, which industry

is slowly being wiped out from India by foreign competition.

India is still the biggest exporter of palmarosa (*Cymbopogon martini*) oil, having exported Rs. 4 lakhs worth in 1937-38, and to maintain this position the product will have to be improved both in quality and quantity. Lemon grass oil, Rs. 7.23 lakhs worth of which was exported in 1937-38, also need looking into, without which it would be extremely difficult to improve or even hold the present position in trade. Producers of essential oils in India ought to take a lesson in this from Mysore, who by producing a really good quality sandal oil, by scientific methods, is competing so well in the world markets.

Very large number of oil bearing seeds are available in Indian forests, only a few of which have yet been commercialised, even though some of them are available in commercial quantity. The possible reason for their having remained unexploited is that proper attention has not been devoted to finding the specific uses for which these seeds are best suited. For example, the solid fats from *Vateria indica* *Sapium sebiferum*, *Garcinia*, spp. and *Shorea robusta* are very good substitutes for animal fats, which are imported annually in enormous quantities. Another example is that of trilaurin which is now in demand as the basic substance for a better type of detergents useful alike in soft, hard and saline water. This is available from the seeds of *Actinodaphne hooker* and *Litsaea* spp.

Tan barks and fruits add considerably to the forest revenue. Most of the tanning materials, except myrobalans, are very largely used up by the leather industry in the country, mainly at Cawnpore and Madras. The total output, however, is not sufficient to meet the entire demand of the country for tanning materials and, therefore, more of these have to be imported but attempts are being made to augment the supply by raising plantations of babul (*Acacia arabica*) in Northern India and wattle (*Acacia decurrens*) and avaram (*Acacia auriculata*) in Southern India.

In spite of the fact that India abounds in medicinal plants, some of which are pharmacopoeial, enormous quantities (worth Rs. 207 lakhs in 1937-38) are imported every year. Only a small proportion of the indigenous drugs are manufactured into finished products, the rest are exported as crude drugs, which on extraction and standardisation are imported back into the country as medical preparations. These procedures, to say the least, are most uneconomic, since most of the drugs could be extracted and made into medicinal preparation in the country, with only a little effort in chemical and pharmacological standardisation. With proper organisation and research it should not be difficult to establish this industry on a firm footing, in India. Importance of the above

is self evident. A few examples are quoted to support this view point. The herb ephedra is chiefly exported but the trade, valuable though it is, is unable to stand the competition in the world markets mainly because of the uncertainty regarding its quality arising from the lack of proper care and attention in collecting the correct species at the proper season. If ephedrine or its salts were to be exported no such uncertainty would exist regarding its quality. *Artemisia maritima* is another, which is exported as crude drug, only a portion of the total output being worked up in the country, for santonin. The trade in this drug would flourish better especially in face of the Russian competition, if santonin were to be exported instead of the artemisia. Same remarks

apply to *Strychnos nux-vomica*. The monopolistic position of India, in this drug, may not last for ever, if conditions remain as they are to-day.

Further, considering the unsatisfactory position of drugs of Indian origin a case has been made for the cultivation of medicinal plants and for closer collaboration between chemists, pharmacologists, botanists and traders. A suggestion has been made for the formation of an association for stimulating the cultivation, improving the quality and general standard of trade with the active co-operation of the agricultural and forests departments of the Government. Such associations exist in many foreign countries and are doing excellent work.

Geology

Upper Cretaceous and Lower Eocene Beds of India

—L. Rama Rao

Prof. L. Rama Rao dealt with the recent advances in our knowledge of the Upper Cretaceous and Lower Eocene beds of India, with special reference to the Cretaceous-Eocene boundary, a field of study in which a large amount of valuable work has been done within recent years. Rocks of this age occur in quite a number of places in India such as Sind, Baluchistan, Punjab, N. W. Frontier Province, Kashmir, Tibet, Assam, and Burma; and we owe our present knowledge of the geology of these areas to the labours of a number of eminent geologists and palaeontologists like E. Vredenburg, W. L. F. Nuttall, L. R. Cox, L. M. Davies, E. S. Pinfold, C. S. Fox, D. N. Wadia, G. de P. Cotter, P. Evans and E. R. Gee. A critical survey of the results of these studies such as is contained in the Address will be useful not only in itself, but also in stimulating and directing further research on proper lines. From the point of view of the study of the Cretaceous-Eocene boundary, the work of L. M. Davies in the N. W. Frontier Province is of particular importance as it reveals the existence here of marine fossiliferous beds probably representing the lowest Eocene horizon in India, which appear to merge conformably into the uppermost Cretaceous beds below: the recent work of Davies and Cox on the Kampa Dzong beds of Tibet shows that here again we have a similar association of Upper Cretaceous and Lower Eocene beds. But in neither of these areas can we be sure of a Cretaceous-Eocene conformity on convincing palaeontological evidences, since unfortunately in both these areas, the beds which are just on the border between the two systems are unfossiliferous. Recent studies by Dr Cotter

seem to indicate that in the Laungshe beds of Burma, there exists a truly conformable passage from the Cretaceous to the Eocene; but to be absolutely definite about this, one would perhaps insist on a more detailed examination of the border beds to make sure that all the connecting zones are present in this succession. Talking of the Eocene beds of the Salt Range, reference is made to the recent work of Davis and Pinfold on the stratigraphical and palaeontological side as a result of which the classification and correlation of these rocks have been thoroughly worked out. The long standing controversy regarding the age of the Saline Series in this area has also been discussed in the light of recent researches, and the conclusion has been arrived at that the problem must still be considered *sub judice*.

Coming to Central India and Central Provinces, it is well known that the extensive volcanic formation known as the Deccan Trap occupies an interesting position in the Cretaceous-Eocene sequence. Our interest in the lower age limit of this formation has been recently revived by the numerous discoveries of fossils by Prof. B. Sahni and others in the *infra* and *inter-trappean* beds of several areas. The importance of these finds was thoroughly discussed in this very section of the Congress only a couple of years ago, from which it will be seen that the opinion is now unanimously in favour of at least a Lower Eocene age.

Passing on to South India, Prof. Rao next referred to the small but nevertheless very interesting and important patches of Upper Cretaceous rocks found along the east coast in the Trichinopoly, Pondicherry, and Rajahmundry areas, in the study of which he has himself been personally interested all these years. As a result of intensive work in these areas, he and his colleagues

at Bangalore Messrs. C. Prasannakumar, S. R. Narayana Rao, and K. Sripada Rao, have made several interesting and valuable observations which have not only added considerably to our knowledge of these rocks but have also opened out new fields of research. The rich algal flora discovered in these beds throw new light on the nature, origin, and distribution of Upper Cretaceous and Lower Tertiary algae in general, and a detailed study of this flora which is now under progress will no doubt lead to results of great value both to the stratigraphical geologist and the palaeo-botanist.

Of particular interest and great importance in the study of the Cretaceous-Eocene transition in South India is the recent discovery by Prof. Rao of an Eocene bed in the Pondicherry area which was hitherto considered as composed exclusively of Cretaceous rocks. It is not unlikely that this will lead to similar finds in the other so-called Cretaceous areas along the east coast of Southern India.

A study of the exact manner in which the transition from the Cretaceous to the Eocene system in India was effected will naturally involve a consideration of the palaeogeography of India during this period, as it would practically be impossible to understand the former without being able to visualise the latter; and to deal with problems of palaeogeography, we must of course widen our outlook and take into account the evidences furnished not only in India but also in the adjacent countries. In the latter part of the Address, Prof. Rama Rao deals with this aspect of the matter, and has given the results of such a palaeogeographical survey based on the recent

work done on the Cretaceous-Eocene rocks of India, Africa, Australia, and New Zealand. Of special interest in this study is the problem of the distribution of the sea in India at the dawn of the Eocene period. On the evidences now available, it appears that during this period there was on the western side, an arm of the of the Indian Ocean which stretched northwards from the region of the present Arabian Sea covering Sind, Baluchistan, parts of the Punjab, N. W. Frontier Province, and Kashmir. Here it seems to have divided into two branches—one going westward towards Persia, and the other eastward towards Kampa Dzong in Tibet. At the same time there was another arm of the Indian Ocean on the eastern side of India from the region of the present Bay of Bengal, extending into parts of Assam and Burma; and it was also a slight transgression of this sea along the east coast that gave rise to the newly discovered Lower Eocene beds of Pondicherry and the estuarine and marine intertrappean beds at Rajahmundry.

Lastly the Professor dealt with some general considerations of vital importance in the proper interpretation of the Cretaceous-Eocene transition in India, and observes: "The study of the Cretaceous-Eocene boundary is a living problem of world wide interest, and it is likely that studies in India will be of fundamental importance in the elucidation of this problem. We have several areas which offer a promising field for this investigation, and a good beginning has already been made. It is up to us now to pursue these studies further, and do the best that we can in this fruitful and fascinating field of research."

Geography and Geodesy

The Place of Geography in National Planning

—S. P. Chatterjee

In any scheme of planning, the physiography of the country is to be known first, then its soil conditions and vegetation coverings. The geographer is competent to furnish ready information on these points. Then, the planner, if he is to plan for building new cities or for developing industry, must take into account the different stages in the historic growth of existing cities or industries. Geography would also help him in this respect. And finally, if all the information regarding the existing conditions be not readily available, a geographical survey of these needs should be conducted.

No country in the world needs this kind of survey more than India. Take, for instance, Bengal, where lands are deteriorating, soils fast losing their powers of productivity, rivers failing to fulfil their task of land building, marshes and lakes increasing in area at the cost of good arable lands, and a large number of population is subsisting on a semistarved diet in a pitiable environment. Other provinces are no better, though their problems may be different. For a proper solution of these, a stock-taking on a provincial basis is needed in the first instance, that is to say, a geographic survey is to be conducted with a view to studying the economic and agricultural possibilities of the provinces, and furnishing materials on which an edifice of future prosperous India could be built up.

Such a survey, if conducted in India, will have to take into account the major problems affecting one-fifth of the population of the world. In comparison with other countries India does not possess any colony, and hence the vast population has to depend entirely on the resources of the country. Unfortunately the factory industry has not yet been fully developed with the result that the burden of feeding the millions has fallen on lands.

The net area sown in proportion to the total area is far greater in Indian India than in British India. This is all the more striking that the natural conditions, such as, rainfall, temperature, soil, relief—are definitely unfavourable from agricultural point of view in most of the States. None of the important Indian States excepting Travancore receives annual rainfall over 50 inches, and several States, between 20 and 30 inches, leaving aside the question of the Rajputana and Punjab States to the west of the Aravallis where the landscape is predominated by the great Indian desert. Most of the States have a continental type of climate with extremes of temperature, and some have no distinct winter season. Our information on soil conditions is meagre, but from the geology of India we find that the residual type of soil predominates in most of the Indian States, which cannot be as fertile as alluvial soil predominating in British India. With regard to relief, practically the whole of the plains watered by the rivers belong to the Gangetic and Indus systems and are situated within British India. The unfavourable climatic, physiographical and pedological conditions are also reflected in the nature of crops sown. This is a point that needs careful investigation, if a scheme is planned in the national interest. A geographical survey of the area covered by surface water, buildings, roads and mantles of really unfertile soil in whole of India is needed before we can say whether the land is better utilized in Indian India than in British India.

From the provincial statistics it is seen, that in Northern India the proportion of cultivated area to the total area is about the same in the Gangetic valley (Bengal, Bihar and U. P.) and in the upper Indus valley (Punjab) and definitely low in the two Frontier Provinces, Assam in the east and N. W. Frontier Province in the west. Sind which receives less than 10 inches of annual rainfall has the minimum area under the plough. In the Deccan, Bombay and the two adjoining States, Hyderabad in the east and Baroda in the north have the maximum area under the plough in whole of India.

As we proceed from Assam to the Punjab through Bengal, Bihar and the United Provinces, we find that the proportion of irrigated area to the total sown area increases steadily following the decrease of rainfall, being maximum in Sind, where irrigation is practised very extensively. There is no doubt that the people of the

lower Gangetic valley and Brahmaputra valleys are not making as much effort in this direction as the people of the Indus valley. It may be argued that irrigation is not the problem with which the agricultural population of the former natural region is faced to-day. But what about solving the drainage problem in Bengal or the problem of bringing more lands under the plough in Assam, which means spending of human energy and getting greater yields from the land? The proportion of irrigated land also increases as we proceed from Assam to Travancore through Bengal, Orissa and Madras. Travancore is one of the rainiest areas of India, and still the area of irrigated land is about one-half of the total area under the plough. This makes us think whether irrigation can be dispensed with in Bengal.

The area of land kept fallow is definitely higher in the lower (Bengal) than in the upper Gangetic valley (U. P.). The same is true in the Indus valley. A detailed survey of lands kept fallow in different parts of India and their mapping are necessary before something can be said for or against the practice of keeping a large proportion of valuable agricultural lands fallow.

After successfully tackling the problem of cultivable waste lands, we should find out the nature of land which is considered as worthless to-day from agricultural point of view. In this connection the activities of the present Russian Government in the Karakum and Kizilkum deserts of Russian Turkestan will not be out of place to mention here. For centuries nothing could be grown in these deserts, but to-day thousands of areas of land are being cultivated with the help of artificial irrigation by hundreds of nomad families who have just settled on land.

Forests still occupy a considerable area though deforestation started from the time the Aryans entered India. The dense forests of the Gangetic valley had to be cleared off to give place to the plants favoured by man—wheat, rice, barley—all of grass family. Forests also indirectly help agriculture by checking the run-off on the surface and thus preventing erosion of the valuable mantle of soil. This is all the more important in hilly countries where there is a danger of the surface soil being washed away. With regard to the distribution of forests in India, the Kashmir valleys and the adjoining mountain slopes in the north, and the Vindhya and Satpura ranges in Central India have yet large areas covered with forests. In the south, in Travancore, forests still occupy than one-quarter of the total area. In the Gangetic valley, the true type of forests are found only in the Sundarbans of Bengal.

As we proceed from Bengal to the Punjab, rice cultivation decreases with the corresponding increase in the cultivation of wheat following the decrease of

The third factor upon which the distribution and growth of the planktonic forms depend are the gases and chemical substances present in the water. Most of the gas comes from dissolved carbonates of calcium and magnesium. Oxygen must also be available for respiration, and its sources are directly from the atmosphere through the exposed surface and from the photosynthesis of the plants in the water. In the case of tropical waters, according to Fritsch (1907) the high temperature involves a decrease in the amounts of dissolved gases, and when the percentage of oxygen is smaller there is naturally less respiration. This is one of the chief causes why certain genera are absent from the waters of the tropics.

The Myxophyceae can make use of all the distintegration products in water and that their luxuriant growth in stagnant waters is due to the large amount of organic matter present. According to Fritsch (1907), frequent changes in the water-level also affect the production of algae, as during dry period the shallow tanks of Ceylon decrease to more than half their normal size, while in the wet season they are overfull.

Different algae have got different requirements. Smith (1924) says that while soft water lakes ordinarily have more Chroococcales than other Myxophyceae that never predominate at any season, hard water lakes exhibit a seasonal variation in the volume and percentage of the Myxophyceae which dominate during late summer or early autumn. According to Rosenberg (1939), the nature of the phytoplankton can be changed by adding suitable chemicals. The hydrogen-ion concentration has also its own effect on the production of the plankton. Wind may also cause changes in the vertical position of the different plankton strata, and there are several other factors which influence the growth and distribution of the plankton. Certain planktons seem to disappear at certain periods and reappear during others. The periodic occurrence of blooms cannot, however, be ascribed to any single cause, but it is due to different factors which work together at different intensities.

The bloom algae give disagreeable tastes and foul odours in water. They reproduce with such a great rapidity in small ponds and protected harbours of lakes that mass accumulation soon results. Again, these algae produce a large amount of suspended colloidal matter, making the water unfit for domestic use. Their gelatinous covering also makes a good harbouring place for all sorts of bacteria. Although the production of water-blooms is a common occurrence in ponds and tanks of India and their waters are being used for both human consumption and domestic animals, more especially in villages, curiously enough, no cases have yet been reported about the fatal effect of these algae. It may be that the Indian water-blooms are harmless, but the

problem requires investigation. Tilden (1935) reports that *Lyngbya majuscula* Harvey, growing in the waters of the Gulf of Manaar, between the island of Ceylon and the mainland, has been reported fatal to horses feeding upon it on the seashore.

The algae (including Myxophyceae) are considered to form the food chain of fish and other aquatic animals. Several workers have recorded the death of fish due to blooming. In the latter case they do not ascribe the killing of fish to any poison, but they think that the death of the algae following their blooming causes an exhaustion of the oxygen supply and this makes impossible for the fish to live. Copper sulphate is generally used in eradicating the water-blooms. This substance is a strong poison, but it can be used quite safely in water supplies as very weak doses of this salt are required to kill the algae. The belief that the treatment of lakes with copper sulphate is fatal to fish is not correct. Surber (1932) reports about the utility of sodium arsenite in destroying some algal growths without causing much harm to fishes, but as this substance renders the water brownish and consequently less transparent, good production of fishes is inhibited. Some workers, such as Langlois and Wiebe, have succeeded considerably in stopping the growth of planktonic algae by stocking fish ponds with young crayfish which keep the water nearly constantly turbid, making penetration of light inadequate. Fritsch (1938) also suggests that the control of algal growth should be attacked on a biological basis and that undue growth of algae will best be checked by association with an appropriate fauna.

The micro-organisms living in the soil consist of algae, fungi, bacteria and protozoa. Almost all the surface samples from the cultivated soils gave good growth of algae. Myxophyceae has been found to resume growth even after 70 years, as for instance *Nostoc muscorum* Kutz. and *Nodularia harveyana* (Thwaites) Thuret. Moore and Karrer (1919) have described algae from the lower strata of the soil, even upto 100 cm. below the surface. Peterson (1928) investigated the soil algae from the various plant formations in Iceland and concluded that the moisture of the soil was the chief ecological factor. Bristol-Roach (1927) made a quantitative examination of soil samples at Rothamsted and concluded that the algal flora is distributed laterally, fairly uniformly, within a limited area in a cultivated soil and that the species found in the lower depths are mainly identical with those on the surface. She thinks that there is considerable horizontal stratification within the soil, the numbers being usually high in the top inch, significantly lower in the second and the third inches, high at the fourth inch depth and considerably lower at the sixth inch. She considers that the fourth inch depth corresponds to the region of greatest biological activity.

The influence of the subterranean algae however on the chemical processes in the soil is slight.

In our own country H. D. Singh worked on the algae of naturally occurring soils of Lahore, and recorded more than two dozen Myxophyceae. Banerji has published a short note on the algae of wet soils of an alluvial paddy field of Faridpur, describing 8 forms of the blue-green algae. Recently R. N. Singh of the Benares Hindu University has made an intensive study of the algal-flora of the paddy field soils of the United Provinces, more especially from Benares, Mirzapur, Gorakhpur and Basti, and recorded 43 forms, out of which 14 belong to the Myxophyceae.

Apart from the systematic study of soil algae, a large amount of work has been done on the ecology of these organisms, with special reference to their economic importance in nitrogen fixation. As a result of investigations of the soil kept moist and exposed to daylight, it has been found that the growth of algae is entirely responsible for the increase of nitrogen in the light. There is a greater increase in the nitrogen-content in the upper layers of the soil containing algae than the lower ones, realizing that the algae, being present in the larger numbers than the bacteria, were more responsible for the fixation of atmospheric nitrogen than the latter. Kossowitsch (1894) considered the possibility of a symbiotic relationship between algae and bacteria. Boulhac (1897), after isolating *Nostoc punctiforme* and *Schizothrix lardacea* in pure cultures, found that these algae, when freed from bacteria, were unable to live in a nitrogen-free solution, but on the addition of a drop of soil extract containing soil bacteria, *Nostoc punctiforme* could fix atmospheric nitrogen.

Molisch (1926) isolated *Nostoc* from a symbiotic stage with *Blasia* and *Cavicularia*, and found that it could grow in a nitrogen-free solution. The investigations of Winter (1935) have shown that *Nostoc* cannot fix nitrogen when grown in mineral salt solution unless carbohydrates are added. When glucose and fructose are supplied, some amount of nitrogen is fixed.

Fritsch and De (1938) report that the amount of nitrogen fixed by the algae in the presence of *Azotobacter* and other bacteria is the same as in pure cultures, and they therefore believe that the bacteria play a relatively unimportant part in nitrogen-fixation in rice-fields. It may be noted that the importance of their investigations lies in the absolute purity of the cultures.

It is therefore left to future investigators to continue work in this direction for determining the soil algae that are able to fix free nitrogen, and also for knowing whether there is any connection between these algae and other crops of the country.

A lot of confusion exists as regards the limitations of the genera and species of the Myxophyceae, and this may to some extent be due to the descriptions of most of these plants being based upon the study of preserved materials. It is therefore necessary that these plants should be studied from an ecological point of view to enable us to know their behaviour under different climatic and edaphic circumstances. It has been experienced that in many cases species, and even genera, merge into one another through intermediate forms, and it is very likely that these are merely habit forms rather than separate plants. The Myxophyceae are very plastic in their behaviour, and ecological study will be necessary to determine how far their features may undergo modification according to the character of the habit.

The heterocysts are generally wider than the cells, and are characterised by the possession of a well-defined thick wall of two layers. The inner layer consists of cellulose, while the outer layer is considered by Geitler (1921) to be of pectic nature. On account of the characteristic construction of the heterocysts and their definite position in individual plants, there has been a good deal of speculation as regards their nature and function. They are considered to be a means of limiting the length of the filament and in several forms their formation conditions the breaking up of the trichome into hormogones, but it would not explain for the occurrence of chains of heterocysts in certain plants, as well as the formation of one pored heterocysts at the ends of short branches in the Nostochopsidaceae and also in *Scytonema Geitleri* Bharadwaja. Moreover there are many forms in which hormogone formation occurs without any reference to the heterocysts.

While Hieronymus (1892), Hegler (1901) and Fritsch (1904) have regarded the heterocysts as store-houses for reserve materials, Brand (1901), Spratt (1911) and Geitler (1921) consider them to represent archaic reproductive organs, which have lost their real function during the course of phylogenetic evolution and have been dragged along as rudiments. Brand and Spratt record the formation of gonidia in the heterocysts, and Geitler (1921) and Canabaeus (1929) describe the germination of heterocysts into filaments. Geitler further observes that the inner cellulose layer of the heterocyst wall serves as a reserve, for it disappears with the germination of the contents. The germinating stages of the heterocysts, however, show great resemblance with those of the spores. It has been shown that heterocysts and spores can replace each other. Canabaeus (1929) noticed that cultures of various blue-green algae not normally forming gas-vacuoles, did so at certain definite salt concentrations, when the heterocysts decreased in size and ultimately disappeared. She, therefore concludes that the heterocysts are receptacles for an enzyme, responsible for the formation of gas-vacuoles. The problem about the heterocysts has not yet been

solved. Their function will remain a mystery till more reliable data, based on further experimental work, are known.

The investigations about the perennation of these plants have been mainly done upon a few terrestrial forms only and practically nothing is known about the aquatic ones. During the period of drought the strata of *Oscillatoria* and *Phormidium*, growing on soil, dry up and get reduced to powder or very small flakes along with the soil. On the arrival of wet conditions the dormant protoplasts resume their growth and produce fresh crop of filaments. In *Lyngbya* the hormogones are further protected by the persistent sheaths of the parent filaments. The sheath in ordinary filaments of *Aulosira pseudoramosa* Bharadwaja is firm, hyaline, thick and stratified. In older filaments it becomes deep yellow or golden brown, as well as thinner, hard and brittle. By the drying away of cells here and there in short or long chains, and by the production of biconcave discs as well as heterocysts, the trichomes get fragmented. The hormogones thus formed may consist of only one two or three cells or may attain some length. These pass through a dormant period within the deeply coloured sheaths. In other cases, owing to the brittle nature of the sheath the filament may break into pieces, each enclosing one or more hormogones. Such pieces may get blown out and distributed by wind and it is by these pieces that the alga perennates during the whole summer. On the arrival of wet season the hormogones secrete a new sheath, which ultimately becomes thick and stratified like that of the parent-filament. The hormogones then begin to germinate, and when they are short, they escape wholly from the sheath of the parent. Long hormogones or short ones, which have grown to a considerable length owing to the available space within the parent sheath, are much delayed in their emergence, and if in the meantime a spell of dry period comes up, the trichomes become divided up into fresh hormogones and their sheaths get pigmented before they are set free.

The data collected so far relate to only a few forms, and they do not afford sufficient information about the probable mode of persistence in the large majority of the non-spore forming types. Further investigations have therefore to be continued in this direction with a view to knowing the complete life-histories of these plants.

The Myxophyceae do not possess a motile ancestor, and the prevalent tendency is towards terrestrial habitat, and there is also complete absence of sexual reproduction. The Chroococcales, which are unicellular and possess a cell-wall are undoubtedly the most primitive of these plants. The customary formation of naked endospores in the Chamaesiphonales may suggest the possibility of this order being more primitive than the Chroococcales forms, as for instance in *Gloeocapsa crepidinum*, *Aphanotheca muralis*, *Chlorogloea microcystoides*, *Gloeotheca coerulea* and *Microcystis flos-aquae*.

It is probable that this phenomenon may be more prevalent than what it is known at present.

Geitler thinks the endogenous division in the Chamaesiphonales more primitive than that in the Chroococcales, and also expresses the impossibility in deriving the endospores from the vegetative divisions of Chroococcaceae, but considers the possibility of a reversed derivation, as is the case in other classes of algae. One can thus think of the derivation of the division in filamentous Chamaesiphonales from the endosporic formation. The alga passes through many stages, such as 'Juvenile-Stage', 'Stigonema-Stage', 'Chamaesiphon-Stage' and 'Pleurocapsa-Stage'. During *Chamaesiphon* and *Stigonema*-Stages the cell stand in such a grouping that they recall the formation met with in the Chroococcales, like that in *Gloeocapsa*. Here, there is no differentiation between trichome and sheath, and spores are formed only in 'Juvenile-Stage'. The same is the case with *Endonema* which shows resemblance with both Chroococcaceae and Hormogonales. It may be concluded that with our present knowledge of the Myxophyceae it is not possible to formulate any definite idea concerning the inter-relationships of these forms, more especially the position of the Chamaesiphonales which is a unique Order in several respects.

All workers believe that there is neither nuclear membrane, nor nucleolus and that if the 'central body' is to be regarded as a nucleus it is one of the simple types. In the cytoplasmic lamellae of the alveolar 'central body' there is a substance which stains deeply with nuclear stains, and according to Poljansky and Petruschewsky (1929) appears to be very similar to chromatin. This substance is observed sometimes as a reticulum and sometimes in the form of granules or little sticks. The 'central body' is thus a little differentiated structure, and the fact that it contains chromatin-like bodies led Baumgartel (1920) to call it an open nucleus, although no differences exist between the chromatoplasm and the 'central body'.

It is now an admitted fact that there exists no mitosis in the Myxophyceae. The cell division begins with a ring-like septum growing inwards from the periphery dividing both the chromatoplasm and the 'central body' into two, the former being affected first. The observations on living specimens, which are likely to show the process of cell-division better than in fixed and preserved material, are, however, wanting.

Prat's (1925) researches show that the different and confusing descriptions given by various authors go to explain that, owing to condensation and storage of assimilates in the centroplasm, the 'central body' with its component parts is greatly variable in the same individual, and so cannot be compared with a cell-nucleus. In any case, all evidences support the comparatively primitive organization of the cell of the Myxophyceae.

The Myxophyceae have been considered to be related to the bacteria since the acceptance of Cohn's "Schizophyta," comprising the Schizomycetes (fission fungi or bacteria) and the Schizophyceae (fission algae), the former being taken as the heterotrophic forms of the resemblances, such as the form of the individual, the division by binary fission, and the absence of chromatophores and a definite nucleus. The blue-green algae differ remarkably in the possession of pigments, cellulose walls, and a 'central body'. Some bacteria are, however, reported to possess pigments, but these pigments are not contained in the cell. According to Fischer (1900) the red colouring matter of the purple sulphur bacteria functions in the same way as the chlorophyll in green plants, but here only the outer layer of the cytoplasm contains the pigment, the central mass being colourless. He considers these pigments to be related to fats, ptomaines and proteins. Lutman (1929) thinks that the purple bacteria may represent the beginning of the development of a colouring matter capable of utilizing sun's energy for the fixation of carbon dioxide. According to Molisch (1907) they represent a physical connexion between the colourless bacteria and the chlorophyll bearing organisms, and are able to assimilate organic material in the light. The Myxophyceae, on the other hand, possess the same four pigments i.e., chlorophyll, carotin, phycocyanin and phycoerythrin, as are found in higher plants, the blue-green colouration of the members of this class being due to the preponderance of phycocyanin.

The heterotrophic colourless forms in the blue-green algae are not known to occur with certainty, although *Oscillatoria decolorata* West is reported to lead a saprophytic existence in stagnant ditches.

One great resemblance between the bacteria and the Myxophyceae is the lack of cell differentiation, but forms which otherwise appear to be quite alike, such as *Oscillatoria* and *Beggiatoa*, have altogether different cell-structure. Guilliermond (1926) has made a detailed study of the cell-structure of two forms of *Beggiatoa*. According to him, the organism, when alive, has its cytoplasm full of small refractive rounded bodies in which more refractive granules of sulphur are present in variable quantity.

In spite of the considerable resemblance in habit and other respects between the filamentous bacteria and the Myxophyceae, no convincing evidence has yet been available to lend support to any affinity between them. It is possible that the filamentous bacteria may represent a special colourless evolutionary series of the blue-green algae in which chemical energy, has been substituted for light energy, but this view requires to be substantiated by further investigations. Till this is done, it would be advisable to assume the Myxophyceae and the Bacteria, together with flagellate protozoa, fungi and other classes of algae, to have developed along somewhat parallel lines from some hypothetical ancestor.

SCIENCE AND CULTURE

MARCH 1940
VOL. V NO. 9

A Monthly Journal of Natural and Cultural Sciences

“The Four-fold Ruin of India”

A GOOD many critics including Mr F. E. James of Madras do not like the following clause in the independence pledge prescribed by the Indian National Congress:

“The British Government in India has not only deprived the Indian people of their freedom, but has based itself upon the exploitation of the masses, and has ruined India politically, culturally, economically and spiritually.”

While justifying this clause in the “*Harijan*,” the Mahatma invites honest criticism on it, and it is in this spirit that this article is written. Our observations are confined only to the “economic ruin” for here one can speak in definite terms while ‘culture’ and ‘spirit’ will always remain matters of controversy, and in many respects our ideas are likely to be widely divergent from those of the Mahatma and his school. In our opinion the Mahatma has treated the aspect of economic ruin far too briefly and has missed the real point.

“Hume, Digby, Dadabhai, Wedderburn, and a host of other known and sober writers have taught the millions that the existing system of Government has drained the country of its wealth and reduced the peasantry to pauperism.”

To this criticism, the supporters of the economic policy of the British Government, particularly Civil Servants, reply, “The condition of the peasantry even during Hindu and Moslem rule was no better than it is now;

probably it was worse.” They refer to actual figures and to the descriptions left by foreign observers that the material condition of the Indian masses during the middle ages was extremely low. In fact, they were little better than serfs. Some even maintain that under British rule, their condition has materially improved.*

*“It is not a stationary, a retrograde, a down-trodden, or an impoverished India that I have been governing for the past five and a half years. Poverty there is in abundance. I defy any one to show me a great and populous country, or a great and populous city, where it does not exist. Misery and destitution there are. The question is not whether they exist, but whether they are growing more or growing less. In India where you deal with so vast a canvas, I daresay the lights and shades of human experience are more vivid and more dramatic than elsewhere. But if you compare the India of to-day with the India of Alexander (when did Alexander rule India?—Editor, *Science and Culture*), of Asoka, of Akbar, or of Aurangzeb—you will find greater peace and tranquillity, more widely diffused comfort and contentment, superior justice and humanity and higher standards of material well-being, than that great dependency has ever previously attained.” (*Lord Curzon in India, 1898-1905*, Vol. I, pp. 62-63, Macmillan Colonial Library).

“As long as the two countries continue to be organised industrially upon such different models, England will be a rich country, and India, by comparison, a poor country. But in truth the comparison ought never to be made; for nothing but confusion of thought arises from the comparison of incomparables. An economic comparison of

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We have no intention to enter into such a meaningless controversy regarding the comparative incomes of a medieval and modern Indian peasant, for the simple reason that the year of grace 1500 cannot be compared with 1940. The ethical value of British rule so far as economics is concerned is to be judged by a comparison between the income of an average Indian citizen of the present times and that of a citizen in another modern country, whose resources are similar to those of India. If this argument is once admitted, there cannot be the least doubt that British rule has not conferred on Indian masses that amount of comfort, material prosperity, and prestige in international affairs which she would have enjoyed, if her resources in agriculture and agricultural industries, in power, in minerals and other potential industries were developed to the fullest extent by the application of modern science and technique by an enlightened* government.

That the argument of the Civil Servants is mere casuistry can be seen from the following quotation about the condition of England before the Industrial Revolution (*The Endless Quest* by F. W. Westaway, pp. 874-878, Blackie & Son Ltd., 1934):

England, Germany and the United States of America may be very suggestive; Mr. Shadwell's "Industrial Efficiency" is sufficient evidence of that. India might profitably be compared with many countries of Eastern Europe which are still at the same stage of industrial evolution. But the comparison of India with England, countries at totally different stages is not only valueless but misleading. The comparison of like with like would perhaps result in showing that Germany is still a poor country compared with England, but I am not at all sure that it would show that India is a poor country when compared with countries which, like most of the Balkan States, still retain the essential characteristics of the old organisation. The difficulty of such a comparison lies in the fact that the industrial revolution is in full swing everywhere, and when once the transformation has begun to take place it proceeds with such rapidity that the country, which has the start of only one generation is far the wealthier. (*The Economic Transition in India*, Theodore Morison, Murray, 1911, pp. 159-60).

The above two extracts have been taken from *Poverty and Kindred Economic Problems in India* by G. Findlay Shirras. Government of India Publication. 3rd Edition, 1935. Pp. 9-10 and 20.

*Enlightened Government is not synonymous with independent government; e.g., China and Abyssinia had independent but not enlightened governments.

"The glamour of the few salient events of that long period as recorded in our school history books gives the ordinary boy a totally false impression of the men of those days. The collection of ruffians whom Duke William of Normandy brought over to invade England in 1066, or those who, luckily for the country, played the game of mutual extermination in the Wars of the Roses four centuries later, are generally thought of by the schoolboy as "noblemen," men of gentle birth, normally living in refinement and discussing art and literature! About the well-being of the ordinary people the boy knows practically nothing. For centuries before Hastings and for centuries after, the majority of the people living in the squalid little towns of England were miserable, half fed, and disease ridden. Picture a principal street of a town, very narrow, probably with overhanging upper stories and therefore dark, with a common open sewer, or rather open ditch, running down the middle, into which sewage and foul rubbish of all kinds were cast. Think of the nature of the sodden ground as century succeeded century, and the effect on the local water supply, almost always, be it noted a local surface supply. Think of the Black Death of 1348, or of the Great Plague as late as 1665. What glorious breeding-grounds for the invading germs! The wonder of it is, not that millions of people died but that any at all survived. Diseases of the worst kind were rife for centuries: plague, cholera, leprosy, typhus, small pox, and many another; and at such times the credulity of the people was astonishing, exorcisms, incantations and charms being remedies frequently administered and greedily accepted.

A ray or two of light broke through in the time of Queen Elizabeth, and a few people began to pay more attention to personal hygiene. The Queen "doth now bathe herself once a month, whether she require it or not.".....

Infant mortality was amazing, Dean Colet (d. 1519) was the only one of twenty-three children to reach maturity. Queen Anne (d. 1714) had seventeen children, and all save one died in infancy, the one surviving to the age of twelve. Medical practitioners, such as there were, were rarely called in for cases of childbirth."

By the middle of the eighteenth century the hygienic conditions of the country began to improve. No government in England would have been justified or could have the remotest chance of surviving for a day if it neglected to bring up the material conditions of the masses according to the best modern standards and also neglected to take steps for the fullest development of her resources in power, minerals, and other industries. If the masses of England were kept in the state of medieval backwardness, and only the money bags of the ruling plutocracy were swollen by the

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exploitation of the dependencies or of the masses of England as was the case with the Russian aristocracy before 1914, England would have had no chance of continuing her great career as one of the main springs of modern civilisation, making the greatest contributions to literature, science, philosophical ideas, industry and technique, and other finer products of the human mind. Has not England, as a result of the last World War of 1914, set in motion her whole intellectual aristocracy for the development of her trade, industry and commerce, and harnessed her scientific men to the task of industrial research for maintaining her pre-eminent position in industry? The Electricity Act of 1927, the setting up of the Department of Industrial and Scientific Research, the establishment of a large number of research organisations like the Food Investigation Board, Fuel Research Board, Coal Utilisation Research Association, Industrial Research Council of the British Iron and Steel Federation, etc., are proofs of her determination to be behind no other nation in raising her material prosperity to the highest pitch and defending her heritage of culture and prosperity. The various social legislations like the Insurance Act, the Education Act, The Public Health Act are aimed at a more even distribution of the produced wealth amongst the masses. Today an average English boy can have free education, and can proceed to higher education (university or technical) if he is meritorious. He has the claim of demanding useful employment, and the masses are far happier, better-educated, and better placed in life than the Englishmen of medieval times.

Let us turn to India, and let the facts speak for themselves. The average income of the Indian today is only Rs. 65 i.e., about 1/30th of that of the average English citizen; illiteracy is 92 per cent and, judge by whatever commodity you want which may be regarded as an index of civilized life, in every case India lags far behind most countries, even behind Turkey, Mexico and Japan whose natural resources are far inferior to those of India. The paradoxical thing about India is, as Dr Vera Anstey remarked, that her resources are abundant; but her people are abominably poor.

It must not be assumed that this aspect of British rule in India, namely absence of a sound policy of economic development according to modern scientific methods for the amelioration of the condition of the

masses, is unknown to the ruling class which determines the destiny of India. If they were at any stage unaware of it, they were awakened by the rude shock of the last World War of 1914.

"The outbreak of the Great War in 1914 drew forcible attention to the extent of India's dependence upon countries outside the British Empire for the supply of many of the necessities of life for her people. It may be recalled that during the War, supplies of dyes, important chemicals, many important medicines were almost completely stopped and prices of textiles soared so high that poor people had to fall back upon old rags. The transport service was completely disorganised, as almost all railway materials had to be imported from foreign countries, mainly England. The Government of India felt the necessity for a change in its industrial policy. In 1915, under the stress of war, the Government of India addressed the Secretary of State as follows:

"After the War, India will consider herself entitled to demand the utmost help which her Government can afford to enable her to take her place, so far as circumstances permit, as a manufacturing country."

This policy was nominally accepted by the Secretary of State for India. As a result of this recommendation, the Government of India set up an Indian Industrial Commission under the chairmanship of Sir Thomas Holland, including amongst its members many notable Indians like Sir Fazulbhoj Currimbhoy Ebrahim, Sir R. N. Mookerjee, Sir Dorabji Tata, and the Hon'ble Pt. Madan Mohan Malaviya. The Commission made a number of very sound recommendations, though not always in the best interests of the Indian masses. They pointed out to the Government that the power resources of India should be developed to the fullest extent, if India were to have her industries developed. Accordingly a hydroelectric survey of India was set up under Mr. J. W. Meares, whose three reports were published in 1922. A subsidiary committee to the Commission was formed under the chairmanship of Prof. Thorpe of the Imperial College of Science, London, to consider the scheme of State co-operation in the development of heavy chemical industries recommended by the Industrial Commission. The establishment of an All-India Chemical Service was recommended to exploit the chemical resources of India.

There were various other minor committees, e.g., the Coal Grading Committee, the Indian Tariff Board, etc. In fact, the Indian Industrial Commission of

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1916-1918 may be compared to a kind of National Planning Committee under a bureaucratic guise, and the Chemical Services Committee and various other committees to the sub-committees recently set up by the National Planning Committee. Of course, it is needless to add that the National Planning Committee set up by the Indian National Congress is far wider in its scope, more thoroughgoing in its plan, than the Indian Industrial Commission set up by the Government of India.

What has been the fate of the recommendations of the Indian Industrial Commission and of its sub-committees? The answer can be summarised in a single sentence "From 1924, due to some mysterious reason the Government of India dropped all ideas of developing the natural resources of India to make her industrially self-sufficient, but concentrated purely on agriculture and agricultural industries." For details the reader may look to an article published in this journal on "Technical Assistance to Indian Industry by the Government of India" (pp. 147-155, September, 1938). What high policy was responsible for this reversal of policy is not known, but India was henceforth to grow only potato and paddy!

Now we are in the midst of another great war and we make no apology for quoting extensively our suggestions made in this journal as early as July, 1938, in an editorial. We have been labouring on these points for a long time and have on many occasions put forth the plea for a better practical realisation of the value of science in the task of making the conditions in India more prosperous.

Let us assume that in course of the next few years this attitude is changed, that both the Government and the political parties of the country are agreed that the solution of India's problems of poverty and unemployment lies in large-scale industrialization of the country, in pooling her resources in power, creating new industries, and reviving the old and decaying ones. It will be similar to the task which confronted the authorities in Russia in 1918, or the rulers of Japan earlier in 1868. If the problems are to be successfully tackled, India, like other countries, cannot depend upon foreign experts; she must create experts and technicians among her own people. The Government will have to look to Indian men of science for advice and guidance, just as Lenin looked to the Russian Academy of Sciences for guidance when he decided to give effect to the various five-year plans. Will the Indian man of science be able to rise to the occasion and shoulder the responsibilities?

"Let us see what the task before him is. At present, the most gifted Indian men of science are engaged in academic researches. Thanks to the retrograde policy of the Central Government of putting foreign experts at the head of every department connected with industries, and of an unsatisfactory method of recruitment for these services, the first class Indian man of science has no opportunity of being acquainted with any industrial problem of the country, except such questions as are connected with agriculture. When therefore scientific men in India are suddenly confronted with such tasks it is natural that they will simply find themselves at sea.

Such moments may arrive earlier than expected; from the events of the last World War it is difficult to see how this calamity can be averted for long. Nations are moving head-long towards each other for a collision. The communications of India with the external world are sure to be more severely interrupted than during the last War, and the supply of many commodities for which India has to depend upon foreign countries such as machinery, petrol, motor cars, textiles, chemicals, railway materials, etc., will be stopped or severely hampered. This will violently disturb the course of human life in India, as it did during the last World War, and public opinion will demand that the Government should do something to relieve distress. The Government will then ask* professors of physics, chemistry and other branches of science to give them some readymade formulae for the manufacture of such goods, and when they are found unable to work out the miracle, civilian anger will rise to the boiling point, and proclaim all Indian scientists as incompetent!

Will it not therefore be a good policy to take the warning in time, and create, whether for emergent military needs or for permanent national work, a National Research Council, with a National Committee for Industrial and Scientific Research as one of its component bodies and with a constitution similar to that of the Imperial Council of Agricultural Research, or better on the model of the Department of Industrial and Scientific Research in the United Kingdom? It will be a body which will draw up a plan of industrial research extending over years, mobilize the available talents in this country (professors of scientific subjects in the universities and research institutes) by distribution of problems, and help them in their work by the

*This actually happened during the Great War, when Departments of Industries were suddenly created, and many fortunate professors of scientific subjects were called upon to become directors of industries on fancy salaries. The country does not yet know what industries have been created due to the labours of these departments. They have since mostly fallen under Civil Service management.

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award of adequate research grants. Wherever necessary, new research institutions will have to be created. The problems should be of a country-wide interest,* and should deal with the essential points in large-scale industrialization."

But one looks in vain for a change of heart! We hear that Britain is fighting for setting up a New Order in Europe but no clear answer has yet been forth coming to Pandit Jawaharlal Nehru's query whether the New Order is going to include India? What steps are being taken for the defence, and maintenance of civilized life now, when the situation is far worse than it was in 1914?

*There is already in existence a department of Industrial Research Bureau, but this does not serve our purpose. The Government has just given us an air-gun, where a howitzer was needed.

Science as the Road Away from War

One of the earliest incentives to war was the invasion of one country by another for the purpose of loot. Later, as we became more civilized, actual looting as a motive yielded place to the control of population for the purposes of taxation and the exploitation of labour and of natural resources. This is all part of the old primitive instinct of animals and men to secure the good things of life by taking them from someone else.

Science, however, has given mankind a method of gaining the good things of life without taking them from someone else and without working inordinately long and hard to produce them. Discovery and development of good things of life by science, engineering, and invention are far more certain and productive sources than organized loot and robbery. To the extent therefore that great groups of people, such as nations, can be induced to support technological development directed towards these ends, to that extent can they satisfy their desires without recourse to war.

More specially, many nations have felt the urge to conquest in order to secure to themselves an assured

Without committing however ourselves in any way to the full implications of the Congress resolution, opinion may be expressed that the wording relating to 'economic ruin' understates the situation as it focuses attention only on drainage of wealth and exploitation. The economic backwardness is 90 per cent due to the absence of a planned policy of development of the country's natural resources. The following clause may therefore be added:

"The British Government has shown the greatest reluctance in adopting a policy for the fullest development of the natural resources in power, minerals, chemicals, forest and agricultural products in which India abounds, according to the latest methods of science and technology, and in taking up a scheme of industrial expansion, and has therefore failed to work for a better and modern standard of life for the Indian masses."

supply of various materials which are necessary to the nation's economy. For example, Great Britain needs oil for her navy and food for her population, which cannot be produced in the British Isles, Germany and Japan need rubber, foodstuffs, and mineral resources. Even the United States—richest of all nations in its mineral resources—is inadequately supplied with such important materials as rubber, tin, and tungsten. Does national safety force these nations to conquest in order to assure themselves of these commodities?

The necessities of national economics could be however taken care of by scientific research at a cost far less than that of a major war and within a time far less than that in which the effects of a major war could be overcome. At the same time this could be done not only without hurting anyone but with great indirect benefit to all concerned.

—From Dr Karl T. Compton's address before the American Chemical Society, with acknowledgement to the *Technology Review*.

National Planning with Reference to the Development of Key Industries*

J. C. Ghosh

Director, Indian Institute of Science, Bangalore

It is a matter of great satisfaction that the subject of national planning is engaging the serious attention of all those, who are interested in the prosperity of the motherland, and who believe that in the search for happiness lies the main spring of all human endeavour. There are some who find happiness only in the realisation of self and in communion with the Supreme Being. They have an ascetic ideal who care little if the ordinary needs of the human body and mind are satisfied or not. Such men and women are extremely rare—there is only one Mahatma in 400 millions of people. The average man, however, can hope for happiness, if the barest needs of life are satisfied on a reasonable basis of work and if he is given some leisure to cultivate his mind and social relationships.

Minimum Requirements for Civilised Existence in India

The following minimum requirements may be laid down for civilised existence in India without any fear of contradiction:

1. Food which would include carbohydrates, fats, proteins, minerals, and protective foods like milk, in suitable proportion at 75 per cent of the level prescribed by the League of Nations.
2. Clothing at 30 square yards per capita per annum.
3. 100 cubic feet of space per capita in clean well ventilated dwelling houses which are easily accessible by road or other forms of transport to urban centres.
4. Provision of free medical aid on the basis of one health unit for 1000 persons.
5. Free education up to the age of 13 years.

*Public Lecture delivered at the Madras session of the Indian Science Congress on January 3, 1940.

Let us examine these standards one by one as they exist now. Excepting in the canal colonies of the Punjab, and the recruiting centres in northern India for His Majesty's Army, where the food consists mostly of wheat and milk, the people of India are in a chronic state of undernourishment. In the Gangetic plain, they generally take two meals a day consisting mostly of cereals like rice with some pulses or vegetables, and only occasionally wheaten bread, fish or milk are taken. And the poorest Indian diet is that of the Madras peasant who practically lives on rice alone. This chronic starvation immediately calls for remedial measures.

Coming next to clothing, the present per capita consumption is 15 square yards. This is hopelessly insufficient even in a tropical country. If clothes, as the poor people ordinarily wear them even now, are to be washed every alternate day and cleaned with soap every week, the per capita requirement per annum must be raised to 30 square yards.

About housing, the less said the better. The dwelling houses of the average cultivator in northern India present a picture which should be considered a disgrace for any civilised society. Dark and damp hovels with mud floors and thatched roofs, with adjoining sheds for all kinds of domestic animals, and with no means of communication except a footpath which is impassable for half the year,—men, women and children, cattle, goats and sheep practically herding together in squalor and depressing surroundings—such is the real picture of village India in the north. No body can be in love with such an environment. They say that the first impulse of patriotism unconsciously develops in the child from the love which he feels for his country considered as an object of beauty. And even in later life it is difficult to keep patriotism alive,

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if one has no mystical perception of the charms of the motherland.

Next to food and clothing, therefore, the immediate objective of a well-planned economy is the provision of suitable dwelling houses for the masses of India. This is a problem of vast magnitude. If we take 5 as the average unit of the family, it will mean building anew practically 70 million houses which would give 100 cubic feet of space to each individual, with provision for doors and windows, with cement floors and decent roofs of tile or galvanised iron, depending on climatic conditions. Construction of metalled roads on a vast scale will have to be undertaken if every village is to have that minimum amenity of modern civilized life, namely, intercourse and exchange of goods with urban and industrial centres. The engineering industries which cater to the needs of the building trade and the transport services will have to be expanded beyond recognition.

For supplying free medical aid and liquidation of illiteracy, 5 lakhs each of well-qualified doctors and well-trained elementary school teachers are necessary; and immense developments in the industries which produce hospital equipment, drugs, scientific appliances, or manufacture paper, pencil, printing ink, will be necessary if this ideal is to be realised.

Planning for a Better Life for the Masses of India

We now know our problem. It is the planning for a better life for the masses of India. It is planning for a state of society where they will look happy and cheerful. It is not planning for the accumulation of more wealth in the hands of those who are already rich or in the hands of those who are enterprising. How is the problem to be solved? That is a big question. That it cannot be solved by the existing methods of free competition in the production of goods and services is certain. These methods have been tried under a peaceful administration for about a century and miserably failed. It has been appropriately said that "the most interesting thing about India is that her soil is rich but that her people are poor." The soil of India is rich; the methods of cultivation not too bad; and better methods which are not difficult to evolve by the application of modern scientific know-

ledge to agriculture can very soon make this country self-sufficient as regards foodstuffs, even according to the improved standards that have just been laid down. But will that solve the question of poverty? No, *this problem of poverty will not be solved until there is a fundamental change in the distribution of occupation among the workers of India.* The National Planning Committee calculated that the *average income of a villager is Rs. 35/- a year.* In the Indo-Gangetic plain, this low income is due to the fact that there is too much pressure on the land. About 70% of the people are directly dependent on land and about 20% more are indirectly dependent on land as landlords, moneylenders etc. The result is that an average family of five has to live on the produce of 2 to 3 acres of land; and no matter how well he cultivates this bit of soil, the family income of a peasant cannot exceed Rs. 35/- per capita a year. Given good health and facilities for credit and marketing, a peasant family of five can easily cultivate 10 acres of land without bringing down the yield per acre, and the family income can therefore be increased three times. But even if all cultivable lands are utilised—which should be immediately done, the holding per family will not increase to a significant extent. We must recognise therefore, that so far as northern India is concerned, the basic industry of India is agriculture not by option but by compulsion. Holdings are too small for a peasant family to live on its produce at a level above the barest margin of subsistence, even if the land were used to the fullest advantage. But vicissitudes of season, lack of credit and marketing facilities, rack renting, and ignorance make the situation infinitely worse. Yet the cry—'Back to land' is often raised. This is a political stunt off the most sinister type and should be immediately discarded for the cry,—'Advance towards Industries.'

In that very rich and practically self-sufficient country, the United States of America, about 30 per cent of the income of the people is spent on food and the rest on the amenities of what they consider as civilised existence. As a corollary it follows, that only 30 per cent of the people are engaged in producing the food requirements of the country. France which is much poorer but also practically self-sufficient, possesses an ideal balance between industries and agriculture with a rural population of about 50 per cent. It is now universally recognised in India that the principal objective of planning the national economy should be to attain as far as possible national self-sufficiency. So far as food-stuffs are concerned, this ideal is attainable. Granted this, if we are to aim at a similar balance as

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prevails in France, it would be necessary to transfer within a definite time period a vast number of people to industrial occupations so that instead of the present 90 per cent, only 50 per cent of the people become dependent on land. Is it possible to do that? Does India possess the resources in raw materials, in power, in technical ability which can bring about this transformation? The answer is that according to competent authorities, India is not only rich in agricultural resources, but also in all those resources in power and raw materials which are essential for building up modern industries. She has as great potentialities for developing a self-sufficient industrial economy as the Russian Republic, if not, the United States of America. It therefore appears that "the most interesting thing about India is that her soil is rich, she has vast possibilities of industrial development, but her people are exceedingly poor." There is something very rotten in the State of Denmark when in spite of plentiful resources, the income of a villager is Rs. 35/- a year, and the average per capita income on the most optimistic basis is Rs. 60/- a year. Even the per capita income of Japan whose resources in minerals, raw material and power are much less than that of India is five times higher than that of India. It was to end this tragic state of affairs that the Ministers of Industries in the self-governing administrations of the British Provinces met together in Delhi in October, 1938, and resolved that the problem of poverty and unemployment, of national defence and economic regeneration cannot be solved without industrialisation. As a step towards such industrialisation a comprehensive scheme of national planning should be formulated and they accordingly appointed a National Planning Committee. The work that has been entrusted to this Committee is so vast in its scope that it had to be divided amongst 30 expert committees.

Key Industries

The problems relating to key industries require immediate attention as in most countries they are directly helped, if not, controlled by the State. They are indicated in the list below.

Key Industries.

1. POWER—Hydro and thermal.
2. FUEL—Coal, wood, mineral oil, power alcohol, natural gases.

3. METALS—Ferrous and important non-ferrous including winning of ore for them.
4. INDUSTRIES for the making of machine tools.
5. INDUSTRIES for the making of machinery and machinery parts.
6. HEAVY ENGINEERING INDUSTRIES for buildings, roads, railways, ships, locomotives, rolling stocks, automobiles, air-craft etc.
7. INSTRUMENTS AND APPARATUS—commercial, industrial, scientific, medical etc.
8. CHEMICALS—including fine chemicals, dyes, drugs, fertilisers, refractories etc.

Each one of these 8 groups of industries has been entrusted to the charge of a sub-committee with the following terms of reference.

1. To make a census of the present production of Indian industries and imports from abroad.
2. To form an estimate of the country's requirements on a progressive scale keeping in view the standard of living as determined before.
3. To survey the potentialities of development in each case with due regard to location, raw materials needed, power supply required, technical skill available, and marketing facilities.
4. To recommend ways and means including legislation and special concessions from the State, for developing each of the industries with a view to attain self-sufficiency.

Power Resources

An adequate and cheap power supply is the key to all industries. I say this with full knowledge of the fact that in India there is a very powerful group of idealists, who feel that the introduction of the modern technical methods is an unmixed evil and should be resisted, who believe that primitive methods create a sense of dignity for human labour and are aids to self-realisation. I would respectfully leave them aside, for 99 per cent of men would not want that human muscles should be asked to bear the pain and drudgery which machines can bear. Judged from this standpoint, development of all industries depend at all

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stages on the cheap supply of power. In the most advanced countries of the West, the output of work per head per year is 1800 units. This work is not derived from human or animal muscles which for the combination of one man and two animals reach a maximum of 75 units. This large output of work in the West has been made possible by utilising coal resources and harnessing water power. The average output of work per head in India is not more than 90 units. This shows why the average Indian is nearly twenty times poorer than a citizen of America or even Sweden, *for wealth in the last analysis is merely the result of work done by men and machines.* So the first necessity for rapid development of industries is to work out a plan by which the power resources of the country can be developed to the maximum extent and cheap power may be placed at everybody's disposal. In India, according to the estimates of Sir M. Visvesvaraya only 2 to 3 per cent of the water power resources has been developed. Of the installed generation capacity of 1.2 million kW., hydro electric power accounts for 450,000 kW. and the rest are thermal generating stations.

The hydro-electric power stations of the Western Ghats, water sources of which are the huge dammed reservoirs trapping the monsoon rains high up, are managed by the Tata Group with a capital of about 10 crores of rupees, and have proved by far the strongest stimulus to the industrial development of the Bombay metropolitan area. The Punjab Government have also harnessed its great rivers and 30,000 kW. have been made available to the industries, but at a cost which is unfortunately prohibitive. The Upper Ganges Hydroelectric Grid takes advantage of the small heads of waters in the canals and now generates 10,000 kW., which is mostly used for irrigation and rural electrification. In Madras, the Pykara project now yields about 40,000 kW. and schemes are under construction or contemplation which would ultimately supply the Presidency with 350,000 kW.

It is unfortunate, however, that due to vested interests or careless planning, the price of power is much higher than that in other countries. Compared with these high prices for power in the great industrial centres of India, the achievement of Mysore in the matter of supply of power to infant industries at .125

anna per unit appears like a miracle. This price is very much less than .3 penny per unit which is charged by the Electricity Board of Great Britain or the Waterfalls Commission of Sweden. Mysore has no black coal underneath the soil, but bountiful Providence has given her plenty of white coal on the surface. And thanks to men of vision like the late Dewan Sheshadri Iyer, and Dewan Sir M. Visvesvaraya, schemes have now been evolved for the ultimate development of about 250,000 h.p., which her beautiful rivers and wonderful falls can produce; and it is also no wonder that the State budget for 1938-39 which has been unanimously passed by both the representative Houses, should have provided for a capital expenditure of a crore of rupees for immediate development of an adequate power supply. The National Planning Committee would wish this brilliant example of Mysore followed in other parts of India regarding the fullest economic utilisation of natural resources in fuel and water power.

Coal is the biggest factor for the industrial development of a country; in India unfortunately coal fields are concentrated in the north east corner, of which the Gondwana deposits contain 60,000 million tons and the Tertiary deposits of Assam about 10,000 million tons. According to existing methods of extraction only 40 per cent of the coal could be raised, and unless improved methods of mining *e.g.*, sand stowing are introduced the life of the coal fields would be very much shortened. Not only the method of raising coal, but also the way it is used, is of fundamental importance for national planning. For example, it is essential, for the development of chemical industries and for national health, that burning of soft coal as such should be prohibited by law. In coke ovens, at high or low temperatures as the case may be, the coal should be distilled to yield tar, ammonia and sulphur, and the residual coke alone should be used for heating and raising steam. We raise on an average about 25 million tons of coal every year, and it should not be difficult to obtain from a well-planned coal distillation industry all our present requirements of ammonium sulphate as fertiliser (we import about 80 lakhs of this material), the benzene and its derivatives needed for our potential fine chemical and drug industries, and the asphalt needed for surfacing our roads. The National Planning Committee is therefore anxious that a Fuel Conservation and Research Board should be established not only with duties for research but also with powers to regulate the production and

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use of fuels available in India—coal, mineral oil, power alcohol etc.

Iron and Steel

The Iron Age dawned in India when human societies in other parts of the world still cradled in the Stone Age or Copper Age. The famous iron pillar at Delhi of rustless iron, forged in the early years of the Christian era even now evokes the admiration of all expert metallurgists. In the middle ages, Indian steel known as wooty steel, a Tamil name of Polad, was a principal item of export and was used for the manufacture of the famous Damascus blades.

The modern iron and steel industry in India, we owe to the vision and enterprise of the great Jamshetji Tata, and the Tata Iron and Steel Works at Jamshedpur, with a capital of 11 crores is the biggest single enterprise of its kind in the British Empire. This corporation along with the Indian Iron and Steel Company of Bengal, and the Bhadravati Iron Works of Mysore, is responsible for the annual production of about 2 million tons of iron mostly in the readily marketable forms like sheets, angles, beams, bars, rails, fishplates etc. But the original anticipation of the late Jamshetji Tata that a sound basic iron industry would give rise to an all-round mechanised industrial development in the country has not yet been fulfilled. In 1937, we imported 300,000 tons of iron, mostly in the form of galvanised sheets, tinned sheets, bolts, nuts, tubes, pipes, wire nails, wire ropes etc., at a cost of 5 crores of rupees. This list is revealing and brings out the paradox, that though India manufactures the high tensile steel which is being exclusively used for the superstructure of the Howrah Bridge, she has not installed machines for the mass production of even screws, bolts, nuts and nails etc.

It is no wonder therefore that when we come to the consideration of the mechanisation industries (nos. 4 to 7 in our list of key industries) we find that we are hopelessly backward, though India stands eighth in rank regarding industrial development in the League of Nations office. Machineries, vehicles, engineering materials, instruments, clocks and watches, arms and ammunition, we import on an average to the extent of 31 crores of rupees. This unpreparedness becomes

all the more lamentable in war time, and even the Commander-in-Chief regretted, in a recent broadcast, that India's limited industrial development makes her as yet incapable of supplying the technical equipment of a modern army. The Chatfield Committee has demanded that India must be self-sufficient so far as the needs of the modern mechanised armies are concerned and the British Government should accordingly give the utmost encouragement to indigenous industry. A similar policy was laid down in 1915 under the stress of war, when the Government of India declared that "India would consider herself to be entitled to demand the utmost help which her Government could afford to enable her to take her proper place as a manufacturing country." But the lessons of the last war were soon forgotten, and the Central Government did not even hesitate to veto a proposal of the Tatas to manufacture locomotives as being unpractical. We are glad that under pressure of public opinion, Government has now been forced to change its mind as regards manufacture of locomotives; it is also a matter of satisfaction that the manufacture of automobiles has been taken up for consideration by the industrial magnates of Western India. But even if these developments materialise, there is still a great leeway to be made up. The Behar Mechanical Industries Committee have just published an illuminating report* in which it has recommended the establishment of a National Engineering Workshop in the neighbourhood of the Iron and Steel Works at a cost of 6½ crores of rupees just to fill up those wide gaps in our industrial structure which has now become painfully patent. It is too early yet to go into the merits of this scheme, but it is obvious that some form of State-aid will be necessary at the initial stages to bring these industries into being, much in the same way that our great iron and steel industry was nursed for years, until very recently when it is on its own legs, and even exports pig iron to England.

Chemical and Allied Industries

The chemical industry is considered a key industry all the world over and ranks with power and mechanisation as of supreme importance in a modern State both in peace and war. A bird's eye-view of the major problems relating to chemical industries and the gaps in their structure is needed to complete this broad review of key industries.

*A review of this Report appeared in this journal in its October, 1939 issue, pp. 242-5.

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Arms and explosives today come naturally first in order of importance. The cordite factory at Aruvankadu manufactures nitric acid, cordite, and other propellants for the need of the Indian Army. But for the use of industries, *e.g.*, for mining and civil population, the explosives were all imported from abroad. It may appear strange, but it is true, that not an ounce of high explosive is manufactured in India. On the recommendation of the Chatfield Committee and with a subvention from the British Government, the Government of India are now putting up plants for the distillation of coal tar at Jamshedpur and Asansol, in close co-operation with the Tata Steel Works and Bengal Steel Corporation. It is intended to convert these coal tar derivatives into high explosives at a factory somewhere in western India. There is no ill-wind which bloweth not some good; if therefore under the pressure of world events, the coal tar distillation industry under the patronage of the Government comes to stay in India, it will give an immense fillip to many subsidiary industries *e.g.*, fine chemicals, dyes and drugs.

We import dyestuffs for our huge textile industries to the extent of 3 crores of rupees a year. This business was mostly done by German firms masquerading as '(India) Ltd.' concerns. These have now been sealed up as enemy concerns, and the country is suffering from an acute famine of dyestuffs and fine chemicals. This subject was anxiously examined at a meeting of the Chemical Manufacturers' Association at Calcutta in December, and at the Industrial Conference held at Mysore very recently. What is true of dyes, is also true of drugs. We import under this head goods worth 3 crores of rupees. There are many pharmaceutical concerns in the country who manufacture medicines according to the B. P. standard. They have devoted their attention more to the production of elixirs, tinctures, vaccines and sera and practically neglected the extremely important branch of chemo-therapy. A notable example of enterprise in this field is that of Sir U. N. Brahmachari whose discovery after years' of patient research of urea stibamine as an infallible specific against Kala-azar has not only made him a prince among medical men and a benefactor of millions of stricken humanity but also a prince among the business magnates.

The heavy chemical industries may be classified into four categories—acids, manures, salts and alkalis. Appropriately the production of sulphuric acid and soda is taken as indicators of industrial development in a country. The annual production of sulphuric acid in India is 30,000 tons or about .003 per cent of world production for the use of a population which forms 17 per cent of that of the world. This low production is due to lack of sulphur in this country and to the meagre development of our fertiliser industry which consumes most of this acid. Sulphur in elementary form or as pyrites are imported from Spain, America, Japan and Italy, countries which are not often very friendly to the British Empire. There is an alternative source of sulphur in the rich gypsum beds of northern India. In Germany, where the position as regards sulphur is similar to ours, intensive researches have made possible the manufacture of cement from gypsum, the sulphurous gases liberated in the process being utilised for the manufacture of sulphuric acid.

As regards hydrochloric and nitric acids, the peace requirements of India are generally supplied by the Indian factories. In the West, nitric acid is now produced by the oxidation of ammonia which again is produced synthetically. In Mysore a plant has just been installed at a cost of Rs. 22 lakhs for the synthesis of ammonia. This would yield 6000 tons of ammonium sulphate which will fertilise the sugarcane fields of the State. The success of this enterprise will be watched with keen interest by Indian technologists and it is hoped that before long big plants for the synthesis of ammonia and its conversion either into fertiliser or nitric acid will be set up in many parts of India where cheap electric power or cheap coal is available to meet the expanding requirements of these materials, under a system of well-planned economy in industry and agriculture.

We import soda ash and caustic soda worth about 1½ crores every year. These are basic chemicals which are required in textile industries and in the manufacture of soap, glass, paper etc. This is a key industry which must be developed in India. It is reported that the Imperial Chemical Industries are putting up a factory in the neighbourhood of Calcutta for the manufacture of soda ash and caustic soda, with another main plant in the Punjab near the salt and lime deposits, the lease for the working of which was granted to them a couple of years ago. The Tata Chemical Industries are also putting up a plant for

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the manufacture of soda ash at the port of Okha where there is a plentiful supply of salt and lime stone and it is surmised that the capital which will be ultimately available for organising this industry is in the neighbourhood of 3 crores of rupees.

There are other industries which offer great possibilities of expansion—the electro-chemical and electro-thermal industries. The manufacture of bleaching powder, chlorate of potash, carbide, cyanide and aluminium depends on these processes. We import aluminium worth 50 lakhs of rupees every year, bleaching powder worth 20 lakhs, carbide and potassium chlorate of equal value. It is strange that sodium cyanide for the extraction of gold worth 3 lakhs of rupees should be imported in to the Kolar gold fields, where electric power sells so cheap as $\frac{1}{8}$ of anna at Mysore. It is also unfortunate that the huge electrolytic plant at Mettur has not yet started production of chlorine and caustic soda. On the foundation of technical knowledge and cheap electric power, plants for the production of these chemicals can be put up with success; and these two pre-requisite conditions for success should not be lacking in this country.

In a running review of this kind it is not possible even to touch upon the major problems of our great manufacturing industries which are not included within the category of key industries; our textile and cement industries, whose expansion ultimately depends on improved standards of living of the people of India; our paper industry which should increase its production four times so as to be independent of foreign supply worth 4 crores of rupees; our glass and ceramic industries, whose present output is negligible compared with the value of imports worth 150 lakhs of rupees.

Plan of Development

Nor is it possible in one lecture even to touch upon the intricate problem of crop planning and marketing of agricultural produce and I cannot do better than place before you with some modification a skeleton plan of ten year development envisaged by an illustrious son of India, Sir M. Visvesvaraya. There are impatient idealists who consider that the tempo of progress in this plan is too slow. They are conservatives who take the opposite view. A plan of

this type however fulfils the need of the hour that the economic scene of India should be seen as a whole.

Schedule of Developments for a Ten-year Plan

No	Item	Units	From	To
1.	National Income (yearly)	Rs. Crores	2,500	5,000
2.	Yearly production from industries—approximate net value.	"	400	2,000
3.	Indigenous capital investments in large scale industries.	"	300	1,000
4.	Iron and Steel	Tons.	2,000,000	3,000,000
5.	Coal mines.	"	24,000,000	40,000,000
6.	Cotton mill industry			
	Spindles.	Number	10,000,000	15,000,000
	Looms.	"	200,000	300,000
7.	Automobiles to be manufactured per annum.	"	...	20,000
8.	Yearly production from agriculture—approximate net value.	Rs. Crores.	2,000	2,500
9.	Increase of cultivated area (British India only)			
	(a) Dry crop area	Million acres.	212	250
	(b) Irrigated area	"	50	60
10.	Roads.	Miles.	259,125	500,000
11.	Railways.	"	42,750	55,000
12.	Electric power plant capacity.	kW	1,000,000	2,200,000
	Electrical energy produced.	Million kW hrs.	1,800	4,000
13.	Shipping.	Tons.	271,830	1,000,000
14.	Population supported by agriculture.	Million.	200	200
15.	Population employed in organised industries.	Number.	1,500,000	10,000,000
	Population employed in all industries.	"	15,281,000	50,000,000
	Population supported in all classes of industries.	"	35,300,000	85,000,000
16.	Scholars in Universities.	"	100,000	200,000
17.	Mass literacy.	Percentage of total Population.	8	50
18.	Population under instruction.	"	5	15

We know the ends we are striving for. The National Planning Committee are very seriously considering the ways and means for achieving these ends.

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The members of the Committee are optimists who believe that if a problem is once stated very clearly, the nation is half-way towards its solution. The late Lord Rutherford used to say "If you know your problem, you have solved three fourths of it." What is then wanted is determination on the part of the Government and the people, particularly scientists, technicians and industrialists, to do the best they can to transform this land of ours into the garden which it should be where every one should be happy and prosperous. We do not understand, why, when all the world over, technicians and business experts are

triumphing over all natural obstacles, it should be said that Indian intelligence and Indian enterprise were so inadequate that they could not grapple with this problem of poverty and economic regeneration. India has a great economic future. Her population and natural resources entitle her to a front rank leadership in this field. But to fulfil this destiny, the sons of the soil must determine to utilise to the best advantage, modern science and technology, to change age-old habits of work and living, to learn to dare and pioneer. And what higher appeal can one make than this that all of us be instruments in translating these hopes into realities, instruments of devoted service to the furtherance of the prosperity of the motherland.

Colchicine

A. Bose

COLCHICINE, a plant product, has been found to be of importance in plant breeding experiments, in addition to the hormones and a few other artificially controlled agencies for conditioning the growth and reproduction of plants. The importance of colchicine treatment will be readily appreciated when it is mentioned that the production of a plant with a double set of chromosomes is one of the means by which plant-breeders obtain bigger varieties of plants with larger flowers and fruits. Such results have been obtained in a great variety of plants (datura, tobacco, marigold, snapdragon, mint, wheat, radishes, hyoscyamus etc.). The effect which colchicine has on increasing the number of chromosomes, almost at will, has been acclaimed as one of the most important genetic discoveries (Wellensiek 1939). The most general characteristic of the mutants thus is gigantism; the size of the whole plant, its leaves and flowers become

enormously increased. Equally important are the results obtained in producing fertile plants from sterile parents, and seedless fruits from fertile parents.

Dustin, Havas and Lits (1937) were the first to report the production of polyploid cells by using colchicine in roots of wheat, shallot, and tulip. In all cases colchicine affects the cytoplasm, inhibiting spindle fibre formation and normal cellular differentiation. Tetraploid, octoploid, 16-, 32-, 64-ploid cells are produced. Giant lobed nuclei with many nucleoli are formed and normal growth is inhibited.

Gavaudan and his co-workers made the important discovery that colchicine has the property of doubling the number of chromosomes in *Allium cepa* (onion). Since then various workers have confirmed this polyploidising property of colchicine in an ever increasing number of plants. The first of them was Blakeslee

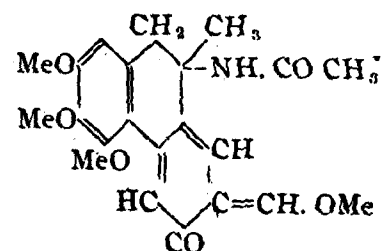
COLCHICINE

(1937), who obtained tetraploidy in *Datura stramonium* as a result of colchicine treatment. He was quickly followed by Eigsti, Nebel, Levan, Kostoff, Walker (1938), and others. Kostoff (1938) reports a tetraploid *Lactuca sativa* produced by acenaphthene.

Havas (1937) has pointed out that colchicine is not a hormone. He has suggested that it influences the activity of the hormones either increasing or antagonising their mode of action.

Colchicine is the active principle of *Colchicum autumnale*. The name of the plant (*Colchicum*) is derived from Colchis, a mythical Greek town. The plant belongs to the family *Liliaceae*. It grows in England, South Europe and Western Asia. It is popularly called meadow saffron. Another species, *Colchicum luteum*, is found in Afghanistan and Turkestan. It is a bulbous herb with radical leaves and large long tubular flowers. The flowers are of a reddish-purple tint. Ovary remains underground but within the tube of the perianth. The plant flowers in autumn.

The alkaloid colchicine $C_{22}H_{25}O_6N$ is usually extracted from the seeds of the plant *Colchicum autumnale*, these being the richest source (0.2–0.4 per cent). Its chemical structure, as given by Windaus, is as follows:



Consequently colchicine is a phenanthrene derivative.

The methods of applying colchicine to plants are many. Some of these are: the immersion of seeds, roots, or shoots in watery solutions of the alkaloid, exposing the aerial parts of the plant to colchicine

vapours created by means of an atomiser, local application on the buds by mixing colchicine with lanolin paste, dipping a slit made in the stem in a small test-tube containing the colchicine solution. Colchicine of concentration varying from .1 to 1.6 per cent is effective. The plants or plant-organs are placed in the solution for 24 to 66 hours.

In animal experiments the technique of using colchicine for cytological analysis is that developed by A. P. Dustin and his school, and is very simple. The previously treated or untreated animals are given a subcutaneous injection of colchicine (0.025 mg. per 20 gm. bodyweight for rats and mice) and are killed in 9 to 10 hours after the injection. The organs to be examined are fixed, embedded and stained, and then its cytology is studied.

Colchicine is highly poisonous to men as well as animals. Lethal doses, calculated per kilogram bodyweight, vary between 0.003 and 0.1 gm. for mice (albino) and between 0.00008 and 0.0006 gm. for man.

The successive symptoms of colchicine poisoning are as follows: sensation of burning in the oesophagus and larynx, violent abdominal pains, vomiting and choleric tendency, progressive diminution of strength and finally collapse. Death follows generally in 7 to 36 hours.

Colchicine, or the various alcoholic extracts of colchicum seeds are chiefly prescribed for acute attacks of gout. It is also effective in neuralgia and chronic headaches. Frequently the drug produces irritation causing vomiting and diarrhoea.

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The Educational Aims and Practices of the California Institute of Technology *

Robert A. Millikan

Chairman of Executive Council, California Institute of Technology

WITHIN the past forty years, thirtyone of our forty-eight American States have passed laws requiring every youth to remain in the secondary school up to the age varying between 16 and 18. As a result, today more than 66 per cent of all young Americans actually attend school up to that age. The fundamental reason for this lies in the improved economic position of the worker which alone has made this possible.

In view of this situation it has seemed to the trustees and faculty of the California Institute of Technology that the first, and perhaps the most important task of the higher educational system, which begins at the end of the secondary school period, or at what we call the twelfth grade (age 16 to 18), is to see to it that there is at that time a very careful selection, on the basis of demonstrated interest, aptitude and ability, of that eighth or tenth of the American youths who have shown in the secondary school period the greatest promise of success and effectiveness in leading the higher life of the nation in the essentially intellectual and analytical pursuits. Broadly speaking these constitute the professions such as the law, medicine, education, government, management, engineering, writing, scientific research, finance etc.

The higher educational system of the country should clearly exist primarily for the thorough training of this best eighth or tenth of the population since nothing is more cruel to the individual or more disastrous to the State, than to attempt to train youths either for jobs which do not exist, or for pursuits in which the individual in question has not the

capacity to succeed. Obviously only a small fraction of the population of any country can possibly be absorbed professionally into the higher intellectual life and responsibilities of the nation; and just as obviously too the average citizen has neither the capacity nor the desire to endure the headaches which these responsibilities entail. No one is more pathetic or miserable than the man who gets into a job in which he finds that he has not the capacity nor the training to succeed.

Having come to the conviction that the so-called universities of the United States are not yet doing either this selecting job, or the subsequent training job, as thoroughly as is desirable, the California Institute of Technology, from the inception of its organization in its present form, decided to admit by examination only, and to restrict to 160 the number of young men admitted each year from the secondary school to its freshman class. This gives it a maximum possible enrolment for its four undergraduate years of 640 men. It actually has today an undergraduate attendance of 617 men and a graduate attendance of about 300 men, nearly all of this latter group being at research of some kind. There are no women at the Institute.

Further, since its avowed aim from the start has been to train as thoroughly as possible primarily scientists and engineers capable of handling the increasing complexities of our modern scientific civilization, and since example is always and everywhere a more potent teacher than is precept, the Institute has made every possible effort to see to it that its permanent staff of about a hundred is as far as possible composed of men who are themselves productive men, each in his chosen field; for a great university has always, from the time of Plato down, been best described simply as group of masters and their pupils

*Lecture delivered before the Indian Association for the Cultivation of Science by Dr R. A. Millikan, on November 27, 1939. Published with the kind permission of the Secretary of the Association.

Liquid Helium and its Physical Properties

M. Zaki Uddin

Physics Department, Muslim University, Aligarh

S. Datta

Lecturer in Physics, Presidency College, Calcutta

In the year 1908, Kammerlingh Onnes, the celebrated Dutch Physicist announced to the world that he had succeeded in liquefying the gas helium, the last of the so-called permanent gases to be liquefied. The story of liquefaction of gases takes us back to the earlier part of the nineteenth century when Faraday first succeeded in transforming the element chlorine, normally a gas, into a liquid. Faraday had reasoned that a gas such as air or chlorine is really a very highly heated vapour even though at room temperature and since a vapour might be reduced to a liquid state by compression, it should be always possible to liquefy a gas by applying pressure. Faraday actually succeeded in liquefying many of the then known gases by mere application of high pressure but gases like oxygen, nitrogen, hydrogen and a few others defied all his efforts. These came to be known as permanent gases. After nearly half a century, oxygen was liquefied and shortly afterwards nitrogen, hydrogen and the other permanent gases succumbed to a combination of low temperature and high pressure, produced by what is known as the cascade method. Faraday had failed because he had overlooked one important fact which was first pointed out by Thomas Andrews, professor of chemistry at Belfast. Andrews showed that in the liquefaction of a gas not only the pressure but also the temperature played an essential part. Unless the temperature is below a certain critical temperature and the pressure exceeds a certain critical pressure, peculiar to the gas, one can never hope to liquefy it.

In the liquefaction of the so-called permanent gases, which takes place at extremely low temperatures, a new principle was applied to produce the cooling by the utilisation of what is known as the Joule-Thomson effect. For perfect gases Boyle's Law, $PV = \text{constant}$, and Joule's Law, $U = CT$, are valid but all ordinary gases lack perfectness due to deviation from both. If a compound gas is continuously forced at constant

pressure through a nozzle or porous plug, due to the cohesive forces between molecules (deviation from Joule's Law) during expansion the gas would become cooled. On this will be superposed the effect due to any deviation from Boyle's Law. In their porous plug experiment in case of most gases like oxygen, nitrogen, carbon dioxide etc., a cooling effect was observed but for hydrogen the experiment showed a heating effect. It was due to the fact that the deviation from Boyle's Law in this case produced a heating effect which more than balanced the cooling effect due to deviation from Joule's Law. Assuming Van der Waals' Equation of State to hold, it is found that the change in temperature produced during expansion is given by

$$\frac{\Delta\theta}{\Delta P} = \frac{1}{C_p} \left(\frac{2a}{RT} - b \right)$$

The sign of $\Delta\theta$ will depend on the initial temperature T and at a particular critical temperature known as the temperature of inversion (given by the relation $\frac{2a}{RT} - b = 0$), it will change from a cooling to a heating effect. Actually in the case of hydrogen a cooling effect was observed when the gas was initially cooled below -80°C .

Thus if any gas under pressure below its inversion temperature is allowed to expand freely through a fine nozzle it will cool down and may eventually reach a temperature at which it liquefies. By an ingenious arrangement of apparatus a quantity of gas cooled by such a process is made to lower the temperature of the incoming gas, which on expansion reaches a still lower temperature, until at last liquefaction takes place. By the application of this principle known as Regenerative Cooling, before the close of the nineteenth century all known gases were liquefied with the solitary exception of helium. Hydrogen becomes a liquid at

LIQUID HELIUM AND ITS PHYSICAL PROPERTIES

-253°C , i.e., only 20 degrees above what is called the absolute zero temperature (20°K), but a lowering of temperature through these 20 degrees presented vastly greater difficulties of attainment than was experienced in lowering the temperature by more than 200 degrees below the ordinary temperature. If Regenerative Cooling based on Joule-Kelvin expansion process is to be effective for helium, the gas must be precooled to below -253°C . In the laboratory of Prof. Kammerlingh Onnes at Leyden the long tried for goal was reached by precooling helium with the aid of liquid hydrogen cooled under reduced pressure. At a temperature of -269°C or about only 4.2 degrees above absolute zero, the first drop of liquid helium fell into the receiving flask, very similar in appearance to a common drop of water.

Liquefaction of Helium

In recent years Kapitza has developed a more efficient technique of liquefying helium by utilizing the adiabatic expansion method i.e., by making the compressed gas do external work adiabatically without losing or gaining heat. The device is in principle the same as that used in Claude's process of liquefying air by allowing engines of the reciprocating piston type. Kapitza had to overcome the difficulty caused by the absence of a suitable lubricant that would not solidify at such low temperature and he ultimately devised expansion engines which do not require any lubricant at all. The piston is loosely fitted inside the cylinder with a definite clearance so that when the gas is introduced inside the cylinder at high pressure it can escape freely through the gap between the piston and the cylinder but the piston is arranged to move so rapidly during the expansion stroke and the expansion of the gas takes place in such a short time that the amount of gas escaping through the gap is inappreciable. The gas cooled by this adiabatic expansion is allowed to cool the incoming gas and during the final stage the cooled gas is allowed to undergo Joule-Thomson expansion when it undergoes liquefaction.

The so-called permanent gases like oxygen, nitrogen etc., when liquefied, behave exactly like ordinary liquids in every way. If the temperature is made low enough they will freeze and form solids which look like snow. Each of them possesses what is called a "triple-point"; a particular pressure-temperature at which the vapour, liquid and solid phases are in equilibrium.

Kammerlingh Onnes found liquid helium to be a colourless mobile and very volatile liquid boiling at 4.22°K under atmospheric pressure. His attempts to solidify helium by boiling under reduced pressure, a method which was successful in solidifying the other permanent gases, proved abortive, the liquid remaining perfectly mobile even at the lowest temperature reached viz., 0.82°K ($0.013 \text{ mm. Hg. pressure}$). This indicated that there was little prospect of solidifying helium by further lowering the vapour pressure of the liquid, probably because helium possesses a different form of pressure-temperature diagram from that of other substances, with no triple point at which the solid, liquid and vapour can coexist. This conclusion was later confirmed by Keesom who succeeded in solidifying helium by applying high pressure to helium in the liquid state. Experiments showed that helium could be solidified at 4.2°K under a pressure of 140 atmospheres while at 1.1°K it solidified only under 23 atmospheres.

Two Kinds of Liquid Helium (I & II)

That liquid helium possesses other noteworthy and unusual physical properties was observed by Onnes who found that the density of the liquid passes through a maximum at about 2.2°K at which temperature there is a sudden change in the slope of the temperature-density curve. It was also observed that if the temperature of liquid helium was gradually reduced, remarkable changes took place in the physical properties of the liquid at a temperature of 2.19°K . Liquid helium above this temperature does not show any anomalous behaviour and there appears to be nothing extraordinary about it. But below this temperature liquid helium behaves physically as a totally different substance i.e., it is abnormally mobile, has extremely low values of viscosity and conducts heat much better than many metals. These observations led to the suggestion that liquid helium can exist in two different forms, liquid helium I above 2.19°K and liquid helium II below this temperature and following a suggestion of Ehrenfest, the transition temperature is called the 'lambda-point,' the symbol λ being often used for latent heat, which implies a transformation. It has been possible to locate this λ point within the narrow range of about 0.0002 degrees. Helium when liquefied at atmospheric pressure is of course helium I. The temperature region between the normal liquefaction point of helium and the λ point, an interval of about 2°C , is the domain of liquid helium I. The region between absolute zero and the λ point, also about 2°C , belongs to liquid helium II.

LIQUID HELIUM AND ITS PHYSICAL PROPERTIES

The peculiarities mentioned above in the properties of liquid helium predict a pressure-temperature diagram for helium very different from that of ordinary substances (Keesom, 1926, 1928). In the ordinary pressure-temperature diagram (fig. 1.) the

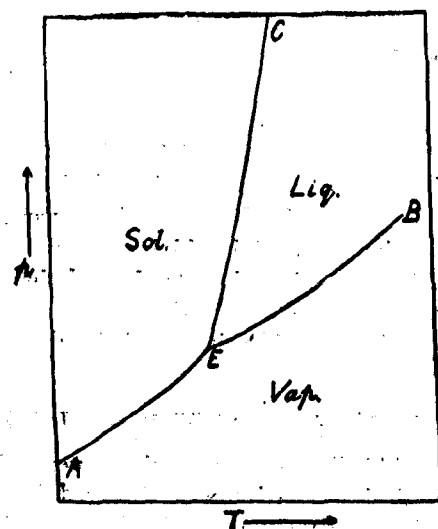


Fig. I.

vapour pressure curve of the solid (EA), that of the liquid (EB) and the melting point line of the solid (EC) meet at the triple point E, indicating that all the three states can exist together in equilibrium only under the pressure and temperature given by the point E. If the substance is in the solid state, its pressure and temperature must be that of some point in the region between EA and EC; if liquid, it must be in the region between EC and EB and if vapour, the pressure and temperature must correspond to some point below EA and EB. In the case of helium, however, solid, liquid and vapour phase cannot exist in equilibrium with each other. If a pointer is stuck into the diagram (fig. II) at the triple point λ and moved upwards in the direction of $\lambda\lambda'$ splitting the line EA of fig. I into two lines λA and $\lambda'A'$, we get a new representation of the pressure-temperature diagram of helium at low temperatures. The region $B\lambda'C$ may be labelled liquid helium I and the region $\lambda A\lambda'$ may be labelled liquid helium II. In fig. II therefore equilibrium between liquid I and vapour will be given along λB ,

between liquid I and solid along $\lambda'C$, between liquid II and vapour along λA , between liquid II and solid along $\lambda'A'$, and between liquid I and liquid II along $\lambda\lambda'$. In other words $A\lambda'C$ is the melting curve and $\lambda\lambda B$ is the vapour pressure curve. The point λ which may be called the triple point of liquid helium I, liquid helium II and helium vapour represents the λ -point. λ may be called the triple point of liquid helium I, liquid helium II and solid helium.

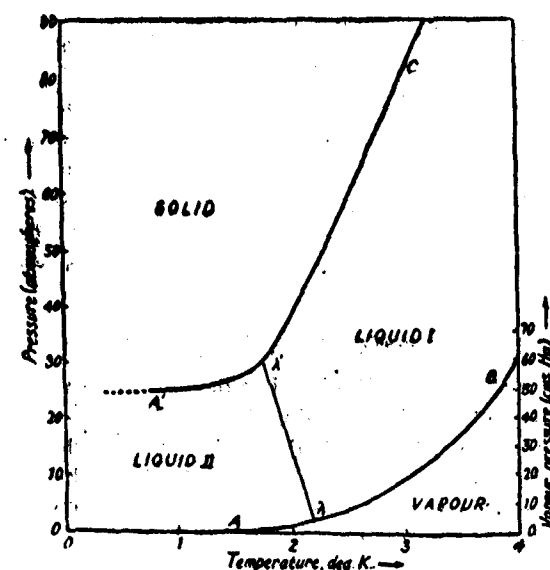


Fig. II.

As has been mentioned before, the difference of temperature between the points λ and λ' is of the order of one thousandth of a degree centigrade. From the diagram (fig. II) it is evident that within this narrow range of temperature near about the λ -point a slight change of pressure would cause a transformation of liquid He I into liquid He II. This interesting phenomenon can be actually demonstrated. Kept in a Dewar flask liquid He I continually bubbles throughout its volume like liquid air. When the temperature is about 2.19°K, a slight reduction of pressure brought about by means of exhaust pumps at once causes a change of the bubbling liquid to a perfectly quiescent liquid which is now liquid He II. The diagram (fig. II) also explains why like other substances liquid helium cannot be solidified simply by lowering the temperature, but a high pressure is necessary to bring about the solidification.

(To be Continued).

Blood Groups and their Distribution in Certain Castes in the United Provinces

D. N. Majumdar

Lucknow University

THE racial significance of blood groups has not been properly evaluated and future research in physical anthropology is expected to concentrate on blood group investigations to find out how far blood group data uphold the evidences of anthropometry. As little is known about the manner of inheritance of physical characters which submit to quantitative estimate, their relations to genic differences is largely conjectural. But blood groups as indices of racial relationship have an advantage over anthropometrical characters as they appear to be typical 'genic mutations.' The variation of the blood groups in man is a little complicated as the gene determining the character has three allelomorphs (or according to the newest data perhaps even four). The interaction of these allelomorphs produces four blood groups which are described as Groups I, II, III and IV, or more conveniently, O, A, B and AB.

The relative frequencies of the four blood groups in various samples of populations have been determined and the relative frequencies of the gene allelomorphs have been deduced from them. The frequencies of the genes A, B and O are denoted as p, q and r. These are obtained by the formulae

$$p = 1 - \sqrt{O+B}$$

$$q = 1 - \sqrt{O+A}$$

$$r = \sqrt{O}$$

In 1919, Hirtzfelds tested soldiers of many nationalities and the results of a vast number of observations have shown that all races have a high percentage of O. The American Indians are at one extreme owing to the rarity of the genes p and q, the Ainus have high values of p and q, a relatively low value of r. The gene p shows a high concentration in Europe and also in North-eastern Asia and from west to east in the Eurasiatic continent the frequency of q increases rather steadily from west to east but drops to the south where among the Australian aborigines q has a very low value (4.4 according to Tebutt and McConnell and nil according to Cleland and Burton).

The North American Indians of purest blood approach 100 p.c. O blood group and though Maisson and Schrader (1933) have discovered a high percentage of A among two related Indian tribes, Blackfeet and Bloods; this A concentration among the latter may be the result of crosses with Europeans (Gates, The Blood Groups and Other Features of the MicMac Indians, J.R.A.I., Vol. LXVIII, July-December, 1938). Gates in his article on 'Eskimo Blood Groups and Physiognomy' (Man, 1935-36) has shown that in the few cases, which could be tested, the pure Eskimo type of face went with the O group, while the Eskimos who plainly showed white and Indian admixture, (the Indian being half-bred white), had the A group. The American Indians are ranked as Xanthoderm (Mongolians) with marked Caucasian affinities. The presence of Caucasian affinities among the American Indians raise difficulties in the matter of their racial affiliation and some scholars have put them as a separate race (Blumenbach, 1775). The Australians are mainly O with A (Burton, Cleland, 1929, n, 226; O, 43.80, A, 56.2; the same authors 1930, n, 296, O, 41.6, A, 58.4). Lee and Douglas found the following percentages (n, 377, O, 60.3; A, 31.7, B, 6.4, AB, 1.6), while Tebutt and McConnell by investigating 1176 cases came to the following percentage distribution of blood groups among pure Australians; O, 52.6, A, 36.9, B, 8.5 and AB, 2.0. The A among the Maoris is high (39.5, Phillips) but much higher among the Hawaiians (60.8, Nigg). While Cleland and Burton got 56 to 58 per cent. A among the Australians, Tebutt and McConnell discovered the percentage varying from 31 to 38 only. But B is practically absent among the Australians as well as the Maoris and the Hawaiians. The A in Australia and Oceania appears to be comparatively higher than in N. W. Europe and equally that of the Armenians who have the highest A in the Old World. A is found in Europe but the distribution of A is such that A cannot be taken as a racial trait of the white race. The Nordics are less rich in A than the Alpine or the Mediterranean.

Among primitive peoples B is not very high. The Bantus have 19.2 p.c. B (Pyper, 1930); American

BLOOD GROUPS AND THEIR DISTRIBUTION IN CERTAIN CASTES IN THE UNITED PROVINCES

Negroes, 20 (Snyder); Solomon islands, 16.8 (Howells, 1933); Papuans, 13.2 (Bylmer, 1932), Fiji, 9.4, (Howells, 1933); Samoa, 13.7 (Nigg); Paniyans, 7.6 (Aiyappan); and the pre-Dravidian tribes of Madras, 9.0 (MacFarlane). Some of the aboriginal tribes of eastern India show a high percentage of B distribution and as these tribes do not seem to have maintained their purity of stock, it is difficult to say how far the B concentration among these tribes is due to B mutation in these parts. Recent investigations of Sarkar on 'Male' blood grouping shows how the 'Male' differs from the 'plains Male' though ethnically there is little difference between them. For example, 'Male' shows 42.13 p.c. O, 25.53 p.c. A, 26.81 p.c. B and 5.53 p.c. AB while 'plains Male' give the following percentage, O, 29.41; A, 8.82; B, 50.0; AB, 11.76. Turning to Hirzfelds' data, we find that the highest percentage of B is found among the Indian troops. The high B percentage extends from India to Korea as suggested by Snyder in establishing his Indo-Manchurian group. According to Hirzfelds (1918), the Hindus have 41.2 p.c. B, the North Chinese (Liu, Wang, 1920) have 34.2, Kirghiz (Libman) 37.8, Uzbek (Belkina), 29.1 and Buriats (Melkich) have 37.5.

Hirzfelds data on the Hindus do not give any definite idea about blood grouping in India as the samples from which the data were collected consisted of the Gurkhas, the Gharwalis, the Jats, the Kumaonis and the Rajputs. As pointed out by Dr Eileen MacFarlane in a recent article (*Journal of Genetics*, Vol. XXXVI, No. 2, pp. 225-237, 1938), these are of little value anthropologically because of the heterogeneity of the samples. Although Hirzfelds' estimate of B percentage among the Hindus may not be accurate, as appears from the recent blood group data for India, there is no doubt that India has a high percentage of B. The Todas of the Nilgiri Hills (Pandit, 1934) show 38 p.c. B; Pathans (Malone and Lahiri) 30.0; Marhatas (Correia, 1934), 34.0; Jats (Malone and Lahiri) 35.5; Hindus of the U. P. (Malone and Lahiri) 37.2; Dravidians of Chota Nagpur (Malone and Lahiri) 36.8; Bengal Depressed Classes (MacFarlane) 42.7; Bengal Mahomedans (MacFarlane) 40.0. Thus B is highest in India and decreases in all directions (H. J. T. Bijlmar, *The Relation of Blood Groups to Race*, J.R.A.I., Vol. LXV, pp. 124-125, January-June, 1935).

To the west of India, B decreases till it reaches its lowest incidence. B dwindles into insignificance in the south west of Arabia and Africa. The predominance of B in India and Mongolia inhabited by different racial stocks is not easy to explain. It appears however that India had great influence in the dispersion of B, it spread to Africa through western Asia and eastward to the Malay Archipelago and further east. The absence of B among Australians, American Indians and pure Polynesians shows perhaps radiation from these areas to India and not the other way. According to Howells (1933), 'B spread from Central Asia and India through Indonesia to the Phillipines along with Hindu influence as late as the first millenium A.D. and filtrated into Europe and still later with oriental trade.' The decrease of B from central Asia to west Europe is interesting because Hindusthan, where B is highest, is believed to be inhabited by Aryan-speaking races or branches of the white race.

Japan and China have a high percentage of A. Of 29,480 subjects investigated in Japan (Steffan, Wellisch and Mivaiu, 1927) 30.0 p.c. show O; 38 p.c. A; 22 p.c. B and 10 p.c. AB. The south China figures are practically similar, viz., 32 p.c. O; 39 p.c. A; 19 p.c. B and 10 p.c. AB. The Negritos, the Melanesians and the Negroes, both western and oriental, possess a low value of A and a conspicuously less but a comparatively high amount of B and a high percentage of O. The Papuans and the Fijians have high values of A as well as O while the proportion of B among them is extremely low. Thus A is found not only among the whites but also among the dark races. Although B is found very high in India and Mongolia, its presence among the yellow, white and dark races proves that the blood groups could not be identified to the racial types. But it must be admitted that we have not yet sufficient data about the blood group distribution among the intermediate groups and when the data will be available, it may be possible to find out the relationships between blood groups and ethnic types. We know that long head and tall stature are not characteristics of the Nordics alone, they are found also among other races, including the Negroes. If the blood groups are taken along with other racial characteristics and if sufficient data on the distribution of blood groups are forthcoming it may be possible to classify races and account for their dispersion.

Dr Ruggles Gates has attempted an explanation of the distribution of blood groups on the hypothesis of mutations. 'The Blood Groups,' writes Dr Gates, 'appear to be typical gene mutations and as such must

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follow the general law of mutations.' The use of the blood group, he argues, in connection with racial differentiations and relationship must then be based upon the theory of mutations. Dr Gates thinks that the blood groups are probably entirely non-adaptive in nature and as such the rate of spread of the A and B will depend entirely on their mutation frequency. He points out that 'the B mutation seem to have begun to appear at a much later period than the A, and A is therefore spread much more widely through the primitive races surviving to the present time.' On this assumption, Dr Gates suggests that the A blood group arose through a O race of men in a particular locality developing the ability to produce the A mutation with a sufficient frequency for it to spread without the aid of selection. Regarding the priority of the origin of A, Gates argues that since various primitive and outlying peoples have A with little or no B, the A must have arisen much earlier in human evolution than B.

Dr Gates thinks that the B mutation has never appeared in such peoples as the Australian aborigines, the Bushmen of south Africa and the Basques of Europe who have a high percentage of A, while their very low percentage of B has probably come in through crossing. The Panyans of the Wynaad Plateau which show 62.4 p.c. of A gives support to Dr Gates' hypothesis regarding the relationship of these pre-Dravidians to the Australian aborigines. But the data on blood groups of the Jews and of low castes in Cochin (MacFarlane) show 62 p.c. A among the White Jews, 50 p.c. B among the Brown Jews and 73.6 p.c. O among the Black Jews. The Bengali depressed castes who belong evidently to the pre-Dravidian or the aboriginal stock and the Bengal Mahomedans who also have indigenous origin, show a high percentage of B. Dr MacFarlane finds the amounts of O and B to vary inversely and she thinks that there may be genes for O in these low caste people with a relatively high mutation rate for B. The high percentage of O among the Brahmins and the Kayasthas of Bengal (43.0) and the increase of percentages of A and B from the higher to the lower castes do not fit in with known racial data, for if B mutation has never appeared in such people as the Australian aborigines and the Bushmen of south Africa, it is difficult to explain why the B mutation has been so frequent among the lower strata of the Hindu society, or among

the primitive tribes of Chota Nagpur Plateau (36.8 B). Even if we admit that mutations are seldom alike, the incidence of B mutations and their distribution will provide interesting material for reconstructing the history of human dispersal.

Recently in connection with an anthropometric survey of tribes and castes in the United Provinces, I have done some agglutinin tests. Below I give the data on 175 subjects belonging to three castes, viz., Kayasthas (47n), Chamar (92n) and Khatri (36n). I propose to correlate serological tests with physical measurements on the people and as such the work is proceeding very slowly, but the data on these tests may be published without prejudice to the work in progress.

I am indebted to Dr G. L. Taylor of the Galton Laboratory, University College, London from whom I had my initiation in this work. The test sera of groups A and B were made at Lucknow and standardised with test sera supplied to me by the Haffkine Institute, Bombay for agglutinin test at Lucknow. The agglutinin tests were done by the titration method. The author's own blood which is B and that of a medical practitioner who is A were used as control and also as check on the potency of the test sera.

Name of the Caste and Number in Bracket.	Percentages in Group				Frequencies		
	O	A	B	AB	p	q	r
Kayasthas (47)	41.4	19.7	30.6	8.3	15.1	21.8	64.3
Khatri (36)	36.5	21.8	35.0	6.7	15.4	23.6	60.4
Chamars (92)	38.3	13.3	38.3	10.0	12.5	26.8	61.8

The total number studied is only 175 which cannot be taken as very representative but when we compare the data with those available for castes and tribes in other parts of India, they give us some indication about the nature of the material we have at our disposal. Malone and Lahiri have given the blood group data of 2,357 Hindus of the U. P. This is a heterogeneous lot as the various castes have been lumped together under one denomination. The results are, O (30.2); A (24.5); B (37.2) and AB (8.1). If my 175 subjects are similarly lumped together, the results would be, O (38.73); A (18.26); B (34.63) and AB (8.33). The blood groups of the Khatri of the Punjab and Kashmir investigated by Malone and Lahiri give the following percentages O (33.3); A (25.3); B (30.3); AB (11.1). Compared to this, the Khatri of U. P. have less A, more O, more B and nearly half AB. The Bengal data (MacFarlane) show that the percentages of A and B increase from the higher to lower castes and that the highest percent-

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ages of O is among the caste Hindus. The increase of B among the Khatri of U. P. is perhaps due to a greater admixture of the Khatri with other groups racially inferior to them. The Chamars possess a high percentage of B and O. All non-caste Hindus of Bengal (MacFarlane) have 30.9 p.c. O, but the Chamars of these Provinces have 38.3 p.c. while the Kayasthas have 41.4 O. On the results of this investigation it is premature to hazard any hypothesis and I should think that until we have more data on the blood group distribution in India the significance of blood groups as racial traits cannot be properly evaluated.

Dr MacFarlane has done well in treating the castes separately for castes are endogamous groups and they have remained so for ages. The large number of data we have on India, thanks to the investigators already in the field, should be used as checks but new data on blood groups will be invaluable as aid to racial classification in India.

If O indicates the degree of isolation, the still large percentage of O in India (43.0 p.c.) among the Brahmins and Kayasthas of Bengal (MacFarlane) and

41.4 p.c. among the Kayasthas of the U. P. (Majumdar) compared to 45 p.c. among the Americans (Snyder), 46.4 p.c. among the English (Hirzfelds), 37.3 p.c. in Germany (Gündel) indicate a racial affiliation with the various branches of the white race. If on the other hand, as pointed out by Dr MacFarlane, there may be genes for O in the low caste people with a relatively high mutation rate for B, the decrease among the higher castes of A which is higher among the European races and a high value of B suggest a racial admixture and the more we know of blood groups the greater would be the possibility of determining the extent of this admixture in the castes and tribes.

It will not be out of place to mention a fact of great sociological significance, namely, the relationship between the Kayasthas of the United Provinces and those of Bengal in blood group frequencies. Choudhury (1936) investigated the blood groups of 154 Bengali Kayasthas of lower Bengal and found the following percentage grouping: O, 38.9; A, 20.8; B, 32.5; AB, 7.8. This compares favourably with the data I have collected on the Kayasthas of the U. P. which are O, 41.4; A, 19.7; B, 30.6 and AB 8.3. It appears therefore that the popular belief that the Kayasthas of Bengal are ethnically different from those of the U. P. is not supported by blood group tests.

Calcutta University College of Science

PREPARATIONS are under way to celebrate the Silver Jubilee of the Calcutta University College of Science on a scale befitting the unique position which the college holds in the field of scientific research and education in this country. The University, it is understood, have appointed Prof. M. N. Saha, Prof. B. C. Guha and Prof. K. P. Chattopadhyay to act as secretaries for organising the celebration.

It is expected that the celebrations will be held for a week after the Pujah vacation this year. Eminent scientific men of the country, public men, political and industrial leaders and ex-students of the College will be invited on the occasion and symposia, popular lectures, demonstrations, exhibitions and socials will be organised.

The Jubilee Committee also contemplate issuing a history of the work done at the College since its foundation, its schemes of development and the funds

which will be required to give effect to the proposed schemes of development. They expect that the ex-students of the College, many of whom occupy responsible positions in life, the Government of Bengal, the industrialists and financiers of the country will nobly respond to the appeal to be issued on behalf of the college and emulate the examples set up by Sir Tarak Nath Palit, Sir Rash Behari Ghosh, late Kumar Guru Prasanna Sinha of Khaira and Acharya Sir P. C. Ray in founding the College and helping in its development from stage to stage.

The University College of Science, it may be recalled, completed last year the 25th year of its existence. The foundation stone was laid by the late Sir Asutosh Mookerjee on March 27, 1914, though the actual work started on account of the outbreak of the last Great War two years later in 1916.

It was the vision and energy of the late Sir Asutosh Mookerjee which led to the development of post-

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graduate studies and research in Calcutta University long before teaching and research were recognised as legitimate and obligatory functions of the Indian universities as a result of the Sadler Commission Report of 1921. The establishment of the University College of Science in 1914 was a sequel to the far-reaching plans of Sir Asutosh. The foundation of the college was rendered possible by the princely munificence of two eminent Bengalees, the late Sir Rash Behari Ghosh and the late Sir Tarak Nath Palit whose donations amounted to nearly Rs. 40 and Rs. 30 lakhs respectively. They practically gave their life's savings to the cause of higher scientific teaching and original research in pure and industrial science which they thought would bring about not only a better cultural level but would also help the industrial development of the country. About four years later, the funds of the College for scientific teaching and research were augmented by the donations from the late Kumar Guru Prasanna Sinha of Khaira.

It is well known that the foundation of the University College of Science led to the unprecedented development of original scientific research in this country. One need only mention the names of Archarya Sir P. C. Ray Sir C. V. Raman, Prof. M. N. Saha, Prof. J. C. Ghosh who have been connected with the College during a considerable period of their careers. It is claimed as the nursery of scientific and industrial research workers who have gone to all parts of India and have given the best of their labour and knowledge for the development of scientific teaching and research in their respective spheres as teachers of science, as scientific workers in Government departments and as scientists in industries.

The last Great War of 1914 brought home to the politicians of all parts of the world the fact that organised science held out a great future for the development of the resources of a country, and soon after the war every civilised country organised its scientific workers for planned schemes of research in all directions. The British Government has been spending since 1925 over a million pounds annually in supplementing the research grants of scientific workers in the universities alone. Many new laboratories affecting the defence and industrial prosperity of the country have been opened, such as the research laboratories of the Admiralty and Air Ministry, the

National Physical Laboratory, the Chemical Research Laboratory, the Fuel Research Station, etc., to which generous citizens have unstrung their purses for the benefit of science. One might mention the magnificent gift of a quarter million pounds by Henry Austin to the Cavendish Laboratory of Cambridge and the gifts of Lord Nuffield to the Oxford University amounting to several million pounds. The amount of money spent in research in England is several millions of pounds which is, however, less than the amount spent in America which is calculated to be about 30 million dollars yearly.

Unfortunately, it is pointed out, for this country research and higher teaching in science have not received the amount of encouragement expected from the public or the State. Bengal has not been fortunate in this respect. In the other provinces due to the educational reforms recommended by the Sadler Commission, post graduate teaching departments in science have been added, and the State is spending a large amount of money from its own coffers, and any early lead which Bengal might have enjoyed, due to the prophetic vision of Sir Asutosh Mookerjee, has disappeared. In the United Provinces of Agra and Oudh, which is the twin sister of Bengal in population and provincial income, the annual expenditure on the science departments of the Universities of Lucknow and Allahabad (excluding medicine) has amounted to about Rs. 8,00,000 per year and within the last 20 years the U. P. Government have spent more than a crore and a half for scientific education and research. The task of financing the higher scientific research and teaching side of universities is primarily the function of the Government, but unfortunately the Bengal Government has done relatively very little in discharging its obligations in this respect. The work in the College has been mainly done with the aid of endowments given by Ghosh, Palit and Khaira.

Within the last 25 years, it is also pointed out, public has not responded to the needs of the College either with the solitary exception of Sir P. C. Ray who handed over his salary of 15 years to the University for the furtherance of scientific research.

In view of the changed world conditions, the College of Science needs a thorough reorganisation if it is to increase its usefulness to the nation. It is to add new departments of research, to have well-equipped libraries, scientific and industrial museums and is to organise a scheme of industrial research by endowment of fellowship.

Results of Experiments on Reviving Organisms Found in Eternal Frost *

P. Kapterev

I HAVE succeeded in reviving spores of embryos of certain organisms which retained their vitality in eternal frost in course of my work at the Skovorodino Scientific Station for the Study of Eternal Frost during the years 1934-1936. This station is located on the Amur Railway. Among the revived organisms were bacteria, fungi, more than 50 algae, one type of moss and one species of the lower crustacea. The age of the revived organisms was ascertained to range from 1,000 to 3,000 years. It was next decided to undertake the revival of some older organisms whose age would be calculated by the tens of thousands of years. With this end in view the Committee for the Study of Eternal Frost of the Academy of Sciences of the USSR sent a small expedition to eastern Siberia to the Bodaibo district on the Vitima river, where, according to available information, layers of silt or peat of a corresponding age could be found in eternally frozen grounds.

After long search we found such layers near the Svetly goldfield on the Zhuya River which is part of the Olekma River basin (220 kilometres north-east of Bodaibo). The total thickness of the quaternary alluvium reaches 150 metres, and the eternally frozen ground runs to 94 metres. During the summer, the ground thaws only 30 to 40 centimetres below the moss cover. There are, however, sections where there is no frozen ground at all, this is probably due to the presence of shifting ground waters. Buried under the alluvium are ancient terraces and beds of rivers and here in spots we found layers of silt with preserved remnants of vegetation. Samples for tests were taken from these layers from mines and drifts at different depths running up to 41 metres. Layers of sand of various thickness range in a certain order; there was sand and gravel, silt sand and sand with clay and large boulders. Of special interest was one spot on

*Expedition of Academy of Sciences to Eastern Siberia in 1937.

the Malaya Tunguska River, where part of the steep bank to a height of 18 metres has crumbled away uncovering a frozen wall composed of horizontal alluvial layers. At a height of 9 metres above the present level of the river we found a silt layer with remnants of vegetation. It had thawed only 3 to 4 centimetres and after cutting the thawed part we were able to take samples of untouched eternally frozen silt.

Another group of samples was taken from a terrace covered with alluvium on the left bank of the Bolshaya Tunguska river near the point where it flows into the Zhuya river. The thickness of the alluvium here reaches only 8 to 9 metres. At a depth of 3 to 3.5 metres we found a layer of frozen peat with considerable remnants of vegetation, among which there were pieces of birch with excellently preserved white bark. The eternal frozen ground begins directly under the thick moss cover at a depth of 30 to 40 centimetres. The entrance into the hole which we dug to obtain the samples was 12 metres above the present level of the river. The distance to the river level is 200 metres. Near the hole we found stumps of larches 150 to 160 years old and lower down, near the river, stumps of 250 to 400 years. Evidently there were no important changes in the river bed during this time.

Samples of the eternally frozen ground were kept in three ways: they were dried and kept in small chunks, samples in a frozen stage were bottled up in sterilized glass jars and also samples after thawing in sterilized jars were kept in pasteurized or distilled water. Micro-biologists, botanists and geologists worked with these samples in Moscow. Dr Krasilnikov has tested the cultures of soil bacteria, fungi and actinomycetes by recreating their natural surroundings with samples of soil at the Institute of Microbiology of the Academy of Sciences of the

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USSR. Prof. K. I. Meyer of the Moscow State University has studied the algae. Almost all of them were of the *Vulgaris* form (see table I).

TABLE I

Surface Layers

(District of Bodaibo, 20 kilometres to the north of Bodaibo. Moss from a hillock)

Revived Micro-organisms: *Mycobacterium brevicale*, *Bacillus roseus*, *Pseudomonas fluorescens*, *Actinomyces sterilis*, *Bacillus mycoides* (non-typical), *Azotobacter* sp.

(Goldfield Svetly. Frozen peat layer directly under the moss cover. Depth 20 to 30 centimetres)

B. megatherium, *Achromobacter litoralis*.

Eternally Frozen Ground

(From a depth of 3.5 metres at the younger terrace on the left bank of the Bolshaya Tunguska river in the district of the Svetly goldfield)

Achromobacter lipoliticum, *Achromobacter liquefaciens*. ALGAE: *Chlorella vulgaris* (considerable quantity), *Stichococcus bacillaris* (little), *Pinnularia microstauron* (Ehr.) Cl. f. *diminutum* Grun. (single species).

(From samples taken at a depth of up to 40 meters in the older layers of terraces covered with alluvium near the Svetly goldfield).

Mycobacterium album, *Micrococcus candicans*, *Achromobacter liquefaciens*, *Mycobacterium citreum*, *Saccharina citrea*, ALGAE: *Stichococcus bacillaris* (Scarce), *Chlorella vulgaris*, *Navicula atomus* Narg. (rather large quantity) *Nitzschia* sp. (much).

Another set of samples was taken near the Station at Skovorodino on the Amur Railway. The station is located in the valley of the Bolshoi Never river, a tributary of the Amur. This valley is about three kilometres wide at this point and slopes lightly to the north. The layer of alluvium is about 20 metres thick at the point where we took the samples. Argillaceous soil predominated in the alluvium in which at times there were seams of dark coloured silt with remnants of vegetation and layers of frozen peat. In certain parts there was ice up to three metres thick.

TABLE II

(From the surface at Skovorodino)

Bacillus silvaticus, *Achromobacter candicans*, *Bacillus subtilis*, *Bacillus pabuli*, *Bacillus roseus*.

(From thawing ground at a depth of 50 centimetres at Skovorodino)

Micrococcus candicans, *Micrococcus ruber*, *Microbacterium brevicale*, *Azotobacter* sp., ALGAE: *Pinnularia microstauron* Ehr., Cl. f. *diminutum* Grun. *Stichococcus bacillaris* (single species).

(From a depth of one meter).

Achromobacter liquefaciens, *Micrococcus candicans*, *Azotobacter* sp., ALGAE: *Stichococcus bacillaris* (very common), *Chlorella vulgaris*.

(From a depth of 1.9 metres).

Achromobacter liquefaciens, *Micrococcus candicans*, *Mycobacterium filiforme*, *Actinomyces albus*,

ALGAE: *Stichococcus bacillaris* (very common), *Chlorella vulgaris* (scarce), *Pinnularia microstauron* Ehr., cl. f. *diminutum* Grun.

(At a depth of 3.4 meters in frozen ground at Skovorodino).

Achromobacter liquefaciens, *Microbacterium album*, *Flavobacterium* sp., *Micrococcus citreus*, *Torula rosea*, *Azotobacter* sp., *Mycobacterium lactis*, *Mycobacterium globiforme*, *Mycobacterium hyalinum* (very scarce), *Mycobacterium citreum*, *Bacillus cereus*, ALGAE: *Stichococcus bacillaris*.

Azotobacter and a large quantity of *Triphoderma* fungi were found in a layer at a depth of 4.6 meters.

(From a depth of 6.5 to 7 meters in a layer with ice).

Micobacterium albane, *Micobacterium filiforme*, *Actinomyces chromogenes*, *Actinomyces sterilis*, *Azotobacter* sp.

It should be pointed out that the vertical distribution of micro-organisms is uneven and at times a greater number was obtained from samples taken at a great depth than from those taken close to the

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surface. Particularly significant is the fact that the distribution by species in different layers also varies greatly. If all our samples had become infected subsequently to their collections, this would not have been the case. This however does not eliminate the question whether the samples and the cultures have not been infected with modern micro-organisms.

It is very difficult to guard against this danger of infection not only under conditions of an expedition working in the field but also in a laboratory. That is the reason why it would be risky to consider all the enumerated organisms as having been revived from eternally frozen ground. Some of them, notwithstanding all precautions, could have penetrated from the outside. This, however, does not apply to all the organisms. To begin with, there is the presence of different micro-organisms in different layers. The considerable number of species and their variety is in itself proof of the fact that infection could not have taken place on a considerable scale. Particularly important is the presence of *Azotobacter* Sp. at different depths in as many as twelve samples. It is well known that the *Azotobacter* is not transmitted through the air and hence the chances of infection are the least. *Azotobacter* has been found both in samples taken from the surface and at the greatest depth, that of 40 metres.

TABLE III

Content of Azotobacteria in the soil.

Location.	Number of Azotobacter cells.
Calculated per one gram of soil from cultures on gel slides	
1. Dogaldyn Springs, 20 km. north of Bodaibo. Surface moss in the taiga ...	20
2. Same location, under the cover of moss on the soil surface ...	400
3. Svetly goldfield. Sample from peat layer at a depth of 5 metres on the left bank of the Bolshaya Tunguska river ...	200
4. Svetly goldfield, 21 meter depth, sandy silt	600
5. Svetly goldfield, depth 40 meters terrace covered with alluvium, sandy silt ...	500

6. Skovorodino Amur Railway silty layer at a depth of 50 cm. ...	600
7. Skovorodino, silty layer at a depth of one metre. ...	600
8-9. Skovorodino, sample taken from hole on ground of station at a depth of 3.4 metres (eternal frost). Two samples gave identical results ...	400
10-11. Skovorodino frozen peat at a depth of 4.6 metres. Two samples gave identical results ...	600
12. Skovorodino, depth of 7 metres, ice with argillaceous soil ...	400

Almost all the revived organisms are of the types well known from the temperate zone. Special mention should be made, however, of the *Nizchia* algae found in the sample from Malaya Tunguska river. As regards its type, it resembles the *Nizchia Vermicularis* but differs in size: it is 34-35 μ long, 2 μ in diameter and the number of hatches runs to 15-16 in 10 μ . The *Azotobacter* found in the eternally frozen ground differs greatly from the known types. For their morphological properties they cannot be classified either with the *Azotobacter vinelandi* or *Azotobacter agile*. Moreover certain cultural and morphological symptoms sharply distinguish them from the common type of *Azotobacter*.

The preponderance of the *vulgaris* forms can be explained by the fact that these are the most vital and resisting to unfavourable conditions. Particularly is this true of algae, of which many were revived but perished under the field conditions of the expedition, having been forced out, to a considerable extent, by the *vulgaris* types and mould fungi. That is why the living organisms which we could bring to Moscow, should be considered only as a small part of the micro-flora preserved in eternal frost.

Of utmost importance was the problem of determining the age of the layers where the revived organisms were found. This work was facilitated by the finding of bones of the mammoth (*Elephas primigenius*), the hairy rhinoceros (*Rhinoceros antiquitatis*), bison (*Bison priscus* var.), deer (*Cervus* Ex. gr. *elaphus*) and the sheep-oxen (*Ovibos moschatus*). The last find represents a new geographic point of the life-zone of this animal. Most of the bones were found in terraces covered with an alluvium at a depth of 30 to 40 meters in direct proximity of the original strata. Prof. V. I. Gromov of the Geology Institute of the Academy of Sciences of the USSR who defined

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the age of the animals, judging by their state, considers them to be of the same age as the alluvium where they were found. The oldest samples have been taken by us from the same strata. Prof. Gromov considers that these bones relate to the recent quaternary period. He directs attention to the fact that the bones of the mammoth are mostly of the smaller species which existed during the last Wurm glacial age. Comparing all the geologic data in the Bodaibo district, we can date back the oldest of the revived organisms to the time of the Wurm glacial age, though it is

difficult to synchronize the east-Siberian quaternary strata with those of Europe. No exact chronology is, of course possible, but it may be considered that these organisms have retained their vitality in eternally frozen ground for no less than 20,000 years. The Skovorodino layers are considerably younger but their age judging by the five layers of peat can also be counted in the thousands of years. An analysis of the pollen of plants made by V. P. Grichuk (Geography Institute of the Academy of Sciences of the USSR) has shown the preponderance of mosses, Lycopodium and grass vegetation. Evidently there the land was not overgrown with forests at that time. No pollen of larch, the tree most common in the east-Siberian taiga at present, has been found.

Theory of Generalized Relativity on Trial

In two articles published in SCIENCE AND CULTURE,* Sir S. M. Sulaiman gave a critical account of the fundamental assumptions on which Einstein's Theory of Generalized Relativity is based, and examined critically the astronomical observations which have been made to verify the predictions of the theory. He showed conclusively that none of the previous observations on any three of the tests of the Generalized Theory viz., (i) the shift of solar lines to the red, (ii) the deflection of light in the gravitational field of the sun, and (iii) motion of perihelion of mercury, can be regarded as conclusive. He therefore cautioned the readers of SCIENCE AND CULTURE against a hasty assumption that the theory has been verified.

Sir S. M. Sulaiman has since given, in a number of papers published in the *Proceedings of the National Academy of Sciences, India*, an alternative theory of the three effects in which no revolutionary concept of space or time is needed. According to Sulaiman, the gravitational deflection is not 1.76", which is twice that required on the Newtonian Theory, but may be as great as 8/3 times the value i.e., about 2.40" sec. He pointed out that the prediction ought to be tested in the future eclipse expeditions.

A total solar eclipse occurred in June 19, 1936 and passed over Europe and Siberia. Expeditions were organised by American and Russian Astronomers. Prof. A. Michailov of the Polhova observatory has just an-

*Vol. I, p. 444 and Vol. II, p. 343.

nounced his results, after a careful measurement of the plates, and finds that his results rather confirm the Sulaiman Theory. The letter to Sir S. M. Sulaiman is quoted in full:—

Moscow, 11 December, 1939.

Many thanks for the reprints just received. At last I am able to give the definitive results for the deflection of light observed by me during the solar eclipse of June 19, 1936. You were right in cautioning that the terms of second order can be of influence in the reduction of the plates. One of the plates showed indeed the effect of a tilt, which had to be eliminated by introducing second order terms. Moreover an arithmetical error was detected in the preliminary result, that I quoted to you in my last letter. Now I obtained the following values.

Two of the eclipse plates were measured twice with different comparison plates.

Eclipse plate No.	Comparison plate No.	Deflection
2	5	2.44
2	6	2.42
4	5	2.85
4	6	2.72
Mean		2.72

Of course the result is rather poor, as the nearest star to the Sun's limb that could be measured was 31' from the centre of the sun. In all only 25 stars could be measured. I must state, that your anticipation that a value much larger than Einstein's is to be expected gives me more confidence in publishing my results. In a short time a full account of the work shall go to press.

Yours faithfully,
A. Michailov.

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Royal Asiatic Society of Bengal

THE annual general meeting of the Royal Asiatic Society of Bengal was held on the 6th February last at 1, Park Street, Calcutta, under the presidentship of the patron of the Society, His Excellency Sir John Herbert, Governor of Bengal. The retiring president Sir David Ezra handed over his charge to the Hon'ble Justice Sir John Lort-Williams, who has been elected the president for this year. In his address, Sir David Ezra referred to the resignation of Mr Johan Van Manen who had been secretary for over 17 years, and to the work of the special enquiry committee. According to him there has been a marked improvement in the activities of the Society both in regard to quality and quantity during the latter half of the last year, after the recommendations of the special committee for proper reorganisation of the activities of the Society had been put to practice. The recommendations included that the post of the general secretary should be strictly honorary, and work of the society should be carried on under the guidance of the general secretary by two assistant secretaries, one looking after routine office administration and the other after the cultural activities of the Society. Owing to financial stringency only the first post has been filled up by Mr J. B. Seal. The procedure laid down for dealing with materials for publication has been modified and intending authors may be assured that their work would henceforth be adequately and impartially referred and published quite expeditiously. The secretary, Dr B. S. Guha, pointed out that the number of publications issued last year formed a record in the annals of the Society as a large number of publications which were lying in the press for years have been completed, due to the efforts put by the new organisation, particularly to the unfailing help given by Dr Bani Prasad. The Society has also undertaken the preparation of comprehensive catalogues, which on completion would give the reader access to all the library possessions. Last year the Society was fortunate in being able to add to its possessions two objects of unusual historical interest. One is the original letter of James Prinsep, in which he announced the epoch making discovery of the name of Antiochus the Great, the Selucid monarch of Babylon in the Asoka Inscription at Girnar to Dr W. H. Mills, who was a vice-president

of the Society from 1833-37. The other is the Bhowal copper plate, issued by the last Hindu Emperor of Eastern India, Lakshman Sena, originally a possession of the Society, which has been brought back by Sir John Herbert, from the India Office, London, where it found its way and lay undiscovered for nearly a century.

Referring to the financial position of the Society the secretary, Dr Guha, pointed out that the income from the investment was insufficient and attempt must be made to increase the permanent reserve. Sufficient available funds would enable the Society to expand their activities in a fuller measure. The Society possesses unique collections of oriental manuscripts, Sanskrit, Pali, as well as Arabic and Persian, and paintings and pictures, which require special protection in the humid atmosphere of Calcutta. The Society intends to preserve these in air-conditioned rooms, but finds difficulty in getting the necessary funds. A look at the annual report at once convinces that the much-needed reorganisation of the Society, effected along the lines suggested by the special committee set up last year, has introduced a new life into the activities of the Society and shows promise of further expansion of its activities. The Royal Asiatic Society of Bengal, in virtue of its past activities and achievements, holds a unique position in the cultural world of the East. Let us hope that this proud heritage will be zealously maintained and the present and future activities of the Society will go to enhance its prestige.

Lac Research in India and London

PRODUCTION of lac, of which India is the largest producer in the world, rose from 12,64,875 maunds in 1937-38 to 14,65,000 maunds, according to the Annual Report of the Indian Lac Cess Committee for 1938-39. Owing to the depressed state of the industry, however the total lac exports fell from 8,75,802 maunds in 1937-38 to 8,46,264 maunds, and prices of shellac reached the record low level of Rs. 11-8 per maund. Seedlac accounted for 30 per cent of all lac exports and shellac for 60 per cent. The bulk of the seedlac went to the United States of America which together with the British Empire took, as usual, the larger part of the exports. Russia is another large consumer.

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New uses for lac products have been discovered by research and this opened the way to fresh markets. The Indian Lac Cess Committee has two research organisations, the Indian Lac Research Institute, Namkum and the Shellac Research Bureau, London. The Committee has also been making grants for co-operative research in England and America. A Marketing Officer of the Committee in London stimulates the demand for lac and lac products in Europe and America and acts as liaison officer between the customers and the Indian Lac Research Institute. The London Shellac Research Bureau has discovered a cheap method of preparing hard lac resin superior in properties to that manufactured by other processes and has developed a lac oil-varnish, the products of which are being used commercially on a considerable scale. They are likely to be used for metallic paints, for water-proofing silk used in water-proof and anti-gas clothing and in "Camouflage" paint work. An experiment on the hot spraying of lac which was undertaken in October 1937 was brought to a successful conclusion and several commercial firms showed interest in its development. The Research Association of British Rubber Manufacturers recorded satisfactory progress in shellac-rubber combinations. The scheme of co-operative research entrusted to the Metropolitan-Vickers Electrical Company, Limited, was carried out successfully in jute-shellac laminated boards, high temperature shellac mouldings and the use of shellac in laminated materials by the hot-spraying process. In America a method for de-waxing lac without affecting its thermal properties has been developed. In the Indian Lac Research Institute success was attained in the preparation of a moulding powder with shellac as the base by condensing it with formaldehyde and urea. Moulding with this modified powder can be made as quickly as with bakelite powders and on the same technique without involving any change in a bakelite manufacturing factory. The distillation of waste lac yields several useful products, one of which in particular, on vulcanising, promises to serve as an excellent lacquer possessing high heat and water resistance. Demonstrations of the improved methods of cultivation were given to villagers and steps were taken to supply them free of charge with brood lac and long handled pruners to encourage the use of the improved methods of the Institute. The Committee adopted certain methods of analysis for analysing samples of shellac, seedlac and sticklac. As a result it has been possible for the Agricultural Marketing Adviser to suggest tentative grade specifications for seedlac.

Imperial Council of Agricultural Research

THE annual report of the Imperial Council of Agricultural Research for 1938-39 gives an idea of the many sided attack made on the problems facing the

Indian cultivator and surveys the advances in scientific research which are expected to raise the yield of crops and the income of the Indian cultivator.

For the first time all rice and sugarcane experiments conducted during the past five years were collated and the results reviewed by the Joint Committee on Field Experiments which recommended a new set of manurial experiments. These experiments have been started in most of the rice and sugarcane experiment stations.

New schemes sanctioned during the year included work on insect pests of sugarcane, investigation into the Striga attack on Jowar in Bombay, research on cocoanuts in Madras, rust-resistant wheats at the Imperial Agricultural Research Institute, New Delhi, water requirements of crops in the Punjab and Indian coffee at Mysore. Experiments on the fixation of nitrogen in rice fields, under both water-logged and dry conditions, have shown that a considerable amount of nitrogen is fixed when the field is submerged, and certain blue-green algae are responsible for this fixation. This discovery is expected to prove advantageous to rice growers. A new species of bacteria, which is more acid-tolerant and fixes more nitrogen than any of the species previously described, has also been isolated at Dacca. Promising varieties of mango have been selected in Bihar for commercial exploitation, and co-operative trials on citrus root stocks under varying climatic conditions have been made in the Punjab, the Central Provinces, Assam and Orissa.

A contribution was made towards the cost of an expedition organised by the Imperial Agricultural Bureau to South and Central America to collect species of potato. The material collected will be tried shortly. Some of the American varieties and their hybrids have been found to be highly resistant to late blight as well as cold. An Indian worker from Madras was sent to America to study tobacco cultivation and processing and two more, one from Bihar and another from Bombay, are to be sent shortly. The Council also initiated inquiries into the extension of cinchona and clove cultivation in India.

On the animal husbandry side, as a preliminary step to the establishment of herd books, the characteristics of seven most important milch breeds of cattle of all-India importance have been defined. Information is also being collected about the various breeds or types of sheep in India to ascertain the production, demand and market value of wool produced. A hide-improvement fund has been created, the proceeds of which will be utilised for improving the flaying of hides and the possibilities of mechanical flaying will be investigated.

The fish scheme in Bengal yielded information on identification of food, sex determination and breeding habit of fish. A fish marketing survey is now in pro-

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gress. Studies on animal nutrition are being made at Dacca, Coimbatore, Sabour (Bihar) and Cawnpore where composition of fodders, the utilisation of molasses as cattle-feed and the feeding value of certain food grains, oilseeds and oilcakes, are being investigated.

Accurate knowledge of the composition of milk is essential both for workers in human nutrition and for assessing the requirements of milch cattle. The scheme in operation at the Agricultural Institute, Allahabad, was designed specifically for this purpose and 842 samples of milk at all stages of lactation of cattle and buffaloes from the farms as well as villages were analysed. A detailed review of the report is expected to be published in a subsequent issue of this journal.

Investigating the 'No Man's Land' of the Atmosphere

OUR present knowledge of the upper atmosphere is chiefly obtained from stratosphere flights with balloons equipped with self-recording instruments and by the method of radio reflection from the different layers in the upper ionised strata above the atmosphere known as ionosphere. But there is a considerable range in the upper atmosphere which is beyond the reach of stratosphere flights with balloons, but lower than the radio reflecting layers. A new technique has been recently devised to investigate this "no man's land" of the atmosphere to obtain information about the temperature, density, presence of clouds; concentration of ozone etc. in those regions. The technique was explained by Ellis A. Johnson of the Carnegie Institution before a meeting of the Philosophical Society of Washington. The beam of a great searchlight was directed upward and made to modulate about ten times a second by an automatic shutter arrangement and at a distance of about 3 miles a large mirror was pivoted upwards to receive the scattered beam from the sky. At the focus of the mirror was placed a photo-electric cell, the current in which was suitably magnified by an amplifying arrangement which made it possible to detect current of the order of 3×10^{-17} amperes. From the geometrical setting of the searchlight and the receiving mirror, the altitudes at which the beam is studied could be found out. The modulation of the light made it possible to distinguish it from the general background of the scattered light from the night sky and the work has to be done on clear nights without moonlight and haze at low altitudes. In the preliminary experiments it has been possible to study the presence of water vapour in the atmosphere, turbulence and winds, dust, fluorescence and absorption at a height of up to 40 kilometers. The experiments indicate that with a searchlight and a 60-inch reflector the study of the upper atmosphere by this

method could be pushed to a height of about 90 kilometers.

Mycenean Occupation of Athens

INTERESTING finds have been discovered during the excavations of last year of the American School of Classical Studies at Athens on the acropolis, which throws light on the interesting and up till now obscure history of Athens of Homeric and Mycenean times. An account of the discoveries by Prof. T. L. Shear, field-director of the excavation, which appeared in the *Illustrated London News*, states that in a rock-cut chamber tomb were found funerary offerings consisting of a number of vases of characteristic form and decorations which make it possible to assign them to the first half of the 14th century B. C. The tomb was discovered in shallow deposits on the north slope of the acropolis and the actual burial chamber is approached by a dromos or passage about 6 feet wide and 45 feet long. The entrance from the passage to the chamber was through a rock-cut doorway which had been closely and carefully packed with stones and had not been evidently disturbed since they were first placed in position. The chamber however, on being opened, was found to be filled with masses of rock, and the passage with earth and small stones containing fragments of Mycenean potsherds. Within the chamber were also found six vases and a cylindrical ivory box of remarkable size and artistic design. The vases however were crushed by the collapse of the roof. East of the doorway were found two large vases and a copper ladle indicating that the vases had contained wine for libation. The cover of the grave, a stone slab, had been removed from the grave and lay in a diagonal position by the grave. No bones were found in the grave but on the floor beside the cover lay toilet objects, a bronze mirror, a small ivory box and ivory pins. A small gold disc was found in the earth filling and three piles of gold ornaments were also recovered. The form and decoration of the pottery as also the carving in relief of the ivory boxes are characteristically Mycenean.

The burial indicates that this was the tomb of a lady who was probably a member of the royal house of Eretheus, the legendary king who ruled Athens in the 14th century B.C. Soon after the burial, the roof of the chamber seems to have collapsed. The chamber was then entered from above and the body removed and in the hurry of removal some of the offerings were overlooked. The discovery, if Prof. Shear's interpretation be correct, throws an entirely new light on the character and extent of Mycenean occupation of Athens of which only fragmentary evidence is available. In the Homeric poems Athens plays a very small and unimportant part. It seems current opinion based on that evidence has to be revised at least in so far as it affects the period long

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before the Trojan wars when Eretheus was king in Athens.

The University of Delhi

SUBJECT to the vote of the Legislative Assembly the Government of India have decided to make a non-recurring grant to the Delhi University of Rs. 8,00,000 spread over a period of five years. Of the total sum, approximately half will be used to assist colleges to move to the University site, the intention being that all the colleges shall ultimately move to the University site. Grants from the Government of India for this purpose will be conditional on the colleges themselves raising a substantial part of the total sum required. The Government of India have also decided to increase the recurring grant to the University at the rate of approximately Rs. 25,000 a year rising to a maximum of Rs. 1,00,000 in the fourth year over and above the present grant. This will enable the University to initiate a scheme for the appointment of professors, readers and post-graduate research scholars in such subjects as the University may decide.

Sometime ago the Hon'ble Sir Maurice Gwyer, Vice-Chancellor of Delhi University, sent to the Government of India a memorandum containing a scheme for the development of the Delhi University. The main features of Sir Maurice Gwyer's scheme are the development in the Capital of an all-India University with special characteristics of its own; the establishment of a number of professorial chairs and readerships; the provision of scholarships and other facilities for post-graduate study and research; the transfer of the constituent colleges to the University area; the fixing of a period of three years as the length of the ordinary degree course; some changes in the University library and increased provision of science laboratories and other buildings made necessary by the suggested developments, and the establishment of a faculty of medicine. The Government of India have accepted the Vice-Chancellor's scheme in principle though its carrying out must depend on the necessary funds being available in future years.

India's Trade with America

U P till now no trade treaty is in existence between India and the United States of America. Present trade between the two countries is governed by the antiquated and obsolete Convention of Commerce between Great Britain and America, which was concluded in 1815. Though there is no bilateral and comprehensive instrument to govern the trade between these two countries, the agreements arrived at between the U.S.A. and other countries are now operative in the case

of India as well. It is reported now that the Indian Chamber of Commerce of America and the present Indian Trade Commissioner have proceeded a long way in their negotiations to conclude a treaty of commerce between India and the United States of America. This information is contained in the report published in the *Hindustan Standard* of Calcutta from its New York correspondent about a dinner given by the Indian Chamber of Commerce in honour of the Trade Commissioner. The Trade Commissioner in his speech, said that one of the very important results for India out of this present war will be acceleration of the pace of industrialisation in India. He thinks that the industrial expansion of the country will lead to the gradual attainment of a balance so urgently needed between our agricultural economy and manufactured industries. He has pointed out that industrialized India will mean increase of purchasing power and hence the exporting countries need not be afraid of totally losing Indian market. But he reminded his audience that India is a price market and hence the price of the articles for consumption in India should not be beyond the reach of the average Indian. He agreed with certain other observers that the success of the Germans and the Japanese in the Indian market is primarily due to the close study of the Indian market through Indian associates and representatives and to the actual associating of Indian elements with their marketing organisations in India.

The trade between India and the United States amounts roughly to \$100,000,000 a year and the balance of trade is slightly superficially in favour of India. This is because India exports raw materials which are imported as finished products. But on the other hand the import of finished products means that the manufacture of the products has provided the U.S.A. with wages, capital investment and other income not reflected on the trade returns. India exports only certain specialities like embroidered goods, brocades etc., and foodstuffs. Recently pyrethrum flowers, Indian chutneys, condiments and curry powder, nuts have been supplied. Several firms have shown interest in jute, fibres, hides and skins, shellac, seeds, oil, drugs and chemicals, Indian fabric goods, table cloths, linen piecegoods, hand-woven textiles and hand-made lace, towels, woollen rugs and carpets.

Announcements

THE Council of the Royal Society of Arts has elected Sir Atul Chatterji as Chairman in the place of Sir Reginald Glancy. Sir Atul Chatterji is the first Indian to hold the office.

A SUM of Rs. 50,000 has been offered to the University of Calcutta by Mr Ranajit Pal Chowdhury for the creation of a fellowship to be called the

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Bipradas Pal Chowdhury Fellowship. The endowment is intended for enabling the University to invite competent scholars from foreign countries to visit India and study under the auspices of this University "aspects of Hindu civilisation and culture."

THE following have been elected as officers and members of the Council of the Royal Society for the present year: *President:* Sir William Bragg; *Treasurer:* Prof. T. R. Merton; *Secretaries:* Prof. A. V. Hill and Prof. A. C. G. Egerton; *Foreign Secretaries:* Sir Albert Seward; *Members of the Council:* Prof. F. C. Bartlett, Prof. P. G. H. Boswell, Prof. F. T. Brooks, Dr C. G. Darwin, Prof. H. M. Fox, Dr H. J. Gouch, Dr A. D. Imms, Prof. C. K. Ingold, Prof. G. B. Jeffery, Prof. R. T. Leiper, Prof. H. S. Raper, Sir Owen Richardson, Prof. E. N. Rideal, Dr F. J. W. Roughton, Prof. W. W. C. Topley, Prof. R. Whiddington.

THE Government of India have been pleased to appoint Mr A. Lehuraux of Chandernagore (French India) a corresponding member of the Indian Historical Records Commission with effect from December 2, 1939. The following have also been re-appointed corresponding members for a period of three years: Dr Radhakumud Mookerji, Khan Bahadur Maulvi Zafar Hasan, Mr R. B. Ramsbotham, U. Ba Dun, Rao Saheb C. S. Srinivasachari, Dr D. R. Bhandarkar, Dr J. C. Sinha, Hakim Habibur Rahman, Lala Sita Ram Kohli, Rai Bahadur Dr S. K. Bhuyan, Dr Balkrishna, Cavaliero Panduranga Pissurlencar, Rao Saheb C. Hayavadana Rao, Dr R. C. Majumdar, Dr T. G. P. Spear, Mr J. C. Taluqdar.

AN Advisory Council on Scientific Research and Technical Development has been set up by the

British Minister of Supply to advise him on scientific and technical problems. The main functions of the Council will be to ensure that the work of the Directorate of Scientific Research is carried out with due regard to recent advances in scientific knowledge, to introduce new fields of research and development, and to make recommendations regarding the most effective use of scientific personnel. The Council is composed of eminent professors and representatives of the Admiralty, Air Ministry and Ministry of Home Security with Lord Cadman, emeritus professor of mining and petroleum technology in the University of Birmingham as chairman and two joint secretaries from the personnel of the Ministry of Supply.

THE following lectures illustrated with lantern slides will be delivered at the Indian Museum:

March 1st.—The Indian Museum by Dr Baint Prashad, D.Sc., F.R.S.E., F.Z.S. F.L.S., F.R.A.S.B., F.N.I., M.B.O.U., Director, Zoological Survey of India.

March 8th.—"The Art of Ancient Egypt," personal experiences in excavating with Mr Howard Carter—by Mr Percy Brown, A.R.C.A., Secretary and Curator, Victoria Memorial Hall, Calcutta.

March 15:—"The Royal Botanic Garden, Calcutta" by Dr K. Biswas, M.A., D.Sc. (Edin.), F.R.S.E., Offg. Superintendent, Royal Botanic Garden, Calcutta.

Three other lectures on "Migration of Birds" by Dr M. L. Roonwal, M.Sc., Ph.D. (Cantab), Zoological Survey of India, Indian Museum, Calcutta; on "Utilisation of the Geological Survey" by Dr Cyril S. Fox, D.Sc., M.I.Min.E., F.G.S., F.N.I., Director, Geological Survey of India, and on "Some Symbols in Indian Art" by Dr Stella Kramrisch, Lecturer on Indian Art, Universities of London and Calcutta, were delivered last month.

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Production of Gas Fuel for Motor Vehicles

THE brief report of a very important investigation by Graham and Skinner carried out at the instance of the British Colliery Owners Research Association, for increasing the calorific value of coal gas or coke oven gas to be used in motor vehicles in place of petrol, has recently been published (*Journal of the Institute of Fuel*, 13, 39, 1939). Sulphur resistant catalyst has been found to deteriorate quickly by carbon deposition due to the reaction $2CO = C + CO_2$ at $400^\circ C$. Finally, however, nickel supported on charcoal made from sugar in the manner described by Chakravarty and Ghosh (*Jour. Ind. Chem. Soc.*, 2, 150, 157, 1925) of Dacca University using 1 per cent cerium nitrate as promoter, has been found to be the most efficient catalyst tested, the gas being purified by passage through silica gel.

Phosphorescent Envelope for Electric Lamps

THE phenomenon of the phosphorescence has recently been utilized by Desmarest for improving the illumination properties of electric lamps as reported in *La Nature* of December 15, 1939. Desmarest has succeeded in depositing phosphorescent salts in crystalline state on the inner surface of bulbs. It is essential that the deposit be made in crystalline state and this is done with the help of an anticolloidal body. The mixture sticks firmly on the glass and takes a calcareous appearance; the phosphorescent property improves rapidly with age.

Such a glass modifies the wavelength of rays passing through it and also renders visible a fraction of the invisible ultra-violet and infra-red rays of the source. For commercial use an ordinary incandescent electric lamp is fitted inside another glass bulb, the inner surface of which has a coating of the phosphorescent substance. There is provision for free ventilation of air in the annular space between the two bulbs and a constant temperature is thus maintained. The assemblage possesses many useful features. The light given out is diffuse and very soft, gives better illumination and does not modify natural colours. It is claimed that along the vertical axis the intensity is greater by about 50 to 90 per cent than the best quality opal lamp of same wattage and by about 50 to 100 per cent than a corres-

ponding clear lamp. In the horizontal plane it is about 15 to 25 per cent better than a clear lamp. Although the maximum intensity of illumination is obtained a few minutes after switching on, the long after-glow following switch-off has got several advantages.

—H. R.

Monel Metal

MONEL metal is an alloy containing approximately two-thirds of nickel and one-third of copper. It is at the present time employed for a wide variety of engineering and industrial purposes. The first production of this alloy in the year 1905 is very interesting. Messrs International Nickel Company had for many years been engaged in mining and smelting the nickel ores from the Sudbury districts of Ontario, Canada, and one large belt of ore was found to contain, in addition to the nickel, a relatively high percentage of copper. As the separation of the two metals was found to be impossible, it was decided to melt the two metals simultaneously and to examine the commercial merits of the resulting alloy. The alloy was found to possess mechanical and corrosion resisting properties of a high order, and was named after Mr. Ambrose Monel, the then President of the Company.

Since that time the use of Monel metal has rapidly developed and at the present time is employed for a variety of applications on account of its strength at high temperatures and its resistance to abrasion and corrosion. Its high strength, good ductility, and ease of fabrication are all of equal practical importance, since they permit its use where corrosion resistance alone would not suffice.

A recent modification of Monel metal known as K-Monel contains up to 5 per cent aluminium. It has good corrosion resistance with the added advantage of increased strength and hardness after heat treatment.

—N. K. S. G.

Lubricants from Fish Oil

AJAPANESE oil company is making arrangements for manufacturing aircraft lubricants on a big scale from fish oil. A site for the plant has been selected

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and preparations are being made for the erection. Besides whale oil, sardine, and herring oil will serve as raw materials. The process is a trade secret and the company claims that the lubricant produced will in no way be inferior to lubricants from other sources.

—N. K. S. G.

Protection from Live Wires

A French engineer has suggested an interesting new method of avoiding accidents due to breakdown of rubber gloves or boots while working on a live wire. His suggestion is that if the interior of the gloves and the boots be rendered conductive and then interconnected by means of cables, any piercing of the rubber will not affect the worker. Whenever there is a breakdown, there is no source of shock to the worker. Due to the metallic connection from one glove to another the current will be short circuited, and the worst that can happen to a worker, is a burn due to heating of the conducting material. Even this has little chance since the worker as soon as he will feel that the conductors are becoming warm can let go the live line which was causing trouble before any harm is done.

Although the metallisation of the interior surface of the gloves or boots is an ideal case, there are practical difficulties, hence the practical scheme suggested is to use a conductive latex for the first dipping in the manufacture of a glove or boot and insulating latex for other dippings. Conductive latex is now already being used for manufacturing of rubber belts for certain special purposes. It has a resistance of 1 ohm per square centimetre which is considerably much less than the skin, even when wet, so that any current reaching it flowing through the rubber would flow through the conductive latex in preference to the skin. Each glove will be provided with a carefully insulated contact, on to which the terminal of an insulated conductor cable can be attached. Where the worker wears only gloves, a single conductor can connect them; if both gloves and boots are worn all four should be connected by cables fastened together.

—N. K. S. G.

Measuring 0.0000001 Inch Thick Oil Film

A MACHINE for testing the lubricating properties of an oil film only 0.0000001 inch thick has been invented at Columbia University. The instrument is also capable of reducing the errors in measuring friction. To obtain films of oil of the above thickness special technique has been developed. The oil is converted to a fine fog and the particles electrically charged. The droplets then attach themselves to a clean metal

surface in the form of a continuous film the thickness of which is uniform and can be varied as desired.

By measuring friction caused by rubbing diamonds and sapphires over highly polished and thinly lubricated surfaces of steel, gold, platinum, etc., university engineers hope to discover some unknown properties of lubricants.

—N. K. S. G.

Iron Ore Reduction by Hydrogen

FOR the first time manufacture in commercial scale of iron by the reduction of iron ore by hydrogen has been undertaken by an American Steel Corporation. The source of hydrogen is the natural gas which is abundant at the place where the factory is being constructed. The hydrogen reduction process will produce a pure grade of iron suitable for special uses in thermal and electrical equipments, and as a catalytic mass.

—N. K. S. G.

Electric Vehicles for Refuse Collection

THIRTEEN electrically driven vehicles have been put into service by the Orleans Municipality in France: three of 7-tons, and five of 5-tons and another five of 2.5-tons of capacity. They are equipped with storage batteries, which supply electricity for driving the car. For the 7-ton vehicle 44 cells are provided with a capacity of 560 Ah. and weighing about 46 cwt. The 5-ton vehicles are provided with 44 cells of 500 Ah. capacity, weighing about 42 cwt and the small vehicles have an equal number of cells with 400 Ah. capacity and weighing 34 cwt.

Records indicate that the consumption of the vehicles are reasonable. The small vans, employed mainly in narrow lanes and streets, consume on the average 1.76 kWh/mile, 5-ton vans 2.56 kWh/mile, and 7-ton vans 3.36 kWh/mile.

The Orleans Municipality believes that the ease of operation and the low running cost will lead other municipalities to consider the possibilities of electric vehicles for this type of services.

—N. K. S. G.

Fibre from Phenol

PHENOL or carbolic acid was originally obtained as only a byproduct of the destructive distillation of coal, but as the growing demand could not be met by the quantity produced by the above method, a synthetic method was perfected for its manufacture. The synthetic process is supplying the industries successfully for many years. The principal use of phenol today is in the manufacture of plastics and resins for the paint and

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varnish industries which accounts for the four-fifths of the total. Phenol and its derivatives are also used for pharmaceutical purposes. Phenol is also consumed by the dyestuff industry.

•Recently Du Pont de Nemours Co. of U. S. A. has developed a process for the manufacture of synthetic fibre from phenol, and if the process comes up to expectations, this source of phenol consumption will be much more important than any other. It is reported that the adipic acid which is the raw material of "Nylon," the name of the new fibre, will be made synthetically by the oxidation of cyclohexanol, which in turn is obtained by the hydrogenation of phenol.

—N. K. S. G.

Production of Power

IN ten years since 1929, electricity production throughout the world is estimated to have increased by 180,000 million kWh over 280,000 million kWh. The United States have increased the production from 120,000 to 148,000 million kWh and the second largest production is in Germany with 55,200 millions kWh from 30,600 million kWh. The figures are given by the Electrical Industries Bank of Zurich, Switzerland. The general consumption for the world per head is estimated at 210 kWh, an increase by 70 kWh. In production per head, Switzerland leads with 1670 kWh, a large part of which is however exported, and then comes

U. S. A. with 1140 kWh, Germany with 810 kWh and Great Britain with 690 kWh.

The Americans are still the largest consumers of power. Figuratively, each family has 120 slaves working 8 hours a day for 6 days in a week. The Science Service reports that in the U.S.A. bituminous coal supplies 48 per cent of the total energy for all purposes, anthracite supplies 6 per cent, petroleum 32 per cent natural gas 10 per cent and water power less than 4 per cent. But in the production of electric power water supplies 36 per cent of the total generation.

New Artificial Fertilizer

THE Agricultural Gazette of New South Wales reports the marketing in America of a new fertilising material known as 'Sea-water Magnesium Oxide.' This product contains from 80 per cent to 95 per cent magnesium oxide, the remainder being combined moisture. The material is claimed to be almost completely available as water soluble magnesia. Previously magnesium sulphate in the form of a kieserite was used in fertilizer mixture. This sulphate contains an equivalent of about 30 per cent magnesium oxide. But now less bulk of Sea-water Magnesium Oxide will be required and it is estimated that a saving of 30 per cent per unit of magnesium oxide will result. The advantages of this new product is that it can be stored for a long time without turning into insoluble form and secondly besides being a source of magnesium, it is an efficient neutraliser of acidity imparting the desired physical characteristics to the fertilizer mixture.

Pauthenier Generator

B. B. Bhowmik

Introduction

High-voltage technique is itself an interesting branch of science. It has received added importance in recent years for its various applications. Super voltages of the order of 4 to 5 millions are now in use for the studies of atomic nuclei and transmutation. Constant potential free from surges or ripples, to give a steady direct current is of paramount importance in such works, because of the necessity of obtaining strictly homogenous beam of electrified particles for accurate focussing. These demands can be ideally met by a suitably designed electrostatic generator. Potential.

very nearly constant, may be obtained by means of voltage multiplying circuits—combination of transformer, condensers and rectifiers, but the efficiency of such generators decrease rapidly at higher voltages. As an illustration it may be cited that in most efficient system, to impress 10,000,000 volts about 10,000 kVA. would be wasted in parasiting-magnetising and charging currents, exclusive of useful current and corona loss. These considerations led Van de Graaff to develop Electrostatic Generator, and he devised an ingenious method of charging a large, insulated, metallic sphere by spraying electric charges on one part of an insulated endless

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moving belt and collecting these charges from the belt on the sphere. This type of generator originated in America where it has come in great vogue and most of the high-voltage nuclear (physics) research laboratories in that country have adopted this method. Van de Graaff generator though ideally suited for nuclear research has a great short-coming in its output current being very limited of the order of a few hundred micro-amperes only and now therefore Prof. Lawrence's cyclotron had come into use.

Theory

The problem of industrial purification of gas and abatement of smoke by precipitation of suspended particles by charging them electrically led Prof. Pauthenier of Paris University, to make a thorough study of the charges acquired by particles in ionised field. He found very interesting results of theoretical importance and of practical possibility of precise control of the charges notably if the particles be spherical of diameters of several microns only and be passed through cylindrical ionised space round a wire emitting ions by corona discharge. Briefly it may be said that if a is the radius of a particle, E the intensity of the ionising field and i the current per unit length of ionising wire, the limiting charge acquired by the particle is equal to $p E a^2$ where

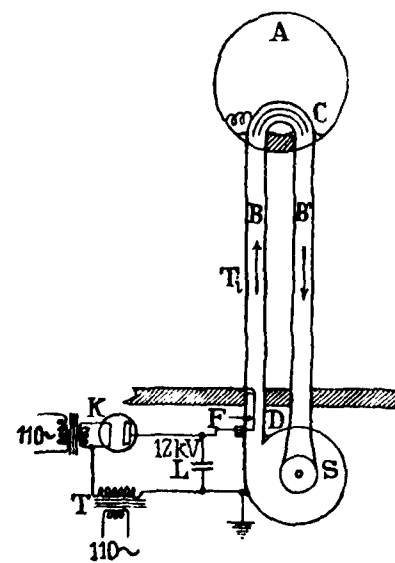


Fig. 1.

p is equal to 2 in case of insulating particle and 3 in case of conducting particle. In passing through the ionised field the particles acquire limiting charges very quickly, (mathematical calculations are not given here) so even if the particles move with great velocity, only a few decimeter length of ionising field is sufficient to charge the particles to their limiting values. It is also very easy

to collect these charges carried by the particles on a suitably insulated sphere. Prof. Pauthenier made use of these phenomena and developed an ingenious device for generation of very high voltage. Subsequent development of this type of generators have now reached a state of industrial importance where steady direct current of several milliamperes are needed at very high potential.

The principle of the generator will be understood from the schematic figure (Fig. 1). S B C B' S is a closed circuit of hollow insulating tube T; through which air is driven at a high speed by means of a high pressure centrifugal pump (Reversed Reaction Turbine) marked S. A quantity of fine powder of glass is let inside through a hole in the lower part of the descending tube B', the hole being closed afterwards. At the entrance of the ascending tube B, the ioniser D is mounted in which a fine filament-F is axially suspended and is connected to an outside potential sufficiently high to produce corona discharge. This high potential (of about 12 kV.) is supplied by means of the transformer T and is rectified by means of the kenotron K. L is a stabilising condenser.

Driven by the turbine, current of air carries with it the particles of glass which get charged while passing through the ioniser D. These particles in their movement come in contact with the metallic portion C of the closed hollow circuit and deposit their charges to it. C is electrically connected to the inside of the metallic sphere A, on which ultimately all the charges carried by the particles are collected and whose potential thus rapidly increases by addition of these charges. The powder particles come out of C down the tube B' to the turbine as neutral particles and commence a new cycle by going up the tube B.

Maximum Voltage Attainable

As to the maximum voltage obtainable from such generator, the first question arises whether the charged particles driven by air will indefinitely go on reaching the collector or the force of Coulomb repulsion will repulse the particles after the collector has reached a certain potential V . This repulsive force according to the previous notation is equal to $p E a^2 V$. Against this force works the current of air of velocity, say u . If the velocity of air is high the mechanical force exerted by a particle is equal to $C \pi a^2 \delta u^2$ where δ is the specific density of the air and C is the aerodynamic constant of the particular form of tube. This force exceeds the repulsive force $p E a^2 V$ when $U^2 > \frac{2pEV}{C\pi\delta}$. To avoid deposit of particles on the wall of the tube, the velocity of air is maintained at about 50 metres per second, under which condition the Coulomb repulsive force never affects the desired limit of potential of the collector for all practical

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purposes. The voltage limit of the collector sphere is actually set by the brush discharge from its surface which depends on its geometrical form and size.

Current Output of the Generator

It is evident that the output current depends on the quantity of charge carried per centimetre cube of air. To increase this charge one may increase the quantity of powder per centimetre cube of air, but there is an optimum condition because if the particles be too numerous near the corona discharging filament, its ionising capacity will be reduced and chances are that the particles will pass through the ioniser without being charged to full capacity—thus reducing the ultimate output current. Another way of increasing output current is by increasing the velocity of air to be helped by improving the mechanical construc-

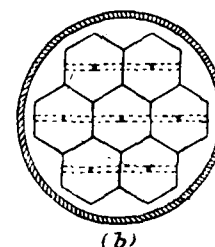
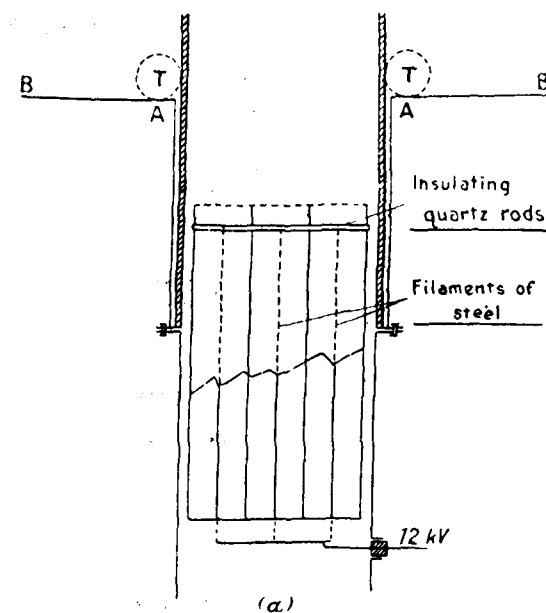


Fig. 2.

tion of the generator. In short, it may be said that about 6 litres of air transport one micro-coulomb. Making diameter of the tube column longer, the output current can be increased to the desired value. By modifying

the construction of the generator and employing several ionisers the output current can be multiplied. This method has been employed in the latest generator described hereinafter.

Ioniser

The essential organ of the generator is the ioniser. If the diameter of the tube column is large, in order to have it efficient, the construction of the ioniser is modified by subdividing it into several tubes of smaller

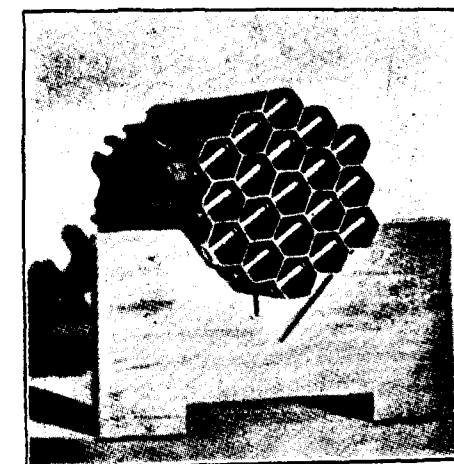


Fig. 3.

diameter each having a central ionising filament of steel hanging axially. Fig. 2 shows schematically the tubes with ionising wires hanging from quartz (insulating) rods, and all ionising filaments being connected to an external potential of about 12 kV. For better utilisation of space, the tubes are made hexagonal in form and mounted in the form of bee-hive as shown in fig. 3.

Nature of Powder Particles

The particles of powder are the carrier of charges to the generator collector, so their role is an important one. It has been mentioned before that if the particles be of conducting material they can carry more charges than if they be of insulating material. In spite of this fact the particles employed should never be of conducting material, first because the insulation of the tube column interior supporting the collector will be adversely affected and secondly, after the collector has reached a certain potential, the Coulomb repulsive force would create an electrostatic pressure of such magnitude that the charge on each particle on nearing the collector would be displaced and concentrated to one side of it and would discharge. Powders of various material have been tried. Ashes of pulverised carbon from heaters have been successfully used in one generator. Fine powders of glass have been

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used in the latest constructed 2 million-volt generator. The powder particles after being in use for some time

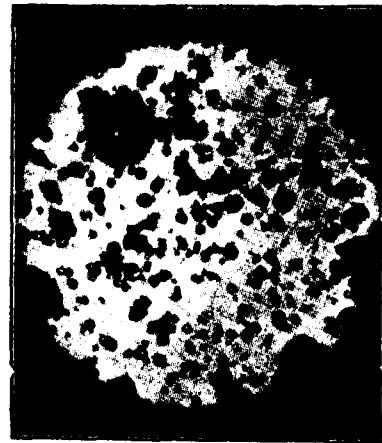


Fig. 4.

becomes dark in colour and almost spherical in form as seen in micro-photograph shown in fig. 4.

Generators

The first generator constructed on this principle was a very small one which delivered the expected current of $4 \mu\text{A}$. and a voltage of 400 kV. In June, 1936, the second generator was constructed with an aluminium sphere of 75 cm. diameter as collector. It was supported on two tubes of special Jena glass. The internal diameters of tubes were 10 cm. and their lengths were 210 cm. The two tubes were joined inside the collector by semi-circularly bent metallic tube divided into several sections. The sectioning of the tube C has the double advantage of easier air-flow without eddies and of offering a larger surface on which the charged particles roll and thus discharge themselves completely. The ioniser used in this generator consists of 7 hexagonal steel tubes of thickness 0.5 mm., external side of hexagon being 17 mm. and their length being 35 cm. All the tubes were soldered together in the form of a beehive. Another aluminium sphere of 75 cm. diameter connected to earth was erected on wheels in order to make it movable for measurement of potential of the generator by spark-gap. Measured in this way the maximum voltage generated was 1200 kV. and its output current was of the order of 50 micro-amperes.

The third generator was built for the Palais de la Decouverte (Palace of Discovery), and was exhibited at the International Exposition of Paris, 1937. The speciality of this generator was in the collector, which

was not spherical. Though a complete sphere offers the best distribution of electric field and minimise the surface discharge, the entering of the tubes into the sphere collector distorts the field and causes discharge at much lower voltage at the joints of the tubes with the sphere specially when the tubes are made large to increase the output current. In order to avoid this, the geometrical form of the collector was made something like a flattened sphere, its equatorial diameter being 1.8 metre and its polar diameter being 1 metre. The ioniser consisted of 19 hexagonal tubes. The insulating tube columns were of porcelain of 15 mm. thickness.

The fourth generator on this principle was constructed at the University of Liege by Profs. Morand and Raskin, the collector being a large cylinder with rounded hemispherical ends. The dimensions of the room in which it was installed being small, the potential of the generator could not be exceeded over 450 kV. Though the diameter of the tube column was only 12 cm. the output current of the generator was 300 micro-amperes.

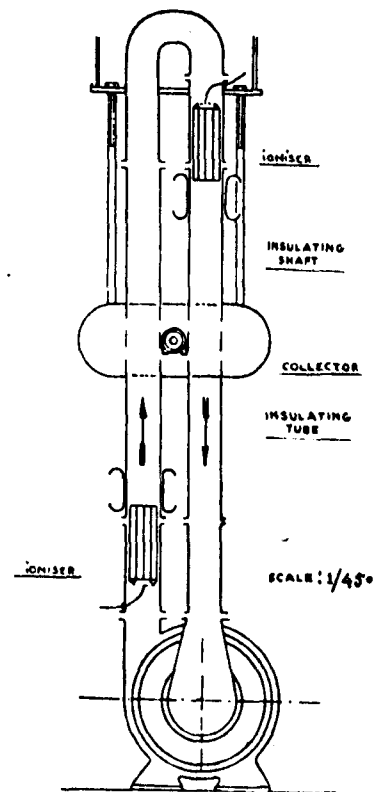


Fig. 5.

This current output can be doubled by modifying the construction of the generator in such a way that the collector is mounted at half way on the tube columns and the powder particles are charged twice, once at the lower end of the tube while going upward and again at the upper end of the second (descending) tube in the downward movement of the particles, the collection of charges

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from the particles being done by means of suspended needles in the middle of the tube covered by the collector. These needles are electrically connected to the collector to which all the charges are ultimately deposited.

A recent improvement of current doubling method by Raskin shown in the schematic diagram (fig. 5), has been applied to a generator built and at present exhibited at the International Exposition at Liege. This generator is capable of delivering 800 micro-amperes and it is expected to go up to one milli-ampere after further adjustments.

The construction of the sixth generator on this principle has just been finished at the Laboratoire Electrotechnique Generale, Paris University. It is characterised by several new features. The current doubling method has further, been extended for quadrupling the

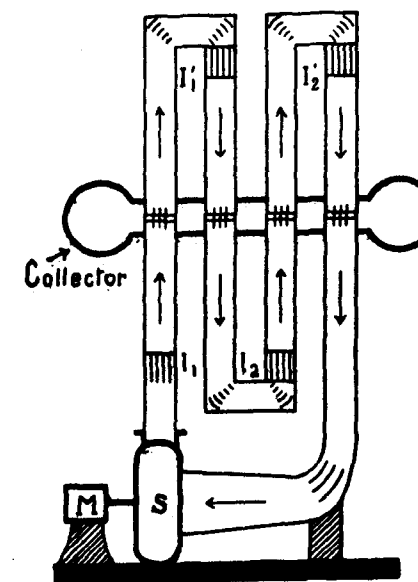


Fig. 6.

output current. Four tube columns have been used in series and four ionisers have been mounted in such way that the powder particles get charged and then traverse the collector depositing their charges on it four times successively per each cycle of their run. The arrangement is schematically shown in fig. 6. M is a motor driving the turbine S. I_1 , I_1' , I_2 and I_2' are ionisers. The collector is mounted at halfway on the tube columns. The charge collecting needles are seen inside the tube columns. At the extreme end of each tube column where the air-current changes its direction, a series of slightly curved parallel blades have been mounted for better air flow. The tube columns are made of pressed varnish

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paper (paper bakelite). A number of bakelite flanges have been (not shown in fig. 6) fixed to the tube column to increase the surface and avoid grazing of sparks on the surface of the tubes. The collector is made of sheet aluminium and has a form of flattened sphere with a large rounded hole in the middle through which the tube columns pass. The generator is designed for 2.5 million volts and for an output current 2 milli-amperes

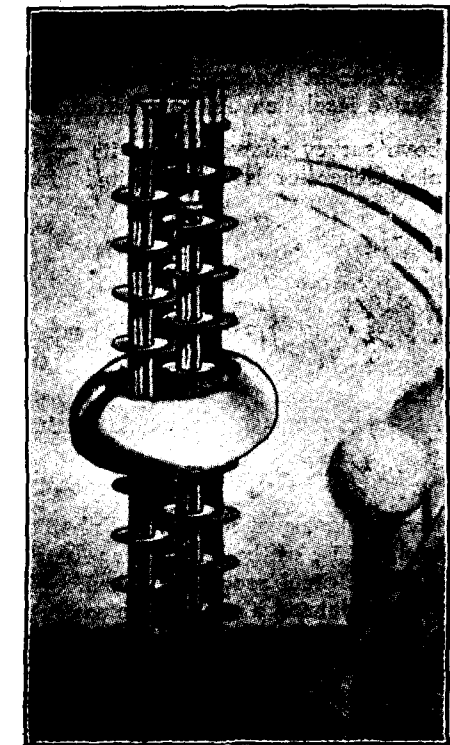


Fig. 7.

at this voltage. Fig. 7 shows a schematic representation of the generator.

Voltage Doubling

From the description of the ioniser given above, it will be evident that either positive or negative potential can be applied for charging the particles, and consequently the generator may have, as desired, either positive or negative potential with respect to earth. All the generators so far constructed are unipolar. Using two identical generators and charging one positively and the other negatively the available voltage will be doubled. Thus in the case of the generator described last a potential difference of 5 million volts would be available.

Price and Running Cost

One of the most important consideration is the cost of this type of generators. The price

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of such a generator for the same output voltage and current would amount to only about 1/3 of the price of a generator of classical type consisting of transformers, condensers and rectifiers. Its running cost is also very small because the only power necessary for its running is consumed by the motor to drive the turbine. The power consumed by the ioniser kenotron set is very small. The only power wasted in the system is in the friction of air inside the tube, which dissipates as heat. This heat is of use in keeping down the humidity making the inside insulation of tubes better.

The above survey shows that in its present form the Pauthenier Generator is well suited for X-ray

therapeutic and nuclear research works when steady direct current of several milliamperes are needed at a very high potential. Its further developments would be very interesting and of immense practical importance.

In conclusion the writer expresses his gratitude to the authorities of Paris University for giving him a special research scholarship from the French National Scientific Research Fund to enable him to undertake research works under Prof. Pauthenier. The writer also takes this opportunity of expressing his profound gratitude to Prof. Pauthenier for offering him facilities to participate in the development work of this new generator and for his kind permission to publish this article.

Science and Moral Lessons

Some writers beginning at least with Robert Southey, have bemoaned the rise of the scientific age as a destructive force in the spiritual progress of man. This force is represented as attaining a hurricane stage in the mass production industries of the present day. But while some authors may not like to run lathes, lathe hands are not a particularly unhappy lot. Labour generally is probably at least as well off as in the days when they endured the burdens of the Middle Ages. I should go much further

than that and represent science as an exceedingly powerful spiritual and moral force. If a man does not learn moral lessons from the observation of the certainty of operation of natural laws, he seems to me to be morally hopeless. The qualities which we commonly associate with high character are, according to my observations, especially marked in persons who have a deep appreciation of facts. Which is cause and which effect it is difficult to say, but in any case, the two are compatible.

—The Scientific Monthly.

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Study of Bacteriology

CALCUTTA University has requested Lt. Col. A. C. Chatterjee, Director of Public Health, Bengal to prepare a draft syllabus in response to his suggestion that bacteriology should be included among the subjects of study for the degree examination of Bachelor of Science. In a note on the subject Col. Chatterjee stated: "With the advancement of scientific knowledge pertaining to the etiology of many diseases, there is a growing demand for the service of persons having knowledge of bacteriology. In the analysis of drinking water, sewage and of various articles of food and drink, the knowledge of this subject has become increasingly important and is being daily applied in the laboratory. Until now for such bacteriological work medical men have been almost solely employed. This is extremely unfortunate, particularly in Bengal, where the number of physicians required for medical work among the population is very low, being about one per 9,000.

"Women are very well fitted to study this subject, because it entails careful handling of costly and delicate instruments. As a matter of fact, in England and America large numbers of women are studying this subject, and are already in the profession. Our women-folk are overcrowding the profession of teaching. The study of this subject will give them an opportunity to strike out a new line and take up a very useful profession."

All India Hygiene Institute

THE annual report of all All-India Institute of Hygiene and Public Health recently published, points out that although it is fully recognised that the country is badly in need of a vigorous and forward policy in regard to public health organisations, even the small number of technically trained personnel is unable to find employment in this national endeavour.

This paradoxical situation arises due to the vast magnitude of the problems on the one hand, and the paucity of funds on the other. Most of the available funds are already appropriated by curative medicine, because as an organisation, it is not only well established by tradition, but yields immediate demonstrable results,

while the results of preventive medicine are difficult to demonstrate and thus funds are not easily available.

Whatever scheme is ultimately adopted, the demand for trained personnel will however remain. Facilities for field training which are essential for public health students are at present inadequate. The health organisations, particularly of rural areas, have not yet become stabilised. On the other hand, health schemes, which have efficiently worked in one area, may require to be thoroughly modified when applied to another locality, thus necessitating a grounding in scientific principles on which health programmes are based. In the present circumstances, training at the Institute, the report says, has been necessarily more of a general nature, but the necessity of harmoniously supplementing pedagogic instruction with field training is kept in view. An account of the investigations carried out in the Institute is published elsewhere in this issue.

Requirements of Drug Manufacture

DRUG manufacture is ultimately dependent on the development of a wide and varied chemical industry. Sulphuric acid, for example, is the key substance used in the production of many chemicals and pharmaceutical preparations (Epsom salt, Glauber's salt, ferrous sulphate, copper sulphate, ammonium sulphate, alum, aluminium sulphate, ferro alum, hydrochloric and nitric acids, etc.). Its manufacture is at present dependent on the supply of foreign sulphur, our indigenous resources not having been utilised. The manufacture of alkalies—soda ash, potash, caustic soda, etc., is yet in its infancy in India and almost the entire supply is being imported from abroad. Practically all organic acids are imported at present and are converted into salts used in pharmaceutical practice. With the exception of alcohol, practically no other solvents such as benzol, ether, chloroform, petroleum ether, etc., are being produced in India. Many of the chemical compounds of arsenic, mercury, antimony, bismuth, etc., camphor, urea, glucose, aniline, are being imported. With all her natural resources, India is not producing starch to any great extent and glucose not at all. Without the development of industries for manufacture of these basic products, India can never hope to solve the problem of drug manufacture and drug supply to the

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people in a satisfactory manner. Thus observed Bt. Col. R. N. Chopra in opening the exhibition organised during the Calcutta Medical College Re-union.

Development of Drug Industry

GREAT Britain was entirely dependent for her supply of nitrogen products on Chile before the Great War of 1914. Within the last 25 years she has developed her ammonia industry to such an extent that she is now completely independent. If this has been possible in Great Britain, there is no reason why it will not be possible in India if properly organised efforts are made. Some of these basic chemical industries, of course, cannot flourish unless the State gives some sort of protection. The nitrogen fixation industry or chlorine producing plants, means a tremendous capital outlay, but the principal products, ammonia, bleaching powder, etc., sell in the market for a few annas per pound. This discrepancy between the capital cost of providing production facilities and the low unit value of the goods produced is a fundamental characteristic of many sections of the chemical industry. It is a factor which obviously makes reasonably settled conditions and State aid necessary, if the enterprise is to make any headway or flourish. The present time, according to Col. Chopra, seems to be most opportune for starting of enterprises of this nature on a large scale, and he has pointed out that any scheme of drug manufacture in India, if it is going to be successful, should have the following objects in view:—(i) To supply the masses of India with medicinal preparations commensurate with their means. (ii) To fight against preparations of impure quality and defective strength getting into the market. (iii) To aim at manufacture of basic materials. The importance of associating strong research units with the manufacturing organisations has not been sufficiently appreciated. Unless this is done the progress is bound to be slow and it will not be easy to improve the standard of preparations manufactured.

Medical School Education in India

THE first Medical School in India was opened at Calcutta in 1822 and at the present day there are 27 medical schools in India. The present inferior syllabus of the medical schools being defective, the passed students have been refused recognition by the Medical Council of India. Hence it has been recommended, at a recent conference held at Delhi, that one uniform minimum standard of training and qualification for practitioners of modern scientific medicine should be established throughout India at an early date to satisfy the requirements laid down by the Medical Council of India. In accordance with this recommendation, all the

medical schools are to be ultimately abolished and some of them will have to be converted into colleges. In the meantime, it is recommended, for recognition by the Medical Council of India, to raise the standard of the medical schools on the following lines:

- (i) The minimum entrance examination for the medical schools should be I.Sc., with chemistry, physics and biology.
- (ii) The course of study should be extended to five years.
- (iii) A better training in the subjects of mid-wifery and diseases of women, including practice and instructions at a pre-natal clinic should be provided for.

The recommendations have already been given effect to in some of the Provinces. Madras has abolished the medical schools and has only the M.B. degree. Bombay has decided to raise the standard to the M.B. B.S. degree. The Cuttack Medical School, Orissa, has decided to extend the course to five years. Nothing, however, has been done so far in Bengal in this respect. The converting of the Dacca Medical School into a college is under consideration. The Campbell Medical School with its enormous hospital facilities is eminently suited for developing into a medical college. This will no doubt entail some additional initial expenditure but recurring expenditure will be less than that of the School at present as the staff of the college would be mostly on an honorarium basis. It is expected that the Government of Bengal with its revenue resources will not find it difficult to introduce the five years' course in the medical schools for the present.

Titanium Salts for Skin Diseases

THE element titanium though classed among the relatively rare elements is the most abundant naturally occurring substance. Recently salts of titanium have been proved to be very effective in the treatment of certain skin diseases. These salts are non-toxic. Metadier (*Med. Pres. Circular*, p. 514, 1939) observed that an ointment containing Titanium oxide 20%, Titanium borate 5% and Titanium salicylate 5% gave very good results in cases of eczema without exudation. Redness and itching sensation are abolished very soon and the condition is improved very rapidly. Dermatitis due to local irritation is also cured by titanium. Nicolas reported that sycosis barbae responded to titanium therapy (*J. de Medicine de Lyon*, p. 397, 1928). Minor skin conditions such as itching due to insect bites, varicose ulcers are promptly cured by titanium. In tuberculous affection of the skin titanium therapy is being tried as the titanium salts inhibit the

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growth and activity of cultures of Koch's bacillus. Mantelin (*J. des Practiciens*, June, 1928) remarked that titanium is of considerable value in the treatment of psoriasis.

—S. B.

Optimum Time for Administration of Protamin Zinc Insulin

THE action of insulin in the preparation protamin zinc insulin is considerably more prolonged than that of free insulin. Chances of hyper or hypo-glycemia with protamin zinc insulin are very rare. Opinions vary as to the time of injection of this preparation in a diabetic patient. Mosenthal (*J. A. M. A.*, 110, 87, 1938) advocates the injection of protamin zinc insulin in the morning. Lawrence *et al* (*B. M. J.*, 1, 487, 1937) obtained satisfactory results in six cases when the insulin was given at bed time. Himsworth claims (quoted by Joslin, *J. A. M. A.*, 109, 497, 1937) to have obtained

very good results by administering protamin zinc insulin at 11 p.m. Mark (*Arch. Int. Med.*, 64, 897, 1939) studied the blood sugar curves resulting from alterations in the time of administration of protamin zinc insulin in diabetic patients. The character of the blood sugar curves was practically the same though the injections were given at different times. There is a normal day to day variation in the blood sugar level when the patient is on the same diet. It is therefore suggested that a single dose of protamin zinc insulin should be given at any time of the day convenient to the patient.

—S. B.

Synthetic Oestrogen

TRIPHENYL chlorethylene like stilboestrol is a very good synthetic substance having oestrogenic properties. This compound is active when administered per mouth. Its oestrogenic action has been confirmed by Macpherson and Robertson (*Lancet*, 2, p. 1363, 1939) after clinical trial in a number of patients.

—S. B.

The Story of Kala-azar

What causes greater destruction of humanity,—wars, pestilence or sudden catastrophies like big earthquakes? War is very spectacular, so are great and sudden catastrophies like earthquakes. But if figures are to be any criterion, there can be no doubt that epidemics and pestilences claim more victims than either.

The last Great War is calculated to have caused amongst all the belligerents about five millions in killed and permanently wounded, but the influenza epidemic which broke out towards the end of the War was almost world-wide and claimed twice as many victims. In former years, diseases attendant on a war claimed more victims than the war itself. It is only recently that the wounded during the war are being properly cared for and a large percentage is being saved. Forty years ago this was not the case. During the Boer War the total number killed in action was only half the number of victims claimed by fever.

Many great historical authorities are of opinion that the cause of decadence of many ancient empires was not internal weakness, or foreign invasions but rather decay caused by wide outbreaks of pestilences such as, malaria and plague. It is said that Rome was

not really conquered by the Barbarians but fell a victim to internal decay due to the outbreak of malaria in the plains of Italy. During the middle ages, there was a perpetual tripartite struggle between the Pope, the Holy Roman Emperor and the Roman citizens for the possession of power in the Holy City; but on more than one occasion, the issue was decided not by the prowess of arms, but by pestilences. In the 12th century, the great German Emperor, Frederick Barbarossa who was also the Holy Roman Emperor, undertook a punitive expedition at the head of a formidable host of German knights and warriors against the recalcitrant citizens of Rome. He found no trouble in conquering the city completely for the degenerate Romans were no fighters, but immediately afterwards Rome's great ally malaria attacked the German host and nearly 95 per cent of the army died within the incredibly short period of a fortnight. The Emperor, almost alone, had to bid a hasty retreat to his northern fastness.

Epidemics in Ancient and Medieval India

In India there have been many well-known instances of epidemics suddenly overwhelming whole provinces and cities. Mr. R. D. Banerjee, discoverer of the Indus

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Valley Civilisation, once told the present writer that almost the whole of Bengal was completely depopulated during the 8th century. In 1575, the city of Gour which was the capital of Eastern India for over 1000 years came under the possession of the army of Akbar, but almost immediately afterwards some mysterious epidemic broke out, which carried away almost completely not only the whole of the Moghul army of occupation but also the major part of the indigenous city population. The survivors deserted the city for their lives, and it was completely abandoned never to be peopled again. Silt and jungle invaded the site and now the grand city which, according to Portuguese observers, had a population of nearly 2 millions, is a vast ruin covering about 30 square miles buried under thick layers of earth, overgrown with dense jungles and haunted by wild animals.

In medieval times, and even 100 years ago, pestilences were supposed to be due to the displeasure of God. It was supposed to be a punishment meted out to erring humanity and generally little systematic attempt was made to stem its progress.

The Burdwan Fever

Epidemics are not only matters of past history. Within living memory, parts of India, particularly Bengal had been in the grip of deadly epidemics. The most well-known instance is the Burdwan Fever which raged between 1859 to 1874 in the Burdwan Division comprising the districts to the west of Calcutta. Before this period, Burdwan Division was supposed to be the healthiest part of Bengal and people from Calcutta used to go to Burdwan and other cities for recouping their health. One well-known observer writing in 1850 writes about the prosperity of the country in the following terms:

"There were few villages in Burdwan, in which there was not a school in which children are not taught to read and write; there is no portion of territory in Hindoostan that can compare with it for productive agricultural value, in proportion to its size; it appears like a garden surrounded by wilderness."

But alas, all this was quickly changed and in 1859, the district became almost a Valley of Death. What has been the cause of this epidemic known as Burdwan Fever?

According to one school of thought, the epidemic was due to the obstruction offered to the natural flow of rain water during the monsoons, by the opening of the East Indian Railway in 1858. To appreciate this

point of view, one has to study closely the physiography of the Burdwan division. This region is traversed by a number of rivers which arise from the Chhotanagpur hills and after traversing the flat plains of western Bengal find their way into the Hooghly river. The most well-known is the Damodar, which has a course of about 600 miles. All these rivers usually run dry but during the rainy season when there is heavy rainfall in the Chhotanagpur Hills they are filled to the full with water and sometimes spread out over the surrounding districts causing flood and devastation. To protect the land and the crops standing on the fields from these sudden inundations, *bandhs* have been erected from very ancient times on both sides. In times of normal flood, peasants used to make breaches in the *bandhs* and used to irrigate their fields. But in 1854 the East India Company, then rulers of India, decided to confer on India the blessings of railway transportation and open a highway of traffic with upper India. The railway line, the present East Indian Railway, passed from Calcutta over the Burdwan district towards upper India. To safeguard the railway line from the menace of the flood the *bandhs* were strengthened, and breach in the *bandh* by peasants was made illegal.

The Havoc due to Epidemic

But such interference with the course of nature had its terrible Nemesis. Two years after the opening of the line, a terrible pestilence known as the Burdwan fever broke out in epidemic form and continued in unabated strength for over ten years. It carried off nearly half the population. The density of population fell from 750 per sq. mile in 1859 to 500 in 1869. The total mortality therefore could not have been less than 4 millions. The once smiling country noted for its salubrious climate was converted into a veritable Valley of Death.

A contemporary medical authority says "the devastation of the epidemic has a very sad tale to tell. Countries that once smiled with peace, health and prosperity, have been turned into hot beds of disease, misery, and death. Villages that once rang with the cheerful, merry tone of healthful infants, now resound with loud wailings and lamentations. Huts, which offered too little space for their occupants, are left without a tenant. The skulls of human beings now strew the fields at every few yards distance. The fell disease has mocked every human effort, and absorbed in its powerful grasp, day by day and inch by inch, every blessed spot which once used to be prized for its salubrity."†

† 'Burdwan Fever' by G. C. Ray quoted in Brahmachari's 'Kala-azar: Its Treatment' published by Messrs. Butterworth & Co., India, Ltd., Calcutta, 1917.

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The havoc created by this epidemic in some of the villages in the district of Burdwan is briefly noted here. In Panduoh where the disease spread in 1862, upwards of 1,200 people died within six months (Elliot). Pillow pointed out that on the first outbreak in a village the disease was of a very rapid and mortal type. The Army Sanitary Commissioner stated in 1872 that the fever was one of the worst pestilences on record, having in a few months cut off 70 per cent of the population of some of the affected villages. The Inspector-General of Civil Hospitals in his report on the Charitable Dispensaries under the Government of Bengal for the year 1871 stated that the mortality in one outbreak amounted alone in a few months to one-third the original strength of the community.

The terrible mortality which depopulated Purbuthulee* and its adjacent villages in 1862, as mentioned in the petition made by the inhabitants of the place to the Government in the same year, must have been due to a great extent, to attacks of fever of a similar nature.

We described the locality as a Valley of Death. But it is not figure of speech invented by us, but was actually used by prosaic medical men of the times. According to the *Indian Medical Gazette*, Vol. VIII 1873 the disease, converted some parts of the districts of Burdwan and Hooghly into a 'Valley of the Shadow of Death' into which if any human being, whether robust or weakling, well nourished or the opposite, entered, he was almost certain to get an attack of fever and get a very severe one, and he might consider himself very fortunate if he escaped out of it with life. The fever, according to Ward, affected every native in Burdwan, and afterwards, according to Metcalfe, every human being resident in the town and affected the rich and poor alike.

Two Angels of Death at Work

What was exactly the nature of this Burdwan epidemic? According to Sir Leonard Rogers, it was a form of Kala-azar. But according to other authorities, the Burdwan epidemic consisted of two types. Firstly the malignant type of malaria, and secondly Kala-azar. The two types are described by the Epidemic Commission in 1864 as follows:—

"The disease is characterised in its deadly form by great general prostration, cerebral congestion and early collapse from which the patient, having no power to rally, is cut off in 36 hours to four or five days. During

*A village on the ruins of an ancient city, supposed to be Parthalis of Ptolemy (150 A.D.), capital of the Gangaridae Kingdom of Megasthenes.

a first attack the head is the seat of congestion. The eyes are bloodshot and aching, the face is suffused, delirium early ensues and collapse terminating fatally in a few hours closes the scene. Next in urgency to the cerebral symptoms, we have to deal with a highly congested state of the thoracic viscera and with great difficulty of breathing; the air-tubes become loaded with mucus and death finally results from asphyxia." This description appears to indicate that this type of Burdwan fever was a kind of malignant malaria.

Another type is described by a well-known medical authority, Dr. G. C. Ray, which is as follows:—

"The first and most frequent in order is enlargement of the spleen. It varies considerably in size, from being just perceptible under the costal cartilages to filling up the whole abdomen. From a distance the pot-bellied feature with distended veins on the surface of the abdomen gives an appearance of dropsy. There may be enlargement of the liver. There may be obstruction to the portal circulation ending in ascites. There may be large prominent veins on the surface of the abdomen. Dropsy is the sequelae with which these cases take a fatal turn.

"The lean emaciated limbs and haggard countenance seen on a bloated trunk gives a most unsightly appearance. Unless timely treated with tonics and nourishment, cancrum oris makes its appearance and puts an end to the patient's miserable existence. It is frequently accompanied by dysentery. There is a watery state of the blood and there may be hæmorrhagic diathesis. Bleeding from the nose and gums is a very common complication. There may be bleeding from the mouth or rectum."

The symptoms described by Dr G. C. Ray make it very probable that this second type was nothing but Kala-azar. There were thus two different angels of death working in this unhappy district.

The Kala-azar Epidemic of Assam and Bengal

The Burdwan epidemic lost its virulence about 1875, but towards the beginning of the current century, the Kala-azar (Black fever) epidemic broke out in a deadly form over many parts of Bengal and Assam. It is called Black Fever because the skin turns black in chronic cases. It occurs in children and adults and is accompanied by enlargement of the spleen and frequently also of the liver. A gradual down-hill course with progressive emaciation, anæmia, leucopenia leads to marked cachexia and hæmorrhage in different parts of the body. It is usually terminated by some intercurrent disease or cancrum oris. The mortality from this terrible disease was until recently more than 98 per cent. The areas

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affected during an epidemic comprised almost whole districts, and whole families were at times afflicted with the disease.

The disease affects mostly the eastern parts of India, such as Assam, Bengal, Bihar, certain parts of U. P. and Madras. But it is not wholly an Indian disease. It also occurs in China, in the Mediterranean basin, certain parts of Greece, Sicily, Italy, Spain, and northern parts of Africa. It has also been found in South America as well. In fact a hot and moist climate and jungle areas are found to be particularly favourable for the prevalence of this disease. In the first part of the twentieth century the disease took such a deadly form in Assam that many areas were converted into veritable Valleys of Death. The district of Goalpara and Kamrup recorded between 1881 to 1891 a decrease in the population much in excess of increase of population in unaffected easterly districts. In the decade 1891-1901 the disease spread to eastern Assam and the Nowgong district of Assam showed a reduction of 31.5 per cent in its indigenous population. It affected whole tracts

and sometimes whole families and villages were wiped out. The labour in the tea plantation of Assam which was mostly imported from Bengal and Bihar was terribly affected and the planters found it difficult to recruit new labourers for their work. The annual mortality during the worst years must have amounted to over a million; and this continued over twenty five years.

Attempts were made by medical men of all shade to cope with the terrible scourge but to no avail. Allopathic doctors plied their patients with large doses of quinine, homœopaths with their own preventives, *Kavirajas* and *Hakims* delved deep into the ancient wisdom of India and Greece, but to no purpose. In despair, the people of the afflicted regions who lived a living death had recourse to black magic. Very often, the epidemic was ascribed to inauspicious position of planets, and services of planetary priests were invoked. But neither medicines nor gods appeared to have the slightest influence on the course of the disease, and a person afflicted with Kala-azar considered himself as 'good' as dead. It was at this state that modern science came to the aid of medicine. The story of the conquest of Kala-azar will be told in a subsequent issue.

Dr. Millikan's Farewell Note

Dr R. A. Millikan before going out to Colombo after his work in India broadcast the following message from the Trichinopoly station of the All India Radio.

I want to say to all my friends that I am very happy to have had the opportunity to make this visit to India. I came here with my associates Dr H. Victor Neher and Dr William H. Pickering to do a particular scientific job in collaboration with the Indian Meteorological Service. I have had the most extra-ordinary co-operation from that service and I am glad to say, which is highly developed and is doing a meteorological job which is a credit to your country. I have also

found that the kind of scientific work going on in India, in other localities, in Calcutta, in Bangalore, in Lahore, in Bombay and in Agra, all of which cities I have visited and in all of which cities I have had the great pleasure of seeing many of my former Indian Associates who have made outstanding names for themselves, names that go round the world like Sir C. V. Raman Prof. Saha the first of Bangalore, and the second of Calcutta. There are also younger men who are coming on, whose names are now becoming well-known. I have great pleasure to associate with all these men and it has been a profitable thing for us to have their co-operation in this scientific job, which we have been doing here in India.

RESEARCH NOTES

Isolation and Properties of Vitamin H

Rats fed on a ration that is well balanced except for a large proportion of egg white as the sole source of protein develop peculiar and impressive skin changes followed by progressive emaciation leading finally to a fatal outcome. This egg white injury is considered a toxic condition. Vitamin H, present in different foodstuffs, has been found to neutralise the toxic effect.

The main sources of vitamin H are liver, kidney, yeast and to a lesser extent cows' milk. Summer milk is more potent than winter milk. Breast milk has only very slight therapeutic potency.

Vitamin H is liberated in a water soluble form by autolysis of yeast in the presence of toluene. It is resistant to boiling and is not precipitated by lead acetate from yeast autolysates, either in acid or in neutral solution.

György, Kuhn and Lederer, (*J. Biol. Chem.*, 131, 745, 1939) record the result of their attempts to isolate the vitamin to study its chemical behaviour and curative property. As liver is a more potent source of vitamin H the question arose as to whether or not it could be separated also by autolysis of liver tissue from the water-insoluble complex in which it occurs. It was found that unlike yeast, liver does not possess the enzymatic apparatus necessary for the autolytic liberation of vitamin H from the compound of greater molecular weight in which it occurs. Digestion with papain and autoclaving at high pressure has proved satisfactory procedure for the liberation of vitamin H from a dry liver powder left after the removal of liver extract in the commercial preparation of Campolon.

Water solutions of vitamin H thus obtained were inactivated by treatment with formaldehyde, nitrous acid, benzoyl chloride and ketone.

By means of electrodialysis the factor was found to have an isoelectric point between pH 2 and 4. The

actual value appeared to be between pH 3 and 3.5. Thus the factor is an ampholyte exhibiting acidic properties. Attempts at precipitation by means of Dakin's method was not successful. The sodium salt of vitamin H is soluble in absolute ethyl alcohol, while $\text{Ba}(\text{OH})_2$ or of $\text{Ca}(\text{OH})_2$ renders the active principle insoluble in ethyl alcohol.

H. N. B.

Antarctic Zone of Maximum Auroral Frequency

Although the zone of maximum auroral frequency is of considerable theoretical and practical interest yet no definite idea of the position of this zone in the Antarctic Continent existed till now except for the very general knowledge that the Aurora Australis has been seen very much less frequently in the western sector (about Graham Land and the Weddel Sea) than in the eastern sector (about the Ross Sea). In an important contribution that appeared in the latest issue of the *Terrestrial Magnetism and Atmospheric Electricity* (Vol. 44, p. 367, 1939), F.W.G. White and M. Geddes from New Zealand utilising the records left by explorers and scientific expeditioners of the Arctic Continent attempted to fix this zone of maximum auroral frequency.

The zone roughly resembles a circle of about 18° centered about a point of 75° south and 129° east, a point near magnetic axis-pole. It has a northerly direction about 150 km. to the east of Little America and from there curves to the westward until it has an east to west trend either over, or just south of Macquarie Island. The roughly circular curvature of the zone brings it near Mawson's station in Queen Mary Land. There is no doubt that the path of the zone lies over the Antarctic Continent and that it passes very near the geographical pole.

A comparison with the Arctic zone of maximum frequency may be of interest. The Arctic Zone is a

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circle of 23° radius about the axis pole. The magnetic field in the Northern Hemisphere is far from circular and it is supposed that the considerable deviation from the circular shape which occurs in the region of 180° east is due to the field asymmetry. In the Southern Hemisphere the field is much more symmetrical and it is to be expected, therefore, that the zone would have more nearly circular form as shown by the present investigators.

Störmer's theory of aurora requires a zone radius of 16°-19° for α -rays. The 23° radius of the Arctic zone is considered to be close to the required figure of 19°, but it seems probable that the zone radius in the Antarctic is in better agreement with the theory. Obviously the greater symmetry of the terrestrial field provides an advantage lacking in the Northern Hemisphere. However, the nature of the evidence from the Antarctic, as observed by the authors themselves, is undoubtedly far from conclusive and there still remains a strong necessity of further measurements.

S. D.

The Influence of Cyanide on Brain Potentials in Man

The study of the effects of various chemicals on potentials has proved to be one of the fruitful ways in the investigation of their intrinsic nature. Rubin and Freeman (*J. Neurophysiol.*, 1, 527, 1938) in an interesting series of experiments gave intravenous injections of .7 cc of 2 per cent solution of sodium cyanide (NaCN), equivalent to 14 milligrams, via the antecubital vein near the elbow. A group of 19 schizophrenic patients were used as subjects. It had already been known that NaCN has a facilitating influence on motoneurons of the spinal cord of cats (Porter, Slair and Bohmfalk, *J. Neurophysiol.*, 1, 166, 1938) and is a strong respiratory stimulant in subconvulsive doses (Lovenhart, Lorenz, Martin and Malone, *Arch. Intern. Med.*, 21, 109, 1918), the carotid sinus being its site of primary action. The purpose of the above-mentioned study was to discover changes, if any, caused by NaCN on brain potentials. These potentials were recorded by means of a standard EEG equipment. NaCN was found to produce a series of deep gasps which occurred 15 to 20 secs. after the injection and lasted for 10 to 20 secs. Usually the brain potentials changed immediately after the respiratory response ceased and they resumed their pre-NaCN level in about 2 mins. In general, and barring certain

instances of individual differences these changes consisted in the enhancement of the alpha rhythm (10 per sec.), i.e., an increase in the amount of activity per unit time, in amplitude and regularity. The motor region and also the frontal regions were most affected, the parietal region the least and the occipital revealed variable results. But in an instance of narcoleptic individual the alpha rhythm, after the usual injection, changed into 5 to 6 per sec. waves, then resolved into an irregular pattern before returning to normal in 2 mins. And in a catatonic stuporous patient who was conscious all the time, the response was practically the same. This increase of brain activity in one series and its slowing and irregularity in the last two cases, the authors maintain, cannot both be explained by (i) small uni-directional cardio-vascular changes following the injection, or (ii) the usual decrease in the blood pH of animals found by some authors under NaCN injection causing a possible decrease in pH of the cortex, or (iii) hyperventilation which is calculated to increase the pH of the cortex and may produce unconsciousness. The authors conclude that both effects are due to the direct action of NaCN on cortical neurones but believe that the pre-existing state of the cortical neurones determine their differing responses. That is to say, if the tendency is towards fast activity (i.e., the alpha rhythm) as in the case of the majority of the patients, NaCN will enhance it. On the other hand, when the cortex is functionally "depressed" as in narcolepsy and in catatonic stupor, NaCN will slow it down.

B. K. B.

Rainfall Homogeneity of an Area

A statistical method for testing the rainfall homogeneity of an area and the use of the method for studying the monsoon rainfall recorded at 11 rain-gauge stations in the Amraoti district (Berar) during a period of 41 years, are discussed in the India Meteorological Department *Scientific Note* No. 84, by Mr N. Rajagopalan. It is important for the correct meteorological assessment to know whether a portion of the country like a district is homogeneous in rainfall. The questions often arise in the meteorological practice as to how many rainfall recording stations should be installed in a particular area and where they should be located. The Amraoti district which was chosen for tests, can be properly divided into two parts: (i) an expanse of level country lying in the rich valley of Payanghat and (ii) a tract of mountainous country of little agricultural value. The first part consists of five *taluks* and the

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second part of one *taluk*. The average monsoon rainfall in the different *taluks* (June to September) lies within the range 24" to 32" except in the last where it approaches 55". It is found that the variability between the rainfall of stations in the district is more than what one would expect according to mere chance. This holds good even if the last *taluk* is left out of consideration. Although the actual amounts of the rainfall may vary from place to place in the same year, the figures recorded during the series of 41 years at the various stations are highly correlated showing that years with excessive rain tend to have heavy rain at all stations and years with scarcity of rains tend to have scanty rainfall at all stations inside the district. Further, the rainfall at a particular station is more closely related to rainfall at stations in the same *taluk* than that at stations further away in their *taluks*. These studies indicate the need for a closer network of rain gauge stations in the district as a whole.

Isolation and Properties of Crystalline Papain

Isolation of crystalline papain from crude papaya latex is claimed by A. K. Ball and H. Lineweaver (*J. Biol. Chem.*, 130, 669, 1939) who prepared it by repeated salting out the protein from the latex solution in presence of sodium cyanide. Loss of activity of papain by oxidation may be minimised by the presence of cyanide, sulphide or cystine and by working at low temperature or preferably excluding the air by nitrogen. The purified enzyme is relatively stable towards oxygen; consequently the original instability is due to the presence of an impurity probably heavy metals. The crystals obtained are thin needle-shaped and their suspensions show no lack in homogeneity under the microscope. The activity of papain is usually determined by its milk-clotting or haemoglobin-digesting power or hippurylamide splitting activity. It is isoelectric at about pH and its molecular weight,

measured by osmotic pressure methods, is found to be 27,000. Papain contains 15.5 per cent N, 1.2 per cent total sulphur of which 0.94 per cent consists of cystine sulphur. The inactivation of papain with iodo-acetate and cystine would seem to indicate the presence of the SH group in the enzyme but nitroprusside and porphyrindin tests fail to demonstrate it. The question of SH in papain therefore still remains unsettled.

A. B. S.

Pyruvic acid in normal and vitamin B₁ deficient states.

B. S. Platt and G. D. Lu (*Biochem. J.*, 33, 1525, 1939) have observed that the amount of bisulphite binding substance (B. B. S.), particularly pyruvic acid is increased in blood cerebrospinal fluid, urine and milk of adult-subjects, in all cases, of fulminating and, in a number of cases, of subacute beri-beri. They have confirmed that there exists a close relationship between pyruvic acid metabolism and B₁-avitaminosis. Their results indicate that the values for pyruvate and B.B.S. in blood and cerebrospinal fluid in subacute cases are within the normal limits or are only slightly increased but they are appreciably increased in the acute cases. Accumulation of pyruvic acid also markedly increases in milk and urine of B₁-deficient patients. The increase of B.B.S. observed cannot be accounted for by the increase of pyruvic acid only. This discrepancy can be accounted for by including acetaldehyde, methylglyoxal and α -ketoglutaric acid in this group. Their origin may be directly related to vitamin B₁-deficiency or they may be the products of pyruvic acid or some other product of metabolism. The amount of pyruvate present even in acute cases of beri-beri does not, however, appear to be toxic. After injection of vitamin B₁, reduction of the pyruvate level of blood and cerebrospinal fluid occurs which is accompanied by an increase in its urinary output.

A. B. S.

UNIVERSITY AND ACADEMY NEWS

PROCEEDINGS AND PUBLICATIONS

Indian Physical Society and the Indian Association for the Cultivation of Science

(Calcutta, November 1929, Ind. Jour. Phy.

Vol. XIII Pt. V)

HAZARILAL GUPTA AND ABINASH CHANDRA: Evaporation from earthen jugs.

NAWAZISH ALI: Absorption spectra of compounds of phosphorus.

F. C. AULUCK: Linear extension of reflected image produced by a surface traversed by waves.

P. C. MAHANTI AND A. K. SEN GUPTA: Isotope effect in band spectrum of tin monoxide.

SACHINDRA MOHAN MITRA: On the polarised fluorescence of organic compounds.

Botanical Society of Bengal

(Calcutta, 2nd February, 1940)

B. C. KUNDU: Origin and development of Jute fibres.

ANNOUNCEMENTS

Entomological Society of India

The Society elects its President every year and other office bearers every two years.

Dr Hem Singh Pruthi was elected President of the Society for 1940 and Mr M. Afzal Husain as one of the Vice-Presidents from among the past Presidents of the Society. In consequence of Dr Pruthi's election to presidentship, Dr N. C. Chatterjee of Dehra Dun was elected Vice-President and Mr P. M. Glover of Namkum, Ranchi, a member of the Executive Council.

Society of Biological Chemists, India

(Executive Committee for 1940)

President: Sir Upendranath Brahmachari, Vice-Presidents: Dr G. J. Fowler and Rao Bahadur B.

Viswanath, Lt. Col. S. L. Bhatia, Dr J. C. Ghosh, Mr R. C. Srivastava, Hon. Treasurer: Mr. B. N. Banerjee, Hon. Secretaries: Dr C. N. Acharya, Mr T. R. Bhaskaran, Members: Dr B. C. Guha, Dr V. N. Patwardhan, Dr M. Damodaran, Dr B. K. Narayana Rao, Mr N. V. Joshi, Mr K. Ramaiah, Mr Jai Chand Luthra, Dr S. Kasinatha Iyer, Dr T. N. Seth, Dr H. D. Sen, Dr K. P. Basu, Dr H. K. Sen, Dr B. Sanjiva Rao.

Royal Asiatic Society of Bengal

(Council for 1940)

President: The Hon'ble Justice Sir John Lort-Williams, Vice-Presidents: Bt.-Col. R. N. Chopra, Sir Bijay Chand Mahtab, Dr C. S. Fox, and Dr Syamaprasad Mookerjee, General Secretary: Dr B. S. Guha, Treasurer: Dr Baini Prashad, Philological Secretary: Dr S. K. Chatterji, Joint Philological Secretary: Mr M. Mahfuz-ul Haq, Natural History Secretaries: Biology: Dr Kalipada Biswas, Physical Science: Dr Maghnad Saha, Anthropological Secretary: Mr H. C. Chakladar, Medical Secretary: Major C. L. Pasricha, Library Secretary: Dr J. N. Mukherjee, Members: Mr Percy Brown, Dr S. C. Law, Dr Kalidas Nag, Sir S. Rahdhakrishnan, Dr M. Z. Siddiqi, and Mr W. D. West.

Physiological Society of India

(Executive Committee for 1940)

President: Bt. Col. R. N. Chopra, Vice-Presidents: Lt.-Col. S. L. Bhatia, Dr John B. Grant, Prof. N. M. Basu, Prof. N. C. Bhattacharya, and Sir U. N. Brahmachari, Secretaries: Dr B. Mukerji and Prof. G. Sankaran. Assistant Secretary: Dr D. N. Mallick, Treasurer: Dr S. K. Sen. Members: Prof. B. C. Guha, Dr B. Ahmad, Prof. B. B. Sircar, Mr P. B. Sen, Prof. N. M. Basu, Mr S. N. Mukerjee, Dr S. Banerjee, Dr P. N. Brahmachari, Prof. W. Burridge, Prof. B. T. Krishnan, Prof. B. Narayana, Prof. S. A. Rahaman, Dr K. S. Grewal, Dr S. M. Banerjee, Dr N. N. Das and Prof. N. C. Bhattacharya.

UNIVERSITY AND ACADEMY NEWS

Indian Botanical Society

(Executive Council for 1940)

President: Dr H. Chaudhuri, Vice-Presidents: Rai Bahadur Prof. K. C. Mehta and Dr K. Bagchee, Secretary: Prof. Y. Bharadwaja, Treasurer: Prof. M. O. P. Iyengar. Members: Prof. S. P. Agharkar, Dr P. L. Anand, Dr K. Biswas, Prof. S. R. Bose, Prof. T. Ekambaram, Prof. S. L. Ghose, Prof. J. H. Mitter, Principal P. Parija, Dr S. Ranjan and Prof. B. Sahni.

RESEARCH WORK IN INDIA

Palaeobotany in India

Lucknow University and other Centres

Since the revival of palaeobotanical research in India in 1921, the workers have multiplied in number and are now scattered over a large country. Hence the need has been felt for co-ordinating their activities by means of a committee representing all workers in the field all over India, specially from Lucknow, Bangalore, Dehra Dun, Surat, Amritsar, Nagpur, Trichur and Mandalay, who are in co-operation with the Geological Survey of India and of some States also.

The fossil floras that are at present engaging special attention are, in order of age, the *Glossopteris* flora (in the Salt Range and in the Bengal and Behar coalfields); the Jurassic (Upper Gondwana) flora of the Rajmahal Hills and of the Salt Range; the early Tertiary silicified flora of the Deccan, and the Pleistocene flora of Kashmir. Some work is also being done on material from other countries: Australia, Brazil, South Africa and Afghan-Turkistan. The following is the progress report for 1939.

Investigations on the flora of some of the earliest of the Gondwana sediments, in the Salt Range, the horizons being as low as 1½ ft., 4½ ft. and 25 ft., above the Talchir (glacial) boulder bed are in progress. Associated with typical impressions of *Gangamopteris* and *Glossopteris*, a new species of *Ottokaria*, *Scmaropsis* spp., *Cordaicarpus*, etc., many different types of spores, winged and unwinged have been found. The cuticles of several of the plants are being described and figured. Study of spores and cuticles are being pursued with a view to see if they can be used for a stratigraphical correlation of the lower Gondwanas and eventually of coal seams in India.

This, the earliest of the known Indian Gondwana floras, has significance in connexion with the question of the climatic conditions in which the *Glossopteris* flora originated. The facts suggest that it was contemporaneous with the Talchir glaciation, spreading into the ice-free areas of Gondwanaland, but retreating as the ice advanced.

The above view is supported by the discovery in a fragment of the tillite from Bacchus Marsh, Victoria, (Australia) of several types of spores identical in structure with those found in the Lower Gondwanas of the Salt Range and in the Daltongunj and Rewah basins. These spores must have belonged to early members of the *Glossopteris* flora. Flying about over the snow and ice the spores must have settled down on the surface and were ultimately entrapped and preserved in the moraines.

Tillites from several other parts of Gondwanaland are being searched for spores.

PERMO-CARBONIFEROUS: The cuticle of *Glossopteris communis* in Daltongunj coalfield, (Behar) has been studied. In the same specimen of shale a number of free-lying spores were found.

From a fragment of shale crowded with leaf incrustations of *Glossopteris browniana* from New South Wales (Australia), has been recovered many double-winged spores of the *Pityosporites* type.

From a piece of *Glossopteris*-bearing shale from Rewa (Central India), some spores similar to those in the Salt Range Gondwanas and also in Behar and Victoria have been found.

PERMIAN: Specimens of *Lycopodiopsis Derbyi* obtained on loan from the School of Mines, Paris, and from the Bonn Museum (Brazil) have been examined in detail and Renault's view that the stele consists of a ring of separate bundles, and that the genus is therefore distinct from *Lepidodendron* has been confirmed. Found in association with members of a *Glossopteris* flora, this species is regarded as a descendant of the southern pre-Gondwana lycopods, some of which are believed to have survived the Talchir glaciation.

TRIASSIC: A small flora collected in the Salt Range from beds regarded as Triassic is being studied. The plant remains are extremely fragmentary and their specific identification has not been so far possible. Isolated spores, some with a well defined triradial

mark, have been obtained. Peel preparations have yielded cellular details in some fragments. The specimens consist of fragments mostly of the equisetaceous and sphenopteroid types; pinnule fragments with a *Cladophlebis* type of venation have been isolated.

JURASSIC: A flora of undoubted Jurassic age, the only one yet collected from definitely recorded localities in Afghan-Turkistan, has been studied. The collection includes, besides such characteristic Jurassic species as *Cladophlebis denticulata* and *Coniopteris hymenophylloides*, the following forms: *Sphenopteris*, *Nilssonina*, *Ctenis*, *Pagiophyllum*, *Mesembrioxylon*, *Podozamites* etc. Of chief interest are some imperfectly preserved fronds which for their pedate habit are remarkably like *Matonia*. A curious strobilus-like impression, *Strobilites* sp. nov., shows a number of obovate seeds or fruit-like bodies attached spirally on an axis.

A detailed investigation of the Jurassic flora of Sakrigalighat in North Behar has been completed. A new type of fructification, *Sukristrobus* gen. nov., is created for strobili with peltate sporophylls carrying numerous sac-like structures. A new species of *Sagenopteris*, *S. Bhambhani*, has been described. The anatomical structure of the rachis of *Cladophlebis Indica* and *Ptilophyllum acutifolium* and the epidermal features of *Taeniopteris* of *T. crassinervis* could be studied to some extent. Several other common Rajmahal forms are also being studied.

A detailed account has been prepared of the anatomy of a silicified fern, *Tinpaharia sinuosa* gen. and sp. nov., discovered at Tinpahar on the loop line of the East Indian Railway in Behar. There are reasons for the view that *Tinpaharia* represents the petrified vegetative organs of the widespread Jurassic fern *Coniopteris hymenophylloides*. The stems, petioles and roots have all been found organically attached together, while closely associated with them are seen leaf impressions, both sterile and fertile, strongly resembling those of *C. hymenophylloides*.

Of some petrified plants from Nipania in the Amrapara District a detailed account of the anatomy of *Taeniopteris spatulata* has been prepared. The epidermal characters on the whole appear to suggest a Bennettitalean rather than a Cycadalean affinity, but the vascular bundles in the midrib are exactly of the type seen in the modern cycads. The correct systema-

tic position of the plant that bore these leaves can only be settled when the fructifications are known.

Of two silicified cones; a male cone, *Masculostrobus rajmahalensis* sp. nov., has been found to contain winged pollen grains of the abietineous or podocarp type, and associated with this cone several lax megastrobili characterised by scales bearing single suberect or inverted ovules with curved micropyles have been observed. It is believed that the male and female cones belong to the same species, but pending a proof of this identity the female cones have been described under a new genus, *Nipaniostrobus*.

Work is in progress for identifying a large collection of Jurassic plants from the Salt Range. Numerous well preserved cuticles have been prepared, and it is hoped to reveal the internal anatomy of some of the mummified plants by means of microtome sections. Among the more important forms in the collection are (a) Ferns (sterile and fertile); a fragment, probably a *Laccopteris*, has yielded some finely preserved spores; (b) Forms of *Brachyphyllum* grading into *Pagiophyllum*; (c) Parallel veined leaves of *Podozamites*; (d) *Otozamites* spp.; (e) Lignites. Cuticular studies are expected to bring additional species to light.

A small collection of Jurassic plants from Tabowa in N. W. Ceylon has been studied and the following are the more interesting forms:

Coniopteris hymenophylloides, *Cladophlebis* spp., *Anomozamites* (? *Nilssonina*) sp. and *Elatocladus plana*. The collection is of interest as it adds to our knowledge of this most southerly outpost of the Indian Gondwanas.

CRETACEOUS: The occurrence of fossil algae in some of the limestones of Pondicherry area was first noted about eight years ago. These fossils are now being examined in detail and the results are likely to throw some light on the exact age of the containing beds.

CRETACEOUS? OR TERTIARY?: The fossil flora of some of the intertrappean beds, recently discovered near Gurmutkal, Gulbarga District, Hyderabad State are under investigation.

CRETACEOUS? and TERTIARY: Some limestones from Assam of doubtful Cretaceous or Eocene age, together with other rocks which are definitely of Eocene age are under investigation of their algal flora.

TERTIARY: From the interbasaltic sedimentary beds of the Deccan a well preserved silicified flora is under study. Already a collection from the region round Sausar in the Chhindwara District has shown that this is a rather specialised flora, consisting largely of aquatic forms such as Charophyta, *Azolla intertrappea* sp. nov. and other water-ferns, including a possible *Regnellidium*, as well as various fragments of aerenchymatous tissues, presumably of aquatic angiosperms. Several types of algae, fungal mycelia with attached fructifications (including a new genus named *Palaeosordaria* and a new species of *Perisporioides*) and isolated spores of various kinds have been figured.

The anatomy of *Palmoxylon kamalam* Rode from specimens collected in the Pupuldoh reserve forest area in the Central Provinces and a new species of *Dadoxylon*, *D. deccanensis* have been studied. Further material of petrified palms and dicotyledons has been collected near Nawargaon, Wardha District.

A comprehensive investigation of Indian petrified palms (form genus *Palmoxylon*) was begun in 1920. So far as known, nearly all this material is of Tertiary age, and most of it comes from the Deccan intertrappean series.

A detailed study of the fossil Charophyta from the intertrappean beds of Rajahmundry area has been completed. Further studies in the fossil algae from these beds are under progress; the genus *Halimeda* and a new species of *Dissocladella* have been noticed.

While studying the algal flora from the Lockhart limestone of the Ranikot succession in the Samana Range in North-West Frontier Province, the occurrence of *Lithophyllum* has been noticed here for the first time.

Fossil algae in the Eocene limestones of the Salt Range has recently been discovered. The outstanding feature of this algal flora is the remarkable association of forms like *Dissocladella*, *Acicularia* and *Neomeris* which are known to commonly occur in Eocene beds, with others like *Diplopora* and *Oligoporella* which are elsewhere unknown in beds younger than the Triassic. A detailed study which is under progress promises to be of great interest, both from the stratigraphical and palaeobotanical points of view.

Two fossil dicotyledonous woods from the Garo Hills, Assam, under the name *Dipterocarpoxylen*

garoense sp. nov. and *Dryoxylon* sp. have been described.

A detailed account of a fossil wood, *Cynometroxylon indicum* gen. and sp. nov., from Nailalung on the Assam Bengal Railway is under preparation.

The best known Pleistocene flora of India is that of the Karewas of Kashmir, only the macroscopic remains have yet been dealt with. Among the genera recognised till now are *Quercus*, *Salix*, *Populus*, *Alnus*, *Berberis*, *Rosa*, *Trapa*, and many others. Over 90 species belonging to 48 genera and 24 families have been determined, nearly all being modern forms living in the valley and neighbouring mountains of Kashmir.

Investigating the microflora of the Karewa beds, collected from several localities: Gulmarg, Bota Pathri, Dangarpur, Hajabal, Satar Siran, etc., (all in the Pir Panjal Range), the following genera have been identified by their pollen grains: *Pinus*, *Cedrus*, *Picea*, *Abies*, *Carpinus*, *Alnus*, *Betula*. Several other forms are still unidentified, the work being handicapped by a lack of knowledge of the modern pollens of Kashmir, which are now being collected.

Detailed information about references and publications of the above works are available from the secretary of the committee at the department of botany, Lucknow University.

Osmania University

The following is a summary of some of the investigations in which the botany department of Osmania University was engaged during the year 1938-1939.

Systematic (Angiosperms): The flora of Hyderabad is being worked out for the last eight years, and reports are being published under the title "Further contribution to some of the common flowering plants of the Hyderabad State; their distribution and economic importance—Dicotyledons." (*Jour. Bomb. Nat. Hist. Soc.*, XL, 2, 1938) in which 255 species belonging to 70 families were recorded. Another contribution was made on "Some of the most important timber-yielding trees and shrubs of H. E. H. The Nizam's Dominions." (*Jour. Os. Univ.*, V, 1939).

Ecology: The vegetation of Adigmet (University area) was studied from both the systematic and ecological points of view (Ecological Studies round about Adigmet, *Sc. Forum*, III, 4, 1939). Observations were made on the aquatic vegetation in some of the ponds. (*Jour. Os. Univ.*, IV 1938).

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Anatomy: Anatomical study has been made of some of the Compositae—*Vicoa auriculata* Cass., (*Cur. Sc.*, 8, 7, 1938), and of some of the Verbenaceae (*J. I. B. S.*, 18, 2, 1939).

A serial is being published on "Some common Indian herbs with notes on their anatomical characters." Two parts have come out (*Jour. Bomb. Nat. Hist. Soc.*, XLI, 1, 1939 and XLI, 2, 1939), dealing with the systematic and anatomical part of *Sesamum laciniatum* Klein. and *Herpestis Monniera* H. B. & K.

All-India Institute of Hygiene and Public Health

Diseases: Results of practical value have been achieved during the year 1938 in various investigations into diseases and nutrition deficiencies. The causation of epidemic dropsy, popularly, though erroneously, known as *beri beri* has been attributed to a poisonous oil for detection of which simple tests have been evolved. The poisonous substance in the oil has been found to belong, to a weed called *Argemone mexicana*, popularly known as *Kata Kar*, *Sial Kanta* and *Odissimari* in different parts of the country, which often grows in the mustard fields.

The relation between rats and plague is well known, but has been revealed by investigations at the Institute that this pest also causes epidemics of severe diarrhoea and certain obscure fevers resembling typhoid.

Investigations have shown that a mild form of scurvy is one of the ways in which the body is left damaged by malaria and that lime juice is a good remedy. The principle has been applied in the new treatment, evolved at the Institute, of black-water fever (a particularly pernicious form of malaria) which has so far proved entirely successful.

A curious phenomenon has been observed namely, that there is, in epidemics, a preponderance of one type of malaria parasite over another. It is now possible on the basis of this finding together with rainfall in dry months, to forecast the probable incidence of the disease.

Studies have been continued on cholera and the conclusion has been reached that cholera incidence is exhibiting a downward trend in some of the worst affected areas of Bengal. Investigations into why cholera persists in certain areas in Bengal and flares up in certain other areas at apparently irregular intervals, are under progress.

Nutrition: With the help of an ingeniously constructed apparatus evolved at the Institute, with which it is possible to study the effect of light on the deeper membranes of the eye, it has been shown that as many as 17 per cent of men taking what is called an adequate diet and 43 per cent of those taking a poorer diet show signs of deficiency. Only in 16 per cent of the latter group was external evidence of deficiency diseases manifest. Most of them made rapid recovery when the element which was deficient in their diet was supplied.

Though popularly and correctly associated with low vitality, unnatural paleness of the face is not always in direct proportion to the seriousness of the condition of the sufferer. The colour is due to a red pigment contained in minute discs in the blood and depends on the amount of pigment, but does not give an indication of the size of the disc carrying the pigment. Regular and correct size of the discs is just as important as, if not more important than, the total amount of pigment. For measurement of the size of these little discs a newly evolved apparatus has been put to practice.

A simple method has been worked out of studying the structure of the teeth, which gives indications of efficiency in the assimilation of lime by the human being, and the milkteeth of children when they drop out, can now be utilized for a study of the nutritional history of the child.

Another finding, which has resulted from investigations at the Institute, relates to the vitamin A contents of the liver oil which can be extracted from certain fish found in Bengal. The virtues of cod liver oil as an article of food depend upon its vitamin A contents, and the liver oils of certain varieties of fish found in Bengal waters locally known as "*bo-al*" and "*a-ir*" are 25 times as rich in vitamin A as Norwegian cod liver oil, and that oils obtained from "*dhain*" and "*shole*" are nearly twice as rich as those of "*bo-al*" and "*a-ir*."

Tuberculosis: Active research is being carried out to discover the causes of high incidence of tuberculosis in the jute industry, and it is hoped that these investigations will in time lay bare the vital points on which an effective and fruitful attack on the tuberculosis problem can be directed. The incidence of tuberculosis of the lungs was found to be as high as 2 per cent amongst workers in a jute mill near Calcutta, with an additional 5 per cent or more of probable cases excluding the calculation of the people actually ill who had dropped out.

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INTRODUCTORY QUANTUM MECHANICS—by V. Rojansky, Ph. D., (Blackie and Son Ltd.). Pp. 544. Price 22s. 6d.

The whole field of atomic physics has become nowadays susceptible to quantitative treatment owing to the development of quantum mechanics; and in these days when quantum mechanics is brought to bear upon subtle processes of sub-atomic or nuclear field, one has no other alternative but to fall back upon a thorough training in the various aspects of the quantum theory. On reading Prof. Rojansky's book we are glad to find that a consistent scheme of presentation of the subject-matter has been developed which, we have every reason to believe, will be of material help to students of pure physics. The author has devoted two long chapters, *viz.*, I and IX, to a course of preliminary mathematics, dealing with differential operators, eigenvalues and eigenfunctions, orthogonal sets of functions, representations of mappings by means of matrices, vectors and matrices, representation of differential operators by means of matrices, etc. A justification for his incorporation of such topics is quite evident: this will serve as a tool with which some physical matters dealt with are to be handled. His introduction of an idea of mappings is very cogent especially in the sense of a process of rearranging the points comprising a plane, so that mappings can be regarded as operators whose operands are vectors. This makes 'mappings' and 'operators' indistinguishable, and they can be construed as interchangeable terms. The differential operators are mappings of a certain space, which has been named the 'function space.' The idea of mappings and their representation by means of illustrations and pictorial designs coupled with typical problems annexed in suitable places will provide the reader with suitable drill in the art of manipulating matrices, which has been found to be a very dry subject for a physicist to tackle.

Chapter II of the book deals with a few remarks on classical mechanics, wherein starting with Hamil-

tonian functions he has worked out the case of the linear harmonic oscillator, its classical limits with regard to position and momentum, and stated the maximal set of conditions for such a particle. Then he remarks: 'If the information concerning the condition of the system at the instant t_0 available to the experimentalist does not constitute a maximal set of conditions.....the computer will not be able to carry out his work entirely on the basis of the laws of motion, but will have to be guided also by consideration of probabilities.' The author has also discussed such topics as 'discrete distributions,' 'continuous distributions,' 'relative distributions,' 'stationary distributions' and the 'probability packets': and has finished the chapter with a short survey of Dirac's δ -function.

In the elements of Schroedinger method dealt with in the third chapter, the author has proceeded with two fundamental assumptions:

1. The possible numerical results of a precise experimental measurement of a dynamical variable are the eigenvalues of an operator associated with this dynamical variable, and vice versa.
2. The operators α and β , to be associated, respectively, with the dynamical variables α and β must be so chosen that $\alpha\beta - \beta\alpha = \frac{ih}{2\pi} [\alpha, \beta]$ where $[\alpha, \beta]$ is the operator to be associated with the classically computed Poisson bracket of α and β .

From these assumptions he has worked out the Schroedinger procedure for calculating the possible results of a precise experimental measurement of the energy of a conservative one-dimensional system, described classically by the potential function $V(x)$. And this is simply those values of E (a number) for which the equation $H\Psi = E\Psi$ possesses well-behaved solutions, the operator being of the type:

$$H = -\frac{1}{K} \frac{\partial^2}{\partial x^2} + V(x).$$

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In the following articles the author has worked out the energy levels of an oscillator, explained what is meant by the 'expected average' of a dynamical variable q , viz.

$$\text{av. } q = \int \bar{\Psi} q \Psi d\lambda \div \int \bar{\Psi} \Psi d\lambda,$$

where the integrals extend over the entire configuration space, and, with the help of the latter, he deduced the several energy states or quantum states of an oscillator. Then he has discussed the case of superposition of eigenfunctions, and the coherent and incoherent superposition of states. At the end of the chapter he has explained the 'Heisenberg uncertainty principle', which is, in short, a *limitation* imposed by the quantum theory on the precision with which the values of canonically conjugate pairs of dynamical variables can be ascertained simultaneously.

In chapter IV further problems in the Schroedinger method have been discussed, viz., rectangular potential wells, one-dimensional box, which are of paramount importance in so far as nuclear scattering and penetration of potential barriers are concerned. Towards the end he has taken up the case of radiative transitions. In this connection, an attempt has been made to explain concisely the *transition probability* for a spontaneous quantum jump from an energy state II to an energy state I of lower energy in terms of Bohr's frequency condition, and the *selection rules* for the transitions. The next chapter is devoted exclusively to methods of solving the Schroedinger equation *numerically* in case the potential function $V(x)$ does not admit of a general analytical treatment: in fact, only a few special forms of the above function lead to explicit solutions. It goes without saying that the choice of a particular process of numerical integration depends much upon the *type* of equation to be handled as also on the *judgment* of the computer. Several methods are discussed, (1) method of two-way integration, (2) Milne's method, (3) Variation method, mainly due to Pauling, Wilson and Kemble, and (4) Perturbation method, especially the Rayleigh-Schroedinger method. It may be noted, in particular, that the Rayleigh-Schroedinger method does not guarantee that the solution in series will be convergent.

Chapter VI appears to be a very important chapter dealing with probability currents and de Broglie waves. Starting with the idea of probability of finding a particle (in one dimension) specified by a norma-

lized Schroedinger function $\Psi(x, t)$, not necessarily an eigenfunction of the Hamiltonian of the system, the author defines, as is usual, the probability of finding the particle at the instant t , to the left of a point x

by $\int_{-\infty}^x \bar{\Psi} \Psi dx$, and then defines the time-rate of

change of this probability at the instant t by

$$S = \frac{\delta}{\delta t} \int_{-\infty}^x \bar{\Psi} \Psi dx.$$

whence, the *conservation equation* (or continuity equation) has been laid down for probability. In the case of one-dimensional potential barriers he has applied the continuity currents, and the mean *reflection* and *transmission of probability currents*, and the mean-stay inside a valley governed by a two-barrier potential. The above discussion smoothly permits one to interpret from theoretical standpoint the emission of alpha-particles by radio-active atomic nuclei. As is well known, the classical difficulty as to how an alpha-particle emitted by a nucleus having a kinetic energy less than corresponding to the top of the potential barrier could surmount the hill, disappeared when the problem was treated quantum-mechanically and independently by Gurney, Condon and Gamow. The author has discussed this point very clearly and deduced the Geiger-Nuttall relation between mean life and range of alpha-activity. The latter part of this chapter has been devoted to the too familiar classical idea of group-velocity and phase-velocity, culminating in that of de Broglie wave, and to a discussion about the points of similarity between the classical motion of a vibrating string and the quantum-mechanical motion of a particle in a "box."

Chapter VII is devoted to a short discussion on constants of motion: the latter part of it leads us into a wave-mechanical treatment of an electron in a crystal moving in a three-dimensional potential lattice. Workers in this field are principally Kronig, Penny, Kramers, and Morse. The energy spectra consist of alternating allowed and forbidden bands characteristic of potential lattices. The subsequent chapter is a very short discussion on the 'momentum method' in contradistinction to the 'co-ordinate or x -method' of Schroedinger's

In chapter X elements of the Heisenberg method are given. It may be noted that the Heisenberg theory was the first form of quantum mechanics followed by the formulation of the Schroedinger theory. The operators associated with dynamical variables in the

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Heisenberg method are matrices, and every operator-algebraic relation that holds between two or more Schroedinger operators holds also between the corresponding Heisenberg matrices, which are Hermitian and consequently have real eigenvalues. The matrix associated with the Hamiltonian of a dynamical system must be a diagonal matrix, and the possible values of a dynamical variable are the eigenvalues of the matrix associated with it. The author has discussed at great length in this connection such topics as diagonalization of matrices, the matrix perturbation method for non-degenerate states and Heisenberg representation of states. In chapter XI an outline of the symbolic method of Dirac has been given very succinctly but clearly and a contrast between Heisenberg's and Schroedinger's methods has been set out.

Full 76 pages have been devoted to chapter XII bearing on problems in three-dimensional motion by the Schroedinger method. Besides some mathematical preliminaries on spherical harmonics a considerable mass of topics has been handled and satisfactorily carried through, viz., the isotropic oscillator, motion of a particle in a central field and force-free field, the Bohr-formula for the hydrogen atom (fixed nucleus and free nucleus), the fine structure of the hydrogen levels, relativity corrections for hydrogen with diagrams showing the Sommerfeld levels.

Chapter XIII deals with elements of Pauli's theory of electron spin. This theory has an interesting history behind it. Bohr's theory does not lead to an accurate computation of the energy levels of atoms having several electrons, although it enables us to gather some important features of the levels. In 1925, Uhlenbeck and Goudsmit preferred the idea that each electron while revolving about a nucleus possesses a spinning motion, and has a quantized spin angular momentum and a spin magnetic moment (being an electrically charged body). This proposal met with a remarkably satisfactory interpretation of the Stern-Gerlach experiment in connection with the deflection of atoms projected into an inhomogeneous magnetic field. It is curious that Sommerfeld succeeded in getting a correct formula for hydrogen *without* making assumption for electron spin. The reason is up till now obscure. The hypothesis of electron-spin can be aptly made to fit into nonrelativistic treatment of quantum mechanics by a method of Pauli. The spin angular momentum can be treated on quite the same footing as orbital

angular momentum. The author has explained in this chapter the Pauli operator and operands, the vectorial relation between orbital, spin and total angular momentum, the spin-orbit interaction and the spin-correction for hydrogen. If the spin correction be not associated with relativity correction, each s -level (Bohr-levels) is raised, and each of the other levels is split up into a doublet; but the arrangement of the levels is altogether different from that required by experiment, and their number is almost twice too great. In applying the relativity correction the adjacent spin doublets are shifted in such a way as their number is reduced to that required by Sommerfeld formula, but the number of *basic states* is still almost twice as great as in the Sommerfeld theory.

Chapter XIV is devoted to an elementary theory of Dirac's electron, which may be said as the "highest refinement" of quantum mechanics of our days. The relativistic equation connecting the total energy E , the potential energy $V(x, y, z)$ and the components of linear momentum p_x, p_y, p_z of a particle of rest-mass m is $(E - V)^2/c^2 = p_x^2 + p_y^2 + p_z^2 + m^2c^2$, and hence the Hamiltonian is $H = V \pm c\sqrt{p_x^2 + p_y^2 + p_z^2 + m^2c^2}$.

If the Schroedinger operator is associated then the eigenvalue equation $H\psi = E\psi$ ceases to be linear. The problem of formulating a relativistic quantum mechanics leads to a veritable impasse. So Dirac attempted to free the Hamiltonian from the radical. He expressed the quantity under the radical as

$\alpha_x p_x + \alpha_y p_y + \alpha_z p_z + \alpha_m mc$, where the α 's were found to be 4-by-4 matrices. The author has discussed the 4 Dirac equations involving Dirac ψ function:

$$\psi = \begin{pmatrix} \psi_1 \\ \psi_2 \\ \psi_3 \\ \psi_4 \end{pmatrix}$$

and worked out the energy levels of the hydrogen atom and the normal state of the hydrogen atom. It is of especial interest to note that besides the *continuous* energy spectrum extending from mc^2 to ∞ and the *discrete* spectrum lying just below mc^2 , the Dirac electron (in a Coulomb field) has a continuous energy spectrum from $-mc^2$ to $-\infty$ and a discrete spectrum lying just *above* $-mc^2$. Whereas in classical relativity theory the state of negative kinetic energy can be discarded altogether, in Dirac's theory the probabilities for quantum jumps from states of positive to states of negative kinetic energy cannot vanish. This means, under certain circumstances, a particle having the mass of an electron with opposite charge should come into being. These *anti-electrons* (of Dirac) actually have

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been discovered by Anderson experimentally: these are *positrons*. In fact, Dirac's 'hole' theory now enables us to interpret pair-production in cosmic showers as creation of both electrons and positrons by high energy photons.

Prof. Rojansky's book is well-written, and a long field of quantum mechanics has been surveyed within a short compass. The diagrams are depicted very clearly and neatly, and the copious exercises appended almost to every chapter will be of great use to those who have a mind to master the subject at a steady pace. We believe that every University and College library ought to possess a copy of this excellent book, and Messrs. Blackie and Son Ltd. should be congratulated on their having published this useful manual on the subject of quantum mechanics.

K. B.

A TEXT BOOK OF HEAT for Junior Students—by M. N. Saha and B. N. Srivastava. (Indian Press Ltd., Allahabad). Pp. 288 with name and subject index. Second Edition.

Text books in scientific subjects meant for Indian students are nowadays too numerous and there is hardly anything to distinguish any one of these from the other. Authors are mostly non-Indians and unacquainted with the standard of teaching and the syllabus of studies in Indian universities. This makes recommendation of a text book very difficult and generally several books have to be consulted to cover the complete curriculum in any single subject. In spite of all that we say about the desirability of students consulting a large number of books, it is universally admitted that the general body of students are very loath to do it. A single book, however, when it is properly written with the full knowledge of the requirements of the students, is very welcome for it can give the students a thorough grasp of the subject and good credit may be secured in the examination with its help.

The book under review is such a one and distinguishes itself from the many other books on the subject. It has grown out of the lectures which the senior author has been giving to the B.Sc. pass class of the Allahabad University for several years and is extracted from the authors' larger work, *A Treatise on Heat*, which was hailed all over the world as the best

advanced text book on the subject. The book is eminently adapted to the needs of Indian students preparing for the B. Sc. pass degree. Students of a two-year Honours Course can also base their studies on it and will require no more than occasionally supplementing it here and there.

Text books of this type have been in want keenly felt by Indian students for a long time till the first edition of the present book was published and appearance of other books of this type in all the branches of physics will be very welcome. Future writers will be benefited by taking this book as their model.

D. P. R. C.

THE ELEMENTS OF PHYSICO-PHARMACEUTICAL CALCULATIONS—by Prof. M. L. Schroff (Benares Hindu University). Pp. ix+281.

In this book, the author has fully explained, using numerous illustrative examples, the physico-chemical principles involved in the analysis of the common chemicals and pharmaceutical products. The book will be of great use to students of pharmaceutical chemistry, as all physico-chemical aspects which are important in modern pharmaceuticals have been lucidly dealt with by the author. Although the book is intended for students of pharmaceuticals, the chapters dealing with oxidation-reduction potentials, pH values, buffer solutions and evaporation and distillation can be studied with advantage even by the students who take up advanced courses of studies in pure chemistry.

The appendix contains many useful data and will be of great help to students in their practical work.

B. C. G.

BUTTER-FAT (GHEE)—by N. N. Godbole and Sadgopal. (N. N. Godbole, Hindu University, Benares). Pp. 176. 2nd Edition. Price Rs. 4/- inland.

It is a comprehensive book dealing with our present-day knowledge of the composition, analysis and food value of different kinds of milk-fat. The authors themselves have worked for many years on the composition and rapidity of butter-fat and the results have been incorporated in the present volume, thus bringing the whole subject in a complete form most valuable to the students. A book of this kind will prove very useful for those who are interested in oils and fats.

M. N. G.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

Electroencephalography

Oscillating potentials spontaneously generated in the human brain were led off different parts of the skull overlying its various functional regions and amplified and recorded by means of a specially constructed low frequency, high amplification voltage amplifier and an ink-writing recorder (Bagchi and Roy).¹ Fourteen unanaesthetized normal human subjects were used in the experiment. They were comfortably seated in a dark semi-sound proof, electrically shielded room (8'×8'×8') and were occasionally stimulated with a light source from the outside. The alpha waves oscillating from 9 to 12 per second and beta waves from 17 to 40 per second, with an amplitude from 50 to 10 microvolts respectively, were recorded. Working toward the establishment of an alpha index norm on Indians and its comparison with that established by Davis and Davis of Harvard², we have found up till now that 3 of the subjects had occipital alpha rhythm (8 microvolts and more) over 75% of the time, 2 subjects over 50% of the time, 4 over 25% of the time, and 5 less than 25% of the time. A 15 watt light reduced or obliterated the alpha rhythm in 68.3% of the instances (N = 71) with an average latent period of .421 sec., and a range from .07 sec. to 1.6 sec. The remainder of the records (31.7%) were unreadable and hence rejected because (i) the alpha waves were down before the instant of the flashing of the light and (ii) the beginning or end of the latent period was not definitely determinable. The alpha waves returned after the light was off, in 1.5 sec. (the median recovery time), with a range from .218 sec. to 8.2 sec. There was a negative correlation (−.24) between the duration of the light and the recovery time, suggesting the presence of uncontrolled factors as adaptation etc., (Bagchi)³ influencing the latter. In the case of one subject, with a 60 watt lamp left on overhead there was a relative amplitude adaptation of the brain rhythm within a certain time. During the period the overhead light was on a weaker light (15 watt) flashed before him unusually prolonged the latent period of the reduction or obliteration of the alpha waves (mean = 2.3 sec., N = 9), indicating the

delayed effect of a lesser stimulus in the presence of a higher excitation level of the brain.

Abnormal waves were also recorded from the frontal region of an epileptic during non-seizure period. Further investigation on normal and abnormal cases is in progress. This is a preliminary report of the first work in this country on human electroencephalography started under the Sir J. C. Bose Research Fellowship Endowment Fund of Calcutta University.

B. K. Bagchi.

Bose Institute
Calcutta, 16-1-1940.

¹ To be published.

² Arch. Neurol. Psychiatr., 36, 1214, 1936.

³ J. Psychol., 3, 463, 1937.

Spiro-Compound

The formation of spiro compounds from the derivatives of 3:3-dimethyl cyclohexane, 2-methyl cyclopentane and methyl ethyl ketone has been studied on the basis of the "Valency deflexion hypothesis" of Thorpe and Ingold.

Freshly distilled 3:3-dimethylcyclohexanone-cyanohydrin is allowed to react with the sodium salt of ethyl cyanoacetate and the sodium salt of ethyl 1-cyano-3:3-dimethyl cyclohexane-1-cyano-acetate, thus obtained, is allowed to react with ethyl-β chloropropionate to yield diethyl-1-cyano-3:3-dimethylcyclohexane-1-α-cyanoglutarate (b.p. 202°-210°/4 mm). On hydrolysis the above ester yields 1-carboxy-3:3-dimethylcyclohexane-1-α-glutaric acid (m.p. 202°). Triethyl 3:3-dimethyl cyclohexane-1-carboxylate-1-α-glutarate (180°-185°/4mm.), obtained by esterifying the above acid, when subjected to the action of sodium in benzene yields diethyl-3:3-dimethyl cyclohexane-spiro-cyclopentane-2'-one-3':5'-dicarboxylate (b.p. 185°-190°/4 mm). Diethyl-1-cyano-3:3-dimethylcyclohexane-1-cyano succinate (b.p. 190/3mm) yields the corresponding acid on hydrolysis.

LETTERS TO THE EDITOR

Similarly 2-methylcyclopentanonecyanohydrin yields diethyl-1-cyano-2-methyl cyclopentane-1-cyanoglutarate (b.p. 205°/3mm). On hydrolysis the above ester yields 1-carboxy-2-methylcyclopentane-1- α -glutaric acid (m.p. 146°). Triethyl 2-methylcyclopentane-1-carboxylate-1- α -glutarate (b.p. 165°/3mm.) (anhydride ester b.p. 170°/3mm.) yields 2-methylcyclopentane-spiro-cyclopentane-2-one-3'-5'-dicarboxylate (b.p. 174°/4mm.) by the action of sodium in benzene. 2-Methylcyclopentane-2'-one-5'-carboxylic acid is obtained by the hydrolysis of the above ester.

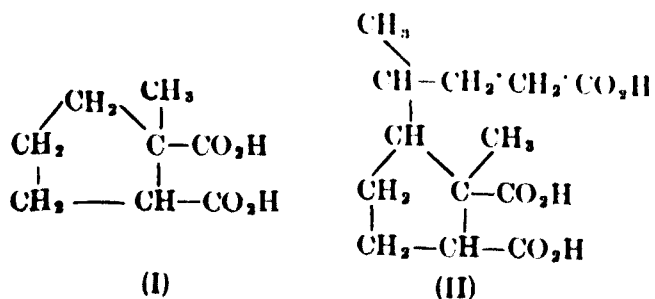
Ethyl β -ethyl pentane β -tricarboxylate (b.p. 165°/4mm.) (anhydride ester, b.p. 170°-175°/4mm.), obtained by the hydrolysis and subsequent esterification of ethyl β -dicyano- β -ethylpentane γ -dicarboxylate (b.p. 194°/8mm.), yields ethyl 3-methyl-3-ethylcyclopentane-2-one-1:4-dicarboxylate (b.p. 150°/4mm.) by the action of sodium in benzene.

Nripendra Nath Chatterjee
Amalendu Bose.

Chemical Laboratory,
University College of Science & Technology
Calcutta, 1-2-1940.

Studies in the cyclo-pentane series. Part I. Synthesis of cyclo-pentane-1-methyl-1:2-dicarboxylic acid (cis- and trans-)

A series of investigations was undertaken to find out a general method to build up a cyclopentane ring with suitable substituents—the knowledge of which was expected to throw sufficient light on the actual synthesis of Wieland's tricarboxylic acid (II), isolated from oxidation of bile acids.



To prepare a reference compound, ethyl 1-methylcyclopentane 2-one-1-carboxylate was converted into the cyanhydrin (b. p. 122°/4 mm) and this on treatment with thionyl chloride and pyridine gave the corresponding unsaturated nitrile (100°-02/mm). The nitrile on hydrolysis with fuming HCl gave the dicarboxylic acid

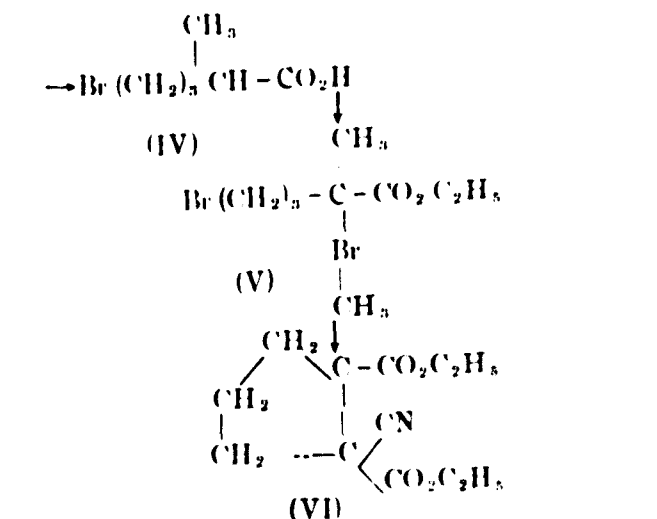
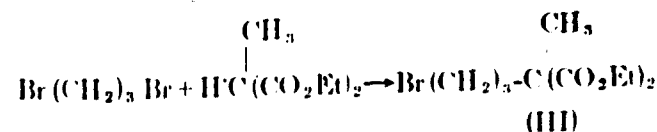
(m.p. 203°-204°). This was reduced with sodium amalgam in boiling solution. The acid was isolated in the usual way and on repeated crystallisation from water it melted at 142°. It is the *trans*-acid.

Ethoxyethyl iodide was condensed with acetoacetic ester in presence of sodium ethoxide to give ethyl γ -ethoxy- α -acetyl butyrate (110°-13°/6mm). This on hydrolysis with 20 per cent H_2SO_4 gave γ -ethoxy propyl methyl ketone (169°/762). The cyanhydrin (122°-24°/9 mm) of this ketone was condensed with sodiocyanacetic ester, to give the corresponding dicyan ester (170°-75°/8 mm) as a viscous liquid. With this however, the cyclopentane ring could not be built up by a method closely analogous to that of Simonsen. Next it was hydrolysed with 30 per cent H_2SO_4 , heated under reflux for 20 hours and the gum so obtained was esterified with alcohol and sulphuric acid whereby ethyl α (γ -ethoxy propyl)- α -methyl succinate was obtained in good yield. Various unsuccessful attempts were made to introduce a carboxyl group into the methylene group of the succinic acid residue through ethyl oxalate.

Next, trimethylene bromide was condensed with malonic ester and ethyl δ -bromo- α -carbethoxy-valerate was isolated. This was hydrolysed with hydrobromic acid in the usual way. The semi-solid mass was converted into chloride with thionyl chloride and was brominated at the α -position with 1.5 mols of bromine. On pouring this into alcohol ethyl δ -dibromo valerate was isolated in good yield (111°-12°/5 mm). On treatment with sodio cyanacetic ester in alcoholic solution for a prolonged period ethyl cyclopentane-1-cyano-1:2-dicarboxylate was obtained in 89 per cent yield. (132°/3 mm). This on hydrolysis with HCl gave crude *trans*-cyclopentane dicarboxylic acid* (m.p. 154°-58°). Subsequently trimethylene bromide was condensed with mono-methyl malonic ester in the usual way to give ethyl δ -bromo- α -carbethoxy- α -methyl-valerate (III) (153°-55°/12 mm). This was hydrolysed with hydrobromic acid and the bromo-acid (IV) together with its lactone was directly treated with phosphorous pentabromide and brominated in situ. On addition of alcohol the dibromo ester (V) was isolated in good yield (118°-20°/6.5 mm). This was allowed to react with sodio-cyan-acetic ester in the usual way giving (VI) (118°-20°/1 mm). On hydrolysis with hydrochloric acid it gave the pure *trans*-cyclopentane 1-methyl-1:2-dicarboxylic acid (m.p. 143° from water; alone or mixed with previous specimen).

If, however, (VI) be heated with HCl in a sealed tube so that hydrolysis and de-carboxylation takes place at about 180°C then a mixture of *cis*- and *trans*-acids is obtained. (m.p. 107°-124°). On treatment with acetic-anhydride the *cis*-acid gave the anhydride which

LETTERS TO THE EDITOR



was separated by distilling under reduced pressure (101°/4 mm). This was hydrolysed by boiling with HCl for 7 hours and on concentrating, the *cis*-acid separates as sandy power crystallising from water containing dilute hydrochloric acid (m.p. 123°-125°). The melting point is not very sharp probably due to the formation of anhydride near about the melting point (mixed m.p. with acid m.p. 142° is (100°-12°). The *cis*-acid is much more soluble in water than the *trans*-acid, the latter however dissolves readily in water in presence of *cis*-acid. The behaviour of both the acids on heating with HCl in a sealed tube is anomalous and interesting results have been obtained in this connection.

The appearance of two contiguous carboxyl groups in *trans*-form during decarboxylation is a characteristic property of the cyclopentane ring as contrasted to the behaviour of the cyclohexane or cyclobutane rings because the former gives a mixture of *cis*- and *trans*-forms while in the latter purely the *cis*-form appears.

My grateful thanks are due to Prof. P. C. Mitter for his valuable suggestions and encouragement during the course of this investigation.

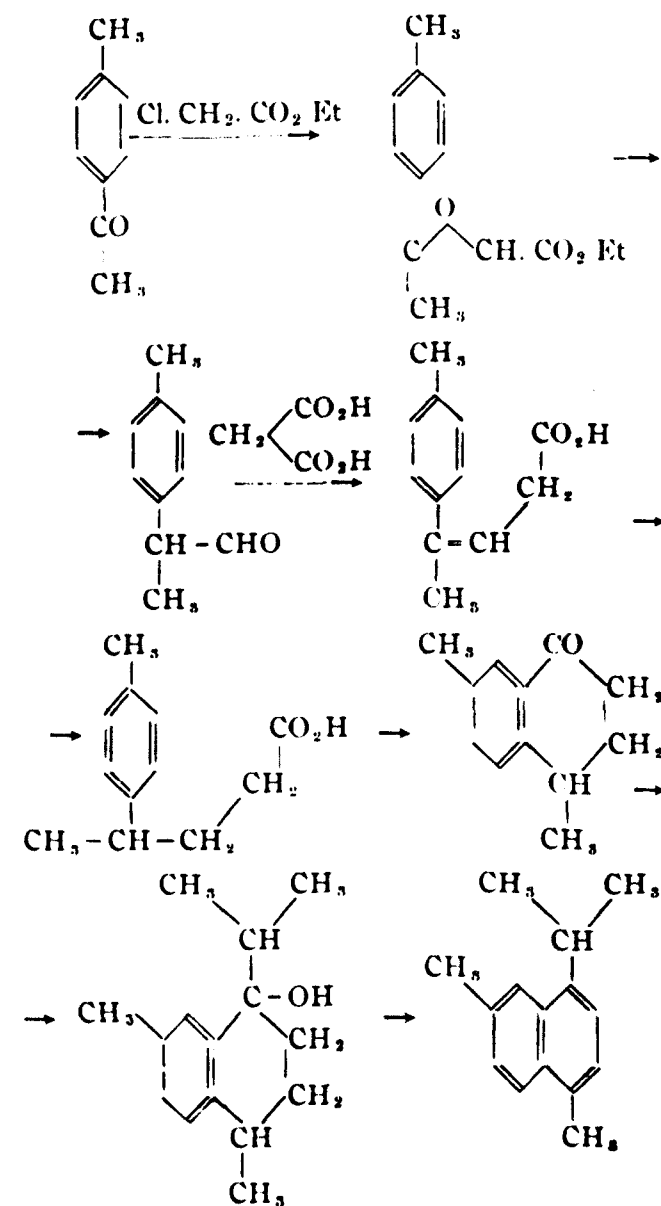
Phanindra Ch. Dutta

Palit Laboratory of Chemistry,
University College of Science and Technology,
Calcutta, 7-2-1940.

* Simonsen, J. C. S., 1171, 1909.
* Fuson, J. A. C. S., 1237, 1938.

Studies in the Sesquiterpene series. Part II — a new synthesis of cadalene

p-methyl acetophenone was condensed with chloroacetic ester in presence of sodium ethoxide to give the glycidic ester (130°-35°/5 mm). On treatment with the calculated quantity of water in an alcoholic solution of the ester containing one molecule of sodium ethoxide it underwent quantitative hydrolysis. The sodium salt was filtered off, washed with alcohol and ether and on acidification of its aqueous solution there was a spontaneous evolution of carbon dioxide with the formation of α -(*p*-tolyl)-propionic aldehyde (92°/6 mm). This is one of the principal products of Etard's reaction on



LETTERS TO THE EDITOR

various monoterpenes and its constitution has been determined from analytical evidences (semi-carbazone m.p. 158°). The aldehyde reacted with bromoacetic ester in presence of Zn to give the corresponding hydroxy-ester (149°/5 mm). It could not be dehydrated, however, with thionyl chloride and pyridine in the usual way, the reaction leading to polymerised products. Similar lack of success was also encountered with other dehydrating agents like phosphorous pentoxide and potassium hydrogen sulphate.

The aldehyde however readily condensed with malonic acid in presence of pyridine and piperidine giving an unsaturated solid acid (m.p. 85°-85°). During the condensation, the double bond migrated from α to the $\beta\gamma$ -position to lie in conjugation with the benzene ring and this explains its resistibility towards reducing agents like sodium amalgam. Consequently it was reduced with HI and red phosphorus through the lactone and γ -(*p*-tolyl)-valeric acid (169°-70°/6 mm) was isolated. On treatment with 85 per cent H_2SO_4 it yielded the corresponding tetralone (118°/4 mm; semi-carbazone 195°-96°). This was treated with large excess of magnesium isopropyl iodide and the resulting product (119°/5 mm) on heating with selenium for 24 hours at 300° gave cadalene (b.p. 106-07°/3 mm; picrate m.p. 114°-15°).

My grateful thanks are due to Prof. P. C. Mitter for his valuable suggestions, and keen interest he has taken during the course of these investigations.

Phanindra Ch. Dutta

Palit Laboratory of Chemistry,
University College of Science and Technology,
Calcutta, 7-2-1940.

¹Rupe: *Ber.* 44, 584.

Distribution of p-Statistics on the Non-null Hypothesis

In a couple of notes published in this journal some time ago, I announced that I had obtained the joint distribution of a class of p-statistics intended to test for the hypothesis that two samples have come from the same p-variate normal population and intended also to serve a variety of other purposes. If k_i^2 ($i = 1, 2, \dots, p$) be the p roots of the determinantal equation $|\Sigma_{ij} - k^2 \Sigma'_{ij}| = 0$, (1) where Σ_{ij} and Σ'_{ij} are the dispersion matrices of two samples Σ and Σ' of sizes n and n' supposed to have been drawn from the same p-variate

normal population with dispersion matrix $||\Sigma_{ij}||$, then the distribution I had obtained was of the form

$$\text{Const. } (k_1^2 - k_2^2) \dots (k_1^2 - k_p^2) (k_2^2 - k_3^2) \dots (k_{p-1}^2 - k_p^2) \times \prod_{i=1}^p \frac{k_i^{n-p-1}}{(1 + \lambda^2 k_i^2)^{\frac{n+n'-2}{2}}} \quad (2)$$

λ^2 being equal to n/n' .

This has also come out in a paper since published in *Sankhya*.² Following up my previous investigation I proceeded to tackle the case where the hypothesis tested is not true i.e., where the two samples are supposed to have been drawn from two populations with different dispersion matrices $||\Sigma_{ij}||$ and $||\Sigma'_{ij}||$. In that attempt I have since obtained the joint distribution of the k_i^2 's for this general case of which the previous one is a special case.

If ξ_i ($i = 1, 2, \dots, p$) denote the p roots of the determinantal equation $|\alpha_j - \xi^2 \alpha'_j| = 0$ (3) and if $\lambda^2 = n/n'$ and if we define quantities z_i such that

$$z_{ij} = \begin{cases} \prod_{i=1}^m \left(\frac{m}{2} \right) & \text{when } i=j \\ \prod_{i=1}^m \left(\frac{m}{2} \right) \prod_{j=1}^n \left(\frac{n}{2} \right) & \text{when } i \neq j \end{cases} \quad (4)$$

then the joint distribution of p-statistics k_i ($i = 1, 2, \dots, p$) comes out in the form

$$\text{Const. } (k_1^2 - k_2^2) \dots (k_1^2 - k_p^2) (k_2^2 - k_3^2) \dots (k_{p-1}^2 - k_p^2) \times E \left\{ \prod_{i=1}^p \frac{z_{ij}}{(\xi_i^2 + \lambda^2 k_j^2)^{\frac{1}{2}}} \right\} \times \left\{ \prod_{i=1}^p k_i^{n-p-1} dk_i \right\} \quad (5)$$

where E is the determinant

$$|(\xi_i^2 + \lambda^2 k_j^2)^{\frac{1}{2}}|$$

It is easily seen that if the two populations have the same dispersion matrix i.e., if

$$|\Sigma_{ij}| = |\Sigma'_{ij}|, \text{ then } \xi_i \text{ ($i = 1, 2, \dots, p$)} = 1$$

and the joint distribution (5) is easily seen to reduce to (3) as it should.

The k_i^2 's are supposed to be arranged in descending order of magnitude starting from k_1^2 . It should be noticed with reference to the form (3) that in it we can make the substitutions for z_{ij} etc. given by

(2.1) only after we have broken up $\prod_{i=1}^p k_i^{n-p-1}$ as a multinomial and multiplied it with the other factors. We cannot start with the substitutions. There is much work to be done on this distribution function before

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we can get at the separate distribution of the individual k_i^2 's and some other suitable functions of k_i^2 's which may be more appropriate for testing certain classes of hypothesis than the k_i^2 's themselves. Work is at present being continued on this.

S. N. Roy.

Statistical Laboratory,
Presidency College,
Calcutta, 20-1-1940.

¹ SCIENCE AND CULTURE, 5, 131, 1939.

² *Ibid.*, 5, 197, 1939.

³ *Sankhya*, 4, 3, 1939.

On the Distribution of Certain Symmetric Functions of p-Statistics on the Null hypothesis

In the research note entitled "The Distribution of the p-statistics on the non-null hypothesis" sent for publication in "Science and Culture" in January last and being published in the present issue of the Journal the distribution of k_i^2 's defined in (1) is obtained in the form (2) on the null hypothesis i.e., when the populations sampled have the same dispersion matrix $||\Sigma_{ij}||$ and is obtained in the form (5) on the non-null hypothesis i.e., when the populations sampled have different dispersion matrices, say, $||\Sigma_{ij}||$ and $||\Sigma'_{ij}||$. All the numbers refer to the foregoing note. If we consider the distribution (2) of that note and define a new set of quantities $u_1, u_2, \dots, u_p$ which are the symmetric functions of the roots k_i^2 's of the determinantal equation (1) of the foregoing note, and which are given by

$$u_1 = \frac{1}{p} \sum_{i=1}^p k_i^2, \quad (u_2)^2 = \frac{1}{p^2} \sum_{i,j=1}^p k_i^2 k_j^2 \quad (i \neq j, \dots) \quad (1)$$

$$(u_p)^p = \frac{1}{p^p} k_1^2 k_2^2 \dots k_p^2$$

then the joint distribution of u_i 's ($i = 1, 2, \dots, p$) has been found out in the form

$$\text{Const. } u_2 (u_2)^2 (u_4)^2 \dots (u_{p-1})^{p-2} u_p^{p-2} \prod_{i=1}^p \frac{du_i}{u_i} \quad (2)$$

$$(1 + \lambda^2 n u_1 + \lambda^4 n u_2 (u_2)^2 + \dots + \lambda^{2p} n u_p (u_p)^p)^{\frac{n+n'-2}{2}}$$

where $\lambda^2 = n/n'$. Just as in (2) of the foregoing paper k_i^2 varies from 0 to k_{p-1}^2 , k_{p-1}^2 varies from 0 to k_{p-2}^2 and so on, and finally k_1^2 varies from 0 to k_1^2 and k_1^2 from 0 to ∞ . So here it has been found that u_p varies from 0 to u_{p-1} .

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u_{p-1} from 0 to u_{p-2} and so on, and finally u_2 from 0 to u_1 and u_1 from 0 to ∞ . The distribution of the u_i 's on the non-null hypothesis is being worked out and will be published in due course. The set of k_i^2 's defined in (1) of the foregoing note may be useful for purposes of testing one category of hypotheses and the set u_i 's defined in (1) of this note may be useful for testing another category of hypotheses and other functions of the k_i^2 's may be useful for other purposes. Detailed investigations into these aspects of the problem are now being carried on by the author and the results will be announced later on.

S. N. Roy.

Statistical Laboratory,
Presidency College,
Calcutta, 7-2-1940.

The Secondary K-absorption Edges of Ferric Oxide in Solid and in Colloidal Solutions

It is well known that the X-ray absorption spectra of metals and their compounds are characterised by the existence of a fluctuation of intensity on the photographic plate towards the short wavelength side of the principal K and L-absorption edges.¹ These maxima and minima usually referred to as the secondary absorption edges are also exhibited by the polyatomic molecules² like $GeCl_4$ in the gaseous state. Such an extended structure which is absent in monatomic gases and vapours has been interpreted³ in the light of the allowed and forbidden energy zones arising from a periodic potential field present in a crystal owing to the regular arrangement of the atoms or ions inside it. Thus a regular arrangement of atoms or ions either in a crystal or in a polyatomic molecule has been found to be the essential criterion of such an extended structure following the principal edge towards shorter wavelengths.

In connection with our study of the secondary K-absorption edges of iron in metallic state and in chemical combination, we have observed such an extended structure in the case of colloidal solution of ferric oxide (Fe_2O_3). Such an extended structure, however, is in keeping with the present knowledge of colloidal particles of Fe_2O_3 which are supposed to be matter in the finest division (10^{-6} cm) in which a regular arrangement still continues to exist.⁴ The K-absorption spectra of Fe_2O_3 in solid and in colloidal solution have been compared, the results being included in the following

LETTERS TO THE EDITOR

tables. K-represents the principal absorption edge, and the Latin and the Greek alphabets respectively denote the minima (maximum absorption) and maxima (minimum absorption) on the intensity curve.

is measured in X. U. and ν in electron volts.

of the primary edge is in all probability within .2 to .3 X. U.

Khaira Laboratory of Physics,
University College of Science,
Calcutta, 5-2-1940.

S. Sen.

1. Table showing the Position of the Maxima and Minima

		K	A	α	B	β	C	γ	D	δ	E	ϵ	F
Fe_2O_3	λ	1736.4	1732.8	1727.8	1722.1	1717.7	1714	1711.8	1703.5	1698.3	1694.7	1689.7	1687.3
(Solid)	$\delta\lambda$	0	3.6	8.6	14.3	18.7	22.4	24.6	32.9	38.1	41.7	46.7	49.1
	$\delta\nu$	0	14.84	35.55	59.29	77.79	93.3	102.6	137.9	160.2	175.7	197.3	207.8
Fe_2O_3	λ	1737.2	1732.7	1728.6	1721.4	1719.6	1717.7	1714.6	1703.6	1696.0	1691.8	1689.0	...
(Colloidal)	$\delta\lambda$	0	4.5	10.82	15.82	17.8	19.5	22.5	33.6	41.2	45.4	47.3	...
	$\delta\nu$	0	18.61	43.89	65.6	73.05	81.0	93.67	140.8	173.3	191.5	199.8	...

2. Table Showing the Position, Relative Shift and Width of the Principal Edge

	λ	ν/R	$\delta\lambda$	$\delta\nu$	width in $\delta\lambda$	width in $\delta\nu$
Fe_2O_3 solid	1736.4	524.80	0	0	3.57	14.67
Fe_2O_3 colloidal	1737.2	524.56	.82	3.32	5.56	22.85

The following peculiarities are noteworthy:

(i) Both in the solid and in the colloidal solution, the secondary structure extends to about 200 volts.

(ii) The positions of the succeeding maxima and minima have not come out identical in the two cases, though the shift of maxima and minima near the principal edge and towards shorter wavelengths is within experimental error.

(iii) The position of the primary edge itself in colloidal solution has shifted towards the longer wavelength.

(iv) The width of the edge has also increased in the colloidal solution.

The observation on the secondary structure in colloidal solution is here taken for the first time.

The error in the measurements of the secondaries may be as high as 1.4 X.U., but that in the measurement

Lindsay and Voorhees, *Phil. Mag.* 6, 910, 1928.
D. Coster and G. H. Kramers, *Physica*, 1, 889, 1934. (Theoretical) D. R. Hartree, R. de L. Kronig and H. Petersen, *Physica*, 1, 895, 1934.
R. de L. Kronig, *Zs. f. Phys.* 70, 317, 1931; 74, 191, 1932.
The Physical Properties of Colloidal Solutions (3rd Edition) E. F. Burton.

Study of Chemical Engineering

In the last February issue of "Science and Culture" there is an article on "Chemical Engineering" contributed by Mr. J. J. Mehta in which it is stated that "it is only recently that the subject has been introduced in the University of Bombay." To remove any misconception about the history of the study of this subject in Indian educational institutions the following facts should be known by all interested persons:

(a) In Calcutta University in the post-graduate course of applied chemistry the subject was introduced in 1922.

(b) In the Harcourt Butler Institute of Technology and the Imperial Institute of Sugar Technology at Cawnpore the subject was introduced perhaps in 1929.

(c) In Andhra University in Waltair it is being taught since 1935.

But in all of these institutions and probably in some others in which it is taught, the subject is only a subsidiary one. The institution where it forms an independent course of study is the College of Engineering and Technology,

LETTERS TO THE EDITOR

Bengal, at Jadavpur. In the College the course was introduced in 1921 and the first batch of graduates in chemical engineering came out in 1925; hence it can claim priority in India in this respect, and the professor in charge of the department, Dr H. L. Roy, A. B. (Harvard), Dr Ing. (Berlin), M. I. Chem. E. (London), is one of the only two Indians who are full members of the Institution of Chemical Engineers, London. In Great Britain, which is the Mecca of Indian students for attaining eligibility for prize posts under the government, the first graduate in chemical engineering came out from Glasgow only in 1928.

When Indian students began to go to foreign countries for further education and training, Oxford and Cambridge (with London in some cases) were selected for liberal education in arts and pure sciences, Edinburgh for medicine, and Glasgow for engineering. All our best students flocked to these places which came to be known to us as the best seats of learning. The poor and perhaps the adventurous youngmen used to go to U. S. A., which as providing seats of learning was not greatly considered. But recently it has been acknowledged (see the article on Massachusetts Institute of Technology in the last February issue) that for training in applied sciences and technology, as well as for highly expensive experimental work in pure sciences the institutions of U. S. A. offer some of the best opportunities. The California Institute of Technology at Pasadena of which our recent distinguished visitor, Professor Millikan, is one of the founders may be given the same place of prominence as the Massachusetts Institute of Technology.

N. K. Sen-Gupta

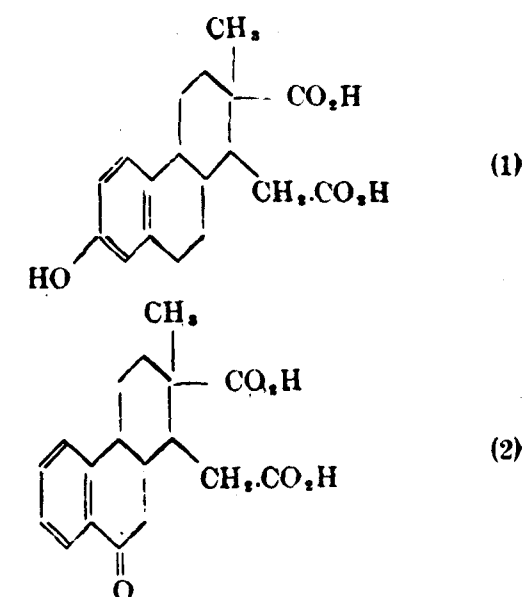
College of Engineering & Technology, Bengal
Jadavpur, 7-2-1940.

Synthesis of Keto-deoxy-oestric Acid

Marrian and Haslewood¹ by fusion of oestriol with potassium hydroxide obtained the dicarboxylic acid (1), for which the name oestric acid has been suggested by Robinson. The *o*-methyl-ether of the above acid has been prepared by the degradation of isonitroso-*o*-methyl-oestrone by Robinson and Litvan² in order to study the formation of the higher homologous acid namely *o*-methylhomooestric acid (cf. Bardhan, J. C. S., 1848, 1936) by Arndt and Eistert's reaction. A synthesis of isomeric mixtures of *o*-methyl-oestric acid has also been described by Robinson and Walker³ in a previous communication.

The present note deals with the synthesis of 2-methyl-2-carboxy-9-keto-1, 2, 3, 4, 9, 10, 11, 12-octahydro-phenanthryl-1-acetic acid (2) by a method which is

expected to be of easy application for the synthesis of both oestric and homo-oestric acid.



Sodio-ethyl-phenyl-cyano-acetate was condensed with β -chloro-ethyl-methyl-ketone to yield ethyl- α -cyano- α -phenyl- γ -acetyl-butyrate, b.p. 172-175°/5 mm. (semi-carbazone m.p. 154-155°), which on hydrolysis gave α -phenyl- γ -acetyl-butyric acid b.p. 195-197°/6 mm. The ethyl ester of the above acid, b.p. 143-145°/4.5 mm. (semi-carbazone m.p. 119-120°) was condensed with ethyl-cyano-acetate in the presence of acetamide to yield ethyl-1-cyano-2-methyl-5-phenyl- Δ^1 -pentene-1:5-dicarboxylate, b.p. 200-208°/4 mm. On treatment with potassium cyanide and subsequent hydrolysis the above unsaturated ester yielded α -phenyl- δ -methyl- δ -carboxy-pimelic acid, m.p. 169-171°, the tri-ethyl-ester, b.p. 202-204°/5 mm. of which underwent cyclisation by means of sodium in benzene solution to yield 2:3-dicarbethoxy-3-methyl-6-phenyl-cyclohexanone. The β -ketonic-ester, decomposed to a certain extent during distillation under reduced pressure its sodio-derivative was condensed *in situ* with ethyl-bromo-acetate and the crude product so obtained was hydrolysed. The resulting gummy acid mixtures were esterified and two esters namely ethyl-1-keto-3-methyl-3-carbethoxy-6-phenyl-cyclohexyl-2-acetate, b.p. 180-186°/2.5 mm. and 3-methyl-3-carbethoxy-6-phenyl-cyclohexanone, b.p. 182-187°/6 mm. (semicarbazone m.p. 175.5-176.5°) were isolated. The first diester was treated with zinc wool and ethyl-bromoacetate in toluene solution and the resulting high boiling product was collected between 186-200°/1.8 mm. The analytical data and molecular weight determination showed that it mainly consisted of diethyl-3-methyl-3-carbethoxy-6-phenyl- Δ^1 :3-cyclohexenyl 1:2-diacetate. The above compound on treatment with an excess of red phosphorus and hydriodic acid yielded a resinous uncrystallisable acidic product, which underwent cyclisation.

LETTERS TO THE EDITOR

with elimination of water by means of concentrated sulphuric acid to give the ketodibasic acid (2), the semicarbazone of which melts at a range of 165-175°.

My best thanks are due to Prof. P. C. Mitter for advice and encouragement during the progress of this work. My thanks are also due to Mr N. Ghosh and Mr B. Bhattacharjya for carrying out micro-analysis of some of the compounds.

D. K. Banerjee.

Palit Laboratory of Chemistry,
University College of Science and Technology,
92, Upper Circular Road,
Calcutta, 7-2-1941.

¹ J. Soc. Chem. Ind., 51, 2777, 1932 cf. Mac-Corquodale, Thayer, and Doisy. J. Biol. Chem., 99, 327, 1933.

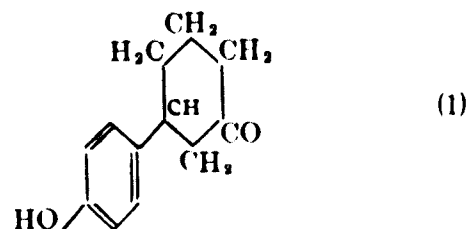
² J. C. S., 1997, 1938.

³ J. C. S., 183, 1938.

Synthesis of 3-(p-hydroxy phenyl) cyclohexanone

Cooks, Dodds¹ etc., prompted by the observation, that 1-keto-1, 2, 3, 4-tetrahydrophenanthrene² produces oestrus, examined a number of related compounds. As a result of their investigation 1, 2-dihydroxy-1, 2-di- α -naphthyl-acenaphthene³ was found active being the first active compound in which the phenanthrene nucleus was absent. Simpler molecules were then studied and substances such as 4, 4'-dihydroxybiphenyl, p-hydroxy-propenylbenzene⁴ etc., were also found to possess oestrogenic activity.

From consideration of the above observations it seemed to be of interest to investigate the physiological property of the ketone (1).



The above ketone has been synthesised by the following method. Ethyl- γ -anisoylbutyrate, b.p. 193-195°/5-6 mm. m.p. 59-60°, (semicarbazone m.p. 120-121°) was acted upon with zinc and ethylbromoacetate in benzene solution to yield the lactone of 1-carbethoxy 2-(p-methoxy-phenyl)-2-hydroxypentene-5-carboxylic acid, b.p. 229-230°/4 mm. β -(p-methoxy-phenyl) pimelic acid m.p. 154-156°, resulting from the reduction of the above lactone with zinc dust and caustic soda, on

esterification with ethyl alcohol and methyl alcohol yielded the corresponding diethyl ester, b.p. 195-205°/4-5 mm. and dimethyl ester, b.p. 187-195°/4.5 mm. respectively. Above dibasic esters on being acted upon with sodium dust in benzene solution yielded the corresponding keto esters which could not however be distilled without decomposition. The crude ketoester however on hydrolysis with dilute sulphuric acid yielded 3-(p-methoxy-phenyl) cyclohexanone, m.p. 83° (semicarbazone m.p. 217-219°). 3-(p-hydroxy-phenyl) cyclohexanone, m.p. 159-161° was obtained by demethylation of the methoxyketone with hydrobromic acid.

The above compound was however found in the Allen-Doisy test to be inactive up to a highest dose of 8 mgms. when injected into castrated mice.

My best thanks are due to Prof. P. C. Mitter for his advice and the keen interest he has taken during the progress of the work. My thanks are also due to Mr S. K. Saha for carrying out the micro-analyses of some of the compounds.

D. K. Banerjee.

Palit Laboratory of Chemistry,
University College of Science & Technology
92, Upper Circular Road,
Calcutta, 7-2-1940.

¹ Cooks, Dodds, Hewett, and Lawson. Proc. Roy. Soc. (London), 114B, 272, 1934. Cooks, Dodds, Greenwood, *ibid.*, 114B, 286, 1934.

² Naturwissenschaften, 21, 222, 1933. Nature, 131, 56 and 205, 1933.

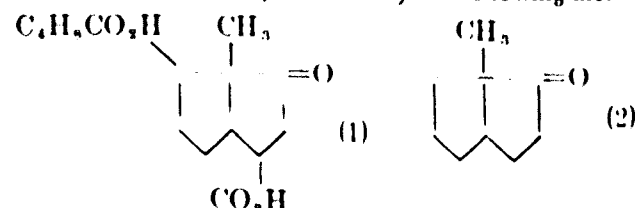
³ Nature, 137, 996, 1936.

⁴ Dodds, and Lawson, Nature, 139, 627 and 1068, 1937.

Synthesis of 7-methyl-0:3:3-bicyclooctane-1-one

By the oxidation of desoxycholic acid Wieland¹ obtained a tetrabasic acid (C₁₈H₃₄O₈). Its thermal decomposition resulted in the formation of a pyroketo dicarboxylic acid C₁₈H₃₂O₈, which is a 7-methyl-0:3:3-bicyclo-octane-1-one derivative. (1)

As a preliminary to the synthesis of the above pyroketo-dicarboxylic acid, the simple cyclopentano-cyclopentane fused ring system with the angle methyl ketone (2) has been synthesised by the following method.



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Ethyl-laevulinate was condensed with ethyl-cyanoacetate using acetamide as a condensing agent to yield ethyl-1-cyano-2-methyl- Δ^1 -butene-1:4-dicarboxylate, b.p. 154-160°/5.5 mm. On addition of potassium cyanide to the above unsaturated cyano-ester diethyl-1:2-dicyano-2-methyl-adipate, b.p. 190-192°/6 mm. was obtained in good yield, which on hydrolysis and esterification yielded diethyl-2-methyl-2-carbethoxy-adipate, b.p. 169-170°/10 mm. The above ester on treatment with sodium in benzene solution underwent cyclisation to yield 2:3-dicarbethoxy-3-methyl-cyclopentanone, b.p. 1530°/8.5 mm. the constitution of which has been settled by Baker and co-workers¹ by its oxidation; the keto-ester was prepared by Baker according to the method used by Ruzicka² for the synthesis of fenchone. The sodium salt of the above β -ketonic-ester was condensed with ethyl- β -chloropropionate in benzene solution to yield ethyl-2:3-dicarbethoxy-3-methyl-cyclopentanone-2- β -propionate, b.p. 194-197°/7 mm. which on hydrolysis yielded 3-carboxy-3-methyl-cyclopentanone-2- β -propionic acid, m.p. 116° (semicarbazone m.p. 228°). Ethyl 1-methyl-1-carbethoxy-cyclopentyl-2- β -propionate b.p. 140-142°/4.5-5 mm. was obtained by the reduction of the above acid by Clemmensen's method and subsequent esterification of the gummy acid obtained therefrom. The above diester was cyclised in presence of sodium in benzene suspension to yield 7-methyl-2-carbethoxy-0:3:3-bicyclo-octane-1-one, b.p. 119-120°/6 mm. which on hydrolysis with dilute sulphuric acid yielded 7-methyl-0:3:3-bicyclo-octane-1-one as a yellow oil, b.p. 70°/6 mm. with strong camphoraceous smell (semicarbazone m.p. 210°).

My thanks are due to Prof. P. C. Mitter for valuable advice and encouragement during the course of this work. My thanks are also due to Mr N. Ghosh and Mr B. Bhattacharjya for carrying out micro-analysis of some of the compounds.

D. K. Banerjee.

Palit Laboratory of Chemistry,
University College of Science & Technology
92, Upper Circular Road,
Calcutta, 7-2-1940.

¹ Wieland and Schlichting Z., Physiol. Chem., 134, 276, 1924. Wieland and Vocke, *ibid.* 177, 68, 1929.

² J. C. S., 1552, 1931.

³ Ber 50, 1362, 1917.

Automatic Counter Controlled Wilson Chamber

A vertical Wilson expansion chamber for cosmic-ray work has been set up. It is 15 cm. in diameter and has a depth of 3.5 cm. The expansion of the chamber,

the illumination of the tracks etc., are controlled by the coincidence pulse from two G-M counters, one placed above and the other below the chamber. The performance of the chamber is satisfactory. About 60 per cent of the photographs contain tracks of cosmic particles.



Fig. 1 shows the track of a single charged particle. Some photographs have been taken with a lead plate of thickness 1 cm. placed just above the chamber. Some of the photographs contain showers of two, four and some times more than four particles. One burst giving at least twelve particles has also been observed. Fig. 2 shows a shower of at least four particles coming out of the lead block placed just above the chamber. The results will be discussed in detail elsewhere when sufficient data have been collected.

The writer is indebted to Prof. M. N. Saha, F.R.S., for guidance and helpful discussions during the progress of the work.

Palit Laboratory of Physics,
University College of Science,
92, Upper Circular Road,
Calcutta, 5-2-1940.

P. C. Bhattacharya

LETTERS TO THE EDITOR

The Fluorescence of Organic Compounds by X-rays (Part II)

In continuation of our previous observations¹ on the fluorescence of organic compounds by the irradiation of X-rays, we have further made a preliminary study of other organic compounds (aromatic) and have measured the positions of the luminous bands with a direct vision spectroscope provided with a wavelength scale. It may

be mentioned here that a complete study not only of the actual positions of the luminous bands of the organic compounds excited by X-rays but also of the optical absorption spectra of these substances is necessary before any suggestion may be made about the origin of fluorescence of these substances by the irradiation of X-rays.

Investigations are being continued in this direction with a "Fuess" spectrograph.

Substance	Position of the luminous band in μ .	Nature of compound	Remarks
Triphenyl methane $\text{CH}(\text{C}_6\text{H}_5)_3$	570—460	Benzene substituent product of methane.	Very strong. Green. Probably there are two bands superposed.
Triphenyl Carbinol $(\text{C}_6\text{H}_5)_3\text{COH}$	600—450	Derivative of Triphenyl methane.	Very strong. Deep green.
Phenazone $\text{C}_6\text{H}_4\text{N}(\text{C}_6\text{H}_5)_2$	560—440	Derivative of Diphenyl.	Very strong. Bluish green with intense spots perhaps due to impurities.
Benzophenon $\text{C}_6\text{H}_5\text{CO}(\text{C}_6\text{H}_5)$	560—490	Derivative of Diphenyl methane.	Very strong. Green.
Salol or Phenyl salicylate $\text{C}_6\text{H}_5\text{OH}(\text{COOC}_6\text{H}_5)_2$	560—440	Derivative of Phenol.	Very strong. Greenish blue.
α -Naphthol $\text{C}_{10}\text{H}_7\text{OH}$	500—440	Derivative of Naphthalene. (OH) group in ortho position.	Weak Bluish violet.
β -Naphthol $\text{C}_{10}\text{H}_7\text{OH}$	550—450	Derivative of Naphthalene. (OH) group in Meta position.	Weak. Green.
α -Naphthylamine $\text{C}_{10}\text{H}_7\text{NH}_2$	560—420	Derivative of Naphthalene. (NH_2) group in ortho position.	Weak. Faint violet.
β -Naphthylamine $\text{C}_{10}\text{H}_7\text{NH}_2$	570—420	Derivative of Naphthalene. (NH_2) group in the meta position.	Strong. Deep violet.
β -Bromonaphthalin $\text{C}_{10}\text{H}_7\text{Br}$	580—500	Derivative of Naphthalene.	Weak. Greenish violet.
Coumarin $\text{C}_9\text{H}_6\text{O}_2$	550—430	Derivative of Cinnamic acid.	Very Strong. Greenish violet.
Umbelliferon $\text{C}_{10}\text{H}_6\text{O}_3$	570—440 The portion 480—570 is more intense.	Derivative of Coumarin.	Faint green.
Benzoic acid $\text{C}_6\text{H}_5\text{COOH}$		Derivative of Benzene.	Strong. Blue.
Para-di Bromobenzene $\text{C}_6\text{H}_4\text{Br}_2$	570—460 570—480	Derivative of Benzene.	Weak. Green.
Resorcin $\text{C}_6\text{H}_4(\text{HO})_2$	560—510	Derivative of Benzene.	Weak. Green.
p -Chloraniline $\text{C}_6\text{H}_4\text{Cl}(\text{NH}_2)$		Derivative of Aniline.	Very weak. Faint green.
p -Toluidine $\text{CH}_3\text{C}_6\text{H}_4\text{NH}_2$		Derivative of Toluene or Benzene.	Weak. Green.

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Substance	Position of the luminous band in μ	Nature of compound	Remarks
Benzol Bichloride $\text{C}_6\text{H}_4\text{Cl}_2$	560—440	Derivative of Benzene.	Moderately strong. Green.
Nitro Bromo-Benzene $\text{C}_6\text{H}_4(\text{NO}_2)\text{Br}$		Nitro-derivative of Benzene.	Very faint.
p -Di-nitro Benzene $\text{C}_6\text{H}_4(\text{NO}_2)_2$		Nitro-derivative of Benzene.	Very faint.
p -Dinitrobenzene $\text{C}_6\text{H}_4(\text{NO}_2)_2$		Nitro-derivative of Benzene.	Very faint.
p -Chlor-nitro Benzene $\text{C}_6\text{H}_4\text{Cl}(\text{NO}_2)$		Nitro-derivative of Benzene.	Very faint.
Nitro-toluene $\text{CH}_3\text{C}_6\text{H}_4(\text{NO}_2)$		Nitroderivative of Toluene or Benzene.	Very faint, except few intense green spots, which are perhaps due to impurities.
Anthraquinone $\text{C}_{14}\text{H}_8\text{O}_2$	610—500	Derivative of anthracene.	Reddish yellow.
Kresolphthalin $\text{C}_{22}\text{H}_{18}\text{O}_4$		Derivative Cresol.	Does not fluoresce except for few green spots which are perhaps due to impurities.

The studies of the shift in the position of the spectrum of the ortho-, meta-, and para-compounds excited by X-rays are interesting. The fluorescence of the nitro-derivatives of benzene is generally very faint and it is difficult to locate the actual position of the spectrum by the direct-vision spectroscope. The spectrum in almost all the cases has a sharp end on the longer wavelength side and a diffuse continuity on the short wavelength region of the spectrum.

The aliphatic compounds like cyclo-pentane cyclo-hexane, paraldehyde etc., though they have a closed chain structure does not fluoresce by the excitation of X-rays.

Our attention has been drawn by Prof. S. N. Bose of Dacca to the observations of Allen and his co-workers (*Jour. Frank Inst.* Vol. 215) on the fluorescing ability of X-rays on some naphthalene derivatives. Further we now find that Newcomer (*Jour. Am. Chem. Soc.* Vol. 42, 1920) has also *visually* observed the fluorescence of many organic substances (including those observed by us) by X-rays.

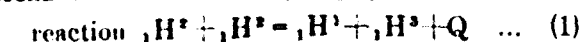
B. B. Ray
H. Bose
K. Das Gupta.

Khaira Laboratory of Physics
92, Upper Circular Road,
Calcutta, 7-2-1940.

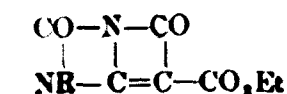
¹ SCIENCE AND CULTURE 5, 496, 1940.

Errata

In the last January issue on p. 443 in the 'Letter' on "The Nuclear Mass and Radio-activity of ^3H ", the second line of the second paragraph should read



In the last February issue on p. 495 the (III) formula should read



Physics

The Diamagnetism of the Mobile Electrons in Aromatic Molecules.

—K. S. Krishnan

According to purely classical theory a free-electron gas should have no diamagnetism at all. If the motions of the free-electrons are however quantised, it was discovered by Landau that the diamagnetism is always just one third the spin-paramagnetism of the free electron gas whether it be degenerate or not. At any temperature however the Landau diamagnetism is always superposed on the predominant spin-paramagnetism. At ordinary temperature, the free-electron gas in a metal is however degenerate and its spin-paramagnetism is given by the well-known Pauli expression for temperature-independent paramagnetism, namely,

$$K_p = \frac{3}{2} \frac{\mu^2}{kT_0}, \text{ so that the associated Landau diamagnetism}$$

is given by $K_d = -\frac{\mu^2}{2kT_0}$ (1) where n is the number of electrons per unit volume, μ is the Bohr-magneton, T_0 is the degeneracy temperature defined by $kT_0 = \frac{h^2}{2m} \left(\frac{3n}{8\pi} \right)^{\frac{2}{3}}$

and the other letters have their usual significance. When the temperature $T \gg T_0$, the electron-gas is non-degenerate so that the Boltzmann statistics is applicable and the spin-paramagnetism of the electron-gas should follow the Curie Law $K_p = \frac{\mu^2}{kT}$ and the associated

Landau diamagnetism of the electron-gas is given by $K_d = -\frac{\mu^2}{2kT}$(2) It would be of great interest to verify experimentally Landau diamagnetism. There are however two difficulties in verifying it, firstly the predominant spin-paramagnetism with which it is normally associated, and secondly the large degeneracy temperature, namely of the order of 10^4 degrees, for the electron-gas in most metals which renders the degenerate states alone accessible for experimenting. There is however, one substance, namely graphite, in which owing to certain very special conditions that obtain, both these difficulties are eliminated. It is found that the abnormally large diamagnetic susceptibility of the crystal of graphite along the hexagonal axis, which is even more than 40 times higher than the quite normal susceptibility occurring in the basal plane of graphite is all due to the

free-electrons, one per carbon atom, which are free to migrate from atom to atom in the basal plane, much in the same manner as the free-electrons in a metal. The restriction of the freedom of movement of these metallic electrons in graphite practically to the basal plane is also evidenced by the enormously greater electrical conductivity of the crystal in the basal plane than along the normal to the plane. This restriction will however be equivalent to an enormously increased effective mass for the free-electron, for motion along the normal to the basal plane and as a result the spacing of the energy levels along this direction will become much smaller than for electrons if they were free to move in all directions and hence the degeneracy temperature is here much lowered. Further the spin moments of the electrons in graphite being paired in such a manner as to give zero paramagnetism, only the Landau diamagnetism of the free-electrons in graphite is responsible for its abnormal diamagnetism along the hexagonal axis. Experimentally it is found by Prof. Krishnan and Mr. N. Ganguly that the abnormal diamagnetism of graphite along the hexagonal axis conforms to the Curie Law given by equation (2) at high temperatures and to the temperature-independent value given by equation (1) at low temperature with the number of free-electrons equal to one per carbon atom and a degeneracy temperature $T_0 = 520^\circ\text{K}$. Throughout the temperature range investigated the abnormal susceptibility per carbon atom is found to be the same as the Landau diamagnetism per electron of a free-electron gas having the above degeneracy temperature. This agreement between the experimental and theoretical value of the abnormal susceptibility of graphite at different temperatures may be regarded as an experimental demonstration of the Landau diamagnetism of a free-electron gas and of its temperature variation in accordance with the statistics of Fermi and Dirac.

The result obtained from the magnetic data that one electron for each carbon atom in graphite is free to migrate from atom to atom over the whole of a layer in graphite is of great significance in connection with the quantum mechanical theory of the structure of aromatic molecules, since each layer in graphite, which is a compact regular hexagonal network of carbon atoms may be regarded as a single aromatic molecule with an enormous number of condensed benzene rings. Such an electron is however known as the mobile electron so as to distinguish it from the other three valency electrons

in each carbon atom, which are localized and take part in binding it to its three neighbours. The occurrence of such mobile electrons is characteristic of all aromatic molecules. They explain much of the peculiarities of the physical properties of an aromatic molecule. One direct consequence of the freedom of the mobile electrons in benzene to migrate from atom to atom over the whole ring, would be an abnormal diamagnetism confined to the direction perpendicular to the plane of the ring. This diamagnetic effect should be even more marked in plane condensed-ring compound like naphthalene, anthracene, etc., in which the migration of the mobile electrons can be more extensive. This explains the remarkable diamagnetic anisotropy exhibited by aromatic molecules. For example in benzene, the diamagnetic susceptibility along the normal to the plane of the molecule is nearly $2\frac{1}{2}$ times that along directions in the plane. Indeed the observed large diamagnetic anisotropy of an aromatic molecule offers a striking evidence for the presence of the mobile electrons and the restriction of the freedom of their motion in the molecule to the molecular plane. Now, when these magnetically anisotropic molecules are arranged in a regular manner as in a crystal, the crystal as a whole will naturally exhibit an anisotropy whose magnitude will depend on the anisotropy of the individual molecule and on their orientations relative to one another in the crystal lattice. The closeness of approach of the molecules which may not be the same along different directions in the crystal, will have practically no effect on the crystal anisotropy, since the diamagnetic moments induced in them will be too feeble to influence one another. In other words, the susceptibility of the crystal along any given direction will be merely the sum of the susceptibilities along this direction of all the constituent molecules. When the magnetic constants of the molecules are already known from measurements on the magnetic double-refraction, magnetic studies on the crystal should enable one in favourable cases to obtain useful information about the orientations of the molecules in the crystal lattice. Such information will be very helpful in any structural analysis of the crystal by X-ray methods. Conversely when the molecular orientations are already known from detailed X-ray studies, the crystal data enable one to calculate the principal magnetic constants of the molecules. Molecular magnetic constants of many typical aromatic and other conjugated molecules have been calculated in this way. This is a more direct, and more accurate

method for finding the molecular magnetic constants, than the one based on measurements on the magnetic double-refraction in the liquid state and besides is more general in its applicability. Theoretically the magnitude of the diamagnetic anisotropy in some simple aromatic molecules have been calculated on a semi-classical theory by Pauling on the assumption that the mobile electrons flow along the hexagonal network of the molecule under the influence of the impressed magnetic field. The values thus obtained agree roughly with the experimental values. On this basis, for example, the large anisotropy of graphite would be attributed to the very large size of the orbits which the mobile electrons can describe in the basal plane, in the magnetic field. On this view any temperature-variation of the susceptibility is not contemplated, and indeed will be difficult to explain. But it is found that experimentally the temperature-variation of the susceptibility is very marked in graphite and that this variation can be explained quantitatively on the quantum mechanical theory, as due to the change of the energy distributions of the electrons with temperature. To explain satisfactorily the diamagnetic behaviour of the mobile electrons in the aromatic molecules one has to adopt a similar method. In fact the diamagnetic susceptibilities of the mobile electrons in chrysene, pyrene and other condensed-ring compounds also show appreciable temperature-variations though much smaller than in graphite, suggesting that the kinetic energies of the mobile electrons in these molecules should as only expected be much larger than in graphite. In this connection it may be noted that Pauling's theoretical values of the diamagnetic anisotropy of a few typical aromatic molecules have been improved upon by London in a quantum mechanical theory and the agreement obtained with the experimental values are much better. It has been explained for example, why the anisotropy of the molecule of diphenyl is found to be considerably larger than twice that of benzene or why, for example, there is a marked difference between the anisotropies of the isomers like anthracene and phenanthrene.

An optical evidence of the presence of the mobile electrons in the aromatic molecules and the restriction of their freedom of movement in the molecular plane, is however to be found in the striking directional variation of the fluorescence and absorption that may be observed in some aromatic molecules like naphthalene, chrysene, etc.

Zoology

Nature and Causes of Evolution and Adaptation of the Air-breathing Fishes

B. K. Das

Certain amphibious, tropical fishes, mostly confined to fresh water and distributed over distant parts of the world, have a double mode of respiration owing to the possession of some kind of special adaptations or structures known as the accessory air-breathing organs or lungs in addition to the gills. They can normally breathe either the oxygen dissolved in the water (aquatic or branchial respiration, and hence called water-breathers) by means of their gills so long as they are in water, or the atmospheric air directly under certain special circumstances (aerial respiration), e.g., the so-called "Walking Fishes" of India or Ophiocephalidae. These are popularly known as the air-breathers or "compound-breathers" (Gemischtatmer). The new adaptation that is most commonly met with amongst the Indian fishes has the form of certain specialised receptacles or chambers lying above the gills, which are called the supra-branchial air-breathing chambers of the "lungs" e.g., the snake headed "walking fish" (Ophiocephalidae), certain catfishes (*Clarias* and *Saccobranchus*), the so-called Climbing Perch of India (or the famous "Koi" fish of Bengal—*Anabas scandens*), the Cuchia "eel" (*Amphipnoides cuchla* the "Koonchey" fish of Bengal), etc. Besides, there are several other very interesting adaptations and modifications.

Even when such fishes are kept immersed in normal clean natural water, they are forced to come to the surface to inhale fresh doses of air, thus apparently showing that in them branchial respiration alone is not quite sufficient to maintain their lives. In fact, they are asphyxiated or "drowned," sooner or later, depending upon the vitality of the individual species of the fish, the temperature and physico-chemical condition of the water, chiefly O_2 and CO_2 tensions, if they are prevented from taking atmospheric air directly. Under normal conditions the series of aerial respiratory movements is repeated several times per hour.

Broadly speaking, all the air-breathing fishes of India are found practically in all kinds of waters, and fall under three main habitat-groups; (i) *The Tropical Fresh-water Group*, (ii) *The Tropical Brackish and Estuarine Waters Group*, (iii) *The Tropical Marine Group*.

As a result of response to the direct effects of environment, chiefly due to the lack of oxygen in the surrounding medium, six main types of beautiful structural

adaptations (or "lungs") have been evolved in the different groups of fishes. They are as follows:

- (i) *Bucco-pharyngeal epithelium*, the first and the most primitive condition, instigated by lack of O_2 in the water—"mouth-breathing" or "Mundventilation" due to "Notatmung" or breathing in distress (e.g., *Monopterus javanensis*; *Pisodonophis*; *Electrophorus*; *Periophthalmus* and *Boleophthalmus*, etc.).
- (ii) *Pharyngeal "lung"*, some kind of definite pouch i.e., air-chamber of "lung" is developed from the dorsal surface of the pharynx (e.g., Ophiocephalidae, and *Amphipnoides* (in this latter fish the "lung"=more or less like an Amphibian lung, and is developed prior to the gills); also a shallow pharyngeal pouch in *Periophthalmus*).
- (iii) *Opercular chambers*, (gills as well)—highly modified and specialised for aerial respiration (e.g., *Hypopomus* (a Sternarchid = the gills and opercular chambers modified); *Symbranchus*; *Periophthalmus*, *Boleophthalmus* and several other Gobiiformes; *Pisodonophis*; *Andamia* and a few other Blenniids as well as some coastal fishes, etc.).
- (iv) *Opercular "lung"*, developed as a diverticulum from the dorsal corner of the opercular chamber=highly vascular. The air-chamber (= "lung") may be quite simple, when it is said to be *monoaccessory* type, or it may be highly complicated due to the presence of certain extra structures lodged inside it (= *diaccessory* type):
 - (a) Simple, free and elongated tubular structure (e.g., *Saccobranchus*).
 - (b) Complicated type (situated within the skull):
 - (α) Air-chamber+3 highly vascular "shelly" labyrinthic plates="labyrinthine" apparatus growing over the 1st gill-arch), e.g. *Anabas* and all other Anabantidae.
 - (β) Air-chamber+2 beautiful, highly vascular, dendritic "rosettes" or the "air-trees" over the 2nd and the 4th gill-arches, e.g. *Clarias*.
- (v) *Special part of the alimentary canal*, highly vascular and specially modified and adapted for aerial respiration. Found in a small group

of fishes distributed over various parts of the world. Air actually swallowed in and pushed backwards into the alimentary canal, a special part of which is respiratory—this may be:

- (a) Stomach—Certain South American Loricariids, such as *Ancistrus* and *Plecostomus*.
- (b) Intestine—Certain loaches (both European and Indian), such as the well-known European mud-dweller (*Misgurnus*—*Cobitis*) *fossilis* and *Lepidocephalus guntea* (=Indian); certain S. American fishes, viz., *Doras*, *Callichthys* and *Hoplosternum* (these last two = *Callichthyidae*).

This kind of aerial respiration performed by a special part of the alimentary canal may be said to represent an intermediate condition of the adaptation between the simple and the most advanced types of air-breathing organs. In correlation with the air-breathing habit the part of the alimentary canal so concerned becomes extremely thin and almost transparent and highly vascular. In these fishes the used-up gas may be passed out of the anus, or from the mouth.

- (vi) Gas-(or Air-) Bladder modified as "Lung" has reached the highest state of perfection so far as air-breathing functions on fishes are concerned, e.g., The Dipnoi (or Lung-fishes) and a few other fishes, viz., the Bichir (*Polypiterus*), the Bow-fin (*Amia*), the Gar Pike (*Lepidosteus*), *Arapaima* (a South-American Osteoglossid), *Gymnarchus* (a Marmyrid—African), *Erythrinus* (an American Characin), the Mud Minnow (*Umbra*) = an Esocid in the stagnant waters of (the formerly united provinces) Austria-Hungary.

There are certain purely water-breathing freshwater fishes in India, which are, however, capable of surviving for at least sometime out of water, although they do not possess any particular air-breathing organ e.g., the "Thorny-backed Eel" (*Rhynchobdella*) and the "Spined Eels" (*Mastacembelus* sp.), certain small catfishes (viz., *Macrones bleekeri*, *M. vittatus* and *Rita buchanani*), a fresh-water Goby (*Gobius giurii*) and a "Puffer" (*Tetrodon cutcutia*).

In addition to the typical air-breathing fishes, there are also some other water-breathing fishes distributed over different parts of the world, which possess certain curious suprabranchial function.

As regards the vascular system it may be said that the arterial supply in these air-breathing fishes is not of

any special interest, but the venous system is very interesting and peculiarly modified in many cases; and in certain forms, such as the Dipnoi and *Gymnarchus* (amongst the teleosts) a separate pulmonary vein has evolved that opens directly into the atrium. The blood from the accessory respiratory organs in the majority of these fishes may be drained either by means of the jugular (i.e., the anterior) vein, or the posterior cardinal vein—in connection with the latter there is often the relay of an inter-renal vein. As a rule, the blood in these air-breathing fishes is of mixed character throughout general circulation, and hence this type of circulatory system is far less efficient than the double mode of circulation met with among the higher vertebrates, but probably the mixed blood is sufficient for the needs of these fishes. It may be tentatively inferred that in the origin of a double circulation there must have intervened a stage in the evolution of air-breathing in which the circulation was mixed (Carter and Beadle, 1931; Carter, 1935).

It is interesting to note that there are even differences in the blood-constitution of the various classes of fishes living in different surroundings—there is what may be called a physiological adaptation in fishes of rivers and streams: river fishes being more sensitive to unfavourable respiratory conditions (Willmer, 1934).

Dealing with physiology of these fishes, Dr Das observed that branchial pulsations vary due to various factors, chiefly the O_2 and CO_2 tensions, temperature, and pH of water.

The majority of the larve, however, living in dirty water carry on "mouth-aeration" (in addition to gill-breathing), which ultimately stimulates the development of some kind of special type of air-receptacle (or "lung").

During aerial respiration the air breathing fishes usually keep near the surface of water and snap air quite easily and frequently with their widely open mouth. The used-up gas is often given off simultaneously from the posterior corners of both opercula, or, less frequently, the greater portion of the vitiated gas may be expelled from the mouth. In the Cuchia "eel" (*Amphipnous*) fish the branchial and aerial respirations are quite independent of each other—a "Proto-amphibian" and it is the most highly evolved air-breather amongst the Indian teleosts. The rate of aerial respiration also varies greatly from $\frac{1}{2}$ min. to 15 min.

These air-breathing fishes are asphyxiated or "drowned" when kept in a large volume of normal, natural water in an aquarium under a diaphragm. Gasp- ing and spasmodic branchial respiration precede, and ultimately the fish gets completely exhausted and asphyxiated. If the air-breathing fish is partially

"drowned," then it can again be brought back to life, i.e., can revive after some time, say in about $\frac{1}{2}$ an hour, by allowing it free access to atmospheric air and at the same time using well-aerated water. The air-breathers can live for a long time out of water (when kept in moist conditions), from about 5 hours to 60 hours according to the species of fishes used. In dry atmosphere they can also survive for some time out of water, from 10 mins. to 6 hours, or so.

The habit of seeking oxygen by swallowing bubbles of air, when the dissolved oxygen in the surrounding water is very low or practically falls, is widely distributed amongst the Teleostean fishes distributed over distant parts of the world. The air-breathing fish differ from their normal congeners in the intensification of this habit, and the reasons for this intensification may be easily inferred: Fishes that habitually live in shallow ponds and streams which periodically become dried up (e.g., *Clarias*, *Saccobranchus*, *Anabas*, *Macropodus*, etc.), or usually in pools and marshes rendered foul by decaying vegetation (*Ophiocephalus* and others), or in muddy holes which periodically dry up (*Amphipnous*), or lead a semiterrestrial life along the coastal mud-flats (e.g., *Perlophthalmus*) must constantly snap air in order to survive at least.

This habit is at first initiated and acquired as a result of the reaction to the physico-chemical nature of the environment, such as especially the O_2 and the CO_2 tensions of the water, heat, occasional drought, etc., and later on it is stimulated and intensified chiefly by migration. The low concentration of dissolved oxygen in the water is the condition of greatest biological and bionomic importance that, as a rule, accounts for the evolution of the diverse types of air-breathing fishes. This habit of swallowing air, being long continued, becomes deeply engrained in the constitution of the species, generations after generations, and is gradually improved and eventually leads to structural modifications, usually in the form of reservoirs adapted to lodge the inhaled air. These reservoirs (or new type of "lungs") are of very different forms and quite independently evolved, in each and every species of fish, and, with but few exceptions, there is hardly any phylogenetic relationship with one another.

It may be said that the various types of air-breathing organs have evolved in fishes living in distant parts of the world as a response to one and the same type of environmental reactions in different kinds of fishes which are, as a rule, not closely related to one another, and these organs are evolved as absolutely new and independent structures for a similar physiological need—in short, the beautiful series of air-breathing fishes present one of the finest examples of what is known as "Parallelism or Convergence in Evolution," which is one of the fundamental factors in evolution.

The study of air-breathing fishes gives the clearest proof that in evolution, function changes first and modified structure follows long after, when the changed function has lasted long and become deeply engrained in the constitution. There seems to be ultimately two possible causes of "Variation," viz., either (a) chance, or (b) reaction to environmental changes (Bateson, 1923), and the study of the air-breathing fishes leads unequivocally to a decision in favour of environmental change.

It is interesting to see how the structure and functions of the gas-bladder of the Dipnoi and of its homologue the primitive lung of anurous Amphibia are physiologically mimicked, so to say, by certain wonderful adaptations or the newly acquired or evolved "lungs" of certain tropical fishes as a response to the direct effects of environment, viz., the opercular "lungs" of *Saccobranchus*, *Clarias*, *Anabas*, etc., and the pharyngeal "lungs" of *Ophiocephalus*, *Amphipnous* and a few others, as well as by certain other types of accessory air-breathing organs (—"lungs"), viz., the highly modified stomach, intestine, etc.

The gap that separates the aquatic from the land vertebrates is a two-fold one, viz., (i) the difference in the mode of respiration between the two, and (ii) the presence of fins in the former and that of the pentadactyle limbs in the latter—it is of fundamental importance to note here that this gap is partly bridged over by the evolution of certain special organs or "lungs" designed to perform aerial respiration, which are physiological equivalents of the true lungs of terrestrial vertebrates: thus now the only shortcoming, so far, lies in the structure of the fins. Indeed these beautiful series of air-breathing fishes depict an attempt towards the gradual mode of evolution, transformation and transition from aquatic to air-breathing terrestrial life.

B. K. Das

President Zoology Section.

Born at Allahabad in 1897, Dr. B. K. Das had his education at Allahabad University. He was one of the brilliant scholars of the University and received his training in zoology under Dr W. N. F. Woodland. After passing his M.Sc. in 1918 he secured two research scholarships and after a year was appointed a lecturer in zoology at the Muir Central College, Allahabad, which post he held till 1923. In 1923 he won the State scholarship for scientific researches and study abroad from the U. P. Government. He took with him a large number of live air-breathing fishes from India to England, and started work at the Imperial College of Science and Technology, London, under Professor E. W. MacBride, F.R.S. He was exempted from appearing in the M.Sc. and the Ph.D. examinations

of London University on the merit his work during the first 6 months of his stay and was allowed to prepare for the D.Sc., degree, which he received in 1926. He was

awarded the Huxley Memorial gold medal and Huxley prize from the Imperial College of Science, London in 1930, being the first Indian zoologist to win this prize in zoological researches (amongst the natural science subjects). Recently his dissections of air breathing fishes have been exhibited in the galleries of the British Museum.



He returned to India towards the middle of 1926 and was appointed university professor of zoology at

Calcutta University for a period of 5 years. After this term he went to Osmania University, Hyderabad (Deccan) in 1932 where he was appointed professor of zoology, and later on confirmed as the Head of the newly-created zoology department, which office he now holds. He has reorganised the zoology department on very efficient and modern lines, and has succeeded in creating a school of research in zoology.

In 1935 Dr Das was deputed as a delegate to the XII International Zoological Congress held at Lisbon, where he read a paper on an air-breathing Indian loach, *Lepidocephalus guntea*. He was elected one of the vice-presidents of this Congress and, in addition, a correspondent member of the Sociedade Portuguesa de Ciencias Naturais.

Dr Das is the author of a large number of papers on the study of fishes, and on subjects covering a very wide range of the comparative anatomy and physiology of a number of groups of vertebrates.

Entomology

Ecology and Control of Insects

—H. S. Pruthi

The use of insecticides for controlling injurious insects has many limitations, especially in countries like India where cost of chemicals is beyond the means of ordinary cultivator, who, on the other hand, is not literate enough to be able to use poisonous materials without risking his own life or that of his domestic animals. Moreover, chemical methods as at present applied suppress a pest for one season only and have to be repeated almost every season. Therefore, during recent years, increased attention is being paid in all parts of the world to evolving other methods, which may be simple in their use and more permanent in their effect.

All forms of animal life are so intimately adjusted with their environment that any change in their surroundings is reflected by a well marked change in their numbers. Thus, if we know the conditions of environment of an insect pest and the influence of changes thereof on its population, it is possible to predict the outbreak of the pest in advance or evolve methods which

would keep the injurious species under control. Environment is however a complex of several factors—physical and biotic, and it is possible to understand its influence only by a careful study of various factors, both individually and in combination. The more important of these factors are light, temperature, humidity, rainfall, food, surrounding vegetation, competitors and parasites.

Of the various physical factors of environment, temperature is undoubtedly the most important single factor. To illustrate the influence of this factor and to indicate how such information can be utilised by applied entomologists, examples are given of Zwolfer's critical work on the nun moth, *Lymantra monacha*, Bodenheimer's on the Mediterranean fruit-fly, Denny's on the upper vital limits of some species infesting grains and of several other works.

The information about the upper and lower fatal temperature limits of injurious species is the basis of control of several stored grain and other pests. The cotton pink bollworm cannot stand a temperature of 50°C for more than an hour. This information is utilised for killing hibernating larvae of this pest by

heating the cotton seed before sowing. Maggots of several fruits flies are killed at 10°C in a short time and the refrigeration of fruits before export is therefore employed as an effective quarantine measure in several countries. Next to heat, the fundamental necessity of insects, as of other animals is the humidity or moisture content of their environment. The humidity of atmosphere being directly dependent on rainfall, the quantity of latter and its distribution in time are very important factors governing the abundance of insects. Cook's work in Canada shows that cutworms are seriously affected if there is more than 5" rainfall between May and July. The soil environment becomes too moist for them and they come out on the surface where they are killed by their enemies. The pest is consequently reduced in number that next year there is no possibility of its assuming serious proportions. Another example of similar work is that on the effect of rain in reducing the numbers of spotted bollworms of cotton in North India. Critical studies carried out at Imperial Agricultural Research Institute have shown that good rains spread over the year do not reduce the pest directly, but indirectly by raising the atmospheric humidity, which is inimical to the bollworm and conducive to the multiplication of its parasite, *Microbracon lefroyi*. Afzal Husain and Haroon Khan's work on the ecology of pink bollworm of cotton in the Punjab illustrates the combined effect of temperature and humidity on insect abundance. They found that temperatures between 72°F and 90°F with a relative humidity of over 70% are most suitable for egg production and oviposition. Similarly Rivney studying the ecology of the thrip *Heliothrips haemorrhoidalis* showed that its distribution in Egypt and Palestine is influenced by temperature and humidity. A temperature range of 15°–30°C and relative humidity of 85–100% are suitable for development, while higher temperature and lower humidity are injurious. He prepared climatographs of Egypt and Palestine and found that areas around Cairo would be most unsuitable for the thrip, which is actually the case, as this thrip has never appeared as pest there. Palestine has suitable temperature and humidity conditions throughout the year, except for short intervals during summer when the thrip undergoes high mortality. The pest is therefore ordinarily not serious in Palestine, but in 1930 and 1931 as a result of the previous autumn being unusually more humid and mild, there were serious outbreaks of the pest in that country.

In nature the distribution and multiplication of various species is determined not so much by any individual factor of environment, but all the physical factors combined together, which are usually termed climate. The influence of climate on the actual habitat of a species is illustrated by the behaviour of the coffee bug, *Antesia* in East Africa. The movements of the bug on different parts of the coffee bush are in consonance with the most favourable climatic conditions. On the basis of

observations Kirkpatrick recommended that except at very high and low altitudes the bug would multiply less on well pruned bushes than on those which have abundant thick foliage.

Proper kind of food or nutrition has a very important influence on the presence or absence of a species in an area independent of climatic conditions. The caterpillars of the nun moth, *Lymantra monacha*, referred to above can feed and develop on a variety of forest trees, but oak, larch and spruce are the most favoured hosts, since larvae fed on them develop quickest, undergo minimum mortality and the resulting adults lay maximum number of eggs. Beach, apple and pine come next and alder is the most unsuitable food in all respects. Not only proper food plant should be available but its stage of growth and the condition of its sap has also important influence on the insect feeding thereon. For example, the size of silkworms and the cocoons produced by them is very much affected by the condition of mulberry leaves given to them as food. Similarly *Aphis maidis* cannot multiply rapidly unless the maize plant is at the stage of putting out tassels.

From these examples it must not, however, be understood as some workers, notably Sir A. Howard, have done, that conditions favourable for plant growth are necessarily detrimental or distasteful to its insect pests. As a matter of fact there are several practices, such as use of nitrogenous manures, green manuring of crop residues, etc., which are helpful for good plant growth and are also conducive to a rapid multiplication of insects. It is also a matter of common observation that resistance to insects and high yield quality in crop varieties seldom go together.

In nature, insects are not only exposed to climatic factors but also to biotic factors such as, parasites, predators, competitors, types of surrounding vegetation, etc. The importance of natural enemies in reducing the population of insect pests is well known and is being exploited by workers on biological control of pests. The basic principle underlying this method is the differential behaviour of a pest and its parasite under the same ecological conditions. This is illustrated by Shelford's work on the aphid, *Toxoptera graminum* and its parasite, *Lysiphlebus tritici*, and by the searches of several other workers. Even small differences in the rates of development of the host and parasite may cause the extinction of one or the other.

The influence exerted by vegetation on insect activity and abundance is illustrated by Swynnerton's recent work on the Tsetse flies in East Africa. He has demonstrated how the vegetational environment favourable for the multiplication of flies can be changed by discriminative clearing, removal of vegetation on borders, burning of grass, etc., so as to effectively reduce the flies below pest proportion.

The combined influence of all factors of environment, both climatic and biotic, is shown by Uvarov's work on Moroccan Locust, *Locustotaurus moroccanus* in Iraq and Syria. He found that this locust inhabits dry level tracts at the base of mountains, which resemble desert in summer but are covered with grass during winter and spring rains. The optimum conditions for development are a temperature of 10°-17°C and rainfall of 35-80 mm from November to April. The absence of these in the plains of Mesopotamia has been shown to be responsible for the insignificant number of the locust in that area. Intensive surveys in several countries inhabited by this locust have shown that the locust "reservations" or "outbreak areas" are concentrated within strictly well defined geographical, vegetational and climatic zones. In some countries, like Hungary and Northern Caucasus, this locust has begun to breed in areas which have become artificially favourable by the drainage of swampy areas or by the hardening of soil due to overgrazing. From the foregoing, Uvarov naturally suggested that the number of locusts may be reduced and the pest therefore controlled in the outbreak areas by periodically ploughing them and by judicious management of grazing, thus bringing about the original conditions which are unacceptable to the locust for breeding.

The control of malaria transmitting mosquitoes by ecological methods has had undoubted success in certain areas and has possibilities of more general application. The fact that most of the vector Anophelines do not breed in sewage polluted water is exploited by feeding industrial wastes, etc., into clean breeding waters. On the same principle the filling of pools and streams with cut vegetation, termed "herbage packing", which not only acts as mechanical obstruction but also pollutes the water and brings about other changes in the nature of micro-organism has been made use of as an anti-malarial method.

Strickland recently showed that water streams shaded by forests in Assam breed only non-vector harmless mosquitoes and when these shades are cleared, malaria carrying species at once appears and begins to breed. Therefore, shading of streams by growing low hedges of duranta, lantana, etc., is being extensively practised in India, Malaya and other countries. These observations also emphasize the necessity of preserving original shade and adding more trees to natural jungle as an anti-malaria measure.

Anthropology

Scope of Prehistoric and Anthropological work in India

K. N. Dikshit

The inclusion of archaeology in the section of anthropology is an essential measure which is fraught with great possibilities advantageous to both the sciences. It is necessary to speed up the programme of research before the pressure of population and the modern tendency of fusion of population destroy the archaeological and anthropological evidence. It is essential that Government scientific departments, universities, museums and learned societies should pool together their resources in order to produce sustained and co-ordinated efforts. The study of fossil man has not been seriously taken up in India. More work is necessary for determining the age of early palaeolithic found with bones of extinct mammals in the river cliffs such as those from the Narbada and the Godavari. The duration, sequence and co-relations of the various Stone Age cultures should

be properly established by more extended work on the lines of the Yale-Cambridge Expedition in the Soan and Kashmir Valleys on the upper palaeoliths in the pleistocene epochs. Careful tabulation of known palaeolithic and neolithic sites and implements, district by district, is necessary before a systematic exploration over the whole of south India including the States of Mysore, Travancore, Cochin and Pudukkottai. The appointment of two qualified proto-historians to the staff of the Archaeological Survey, as recommended by Sir Leonard Woolley should be brought into effect as early as conditions permit. Study of rock paintings and rock shelters in the Vindhya, Kaimurs and Mahadeo Hills should be systematically pursued. In the field of the pre-historic civilization of Sind, the further extension of work on cemeteries at Harappa and Damb Buthi may bring additional skeletal material to what is already known from Nal, Harappa and Mohenjo-daro. The sequence of the Indus Culture and finds of copper implements in the Gangetic Valley should be definitely established by further work. In the south of India the passing of the

neolithic into the Iron Age should be carefully investigated, particularly in the vicinity of the cinder mounds of Ballary. The discovery of neolithic and Iron Age finds and rock shelters in the vicinity of Mauryan sites in south Hyderabad and north Mysore raises expectation of links being established between the historic and pre-historic epochs in the south. Large scale anthropometrical work should be undertaken in connection with census operations and the supply of trained workers should be organised by the universities and the learned

societies. Skeletal material of the ancient historic period has been first discovered recently in Ujjain. The preservation and interpretation of these require more qualified students, which universities should endow. Material of great value for the anthropological and ethnological studies is available in stone inscriptions and copper plates. Great scope exists for work and training of scholars in every branch of anthropology, but India must organise its own work in a spirit of self-reliance.

Medical and Veterinary Research

Development of Animal Husbandry in India

J. R. Haddow

Reference to animal husbandry subjects can be found in the earliest literature of India and the early stages appear to have differed in no way from those in other parts of the world except that owing to climatic and geographical conditions a wider range of species was available for domestication than usual and the selection of a particular animal appears to have depended on its presence in large numbers rather than on fundamental economics. The production of work has thus been in competition with and not in correlation with other forms of production, notably so in the case of milk and wool. Of much greater importance, however, in the advancement or, as it certainly was one time, the retrogression of animal husbandry were the presence or absence of disease and famine, and one is led inevitably to the conclusion that these two factors were the main, if not the sole, controlling forces in the development of animal husbandry.

The general trend has been to meet the influence of these factors by encouraging unrestricted multiplication—a trend which has been so deeply inculcated that it has become a part of the older religions—apparently on the principle that if there are a large enough number of animals, sufficient will survive either a famine or an epizootic to rapidly repopulate the denuded areas. This trend led to the formation of a vicious circle in which the risk of famine damage and the frequency of major epizootics is continually increasing and there is also a coincident reduction in utility. The degeneracy of malnutrition, susceptibility to disease and parasitic invasion are interwoven and naturally in the end react adversely on the

controlling force, man himself. This process continuing over hundreds of years would, despite the efforts of the wealthy few, lead slowly but surely to the destruction of breed characters and to the degradation of type.

Any development which has or is taking place must, therefore, be considered as progress in the abatement of disease, provision of fodder in suitable amounts and adequate in quality, the formulation of a definite objective in breeding operations and the general education of the husbandman himself. Large epidemics in the past have served to keep the cattle and possibly the sheep population in India within limits reasonably close to optimum use of the available food supply and it has even been mooted that outbreaks of diseases for which a control is readily available might be made use of now by the immunisation of the better type of animal alone in the hope that the unwanted would be more quickly eliminated. It is needless to say that such a measure, apart from the grave practical difficulties involved, would be extremely wasteful and unfair in its application. The elimination of the surplus should be through the medium of fair competition with those of better quality provided that the means for the preservation of the better quality animal is to hand, for, a vicious circle once having been formed, it is necessary that, if the progressive development of quality is to take place by grading up local stocks, the means for prevention must have a cash value commensurate with the value of the animal to be protected and must, therefore, in the beginning be extremely small.

This essential has undoubtedly prevented the wider application of many of the already well-known methods of disease prevention in India. A typical example of this is to be seen in the case of Rinderpest. Apart from initial religious prejudices of the husbandman the serum

simultaneous method of inoculation could not be given a fair trial till a cheaper method was discovered by Dr Edwards about 15 years ago by the use of a strain of virus fixed in goats which had lost most of its virulence for cattle without any impairment of its antigenic properties.

One reason why it has taken all these years for a cheap and efficacious method such as this to obtain popular approval is that the epizootiology of the diseases of domesticated animals in India has hitherto received little attention and but a few organised studies in this direction have been recorded. Lack of sufficient trained staff has in the main accounted for this but the growing interest in the ultimate results produced by extensive preventive measures will make it necessary to study in detail the epizootiology of at least the main scourges as early as possible.

Difficulties in the progress of the control of other diseases of viral origin can, with the exception of foot and mouth diseases where the efforts are spasmodic, largely be attributed to the lack of correct diagnosis and it is only in recent years that the extent to which virus infections may be responsible for wastage has been fully realised, but much work and study and a number of research teams will be necessary before substantial progress can be made in the diagnosis and cure of these diseases.

Under-nutrition of animals is evident everywhere but the danger has been realised and steps are now being taken all over India to ameliorate the position. The object of these measures is in the first instance, to increase the total quantity of foodstuff available by making use of reserves at present improperly used or by replacing those of little value by those of better quality, such as is being attempted in the forest grazing areas, by increasing the use and availability of industrial by-products such as molasses and by providing specifically for the nutritional requirements of farm animals to make good the deficiencies, or supplement the food values of these grazings and by-products.

Common grazings are bound to deteriorate if they are not subjected to some form of control and particularly in India the practice of over-grazing at once brings into play the forces causing erosion and this initiates a progressive loss of fertility. Such grazings cannot be improved until the stock they carry is reduced to a number commensurate with the productive capacity of the land. Once erosion has ceased either by the natural regeneration of vegetation or by artificial means the carrying capacity will undoubtedly rise. At the same time much can be done to favour the increase of species valuable for fodder and for soil improvement.

It cannot be expected that farm animals whatever their purpose, can subsist entirely on the waste materials of intensive farming for the production of man's food and industrial material. It is a striking feature of animal farming in India that in those areas with rich soils devoted to the intensive production of man's particular needs for food and commerce, degeneration is most marked, while the best types of the various Indian breeds are invariably to be found in the more arid areas fringing on desert zones where indeed fodder must be specially grown for animals if they are to exist at all.

While the main attack on under-nutrition may now be said to have been launched, there are also certain other aspects of nutrition which have shown themselves to be of urgent importance. For example the glut of green feed which comes with the advent of the monsoon is shortly replaced in most parts by a long period in which little or no green food is available to the general mass of animal population. Given fairly normal conditions the supply of green food lasts just long enough to enable the animal to make up his stored reserves of vitamin A to a degree sufficient to carry him over the long period of deficiency, but should any factor upset this rather fine balance such as a short monsoon a period of confinement as in town dairies or an increased demand on the system such as an increased milk yield, trouble of a serious nature will ensue.

In certain areas measures will also have to be taken to remedy various mineral deficiencies of the soil which are reflected through the fodder grown on the health of the animals farmed thereon. In the competition for certain substances, particularly protein, man has claimed practically all that is available. If breeding stocks of real value are to be built up, this position must be remedied and much more protein than is at present usually supplied must be made available.

Development from this point onwards will depend upon an increasing knowledge of the science of genetics. Many interesting and complicated problems present themselves at once. At one end of the scale, if scale it may be called, is milk and at the other end is draught. Much may be learnt from the experience in other countries where the end objectives have been milk and beef, although it does not necessarily follow that the same path must be pursued with milk and draught, in fact the latter quality, as far as I know, has not so far been given any scientific standards upon which it could rely for guidance. On the side of milk production one has to consider the development of the buffalo, at present the premier milk producer in India and it is not easy at present to define the respective roles that each species should take.

In the case of the sheep, wool production immediately leaps to one's mind. In this animal specialisation is

almost entirely absent and the objectives must be first to investigate the possibilities of wool, mutton and transport separately before attempting to combine them indiscriminately. At the outset it is clear that one would not attempt to turn an animal with a valuable coat into a beast of burden. The goat, "the poor man's cow" also presents interesting problems. Allowed to range unrestricted the milch goat can exist and produce a modicum of milk where the cow would starve but under such conditions there is no doubt that by the damage caused to useful shrubs and young trees the species becomes a nuisance to those engaged in fighting soil erosion.

With regard to the horse little need be said. With the advance of mechanical transport its uses have become more limited and in India the donkey also competes though in the latter case scant attention has been paid to development. Work in this direction might be well repaid.

As regards poultry, their development has been restricted by various factors, principally the difficulty of supplying distant demands and until such obstacles have been removed little advance can be expected. The improvement of local breeds either with or without the introduction of foreign blood appears to be the problem of the moment.

Of the other species the lines of possible further development are at present not clear. The camel, however, restricted its use, has an undoubted field. The pig, an animal at present only farmed by the depressed classes has its uses and may also be fitted economically into the complete picture. There is likewise the very specialised case of the elephant.

Lastly and by no means least important comes the general education of the husbandman himself. As with his animals, so he himself must have a fair insurance against famine and disease if he is to take an active part in the development of the industry which he controls.

Agriculture

Some Problems of Crop Production in India

J. C. Luthra

Prof. Jai Chand Luthra began with a brief history of the standard of agriculture in India in the past, particularly referring to the superiority of cotton grown in the old days and the fineness of cloth manufactured from it. Like cotton, types of high quality of other crops, such as wheat, rice, etc., were discovered by plant breeders in mixtures grown by farmers before the work of improvement of these crops was taken up about 35 years ago.

The decline of agriculture before the 20th century may be chiefly attributed to the farmers' carelessness in regard to seed selection. To select a good seed as the foundation of agriculture three aspects should be considered, (a) high viability, (b) purity, and (c) freedom from contamination of insect pests and seed-borne diseases. There is a very great need for a Seed Act in this country as they have in Europe, America and Japan. Several factors influence viability of seed. The more important of these are temperature and humidity prevailing during the period of maturity. In connection with the influence of weather on wheat, it is observed that hot and dry winds in March in the Punjab have a desiccating effect on the developing grain with the result

that the weight of grain is reduced by as much as 60 per cent and vitality is lowered by 20-30 per cent. Such shrivelled grains, however, were found capable of producing a crop which bore plump grains of normal size and form. It is concluded from the experiments that there is no advantage in grading wheat for size in the produce of pure lines in order to get higher yields.

As a result of the work done in India on seeds, it has been found that seeds of vegetables, e.g., cauliflower, onion, turnip, etc., lose vitality completely after 3-4 years. In the case of pulses, seeds of Mung (*Phaseolus mungo*), Urd (*P. radiatus*) and Matki or Moth (*P. aconitifolius*), and gram (*Cicer arietinum*), improve in the second years. Seeds of wheat and cotton lose 50 per cent viability after 5-6 years and are altogether dead in the 9th or 10th year. Seeds of flowers and vegetables imported from abroad are frequently found to have lost their viability wholly or partially. At present unfortunately there are no laboratories equipped with modern seed testing appliances even in the agricultural colleges in India. A study of the relationship of germination capacity with the structure of the seed has shown that low viability in some leguminous crops is due to the imperviousness of its seed to moisture. Various methods have been employed for securing good germination of Senji seeds (*Melilotus parviflora*). At Lyallpur, a simple method has been devised in which a 2-lb bottle is half filled with seed

mixed with small-sized gravel and shaken for 5 minutes. The treated seeds have given a germination of 90 per cent as against 30 per cent of the untreated seed. In some crops, the colour of seed is an index of its viability. It has been observed at Lyallpur that the yellow seed of Berseem (Egyptian clover) (*Trifolium alexandrinum*) gives a germination of 70 per cent as against 40 per cent and 15 per cent of the brown and the black seeds.

Commercially, the quality of a produce must conform to the standard required by the buyers. But for want of appreciation of quality, it is difficult to find in the Indian market any consignment conforming to the standard. In consequence, Indian produce is condemned in European markets. Owing to the absence of marketing organizations, the farmer has no incentive to maintain any standard in his produce. The produce is not properly stored and this results in much damage and consequent depreciation in value. The loss of 2.4 crores of rupees a year during storage by insects and other causes can be prevented to a large extent if the farmer could be persuaded to realise the value of pure seed. Seeds of weeds also are responsible for a large amount of loss. Besides, the actual produce and the calculated yield from the quantity of seed sown are not commensurate, mostly owing to destruction of seedlings by rats, birds, white ants, worms and diseases in the field. Investigations should be conducted to find a remedy for this loss.

Vernalization of seeds for accelerating the reproductive growth in plants with a view to inducing early ripening has been adopted on a field scale in Russia. There is scope for its application to important foreign varieties of crops for their acclimatization in India. In the Punjab, vernalization will find useful application in several crops. In oilseeds, it will be very helpful if crops can be made to flower and seed earlier so as to escape damage from frost. Where cottons have to be sown late (on 15th June or after) particularly to save the crop from the Root-Rot disease, early flowering induced by vernalization will improve the yield. In the introduction of superior types of cottons and wheats from abroad, it was observed that the climatic conditions stood in the way of flowering at the proper time.

Closely connected with the purity of the seeds is their nutritive value. The quality of some seeds as food and their capacity for propagation are influenced by the type of manures applied for their production. The analysis of Anjan grass (*Pennisetum cenchroides*) at different places illustrates how nutritive value is affected by climatic and soil factors. A new field of scientific investigation is offered in the production of farinaceous and other patent foods—worth 74 lakhs—now imported into India and for which suitable raw material is available in abundance in this country.

Many crops frequently suffer from diseases that are carried by seeds. Wheat, barley, oat, rice, and

millets are seriously affected by various smut diseases and mostly they are seed-borne. In this connection Prof. Luthra referred to his new method of the application of solar energy to eliminate Loose Smut (*Ustilago tritici*) from wheat grain and to control oat smut (*Ustilago avenae*). This simple measure and the recent discovery in the Punjab of gram types resistant to the blight disease (*Ascochyta blight*) would save these crops from loss amounting to millions of rupees. Similarly selections of wilt resistant strains of Arhar (*Cajanus*) and cotton made at Pusa and Poona have helped in raising healthy crops. Besides seeds, plant structures, e.g., setts of sugarcane, potato tubers, and nursery stock harbour and convey diseases.

The systematic work on plant breeding done in India has resulted in the evolution of improved strains of several staple crops. The total additional amount which the growers have been getting annually as a result of the introduction of improved varieties of cotton, wheat, rice and sugarcane, is nearly 21.6 crores of rupees. The net annual expenditure on agriculture of the Central and Provincial Governments was about 1.5 crores of rupees during the year 1936-37, i.e., about 8.6 ples per acre on the total cultivated area including the Indian States. Great Britain, which is of the size of one major province of India, spends about 1 crore of rupees on agricultural research of which 90 per cent is contributed by the State. The provision of 1.5 crores of rupees for India is very inadequate.

In effecting any improvement in agriculture, the farmer's economic condition must be taken into consideration. The problems of education, indebtedness, and sanitation are for the Government to solve. The work of rural development that is being done in various provinces promises well, but it must be sustained and concerted, if any permanent result is to be obtained. The work which is being done in Russia may serve as a guide in this direction. At the present time, however, prices of produce are still low, manures are not available at an economic price, and marketing arrangements are yet in their infancy. The educated classes are still averse to farming. The landed aristocracy of India has not started giving the necessary attention to improving their lands and the yields. The farmer lacks the initiative and the necessary means to make trials to achieve something better than he has. The advisory staff of the government agricultural departments is not sufficient to carry out door to door propaganda for scientific farming and agriculture as there are 700,000 villages to be visited for this purpose. The interval between the first and the second visit will obviously be far too long and the effect of the first lesson will be altogether lost. For creating real interest in improved methods of farming in villages, a constant companionship with a forward class of farmers is absolutely essential. For protection against outside

forces, the farmer will look naturally to the State. Recently a bill was introduced in the British Parliament to maintain prices at the required level. If India is not prepared for such drastic steps, similar measure is necessary for affording relief to the growers of food crops. The pressure on land which is already heavy is still increasing. It is therefore desirable at the same time that part of the agricultural population should be diverted to some better paying profession. A new scheme of economic planning as is being contemplated for India will tend to rehabilitate agriculture by stabilization of prices, improvement of the standard of living of peasants, increasing their purchasing power, creating marketing and credit facilities, co-ordination of agriculture with other allied industries. Immediately non-official agencies

are required to co-operate with the agricultural departments in the raising, storing and distribution of seeds of improved crops and educated agriculturists should be encouraged to take to the business of farming and seed supply.

In view of the great danger of farming being replaced by synthetic production of food and manufacture of artificial textile fibre instead of cotton, Prof. Luthra urged that the Indian Science Congress should set up a committee for the consideration of the economic problems which would keep in touch with the research done in the provinces and would remain in communication with the Imperial Council of Agricultural Research as a link between the intelligentsia and the Government.

Physiology

Rice

—W. R. Aykroyd

Rice is the staple food of about half the human race. In India the area under rice exceeds that under all other cereals put together. Diet surveys in India have shown that the poor rice-eater consumes, in addition to his staple cereal, which provides 80-90 per cent of total calories, only very small quantities of other foods such as pulses, vegetables, fruits and meat. Milk and milk products are taken in negligible quantities or not at all. In the circumstances the nutritive value of the main ingredient in the diet is of primary importance.

Rice is a poor source of fat, vitamin A, certain vitamins of the B₂ group, and calcium. Its total protein content is low compared with that of other cereals, but the biological value of its proteins is comparatively high. Milled rice is poorer than under-milled rice in most important constituents. Parboiled rice, even when highly milled, retains most of the anti-beriberi vitamin B₁, originally present in the unmilled grain. The steaming to which the grain is subjected during the parboiling process causes vitamin B₁ and a number of valuable food factors, present in the outer layers, to diffuse through the grain, so that they cannot be removed when milling subsequently takes place. The washing and cooking of any kind of rice reduce vitamin B₁ and nicotinic acid content by about 50 per cent. Nicotinic acid is an important member of the B₂ group of vitamins.

In India, beriberi is endemic only in the northern Circars district of the Madras Presidency. In other

parts of the country it is relatively rare. Its geographical incidence can be explained by the fact that in the northern Circars raw rice is usually consumed, whereas elsewhere in the rice-eating areas of India it is the general custom to consume rice in the parboiled state.

Hand-pounded rice is superior to milled rice as an article of diet, but the difference between the two is small when rice is parboiled. Any tendency to abandon parboiled milled rice in favour of raw milled rice should be checked by educating the people about the greater value of the former. In the Madras Presidency, about 70 per cent of the rice-eating population consumes machine-milled rice and in the circumstances it might be very difficult to bring about a general revival of the practice of pounding. The rice mill has spread everywhere. In other parts of India, the majority of rice-eaters still consume hand-pounded rice. In areas in which the population is still economically adjusted to the production and consumption of hand-pounded rice, there may be a case for checking the penetration of the mills by legislation. But in nearly all such areas outside the Madras Presidency, parboiled rice is consumed, and it is questionable whether the differences in nutritive value between hand-pounded and machine-milled parboiled rice are large enough to justify legislative and administrative action against the mill. The use of home-pounded or under-milled rice may be encouraged by education and propaganda.

Milk contains many of the food factors in which rice diets are deficient, and every effort should be made

to increase milk production. Skimmed milk and butter-milk of good quality are valuable supplements. The partial substitution of rice by one of the millets, particularly ragi (*Eleusine coracana*), improves poor rice diets. The production of vegetables should be increased, special attention being given to green leafy vegetables which are rich in vitamin A and calcium. The fishing

industry should be developed and attention given to the production of fish liver oils rich in vitamin A. Typical rice diets contain insufficient calcium. When children cannot be provided with milk, the regular administration of calcium lactate does something to improve their state of nutrition.

Psychology

Psychology and Educational Research

- D. R. Shendarkar

Research in Education

Psychological experimentation in the field of education has gradually developed from problems of pure experimental psychology to those having to do directly with the teacher's every-day job. The need for a new type of psychologist *viz.*, one trained to detect and solve problems growing directly out of the teaching field has consequently arisen. The contributions of psychology to educational fields such as methodology, educational measurements, testing intelligence, aptitudes and personality, pre-school children and vocational and educational guidance are not mean ones.

It must however be admitted that the training college psychology courses are far from satisfactory when tested on the criterion of practical utility in actual teaching. Topics like the nervous system, mind-body relation, sensation and illusion are too academic. Moreover, the psychological facts are usually illustrated in terms of laboratory settings rather than with reference to school situations and problems, thus making the presentation also divorced from practice. A functional approach is therefore recommended so that the course in psychology may be built round vital school issues and problems.

Most of the Indian universities have not yet instituted research degrees in education. Thus there is little of training and guidance in educational research at the Indian universities. There is consequently a need of a central Institute of Education. The office of the Commissioner of Education, Delhi, would be the most suitable nucleus for such an Institute. The functions of the institute will be:

- (i) to possess up to date references, journals, books and appliances,
- (ii) to render skilled assistance to investigators,
- (iii) to supplement the research work of individuals so as to cover the whole field of education,

- (iv) to start a journal to embody the educational investigations all over the country, and
- (v) to select persons with the necessary talents, to give them the requisite training and to afford facilities for educational research.

The institute would thus serve as a training and consultative body as also a centre for research.

Methods and Tests for Teaching

It is claimed that conditional reflexes are the basis of all human learning and habits; but little use is made of them in the education of the young. The laws and theories of learning were the result of experiments on animals. They have yet to be applied to the learning of human beings. The practice curve obtained in the experimental work on remote branches like typewriting and telegraphy refers to a skill curve; while in actual teaching we meet with mostly knowledge curves where experimentation is lacking. In the matter of economy of learning, experiments have been made with rote memorising, not with rational understanding. The experimental results on forgetting could be used with advantage by the teacher in spacing revisions. Transfer from method to method has been neglected in the experimental literature; yet it is of vital importance in education and in life. Individual differences long overlooked by psychology are of much importance for pedagogical practice.

Psychological methods and tests invented up till now are however of much use in our educational institutions. Intelligence tests are now used for admission to different types of schools, diagnosing backwardness and feeble-mindedness, classifying pupils, comparing alternative methods of teaching, offering vocational and educational guidance and diagnosing the troubles of difficult children. Among the factors determining success in school or in life, emotions and temperament, will and character, are no less important than intelligence. For testing emotional susceptibility the psycho-galvanic reflex coupled with associative reaction is used with success. This technique has found application in the discovery of complexes

and detection of crimes. In the measurement of character, however, experimental methods have not yet proved satisfactory and consequently observations and rating scales are used instead.

Education and Guidance

Regarding assessment of education a great objection exists against examinations owing to the variability of marking which has been experimentally demonstrated. To make marking objective, consistent and comparable the new examination and scholastic tests have been devised. The new examination, like the intelligence test, involves a large number of small questions requiring little writing to answer them. The marking is consequently objective. A large portion of the school subjects can be tested satisfactorily in this way. In scholastic tests, a subject is analysed into its components and tests are prepared for each aspect separately. Thus tests are now available in reading, spelling, arithmetic and even in a qualitative subject like handwriting.

In the choice of career the help of vocational psychology should be more widely taken. In offering guidance it is necessary to have a psychological analysis made of available occupations and the individual's mental and temperamental make-up has to be assessed. In the latter connection, psychological tests are used for measuring intelligence and special abilities and interview is used for measuring temperamental qualities. For proper guidance children should be studied at two stages. In the primary stage their general educable capacity should be tested. In the post-primary stage we have to be on the lookout for discovering such abilities as mark them out for special occupations or types of vocational schools.

Educational Reorganization

In the educational reorganization of this country provision should be made for different types of vocational schools. The aim of lower secondary schools would then be to supply the basis on which to differentiate pupils for admission to the various schools according to their capacities, interests and mental ability rather than according to scholastic attainment. There

must therefore be considerable scope for experimentation at the lower secondary stage. For this purpose besides school records and examinations, tests of intelligence, performance tests, vocational tests and tests of specific abilities will prove useful. To this end available occupations will have to be analysed and psychological tests in use elsewhere will have to be adapted and standardized to suit local conditions and requirements. The problems that await solution are firstly collection of data regarding the available vocations, secondly analysis of the vocations into the mental abilities required for success therein, and thirdly development of psychological tests of such mental capacities.

To go to the root of the problem, child psychology should be more popularly studied and the parents should be aroused to take a keen interest in these studies. As the child grows he presents a number of problems for whose treatment it is necessary to understand how the mind of a child grows and what is at the basis of his peculiar behaviours. Even undesirable actions on the part of children may be normal ways of growth. Hurry to make children behave like grown-ups should be avoided. Harsh methods make them hate us and bind them in infantile ways. Forcing early compliance with our wishes through the motive of fear should be avoided. Our aim should be to lessen the emotional element in the undesirable behaviour and develop a matter-of-fact attitude. A number of children suffer from undesirable and troublesome habits, traits or behaviour. These are merely the outward expressions of underlying physical, mental or social disturbances. The psychological treatment of children's problems is now carried out in child guidance clinics. The aims of these clinics are:

- (a) to diagnose the causes of the abnormal behaviour of children suffering from emotional or moral disorders,
- (b) to provide treatment for children suffering from emotional or behaviour troubles, and
- (c) to assist parents, teachers and social workers in the psychological prevention and treatment of the difficulties of problem children.

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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

APRIL 1940

VOL. V NO. 10

National Research Council for India

THE formation of the National Planning Committee with 29 expert sub-committees by the Indian National Congress for framing schemes for the economic development of India contributes a landmark in the history of our country. While the fruition of planning is not possible without political power, the very recognition of the need of planning leading to actual work must be considered as a very notable advance in the political thought of the country. While this work of planning is going on, the wide-spread desire in India to have a central organisation for the promotion of scientific research in all aspects on a planned and co-ordinated basis is growing from day to day. Such research must be considered the *sine qua non* for the economic and cultural development of any modern country and the creation of a central organisation for this purpose in this country is long over-due.*

There appears, however, to be still some confusion of thought on this question. The exigencies of the war have thrown into bold relief our economic and industrial backwardness and attention has therefore been naturally focussed on the immediate need of industrial development in certain directions. Sir M. Visvesvaraya as President of the Court of the Indian

Institute of Science has therefore lately proposed that, if the Government of the country does not come forward with any constructive proposal, steps may be taken for the formation of an unofficial committee which might function as a National Council of Industrial Research. Sir M. Visvesvaraya suggests that "applied research should be preferred as far as possible to pure research, and the research problems chosen should be distinctly industrial in character." No one denies the immediate importance of industrial research or research in applied sciences, but it is rather hazardous to insist on the mere industrial aspect. Bt.-Col. R. N. Chopra admirably summed up the correct approach in his Presidential Address to the National Institute of Science at Madras this year, "Pure scientific research is as essential as that specifically devoted in the attainment of any industrial object. While industrial research is confined specially to investigations which have a direct bearing on the development of any industry, it would be a truism to assert that discoveries made in the domain of pure science may and often find application in industries at a later date, and that industrial application, though its precise form cannot always be foreseen at the time, has come to be an expected incident in the after-life of the discovery.

This principle is fully accepted in the highly organized machinery for industrial research in the United States of America the example of which, with necessary modifications, may give us guidance in the formation of a National Research Council. In the

*A National Research Council will stand to the National Planning Committee in the same relation as the Academy of Sciences in Russia stands to the Soviet Planning Commission (See Bernal's *The Social Functions of Science*, p. 443).

NATIONAL RESEARCH COUNCIL FOR INDIA

U.S.A., a great deal of importance is attached to researches in pure sciences. The connection of such researches with any of the industries is often not obvious, but all the same they are encouraged in the hope that they may provide the raw material for industrial research, and further owing to the interdependence of different investigations, progress in any one science may have a very marked bearing on the development of others. Industrial research work in the United States of America, according to Flemming, has developed along certain definite stages:—

- (a) Industrial research applied to the elimination of manufacturing troubles.
- (b) Research having some new and specific commercial object.
- (c) Research in pure science with no specific commercial application in view.
- (d) Research applied to public service.
- (e) Research for the purpose of establishing standard methods of testing and standard specifications connected with the purchase of raw materials.

Research laboratories in the States are attached to or supported by manufacturing corporations, associations of manufacturers, universities and colleges, national institutions, commercial laboratories and scientific societies. Apart from numerous endowments and appropriations made for research to various universities, colleges and government departments, there are in the States a large number of funds that have been established for the endowment of scientific research alone. Though a number of them are for the promotion of industrial research, others were founded for providing the necessary funds for medical, astronomical and general research in other sciences. In 1917 a National Research Council was first appointed by the National Academy of Sciences at the request of the President of the United States. This Council includes the most prominent research men in the States and all departments of research are fully represented. Its object is to co-ordinate the scientific research work of the country in order to secure efficiency in the solution of the problems of war and peace, and this Council has rendered possible the nationalization of research in the country. Selection and training of research men

have also been given special attention to, and it has been found that 'while full credit should be given to the genius who can often achieve so much with very limited facilities, it is a fallacy to assume that research work of great value cannot be carried out by men of more than average attainments. This is illustrated by the success achieved in many of the laboratories in the States, where, with suitable organization, important investigations both directly connected with industry and in pure science have been successfully dealt with by men of no more than average ability working under competent direction.'

In this connection it is also pertinent to note that the National Research Councils in almost all countries where they have been constituted are not specifically concerned with the promotion and co-ordination of industrial research alone, but were principally designed with a view to organizing, promoting and collating research in pure, as also in applied sciences, calculated to promote an all-round economic development of the countries concerned and general advancement and diffusion of scientific knowledge. In India to start a National Council for Industrial Research alone at this time would seem like putting the cart before the horse, as there exists at the present moment no machinery whatsoever for the planning and co-ordination of general scientific research.

Board of Scientific Advice (1902-1924)

In this connection it would be useful to include here a short history of what has been done so far for the provision of such a machinery in this country. In 1902 the Government of India made provision for the co-ordination of the official scientific enquiries in the country in a Board of Scientific Advice. This Board was formed in accordance with the Government of India Resolution dated 28th of August 1902 and the Board consisted originally of the following officers:

The Surveyor-General of India; The Meteorological Reporter to the Government of India and Director-General of Observatories; The Director, Geological Survey of India; The Director, Botanical Survey of India; The Superintendent, Natural History Section, Indian Museum (now the Director, Zoological Survey of India); The Inspector-General of Forests; The Inspector-General of Agriculture; The Inspector-General, Civil Veterinary Department; and The Reporter on Economic Products to the Government of India.

NATIONAL RESEARCH COUNCIL FOR INDIA

The Secretary to the Government of India in the Department of Revenue and Agriculture was *ex-officio* President, with the Director, Botanical Survey of India, as the Secretary. The Board met periodically, discussed problems of common interest and published an Annual Report in which the progress of research in India by Government institutions during the year was summarised subject by subject. These Annual Reports though departmental and confined, as was natural, almost entirely to work done under official auspices, were of considerable value; but the activities of the Board were suspended in the fatal year 1924 when, as shown in the editorial article of the last March issue of this journal, the Governments' views regarding industrialisation underwent a somersault and have not since been resuscitated. The reports of the Board were communicated through the Secretary of State for India to the Royal Society, who appointed an Advisory Committee to consider them, and from time to time furnished the Board and the Government of India with valuable suggestions and advice. This Board was purely an advisory body without any administrative authority whatsoever. It could only recommend and advise, which it did as the occasions demanded, but its recommendations required financial provision, and this the Board could not make, nor could it see that the provision when made was applied in accordance with its recommendations. The suspension of the Board, according to a well-informed authority, therefore, was caused not so much by financial stringency of 1924, as by the fact that under the Reforms the administration of all the scientific departments became concentrated in one department of the Secretariat, which resulted in the maintenance of a non-scientific bureaucracy, unhampered by any advice whatsoever by the scientists, for the control of all scientific work carried out under the auspices of the Government.

En passant a reference may be included here to the Indian Munitions Board, which was created as a separate department of the Government of India during the World War of 1914-18. This agency, however, was established mainly for the co-ordination and supply of war materials, and not for fostering scientific or industrial research, much less for establishing and developing industries in the country.

Proposals for a National Research Council

In 1930 in connection with a proposal for India to join the International Research Council and its various Unions the Government of India consulted the Heads of its various scientific services and non-official scientific bodies, including universities, in regard to the constitution of a National Research Council, as a result of which detailed proposals for the formation of such a Council were submitted to the Government in 1931. These may be summarised as follows:

(1) With reference to the questions raised regarding the formation of a National Research Council for India, it was remarked that if the functions of the proposed National Research Council are solely to be those of co-operating and collaborating with the International Research Council, the formation of a special body is unnecessary, as sufficient channels for co-operation in science, and particularly in the various sciences outlined in the Government of India's letter, already exist. If, on the other hand, the functions of the National Research Council are to include the stimulation of and co-ordination between the various scientific research workers and organisations throughout India, the formation of such a body may ultimately be for the benefit of scientific research in this country.

(2) Although the conditions at the time were not considered favourable for the institution of a National Research Council on the lines analogous to those followed in most other countries, since there was then in India no body comparable to the Royal Society of London, the French Academie des Sciences, etc., it was suggested that such a Council was desirable. The formation of such a body as the proposed National Research Council might lead ultimately to the development and formation of such a Society or Academy. (Here it may be noted that the following institutions of an Academy rank have since been founded: the National Institute of Sciences of India in Calcutta, the Indian Academy of Sciences at Bangalore, and the National Academy of Sciences at Allahabad).

(3) It was opined that the National Research Council should ultimately be a non-official body, but at its inception it seemed both desirable and necessary that there should be some official representation on the Council and, in view of the existing state of scientific development in India, it was proposed that at present the Heads of the various Scientific Departments of the Government of India must be on the National Research Council.

THE PROPOSED DRUGS ACT OF

The Council trusts that the Government will not fail to appreciate the importance of industry and pharmacy in relation to any measure connected with drugs, the large majority of which are ially chemical.

The proposed Act makes provision for the appointment of expert sub-committees by the Technical Advisory Board for particular matters. It is as, however, that if there is not a sufficient number of technical experts who are directly conversant with the needs of the drug industry and with the chemical and pharmaceutical problems connected with it, which must of necessity be of a highly technical nature, the board itself cannot be sufficiently competent either to decide on the nature of the sub-committees or on their composition. It is not desirable that the Technical Advisory Board should act merely as a post-office or even as a body concerned with broad generalisations. This may definitely prejudice the drug industry and the profession of pharmacy in India and therefore, indirectly, the entire people of India.

As the proposed Act does not provide for the appointment of provincial boards and as the Provincial Governments will be guided by the Technical Advisory Board, it is especially necessary to be very careful in the composition of the board which will command the confidence of the Provincial Governments and the people of the provinces by ensuring the maximum competence.

Since this Board will advise the Central and Provincial Governments on technical matters and will have to direct the Central Drug Laboratory, it must have direct scientific and expert knowledge of drugs in all their scientific and technical aspects. The proposed Drugs Technical Advisory Board is loaded with much on the official side, and it is to be noted with regret that it does not provide for a representative of the non-official body of technical knowledge available in the country. This can be best effected by representation of non-official scientific organisations, connected with pharmaceutical and other sciences of chemistry, in the proposed Board. In matters of scientific nature, it is recognised everywhere that a free and frank exchange of views of opinion, carried through a suitable machinery recognised by Government, is beneficial to the latter.

The Council, therefore, suggests that the composition of the Technical Advisory Board should be as follows:

- (i) Director-General, Indian Medical Service, *ex-officio*, who shall be Chairman,
- (ii) Director of the Central Drugs Laboratory, *ex-officio*,
- (iii) Director of the Central Research Institute, *ex-officio*, (provided he is in charge of the testing of sera, vaccine, etc., of the Central Drugs Laboratory),
- (iv) Director of the Imperial Veterinary Research Institute, Mukteswar, *ex-officio*,
- (v) Chief Chemist, Central Revenues, *ex-officio*,
- (vi) two persons holding the appointment of Government Analyst under this Act or of Government Chemical Examiner, to be nominated by the Central Government provided they hold the minimum qualification of a post-graduate degree in chemistry or its equivalent,
- (vii) one pharmacologist of the Central Drugs Laboratory to be nominated by the Central Government. In case, the Director himself is pharmacologist this position should be left vacant,
- (viii) one chemist of the Central Drugs Laboratory to be nominated by the Government of India, provided the Director-in-charge is not a chemist himself,
- (ix) one person to be elected by the Inter-University Board, India, from among teachers of medicine or therapeutics on the staff of a University or College in British India providing a course of study which qualifies for admission to the examination for a degree which is recognised qualification under the India Medical Council Act, 1933,
- (x) one representative of the Indian Chemical Society, who has direct experience of drugs, to be elected by the Council of the Indian Chemical Society,
- (xi) one teacher of pharmaceutical chemistry or pharmacy of an Indian University to be elected by the Inter-University Board,
- (xii) one technical chemical expert with proper scientific qualifications to be nominated

THE PROPOSED DRUGS ACT OF 1940

- by the Indian Chemical Manufacturers' Association,
- (xiii) one representative of the Indian Pharmaceutical Association possessing the requisite pharmaceutical qualifications and experience, to be nominated by that body,
- (xiv) one representative of the Institution of Chemists (India) to be nominated by that body.

In suggesting the above modifications of the personnel of the Board the Council of the Indian Chemical Society has not overlooked the importance of including the administrative heads of the different Government institutions as proposed in the Act but

Science and World Progress

Science is responsible for the progress made and the high standard of living attained by people in several Western countries. The present-day world progress and civilization are almost entirely due to science and to industries and commerce based on science. India too, though lacking in power of initiative, has shared in this progress to the extent permitted by her political condition.

In the middle of the last century, universities in Europe gave instruction in natural philosophy along with law, theology, medicine, teaching and the humanities. Natural philosophy was grouped under three main heads, physics, chemistry and biology. In a recent publication entitled "*The Romance of Research*," science is described as the father of present-day progress and natural philosophy as its grandfather. Natural philosophy includes physics, the source of energy; chemistry, the source of matter, and biology, the source of life and living things. Other branch sciences have sprouted from these. To-day it is said that these main sciences have fathered a long list of descendants. Amongst the more important branches of applied science may be mentioned civil, mechanical and electrical engineering, chemical technology, geology, mining, physiology, psychology and many more.

Means of communication like telegraphy, telephone, and the wireless, aeroplane, automobiles, steam engine, electric power and light, help individuals to travel speedily, to communicate with one another in business pursuits and thereby to do much work in less

time. Methods of warfare have been considerably modified and the arms and ammunition of present-day manufacture have a more deadly effect. Aeroplanes enable people to travel at a rate of 200 miles an hour. The journey across the continent of America is accomplished in 16 hours and that across the Atlantic in about 33 hours. Nowadays, the journey from London to Bombay takes only about 27 hours.

In conclusion, the Council also recommends that a Pharmacy Act should be taken up along with this Bill or at an early date. The adoption of courses of teaching in pharmaceutical chemistry by different universities is being delayed owing to the absence of a suitable Act which will control the pharmaceutical profession in India.

The primitive nations supply their own wants by manual and animal labour but modern nations have multiplied their capacity for economic activity by their knowledge of science and the liberal use of machinery. England and America have enormously increased the working power of their population by substituting inanimate for animate power. The benefits they are deriving is estimated as equivalent to the output of work of 30 slaves per head of population. In India, the corresponding equivalent is not 20 or 30 units as in those countries, not even two or three units but only about 1½. This will give some idea of the small amount of work done and of the low capacity of our countrymen, for producing wealth.

Turning to benefits from biology, it may be said that within the past 300 years, the average expectation of life in England has doubled. The present estimated duration of life in England and Germany is about 55 years while in India it is only about 27. This is also a clear proof of the economic poverty of our people. —Sir M. Visvesvaraya in a speech at the Royal Institute of Science, Bombay.

Warfare in Indian Cave Art

Lt. Col. D. H. Gordon

THE general impression gained of the human figures in the bulk of the shelters in the Mahadeo Hills (in Central Provinces) is one of men in the act of shooting with bows and arrows and of men brandishing swords. It is only the exceptional paintings that depict scenes of peace and domesticity. One gets an impression of a pastoral people engaged in cattle herding and cattle raiding, with hunting and honey-taking as occasional occupations. Though the word 'mystery' should be abhorrent to all serious minded archaeologists, it is certainly very strange that there should be in these primitive rock shelters, surrounded as they are by dense jungle and precipitous ravines, a record of a people who employed all the arts of war known to their age. Somewhere, certainly not in the hills where their paintings are found, they rode to war on caparisoned horses, and advanced their spearmen in ranks to encounter the enemy.

The normal equipment of these warriors seems to have been bow and arrow or sword and shield, and it is probable that a dagger completed the equipment of both bowmen and swordsmen. Besides these there are axe wielders, spearmen and rock-throwers. The majority fought on foot but there are plenty of horsemen to be found of all periods from Early 2nd to Late 4th, and helmets wherever they appear to be indicated, are worn almost exclusively by the mounted warriors.

The plates however show more clearly than any amount of writing the types of warriors and their equipment. Plate 1. gives a number of types and equipment. Starting from the left two swordsmen come first, the upper, with most elaborate flowing streamers, has a long sword and long dagger, and the lower, a strange figure from Adamgarh caves at Hoshangabad, has a curious, possibly plumed, headdress. Next are two archers, the lower one equipped with a type of battle-axe only seen in the paintings of the Late 4th Series, then two trumpeters and lastly a man with axe and dagger and a rock-thrower in the dark red of the Early 3rd Series.

Trumpeters are shown with various instruments, with trumpets like a short post-horn and also a curved natural horn in Jambu Dwip No. 5, a double-pipe both in Jambu Dwip No. 4 and at Jhalai, and one of wide uncertain shape in No. 1 Cave, Marodeo 1st Group.

Plate 2. shows a number of types of swords and shields and axes. The swords are almost invariably straight with narrow or broad blades. A Cross device on shields is fairly common amongst a variety of ornamentations with which they were adorned, including a decoration of loops round the edge and a large tassel hanging below, found chiefly in Late 4th specimens. Axes though not particularly common are of four or five different types. A type of small hatchet, which must have been carried as a matter of course in the jungle, is the most common, this type is shown in *Indian Art and Letters*, 1936, Plates VI and XI. There are also light bladed battle-axes as shown in Plate 1. fig. f., which must have been quite unsuitable for wood cutting, and the type with a long drop to the blade as in Plate 1. fig. d. which is of the type of the Norse "Skeggox" or "beard-axe". Plate 2. shows a long axe of heavy felling type and a light battle-axe, also unsuitable for wood cutting, with a narrow crescent shaped blade.

Finally there are two warriors out of a number painted in a row just above an almost inaccessible ledge at Dakan Kol Cave, Dauri. They have curious helmets reminiscent of visored Greek helmets of the classical period.

These plates cover the equipment of the warriors of the period quite adequately, now there follow three figures devoted to battle scenes. Plate 3. fig. a. shows two opposing forces in conflict. Archers, swordsmen and cavalry are all represented. Of the forces advancing from the left the leader is shown in the act of falling, dropping his sword, shield and staff. Fig. b. shows a mounted warrior and men on foot, one of these latter brandishes a curved broad-bladed sword shaped like a *kukri*, or an ancient Greek sword which was closely of this type.

Plate 4. fig. a. shows a battle in which men are engaged from the back of an elephant, this is the only

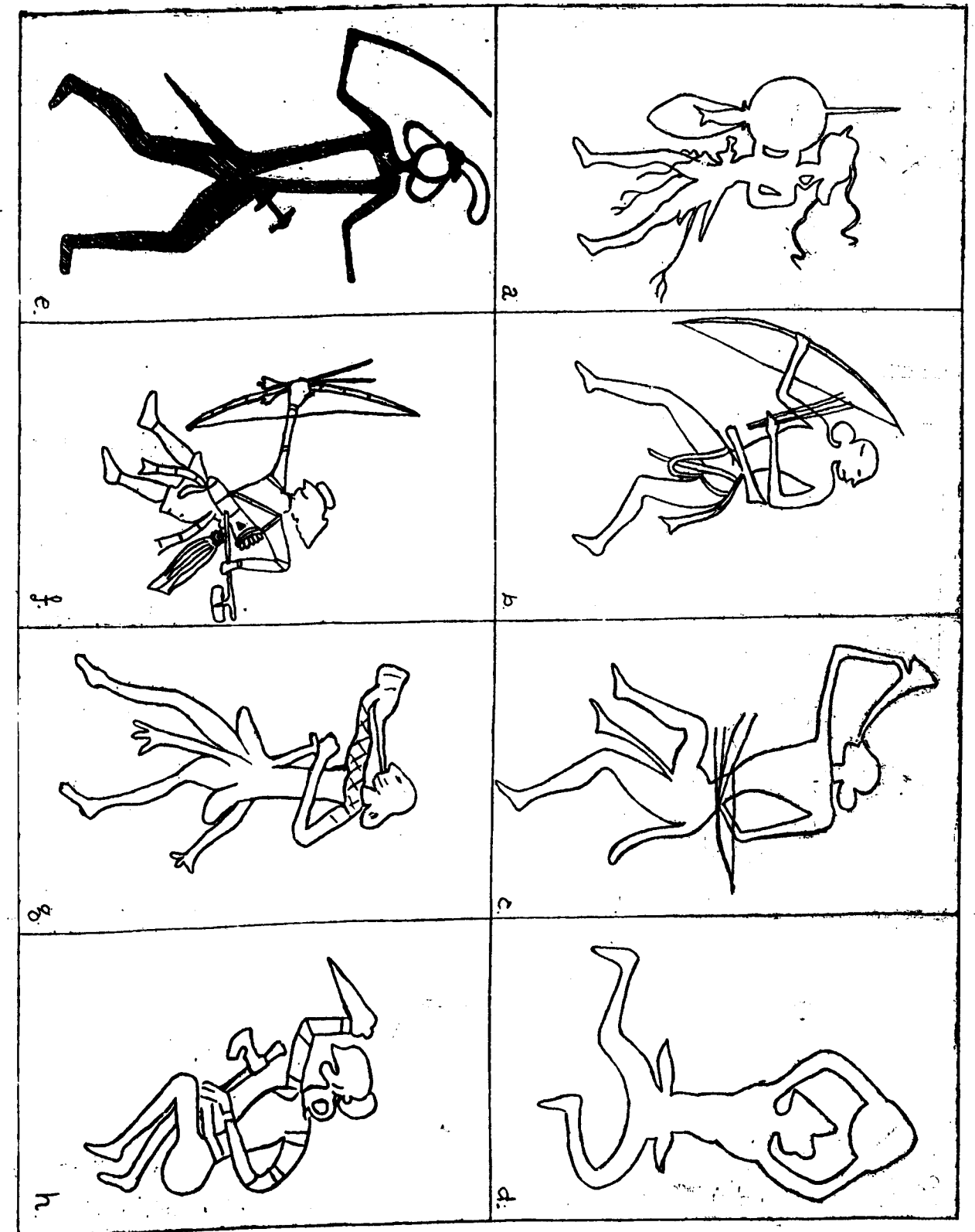


PLATE 1—(a) Kajri Ghat, Late 3rd. (b) Dorothy Deep Shelter, Early 4th. (c) Jambu Dwip No. 5, Late 3rd. (d) Jambu Dwip No. 4, Early 3rd. (e) Adamgarh Quarry No. 4, Early 3rd. (f) Bori, Late 4th. (g & h) Marodeo No. 1. 1st Group, Late 4th.

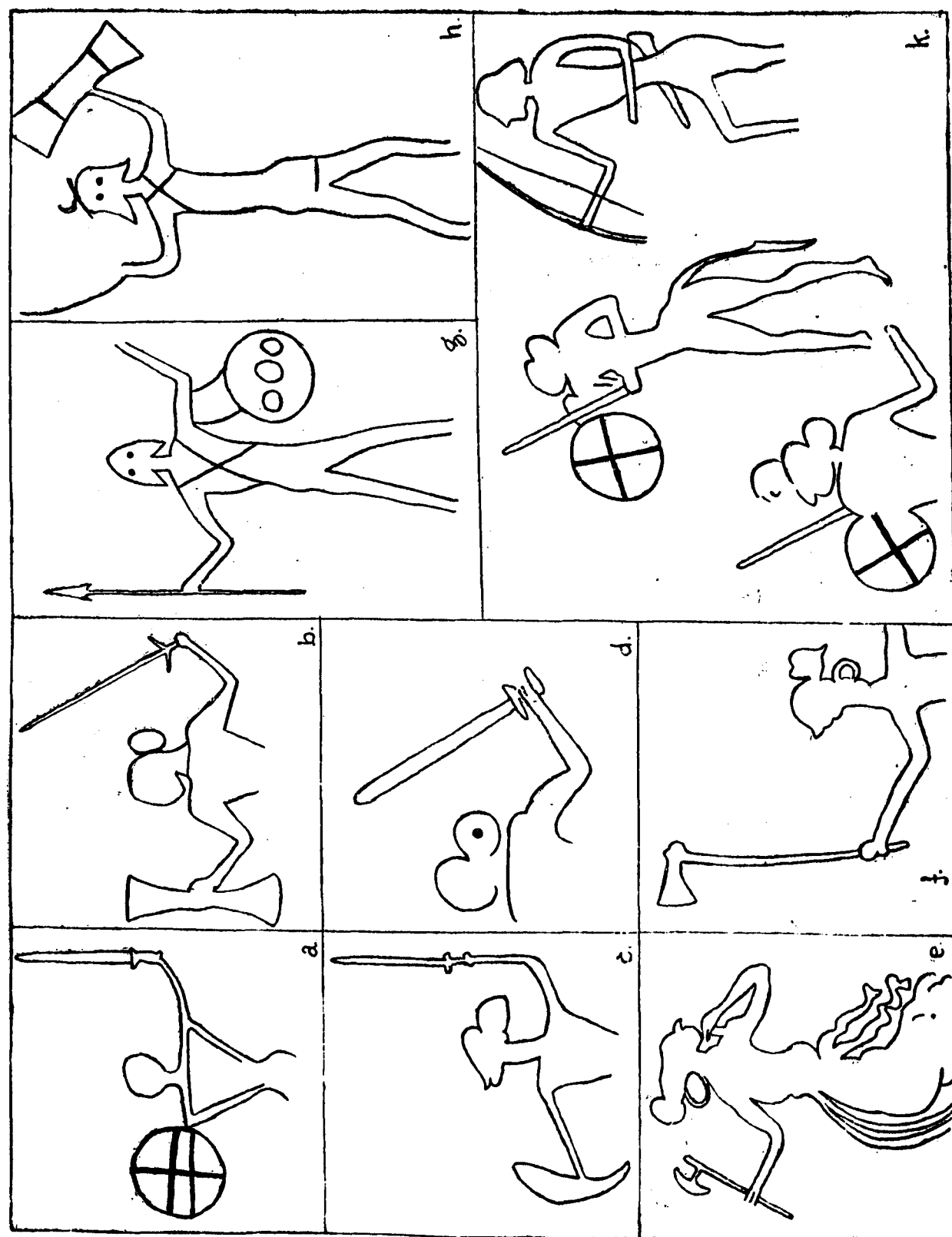


PLATE 2—(a—d) Types of swords and shields, Early 4th Series. Dorothy Deep Shelter. (e & f) Types of axes, Late 3rd Series, Nos. 2 & 3. Marodeo 1st Group. (g & h) Helmeted warriors, contemporary with Late 4th, Dakan Kol Shelter Dauri. (i) Group with red crossed shields, Early 4th, Dorothy Deep Shelter.

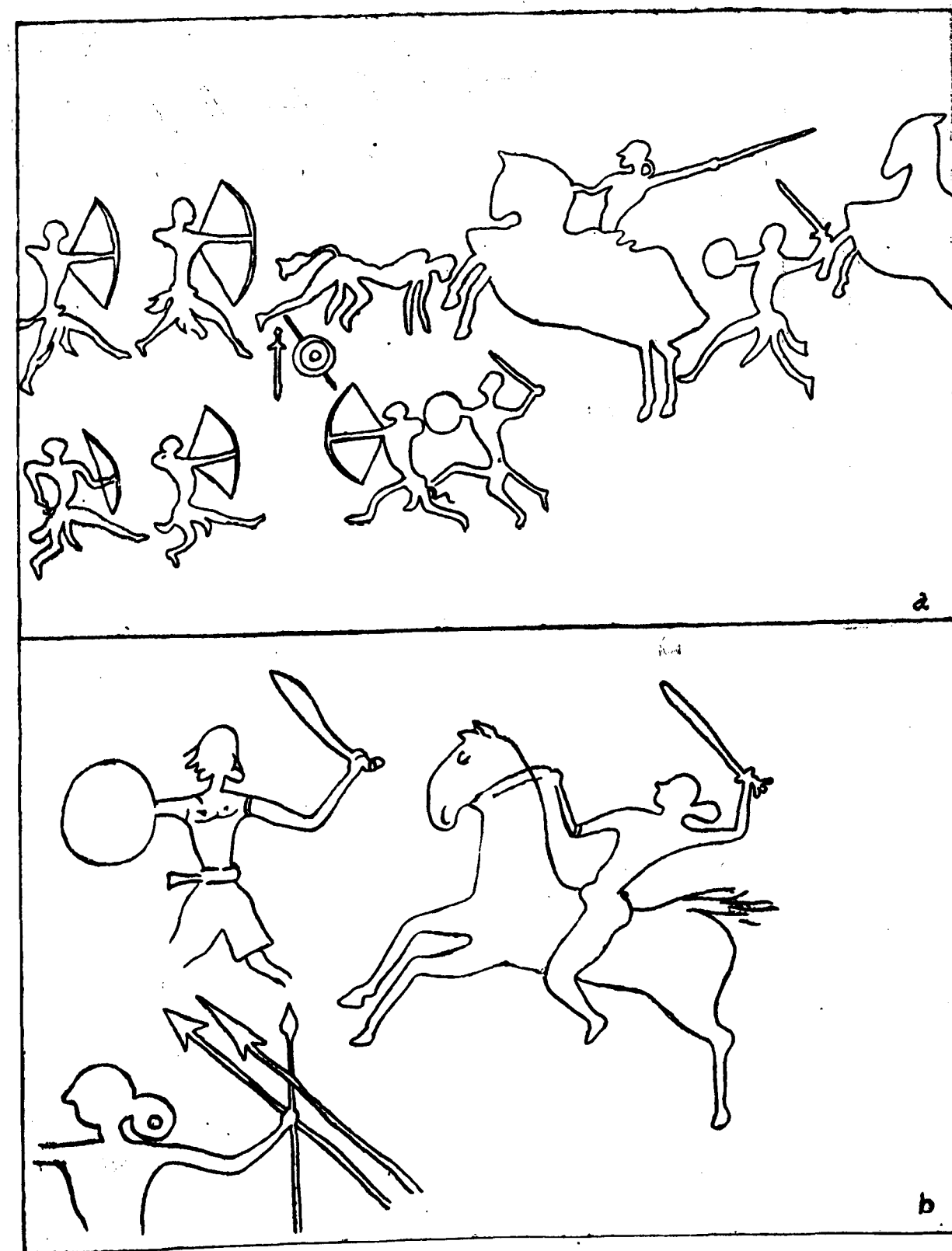


PLATE 3—(a) Battle Scene from Jambudwip No. 3. (b) Portion of Battle Scene from cave on Mayhew Peep.

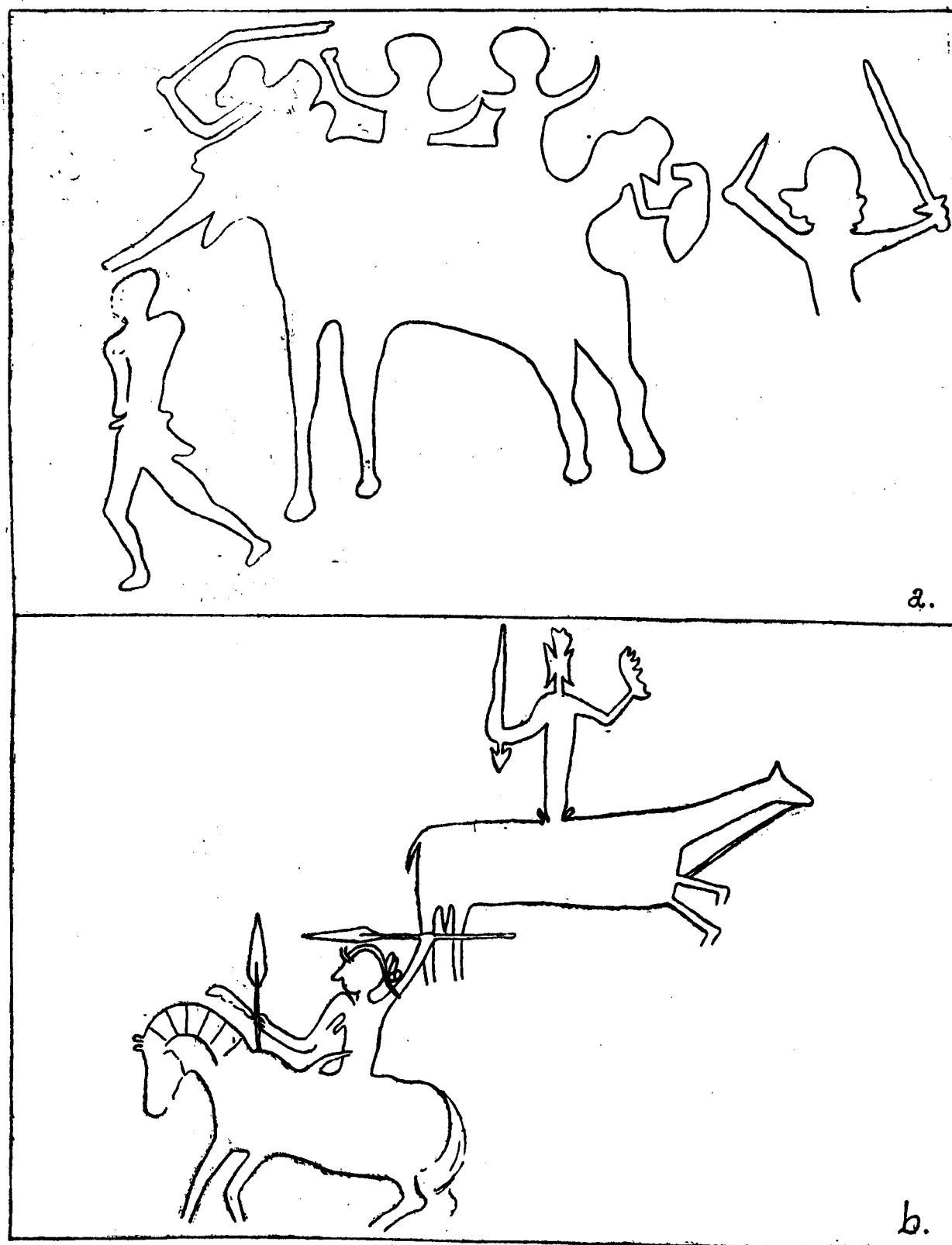


PLATE 4—(a) Battle scene with men fighting from an elephant. Adamgarh No. 3, Hoshangabad. (b) Sequence; mounted warrior of Early 4th Series, superimposed on ditto, Late 2nd Series. Dorothy Deep Shelter.

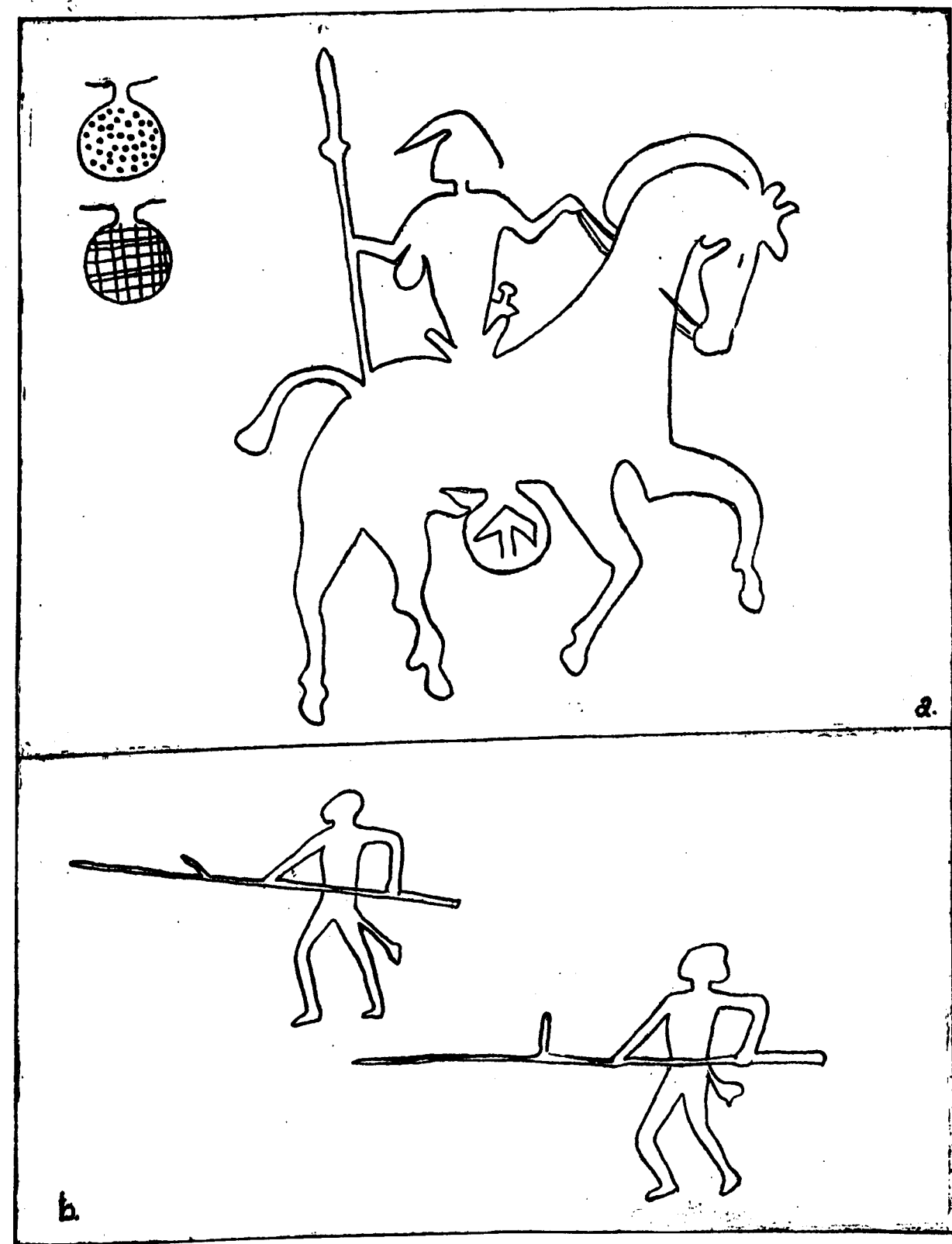


PLATE 5—(a) Horseman and examples of crests or horse brands, Adamgarh No. 4. (b) Pikemen, Jambu Dwip No. 3.

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of 6×10^{-5} cal deg $^{-1}$ cm $^{-1}$ sec $^{-1}$, of the same order as that of gases at ordinary temperature. But for helium II they obtained a value of 190, an astonishing figure which is 3×10^4 times that of helium I and is about 200 times the conductivity of copper at room temperature. Zaki Uddin (1937) carried out more careful measurements of thermal conductivity of the liquid. The arrangement consisted of a cylindrical glass bulb sealed on the top of a capillary tube and containing a heating coil. The bulb was evacuated, immersed in a liquid helium bath and then filled with the liquid. The temperature of the heating coil was raised when some of the helium in the bulb evaporated. From the difference of level in bulb and bath the vapour pressure in the bulb could be calculated and hence the temperature difference between the bulb and the bath was known (i.e., between the ends of the capillary). The calculated value of conductivity was reported to increase as the temperature-gradient increased, reaching a value as great as 1.1×10^4 cal deg $^{-1}$ cm $^{-1}$ sec $^{-1}$ for $\Delta T 10^{-5} = 5 \times 10^{-5}$ K and $T = 2.06^\circ$ K. This gives a ratio of thermal conductivity of liquid helium I to liquid helium II of the order of 10^8 . It was found that the conductivity depends upon several factors e.g., temperature-gradient, diameter and length of the tube and temperature of liquid helium etc., the maximum being reached for $T = 1.9^\circ$ K. Keesom, Keesom and Saris (1938) have found the maximum value at about 2° K. Kurti and Simon (1938) have measured the heat conductivity at a still lower temperature and have found that heat conductivity is small between 0.5° K and 0.2° K. As has been mentioned elsewhere in this article, the abnormal values of thermal conductivity cannot be explained as due to a turbulent motion setting up in the ordinary manipulation of the liquid owing to its extremely low viscosity or to any change from liquid to crystalline state at the λ -point. The results still remain to be explained.

Surface Tension and Compressibility

The surface tension of liquid helium II has been measured by the capillary method by Urk, Keesom and Onnes (1926) and found to hold a linear relation with temperature between the range 4.2° K and 2.4° K, the temperature co-efficient being about -1 dyne per cm. per degree. At the λ -point there occurs a sudden change in the value of surface tension, the graph bending over nearly horizontally

and giving a constant value of 3.2 dynes per cm. at 1.5° K. Measurements of the compressibility of liquid helium by Keesom (1936) at pressures between 5 and 10 atmospheres gave a value of 0.8×10^{-10} c.g.s. unit. As compared with the value 0.39×10^{-10} for water, the compressibility of liquid helium is indeed very large and it has been stated that this has the greatest compressibility of all liquids.

Velocity of Sound

At about 4.2° K (normal boiling point) the velocity of sound in helium gas is of the order of 110 metres per second. It naturally increases in the liquid at lower temperatures the value being 223 metres per second at λ -point and 232 metres per second at 1.8° K. These results do not call for much comment. The values of γ , the specific heat ratio, in accordance with these values of the velocity of sound, show a gradual increase with temperature above λ -point in liquid helium I.

Electrical and Optical Properties

The electrical resistance of liquid helium has been measured by Wolfke and Keesom (1936) by connecting in series a condenser and a galvanometer to a battery of 250 volts and immersing the condenser in liquid helium. The minimum possible values of the specific resistance for liquid helium was found to be of the order of 10^{15} ohm cm. and no measurable change was noticed at the λ -point.

The dielectric constant of liquid helium shows a maximum value at the λ -point ($K = 1.056$) as determined by Wolfke and Keesom (1928). The relation between dielectric constant and temperature shows a sudden discontinuity at the λ -point, the curves being similar to the density curves. The electric polarisation $P = \left(\frac{K-1}{K+2} \right) \frac{1}{d}$ however shows practically no change on passing through the λ -point, the values in the immediate neighbourhood being of the order of 0.1245.

The refractive index of liquid helium as determined by the Wollaston Cell method by Wilhelm and Cove (1938) gives a value of 1.208 ± 0.006 for liquid helium II (against gaseous helium) at a temperature just below 2.1° K. The refractive index of liquid helium I just above 2.2° K is slightly less than this. More recent determinations by Johns and Wilhelm (1938), and Burton (1938) of refractive index give $\mu = 1.0206 \pm .0012$ for helium I at 4.22° K and $\mu = 1.0269 \pm .0064$ for liquid helium II at 2.18° K.

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McLennan and collaborators (1932) tried to study the classical and Raman Scattering Effect in liquid helium I and helium II. No effect could be observed in liquid helium I due to continuous bubbling in the body of the liquid. For liquid II also the scattering is very poor and only some faint wings were observed. No conclusive results can be expected unless the experimental difficulties can be overcome by means of some improved arrangement of apparatus.

Calorimetry

Specific and latent heats of liquid helium have been determined at Leyden by measuring the rate of change of temperature and absorption of heat at constant temperature, heat being generated electrically and temperature measured by resistance thermometers. Latent heats of fusion, as determined by W. H. and A. P. Keesom (1936), are 0.835 cal/gm. at 2.5° K, 1.089 cal/gm. at 3.0° K and 1.365 cal/gm. at 3.5° K. Using these values in the well-known Clausius-Clapeyron equation, the change in melting point with pressure comes out to be 0.02° per atmosphere which is in agreement with the slope of the melting point line of solid helium in fig. 2 (see last issue). The latent heat of vaporisation between 1.5° K and 3° K is about 5.5 cal/gm. and Dana and Onnes (1926) have found a small anomaly at the λ -point. So small a value of the latent heat of vaporisation (for water it is 540 cal/gm.) explains the necessity of good heat insulation if the liquid is to be preserved for any length of time. The latent heat of transformation from liquid helium I to helium II cannot be greater than 0.002 cal/gm.; probably it is zero and so a transformation from liquid I to liquid II cannot be regarded as a thermodynamic change of phase. It has been called a phase change of the second order by Ehrenfest (1933).

A study of the specific heat of liquid helium yields interesting results as observed by Wolfke and Keesom (1936). The specific heat rises from 2 cal/gm. per degree to 6 cal/gm. with rise of temperature up to 2.19° K. It then suddenly drops down to 1.5 cal/gm. per degree within about 0.001° K.

X-ray Study

Keesom and Taconis (1938) studied the structure of solid helium compressed in a thin walled aluminium tube under a pressure of 38 atmosphere, with a Debye-

Scherrer Camera. The great experimental difficulties to be overcome may be easily appreciated as the whole camera had to be kept below 1.7° K by suitably maintaining a flow of liquid helium II. They concluded that solid helium has a close packed hexagonal structure. The structure of the liquid was studied by using a jet maintained from the bath by using a centrifugal pump. Liquid helium I gave rings like other ordinary liquids. Those for liquid helium II fitted a structure "based on a face-centred cubic lattice from which half the atoms have been removed, in such a way that each remaining atom is surrounded by six other atoms and by six holes."

Some Strange Properties

While experimenting on the thermal conductivity of liquid helium, Allen and Jones (1938) observed that small heat flow produced a rise in the level of liquid in a closed bulb sealed to the top of a narrow capillary tube, the other end of which was immersed in a liquid helium bath, instead of the expected fall due to increase of vapour pressure inside the bulb. The rise of level was strikingly demonstrated by employing an arrangement where a capillary tube was connected at the bottom to a wide tube filled with emery powder and open to the liquid bath. When radiation from an electric lamp was allowed to fall on the emery powder the heat was sufficient to cause a rise of level of the liquid so much that a jet of liquid helium was observed to flow out of the capillary forming a fountain several inches high.

Liquid helium II as we have seen possesses many remarkable and strange properties but the strangest of them all was discovered in 1938 by Daunt and Mendelssohn (1938). They made an experiment which is quite simple. A small beaker was suspended by means of glass fibre and gradually lowered into a larger vessel containing liquid helium II. When the small glass beaker is dipped into the liquid with the closed end a little under the surface with the open end still considerably above the surface of the liquid, the small beaker is found to be filled up with liquid helium II until the level inside and outside the beaker is the same, this filling up taking place in a fraction of a second. If then the beaker was raised the level inside it fell until the levels inside and outside were again the same. It was conclusively shown that the liquid flowed up the outside surface of the beaker over the rim and down into the interior. Such strange effect is not observed in liquid helium I or any other known liquid. It is absolutely unique in our experience. The

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rate of flow was found to decrease as the temperature increased, the phenomenon stopping altogether above the λ -point. The experiments suggest that the surface of a solid in contact with liquid helium II is covered with a thin film along which the liquid is transferred to the lowest available level. From a study of the thermal conductivity of films of liquid helium II Zaki Uddin (1937) tried to calculate the value of their thickness and found it to be of the order of 10^{-6} cm. Kikoin and Lasarew (1938, 1939) measured the thermal conduction of helium II films by using a glass rod, heated at the top with its lower end dipped in liquid helium II. They estimated the thickness of the film to be between 10^{-6} and 10^{-6} cm., and showed that the thermal transfer is very high. Their results have been confirmed by Daunt and Mendelssohn (1938) who also suggest that the whole heat transfer can be accounted for as due to transport of helium along the surfaces.

Conclusion

In this article an attempt has been made to describe some of the interesting experimental results that have been obtained regarding the strange behaviour and properties of liquid helium I and helium II. What actually happens at the λ -point is not as yet clearly understood and though theoretical physicists are not sitting idle and have advanced several theories to explain the observed phenomena, up till now no satisfactory theory has been developed which takes into account all the known properties and behaviour of liquid helium at the critical point. It is not possible in this article to discuss the full significance of the theories which have been recently proposed to account for the striking differences of behaviour between liquid helium I and helium II. It may however be mentioned that two theories viz., (i) order-disorder crystalline theory (advanced by Simon, London, Frölich, Jones, Keesom, etc.) and (ii) Degenerate Bose-Einstein gas theory (advanced by London, Tiza etc.) have been partly successful in explaining the observed facts. The first theory can successfully explain the negative expansion co-efficient of liquid helium II and also the discontinuity in specific heat at the λ -point, whereas it cannot explain the low value of viscosity. The second theory which suggests that liquid helium II should be treated as a degenerate

Bose-Einstein gas, can explain the discontinuity in the value of specific heat and by making a few assumptions. Tiza has also used this theory to explain the abnormal thermal conductivity and viscosity.

The properties of matter near the absolute zero are of great interest and fundamental importance and the study of the physical properties of solid and liquid helium below the λ -point up to the lowest temperature attainable near absolute zero is sure to yield further important results.*

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*Summaries of earlier and more recent work on liquid helium have been given by Jackson (*Low Temperature Physics*, Methuen & Co., London (1934), Satterly (*Rev. Mod. Phys.* 8, 347, 1936) Vick (*Science Progress* Vol. 33, 1938-39) and in the *Proceedings VII Refrigeration Congress* (Leiden 1937).

Need for a Central Science Library in India

SCIENTIFIC research has in recent years made tremendous progress both in the pure and applied fields. The extent of the results hitherto obtained can be measured from the fact that there have been 36,000 scientific periodicals so far published, of which 15,000 are said to be current. According to *Nature*, 1932, 7,50,000 scientific articles were published in 1931. If such a census is taken of the books published so far, the figure will run into millions. A periodical census of these periodicals and books will prove very interesting, as it will reveal not only the number of discoveries made but will also show the widening extent of the ground covered by scientific research during the passing years.

It is well known that no progress in research can be achieved unless the worker is fully apprised of the recorded findings of his *confreres* either living or dead. In other words, books and journals are the foundations on which future progress is built. When knowledge becomes very extensive and its dissemination difficult, the collection of books, periodicals, etc., at a certain fixed place for a large number of people becomes a very useful method. That is how a library comes to serve the people. A library is a temple of knowledge which lends itself to human progress to an enormous extent.

In India, although some efforts have lately been made in advancing the library movement—especially public libraries and those specialising in Arts subjects, yet there is much leeway to be made in the provision of scientific literature so as to adequately serve the needs of the nation. There is no library in India which can claim to possess a sufficiently large collection of scientific literature which might be called a scientific library of a moderate size. This is partly due to inadequacy of funds and partly due to the fact that modern scientific research in India is of relatively recent origin.

Speaking of the United Kingdom where within a comparatively small area a very large number of libraries abound, such as the British Museum, the National Library, and the libraries of the Royal

Society, the London University, the Chemical Society, the Linnean Society, the Zoological Society, the Royal Entomological Society and those of the various departments of the Government, the necessity for establishing a Science Library which would eventually develop itself into a national library of science was felt. The Science Museum and Library of South Kensington has well nigh fulfilled the dreams of the organizers and has earned a reputation which is practically worldwide. It contains 250,000 books, and takes 10,000 periodicals, nearly 75 per cent of the current ones. Including published bibliographies, the Science Library already contains 40,000,000 references. It can be easily imagined how great is the service this library has been rendering to the scientific public of the country. There is nothing like it in India. But that there is a definite need for it is unquestionable. There is also no library in India to which one can look for a collection of references at one place on a particular subject except those concealed in the various printed indexes of abstracting or other journals out of which one has to dig out the required information. This is a task which consumes a lot of the valuable time of the research worker. But if this task is entrusted to an all-India institution, the difficulty of the research worker is bound to be considerably reduced and he will not have to spend a good deal of his valuable time in searching the old references before starting his experiments.

The first question for serious consideration in this connection is how such a library can be organised in India. The appropriate body to take up this question is either the Indian Science Congress Association or other scientific bodies like the National Institute of Sciences, India, the primary function of which is to promote and co-ordinate scientific researches all over the country. It may be mentioned here that the Inter-University Board advocated the introduction of inter-library borrowing by means of which the participating libraries were expected to reciprocate loan of publications and thus reduce the difficulties of research workers. Experience has however shown that in the absence of a comprehensive catalogue for all-India,

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face of severe erosion in the catchment area which supplies the underground water table.

Methods of Control

Practical measures of control lie mainly in the hands of the Indian cultivator. He must make each field as nearly self-contained as possible for rain catching, and he must learn that a few well-fed animals are better value than a big herd of scraggy ones. It is only through education that these facts can be put before him. It is not enough to persuade him once a year to turn out for a "*watbandi* week" (in the Punjab) or attend a local cattle fair to see other people getting prizes. What is required in the zamindar is a new habit of mind which will keep these all important facts well in the forefront of village politics every day in the year.

There are, broadly speaking, three types of erosion, namely sheet erosion, gulying, and wind erosion. The first is the most wide-spread and dangerous, for it can do great damage before it becomes apparent to the farmer. Sheet erosion occurs on all ground with even a very gentle slope when heavy storms fall upon exposed soil. The first effect, which often goes unnoticed, is the removal of the finer soil particles in suspension, leaving the coarser particles behind. These finer parts of the soil are valuable because they help to bind the soil into crumbs. The capacity of the soil to retain moisture and soluble plant food depends largely upon this crump structure. If the finer particles are lost by sheet erosion, the soil deteriorates. In extreme cases the whole of the top soil is removed bodily, leaving behind only an infertile subsoil of clay or gravel. Sheet erosion is common throughout India excepting areas irrigated by canal or well, but is of course more serious on all sloping lands.

Gully erosion is much more obvious and frequently follows after sheet erosion as a later stage of deterioration. When there is not enough vegetation to impede the run-off of storm water, the proportion of rain not absorbed by the soil finds its way downhill in a series of small torrents. A vicious circle is set up, because each channel is cut wider and deeper by every succeeding downpour, and the torrent tears soil from the sides and bed of the gully. Loss of soil is increased by the cutting back of each branch gully into the higher ground behind. Deeply gullied "bad lands" are to be seen in many parts of India wherever the level of the land surface is high above the bed level of nearby rivers.

Both sheet and gully erosion are caused by water action, but another form of erosion results from wind action. Open treeless plains of dry light soil are particularly susceptible when the natural grass cover is destroyed by ploughing or heavy grazing, for the exposed soil can then be whipped up and carried away by strong winds.

Ground thus disturbed develops a peculiar topography of low hummocky sandhills on top of which deep-rooted bushes survive after all other vegetation has given up the unequal struggle. Actually India as a whole does not suffer from wind erosion to the extent that has occurred in the so called 'dust bowl' of the middle Southern states of the United States of America, or in the inland livestock ranches of Australia or along the southern fringe of the Sahara. But in certain restricted areas in India it is a very definite menace. Two examples which many people must have noticed are just north of Campbellpur in Attock district, and along the Delhi-Lahore road near Doraha.

The harmful effects of these three forms of soil erosion go far beyond the removal of the valuable top soil on which plants depend for their nourishment. One direct effect is of course a gradual decline in crop yields which more than off-sets any gains brought about by seed selection and manuring. The direct effect in pastures and grazing lands is to reduce the capacity of the land for carrying livestock, for good pasture may carry a cow for every two acres, but eroded pasture land may not keep a cow properly on ten acres. Erosion also has indirect results, of which the most important for us in India is the dumping of huge quantities of sand in the river beds so that the bed must inevitably be raised and thus exaggerate the effect of floods. Another effect is to increase the severity of the intervening drought periods. This is because each small stream in the eroding foothills discharges perhaps 80 or even 90 per cent of heavy storms within an hour or so, and only a very small part of the rain soaks into the bare ground. Apart from the rivers therefore the level of the water-table underground is apt to shrink because the amount of percolation or seepage through the soil into the underlying rocks and subsoil is less. Springs and wells are fed by reserves of water stored underground, but these reserves dwindle because eroded soil will not allow rain to penetrate underground, so that wells dry up, springs are reduced to a trickle, and rivers that once flowed all the year round now fail in the dry period.

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To stop the rain getting straight into the rivers one must logically start at the top of each small catchment and tame the little waters before they have become big ones. If the land is all under cultivation, then it is purely an agricultural problem to control the run-off from each field. In hilly country however it is generally more a question of forest and grazing land with perhaps scattered fields on steep slopes.

Work in the Punjab

Many people have got the impression that land under forest is not subject to erosion, but this is not entirely true. A good forest with a deep undisturbed layer of forest soil is a marvellous sponge, but if the place is heavily grazed and the forest floor beaten hard by the hooves of animals, then the run-off can still be very heavy. Similarly with grassland and scrub jungle if the natural cover of grass is maintained it will have a considerable sponge effect, but if heavily grazed, it will not. Our aim must therefore be to reduce the amount of grazing and substitute the cutting of grass and the stall-feeding of a smaller number of selected cattle. In this change-over from the old system to a new one, it is the first stage which causes most trouble, for the graziers cling to their old habits and prefer quantity to quality in their herds, even after they realise that one good stall-fed buffalo will give twenty times as much milk as a scraggy animal wandering half-starved on the village waste land. In Hoshiarpur district in the Punjab some 80,000 acres of grassland have been closed to grazing during the last four years. This work was started by a forest officer doing propaganda from village to village, explaining the benefits of closure, and getting the people to apply voluntarily for closure. There is also a local land preservation act known as the Chos Act which gives government power to enforce closures in this badly eroded Siwalik range. *Cho* is the local name for a sandy torrent bed which issues from the Siwalik hills; the Siwaliks are of very soft sand-rock which is peculiarly liable to gully erosion. As a practical example the people of Hoshiarpur had before them some old closures which were made compulsorily under the Chos Act in 1905, and these old closures now bring to the owners a very handsome income from cut grass. There is still much suspicion in the minds of the villagers, who are afraid of government's intentions, and even when they are persuaded that their land is not going to be seized, party faction often prevents the forest officer from getting

the necessary two-thirds majority of the landlords to apply. During the last year the services of the Co-operative Department have been secured, and a special staff is now organising *cho* reclamation societies, most of which are prepared to ask for government help in making extensive closures of their waste lands, as a preliminary step towards reclaiming some of the thousands of acres which have passed out of cultivation through torrent damage. As an example one society in a small village called Bhatrana, formed only a few months ago, has already undertaken the training of its *cho* bed by means of planting live hedges of *banha* bush in the sand. They have made a splendid beginning which if logically carried out to its conclusion will not only secure their land against damage but will reclaim much that has already been lost. Even the most dangerous *cho* can be canalised and kept under control, by keeping its banks under a dense forest cover of all the trees and plants most useful for binding sand and resisting water action. One cannot expect the individual villager to give up a large part of his holding for this defence work, and in order to ensure the safety and permanence of these shelter-belts, it would be best to have them placed as a common holding directly under the control of a trained forester or forest guard working as the servant of the co-operative society. The society not only shares out the profits from the sale of forest produce but should act as a sort of land improvement committee for the whole village.

Turning from the village to the wider aspects of erosion control the Punjab has already got a small but efficient organisation. A new conservator's circle has been formed under the forest department called the Anti-Erosion Circle, and under this come several foothill charges such as the Ambala and Hoshiarpur Siwlika, Gurdaspur, Gujrat, Jhelum Salt Range, and the Kangra and Rawalpindi village forests. In each of these areas some form of active counter-erosion work is going ahead, varying according to the needs of the locality. It may be entirely a matter of controlling the grazing so that the steep, uncultivated land will have a chance of reclothing itself and producing a crop of cut grass and firewood. It may be that there are square miles of badly gullied lands which are now a serious menace but which can be rendered harmless and productive by some simple engineering work such as contour trenching or the building of small check-dams of brushwood or stones along the bottom of each *nala*. It may be that the cultivated land is suffering from extensive sheet erosion which can only be cured

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by getting every cultivator to make each field a self-contained catchment to hold all the storm water which falls upon it. It may be that the village has once had extensive forest of its own which has been destroyed through continuous misuse and over-felling in which case reforestation has to be undertaken by closing it to grazing and sowing or planting trees. It may be that there is a great shortage of fodder and this can be met by the planting of trees which can be lopped to produce leaf fodder. This generally entails the making of a forest nursery from which tree transplants can be supplied free to the villagers for planting. It may be that one particular torrent is doing so much damage to the villages along its course that special reclamation work has to be undertaken in its area. All

such work needs a good deal of technical knowledge, and yet the damage is so widespread that obviously the provincial government cannot be expected to undertake the whole thing. All it can do is to demonstrate on a small scale what the villagers themselves can undertake, and then depend upon education and propaganda to push it forward on a much higher scale. It is here that the work of the co-operative societies is so vital, and the most hopeful development during the last year in Hoshiarpur has undoubtedly been the live spirit of co-operation which has sprung up between the villagers and the forest and co-operative staffs working in close collaboration. Here is an experiment in really practical democratic village management which should be watched with the greatest interest by all who have the welfare of the villager at heart.

Industries and Scientific Research

Industries are most necessary for national progress and prosperity, and research in applied science is very essential for promoting industries, especially heavy or large-scale industries. This fact is not fully realised in our country.

We have neglected the preparation of secondary products and as a result are treading the path of industrial decay. The 1931 Census showed that ruralization has been on the increase. What the country wants is growth of economic power in our population and rapid increase of production in agriculture and industries. Production in agriculture and industries should be advanced by a large use of machinery and by the adoption of the latest scientific methods, commercial practices and discipline of the Western world.

Difficulties and discord run wild in our country in many departments of national life, and scientific activities are not immune from this malady. There is some element of discord regarding the relative importance of research in pure and applied science. The universities and colleges are accustomed to pure science and are proud of their knowledge of theory; and much of the research work done at present is therefore of an academic character.

Of course, theoretical research paves the way to industrial research and should not be neglected. But what is particularly wanted is that industrial research should be greatly strengthened and the existing disproportion between the pure and applied science remedied without delay.—Sir M. Visvesvaraya at the Royal Institute of Science, Bombay.

A Scheme for Vocational Guidance Work

Krishna Chandra Mookerjee

Department of Psychology, Calcutta University

It is being increasingly felt that sound individual analysis coupled with well-planned occupational analysis gives materials by means of which we can put the right man in the right place. The vocational psychologist should have, on one hand, an understanding of the individual's aptitudes, abilities, interests, educational attainments, temperamental qualities, physical condition, family tradition, social environment and the like; and on the other hand, he should have a clear analytic knowledge of the requirements and conditions of success which prevail in the various branches of industry, commerce and the professions. He should be able to give the individual, in his search for the most suitable career, some information regarding the various duties which have to be performed in the occupations under survey, the type of machinery generally used, the conditions of work, the rate of pay, the period of training required to be spent before actually entering into the profession.

For evolving a practical scheme for vocational guidance work in our country it is essential to have a register containing reliable information about the more common occupations in which our young boys and girls may be employed. To advise on the suitability of the future career for our boys and girls we should consider mainly the following tests and measurements. It should be preferable, in connection with the guidance work, to adopt one individual test and one group test for these measurements.

General Methods for Guidance

Measurement of the Level of Intelligence. A table showing the level of intelligence required for various types of occupations has to be drawn up at the beginning. For this part of the work it would be better to be content for the present with the table supplied in 'Hand Book of Vocational Guidance' (Oakley and Merae, University of London Press Ltd.), but it must be remembered that a table like the one given in the book has to be drawn up for our country at the

earliest opportunity because the intelligence requirement for various jobs in our country can never be the same as in the case of Englishmen.

Measurement of the Practical Intelligence. This can be effectively done by performance tests of intelligence.

Determination of the Scholastic Level. To determine exactly the level of scholastic attainment in individual cases a few important scholastic tests may be applied, e.g. arithmetic test.

Measurement of Interests. Though the statisticians nowadays do not find very significant correlation between interest and ability, it is not advisable to dispense with the interest factor altogether. The nature of individual's interests may be ascertained by the questionnaire method. (In drafting the interest form it is desirable to take into consideration Strong's interest blank, Cattell's interest test and the form once prepared by the psychology laboratory of Calcutta University). Along with this questionnaire form another form seeking information on the individual's leisure interests should be used. This form will be similar to that used by National Institute of Industrial Psychology (N. I. I. P.),* for the same purpose. Finally a chart is to be prepared from the records obtained from representative persons of different vocations to show the relation between interests and success in different vocations. From this chart it will be possible to read off roughly the future career of the individual who may show interest in particular groups of things or activities.

*The National Institute of Industrial Psychology of London since its formation possibly in the year 1920 has been doing useful service in this direction. In its early career the Institute carried on investigations into problems of Industrial Psychology but later on it included vocational guidance and selection and other allied problems of applied psychology, within its fold.

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Assessing of Temperamental Make-up. It is essential to assess temperamental qualities as far as these can be done. To achieve this in practice usually some form of rating scale is employed. The rating is done by the examiner as a result of his observations during the standardized interview which is sought mainly for this purpose. It is doubtful, however, if any value can be placed on such a procedure because individuals tend to vary considerably in their reactions to different circumstances. Only outstanding temperamental traits of an individual may be detected during the interview as suggested above. In order to avoid this difficulty it is desirable to use a more elaborate method for judging temperamental qualities, as described below, and to use the interview method as complementary to that method. This method makes use of two types of forms. On first type, persons to be tested are required to underline whichever of the qualities mentioned in the list in a paired form (usually in opposites) they think they possess. They can also indicate the degrees of these various qualities by different types of marking. In the second type of form the words are not arranged in paired order as in the other form and the qualities mentioned are generally absolute in nature. Here persons are asked to underline whichever of the qualities mentioned in the form they think they possess. In addition to these two subjective forms a third form should be utilised to elicit information on some of the more important temperamental traits. The object of introducing this form is to obtain an indirect verification or otherwise of subject's judgement and to explore the trend of subject's unconscious mind. This form should consist of questions carefully designed in such a way that the psychological import of these be not too obvious to the subject. This form would be very valuable aid to the vocational advisers.

Different professions require different temperamental make-up and as such it is necessary to prepare separate temperamental charts for them. In our country the preparation of such charts may be undertaken with the help of the answers obtained from representative persons of different vocations.

Testing of Special Abilities. The testing of special abilities is very important for guidance purpose; otherwise a high potentiality in one of these may go undetected. It is however not possible

to measure all the special abilities, because (a) sufficiently reliable objective tests for measuring all these abilities are yet to be developed, and (b) even if and when all the tests were available it would not be possible to make use of all of them due to limitations of time. However the testing of the following important special abilities, corresponding to each of which there are reliable objective tests (vide *Hand Book of Vocational Guidance*), may be undertaken:

(a) Arithmetical ability, (b) Linguistic ability (both written and spoken), (c) Mechanical ability, (d) Constructional ability, (e) Social ability (both direct and indirect), (f) Manual dexterity, and (g) Methodical ability.

Health Conditions: The efficiency and deficiency of the individual's bodily apparatus should be revealed by a thorough medical examination. This examination will also bring out positive indications or contra-indications for particular types of jobs.

Social Conditions: Information regarding the individual's social status, financial position, home circumstances are classed under this heading. The individual must fill up a form containing these points. The information supplied by the subject should however be confirmed and further supplemented by reports obtained from parents and other sources. This report should always be considered as a confidential document.

The results from all these tests when completed will give a fairly comprehensive picture of an individual. Other factors may on occasions play an important role in influencing the final pronouncement of the vocational adviser. The career that seems to be most fitting for an individual may not be the most practicable one, and a choice may require to be made of a second best. The state of employment, the conditions at home, the need for immediate earning, all play their respective part in determining a choice, irrespective of the potentialities and talents which the individual happens to possess. In addition to all these, the wishes of the individual's parents and the likes and dislikes of the individual himself, must also be taken into consideration.

Selection of Tests for Different Vocations

A few words on vocational selection may be added in conclusion since the two problems are inseparably connected. On examining the various

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methods which have from time to time been developed for the proper selection of personnel it is found that two methods of approach to the problem are open to a modern psychologist—a synthetic method and an analytic method.

In approaching the problem of vocational selection from the synthetic side, two methods of procedure are available. A standardized sample of the work may be used as a test. National Institute's selection test for typists falls within this class. This test may be adopted here. The other procedure consists of using a test analogous to the job in hand but not identical with it. The test is so devised that it presents a situation similar to that to which the applicant has to adjust himself in the real occupation. Some selection tests for tramway workers (of the N. I. I. P.) fall within this class. The difference between the two types of synthetic tests is that the former presupposes some amount of training on the part of the individual while the other type is supposed to measure native ability.

The analytic approach to the problem of selection is the one most in favour, the reason being that the tests can be given to the beginners, who are not already in any employment. This method consists of analysing the work to be performed into its elementary constituents. When this analysis, or occupational analysis as it is called, is complete, tests are designed and instead of a single test a series or battery of separate tests bearing on the results of analysis are given. There are three distinguishable stages in the preparation of these tests. The first stage is to make a thorough occupation analysis or a 'job' analysis, as it is called, of the work in question. The next stage is to devise tests which will measure these essential traits. But it should be settled whether the tests are to be given individually or

to a group, whether they are to be pen and paper tests or performance tests. Once the tests have been devised and selected, the method to be used in explaining the tests to the candidates, and of scoring the tests to make the whole procedure as objective as possible, must be carefully considered. Next comes the third and most important stage when the tests themselves have got to be applied in practice to see if they are really of diagnostic value. For this purpose a group of individuals representing the particular occupation should be chosen and the tests should be applied to them. The group is so chosen as to include good, poor, and mediocre workers of that occupation. Finally the results of the tests are compared with the efficiency of the workers at their work. In addition, the selected tests should be given to a large number of persons of the same age, sex and standing so as to obtain norms for different grades of workers in that occupation.

This method has been utilized by the National Institute to devise a number of their selection tests, the most important of which is a test for motor drivers. The following selection tests are very important for our country and they may be adopted without delay:—

1. Selection tests for Salesmanship ... (N. I. I. P.).
2. Selection tests for Motor Drivers (N. I. I. P.).
3. Selection tests for Typists ... (N. I. I. P.).
4. Selection tests for Clerks ... (N. I. I. P.).
5. Some commercial and trade tests ... (N. I. I. P.).

For selection tests of other semiskilled and highly skilled occupations, observations in a small factory in Calcutta (or elsewhere), may be started. The special abilities or dexterities required for work in different departments should be analysed first and then the 'tests,' whose application will lead to prediction, are to be devised.

Environment and Physical Changes of Man *

PHYSICAL anthropology has changed its character in recent years. It is no longer a science of mere race-classification and racial analysis which at one time engrossed the attention of anthropologists in Europe. Race-questions have however been taken up by politicians and statesmen. It should be noted that racial discrimination in some form or other has been in existence from time immemorial but certain physical anthropologists have given it a scientific form and this is being exploited by unscrupulous politicians. Realising the mischief that is being done to the cause of humanity and human civilisation, physical anthropologists in Europe and America are now trying to direct their activities to more fruitful channels. A brief description of the new channels of anthropological research appears in the presidential address which Prof. Le Gros Clark delivered before the anthropology section of the British Association for the Advancement of Science at its last session. (See pp. 332-5 of this volume of this journal).

One of these problems is the influence of environment on human groups. This is the theme of enquiry in a recent publication—*Migration and Environment—A study of the physical characters of the Japanese immigrants to Hawaii and the effects of environment on their descendants*—by Dr H. L. Shapiro of Columbia University. Twenty-seven years ago in 1912 the same problem was tackled by another great American anthropologist, Dr Franz Boas in his classic work on the *Changes in Bodily Form in Descendants of Immigrants*. He carried his investigation on the immigrants to the United States and established beyond doubt that the children born in America of immigrant parents were slightly but surely modified and the longer the stay of the immigrant parents on American soil before the birth of the child, the greater was the amount of modification. This evoked brisk discussion among anthropologists of both the hemispheres but unfortunately it could not make any permanent impression on the physical anthropologists. Dr Shapiro has again drawn the attention of anthropologists to this problem though the venue of research

has been transferred from America to Hawaii. He has questioned some of the fundamental articles of faith of the physical anthropologists in the following lines. "Although the individuals of a group vary within fairly wide limits, their average characteristics have commonly been regarded as unchanging over long periods of time. In fact, the vast bulk of comparative racial studies rests on this tacit belief in the stability of the statistical balance of the component variables of a population" and it has "assumed the guise of an article of faith beyond the necessity of examination." The physical anthropologists, according to him, theoretically acknowledge the principle of evolution but in practice pay little heed to it. They assume changes in human groups but these are so slow that even in relatively long periods of time they are imperceptible. This allows comparative study of "contemporary groups living in diametrically opposite environments without regard for the possible effect which these diverse environments might exercise on the very differences they scrutinize." Such an attitude also makes it possible to compare the historic and prehistoric populations as contemporary peoples. These assumptions about the relative stability of human population through ages and through wide fluctuations in environment logically question the theory of human evolution. "Such an interpretation would minimize the effect of environmental shifts which we know have on occasion been considerable. It would deny all but the minutest effects to the accumulation of mutations. It would erase from practical consideration the working of differentials in a given population. It renders man static in a world of flux and change. To doubt the accuracy of this representation of man does not thereby impose an acceptance of a state of affairs in which man is a completely unstable organism constantly veering like a weather vane with the winds of environment. It does, however, impose the necessity of re-examining the basis for such a belief by testing it against the realities as we find it in nature." *Migration and Environment* is the outcome of such an examination.

The subject for this study were the Japanese immigrants to Hawaii and their children. "All the individuals scrutinized are of unmixed Japanese

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ancestry." There are both male and female subjects and they are further divided into three groups according to birthplace and residence. The first group includes persons who "were born in Japan and have remained there all their lives, moving within a narrow geographical orbit and marrying into the local population." They are termed as 'sedentes' by the author and they have been included for the purpose of comparison. The second group consists of Japanese immigrants who have settled in Hawaii. The majority of these immigrants settled in Hawaii between 1898 and 1907, that is from the abandonment of contract labour and stoppage of passage money for the return journey till the Gentlemen's Agreement came into effect. The third group contains the "children of Japanese immigrants who have been born and bred in Hawaii. The overwhelming majority of subjects in this group was born after 1900." This tripartite division forms the fundamental basis of this study. The number of subjects examined for this study was 3000 in all but out of this only 2594 have been utilised and the rest left out on account of various reasons. The measurements and observations were carried out by a single individual—Dr Frederick S. Hulse—from January 1931 to February 1932. Dr Hulse followed Martin's instructions in his field-work. "The full field schedule included 43 measurements, 21 indices, and 41 observations. Of these.....28 measurements, 21 indices and 41 observations were employed in the statistical analysis."

The working out of this large series of measurements and observations reveals a very unexpected picture. The group of immigrants distinctly differs from the sedentes as a type. "The immigrant males are on the average heavier than the sedentes; they have shorter trunks and longer legs; their distal arm segments are longer; their shoulders are wider; their chests are broader but shallower;..... They have higher heads, wider bigonial diameters, longer total and upper face heights, greater dimensions for nose height and length, less salient nasal tips, narrower noses, narrower inter-ocular and wider bi-ocular diameters." As a result of these differences in the absolute body measurements the indicial relationships also necessarily differ. These divergences reveal, according to our author, "not a random sample of the population represented by the sedentes" but a selected group. The female immigrants also diverge from the female

sedentes in the principal corresponding features with certain important deviations. Thus they are taller than the sedentes and all the segments of their arm are longer. In spite of these differences from the males "in the vast majority of traits the female immigrants follow the precedents established by the males in their differentiation from the original stock." Thus it may be said that the immigrants constitute a "distinct subgroup characterized by significant departures from the Japanese type." The emergence of this sub-type, our author shows, is not due to any physical selection on the part of the recruiters nor is it due to any social, economic or psychological factor. He, however, cautiously points out that the sedentes of the northern districts were more like the immigrants as a whole as well as the immigrants of the same area. The sedentes of the southern districts on the other hand differed from the immigrants of their own area as well as from the sedentes and immigrants of the northern districts. This might have been due to the historical movement of the Japanese towards the north, producing an 'immigrant type' there, which has been repeated in the movement towards Hawaii. But even this does not satisfactorily explain the difference between the two groups "since the subjects in the control series of sedentes are close relatives of the immigrants and they have both been bred under similar conditions." So far as regards the sedentes and the immigrants; next our author compares the Hawaiian born with the former two. His analysis shows that the Hawaiian born differ from the sedentes as well as from the immigrants but the difference with the former is greater than that with the latter. The Hawaiian born males differ from the immigrants and sedentes in 55.2 per cent and 79.3 per cent of the measurements and in 42.9 per cent and 90.5 per cent of the indices respectively. The phenomenal increase in stature of the Hawaiian born (4.11 cm. in males and 1.71 cm. in females) over the immigrants cannot be accounted for merely by the age discrepancy and has to be attributed to other dynamic forces. Dr Shapiro has tried to find out the causes of this differentiation of the Hawaiian born from both the immigrants and the sedentes. According to him neither social factors nor age discrepancies are responsible for this difference. Occupation also, in his opinion, has not directly influenced the situation though it has possibly exerted some secondary influence. The immigrants differ from the sedentes in both qualitative and quantitative characters while the Hawaiian born show further considerable modification in the latter without any change in the former. This quantitative modification in the Hawaiian born

*Being a review of the book, *Migration and Environment* by Dr H. L. Shapiro, Columbia University, 1939.

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Combating the Magnetic Mines

DURING the last few months the British Navy at mercantile marine had to face a grave menace due to indiscriminate laying of what are known as magnetic mines in the channels and the North Sea. The mechanism of magnetically detonated mines could not be kept a secret for long and once the scientists and engineers have found a clue to the working of the mines, suggestions have been pouring forth from different quarters showing how it would be possible to set off the mines before they could do any damage. The mines are equipped with high frequency oscillating electric circuits of the type used in radio-transmission or reception. Just as in simplest type of radio receiving sets even bringing the hand near a knob may disturb the oscillating circuit and give rise to squealing noise, presence of a mass of steel or some such agency would change the stability of the field of a balanced electromagnetic circuit with which the mines may be equipped and that in turn affects an amplifier circuit. This disturbance then throws a switch or makes a contact which sets off the detonating mechanism. Even very feeble interference due to presence of a mass of steel at a distance which in itself is unable to work the detonating mechanism may be suitably magnified with the aid of amplifying tubes as are used in ordinary radio sets and local batteries placed inside the mine.

William Dubilier, the well-known inventor of Dubilier Mica Condensers, has suggested that these mines can be destroyed before doing any damage by the use of electromagnetic fields created on crewless floats or rafts controlled from a distance. Such field would have far wider ranges than steel nets now reported to be dragged through the waters of mined channels. Dubilier proposes the use of few wooden ships separated by a few hundred feet carrying a cable between them extending from ship to ship in the air. This cable will be charged with a heavy current (1000-5000 kW) and at short distances along the cable are to be placed powerful electromagnets energized by the current. The electromagnetic field created would disturb the oscillations in the mine circuit and actuate the delicate trigger mechanism. Interfering the oscillatory circuit only for a fraction of a second would be sufficient to cause the charge to be exploded so that the electromagnet may be energized only once in every five seconds for a flash like

period. Dubilier has proposed an alternative scheme in which a large ship would be connected with two crewless rafts by means of cables and as the rafts would clear the course of the ship the latter would run little risk of being blown up. These robot rafts would be driven, steered and electrically controlled from the ship through its connecting cables and would carry large electromagnets. The large ship, the two rafts and the connecting cables would form a triangle.

Dubilier also suggests that in all channels leading to the estuaries and harbours of Great Britain cables carrying electromagnets be laid which may be energized by powerful generator on shore. These would make the laying of magnetic mines by enemies extremely hazardous because if the current happens to be flowing at the time a mine is being laid the U-boat and its load will be blown up along with the mine.

Science in 1939

THE *Science News Letter* has published a resume of the progress made in different branches of science during the year 1939. The most notable achievement in physics was the splitting of the uranium atoms with a release of their atomic energy under neutron bombardment into atoms of barium, krypton, lanthanum, xenon, calcium, rubidium etc. Uranium fission* originally discovered in Germany was quickly confirmed in many other laboratories in Europe and America. The fission of uranium was found to be accompanied by the emission of other neutrons in a delayed reaction, which, it was hoped at that time would supply the link in a chain reaction that would make possible the practical release of uranium's atomic energy. Thorium and protactinium were also found to split up in a similar manner. The important fundamental physical constant *viz.*, velocity of light was determined for the first time by a completely automatic method that makes the observations completely independent of the observer. The most sensitive current detecting device ever created was developed which can detect 1×10^{-21} amperes, roughly equivalent to a current due to one single electron passing down a wire every five minutes. A new device using a flickering searchlight and photoelectric cell detectors was developed for studying the density, temperature and other

*See footnote on the next page.

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physical conditions of the atmosphere* up to heights of nearly 25 miles. The world's most powerful continuous magnetic field, with a strength of 100,000 gauss, has been produced by the magnet developed at the Massachusetts Institute of Technology.*

Excellent catalytic properties of hydrogen fluoride was discovered. It was found to improve the yield of many organic chemical reactions and make possible some which have not previously been attained. A new synthetic silk fibre, Vinyon, made from polyvinyl acetal resin, approached commercial production. A chemical necessary for the manufacture of carbon dioxide in food formation by plants was found. A substance that makes plant wounds heal was discovered and named Traumatic acid. Colchicine* was extensively applied in the breeding of new varieties of plants. Vitamin K has been obtained in crystalline forms and its chemical constitution determined. Similar compounds synthetically prepared exert the same influence in producing the formation of prothrombin, one of the factors necessary in blood coagulation. They have been used in certain diseases in which bleeding occurs from lack of prothrombin. "Hormone banks" a new technique in endocrine therapy, consisting of burying several months' supply of hormone in pellets under the skin, was successfully used in cases of hypogonadism in both males and females.

The use of the new chemical remedy sulphapyridine cut down materially the pneumonia fatality rate in 1939 and this and the related chemical sulphanilamides* were reported to give promising results in the treatment of small-pox, primary peritonitis, certain tropical diseases, gonorrhoea and ulcerative colitis. It was however found to produce no effect in tuberculosis.

Saving the Elephanta Caves

IN a recent talk at Bombay, Rao Bahadur K. N. Dikshit, Director-General of Archaeology described the recent attempts made by his department in rescuing the Elephanta caves from threatened disintegration by climatic conditions. The story of Elephanta begins sometime in the sixth century, when, after centuries of Buddhist activities, the ancient Hindu faith had been revived in the Deccan. The construction of the Shiva

*The reader is referred to the following pages of this journal where more exhaustive accounts have been given.

- Fission of Nuclei, 5, 168, 281-4, 1939.
- Investigating into Atmosphere, 5, 530, 1940.
- Powerful Magnet and Massachusetts Institute of Technology, 5, 458-62, 1940.
- Colchicine, 5, 511-2, 1940.
- Sulphanilamides, 4, 585-6, 1939.

temple with shrine and subsidiary establishment on this solitary sea-girt island was probably carried out under the orders of some Chalukya king ruling over the Konkan coast. With the passing of the island into the hands of the Portuguese in 1534 the caves gradually deteriorated and rapid disintegration set in. Worst of all, the Portuguese made the images targets for shooting practice. When the British took possession of Elephanta in 1774, it took several years to clean up the accumulated debris and water before the sculptures were fully visible. After about a century the Government of Bombay undertook some substantial measures of conservation which gave the caves a longer lease of life.

Five years ago, the archaeological chemist sounded a note of warning and reported that sea salts working their way right into the fabric of the stone were responsible for much of the damage and disintegration of the walls and sculptured panels. In 1935 a portion of one of the heads of the famous *Trimurti* came down. The Government of India at this stage appointed a Committee of Enquiry whose recommendations have now been worked out by the archaeological department. For the elimination of sea salts paper pulp method has been found to be most effective. The affected panel is swathed in a wet blanket of paper-pulp which gently brings out the mischief making salts to the surface, and repeated applications result in rendering the sculpture salt free and at the same time effecting a remarkable improvement in the external appearance. Another danger was due to percolation of rain water from the ceiling of the caves, the rock above which was soft and spongy. It was obvious that the percolation from the hill behind the caves must be effectively stopped and the department decided to employ such cementation processes in these rocks as are usually employed in stopping leakages in masonry barrages holding up mighty reservoirs. Series of holes were drilled in the rock to an average depth of 70 feet and liquid cement was grouted in them under pressure amounting to 100 lbs. per sq. inch. The cement running into all the hidden crevices and interstices of the rock made the same an impervious mass through which little water could percolate. The result of this work, the first of its kind to be tried on any ancient monument, has been quite gratifying and during the last two monsoons the danger of percolation has been reduced to a minimum.

Total Solar Eclipse of October 1, 1940

THE joint Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society prepared long ago plans for a number of expeditions to observe the total solar eclipse that will take place on October 1, 1940. Professor J. A. Carroll of Aberdeen was to have gone to Brazil with an objective interferometer and an echelon spectrograph for a study of coronal and chromospheric line contours and wavelengths. The Royal Observatory, Greenwich and the Cape Observatory

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were to have gone to Calvinia for a study of the Einstein displacement of stellar images, for a spectrographic study of the chromosphere with a moving plate camera and for other works. Professor H. Dingle was to have gone to a station near the edge of the belt of totality for work on wavelengths and intensities of chromospheric lines near the cusp. The Solar Physics Observatory and the Radcliffe Observatory, Pretoria, had a programme including work on the extreme ultra-violet spectrum of the chromosphere and corona, a study of chromospheric line intensities at different heights with a camera having a plate moving intermittently and also polarization studies of the corona and of the sky close to the eclipsed sun.

In a statement recently issued by Professor F. J. M. Stratton it has been stated that unfortunately, due to the outbreak of the war, most of the expeditions will have to be abandoned and the Committee has now decided to concentrate on one expedition from the Cape and Radcliffe Observatories to Calvinia, which will try to carry out the programmes of all the previously contemplated expeditions, as far as practicable.

Tube Wells for Irrigation

A TOTAL of 1,478 tube wells have been sunk by the Government of the United Provinces in dry tracts of the western districts of the Province which had hitherto remained without canal irrigation mainly because of seasonal shortage of water in the rivers feeding the irrigation canal systems. These wells protect an area of nearly a million and a half acres. The typical tube well has a discharge of 1.5 cusecs and commands 1,000 acres or 1.5 square miles on an average, providing for the extraction of one cusec per square mile from the sub-soil. Borings go down to 250 feet to 330 feet and 100 feet of 6 inches strainers are provided in good water bearing strata of coarse and medium sands. Each tube well is provided with about $2\frac{1}{2}$ miles of channel, of which a part, six furlongs to a mile long, has been lined with masonry. To ensure proper consolidation lining was laid after the earth channels had run for two seasons. The lined channels have generally stood well and the average expenditure was Rs. 1,700 per mile of channel. Experiments with piped supply on new wells after the practice obtaining in California, are now under contemplation. The crop experiments carried out in 1938 by the Agricultural Department in average zones, have demonstrated that the yields are appreciably larger under normal conditions for both sugarcane and wheat with tube well irrigation than without.

Originally expected to run 3,000 hours in a year of normal rainfall, the tube wells actually have run far longer in 1938-39. Dr. McKenzie-Taylor, Director,

Punjab Irrigation Research Institute, who examined in detail the effect of tube-well pumping on sub-soil water table, is of opinion that the average depth of water table over the area drawn upon taken over a number of years is practically constant, indicating stability. The tube wells are worked by hydro-electric power generated from seven falls in the Ganges canal, which, with the steam power station at Chandausi, develop between them a total of 28,000 kilowatts. The balance remaining after pumping irrigation water direct from the Ramganga and Kali Nadi rivers and from the State tube wells and 200 privately owned tube wells, is used for minor industries and for domestic supply in 80 towns of the ten western districts of the province. The main industries connected so far are the vegetable ghee factory at Begumabad, oil crushing and spinning mills at Aligarh, steel rolling mill at Shahdara and the uardboard factorf at Meerut. In addition a large number of small industries, such as flour mills, etc., are served.

Two Thousand Years Old Coins

IN a monograph in the *Memoirs* of the Archaeological Survey of India. Mr E. H. C. Walsh, a well-known authority on Indian numismatics has published the results of his study of a number of coins found in two hoards of punch-marked coins more than 2,000 years old discovered in Sir John Marshall's excavation on the Bhir Mound, the oldest of the three successive cities at Taxila which dates back to the 6th Century B. C. and was occupied for 400 years. The larger hoard consists of 1,055 punch-marked silver coins, 33 long-bar coins and 79 minute coins and the smaller of 176 debased silver punch-marked coins. The long-bar coins in the larger find, according to Mr Walsh, are as much indigenous as the other punch-marked issues and do not indicate Persian influence. Certain minute coins less than $1\frac{1}{5}$ of an inch in diameter and weighing about $2\frac{1}{2}$ grains are the most unique amongst the finds.

The find throws a flood of light on the significance, grouping and sequence of the most ancient type of Indian coins found all over India. The coins furnish a future standard of reference for punch-marked coins as the coins extend over a longer period and contain more varieties and are in every respect more complete than the British Museum specimens. In the smaller find, 171 coins are of one class and are chiefly of interest because of their abnormally high weight (due probably to the debased metal), and of different varieties, mostly debased and crude imitations of the "Taxila Mark" on the reverse. From a study of the weight of the coins the conclusion is reached that India must have had from the earliest times an independent indigenous system of weight. Like other punch-marked coins, the coins in these hoards also bear neither the date nor the name of the king, but the date of the deposit of both the hoards

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is fixed by other extraneous coins of rulers with known dates. Two gold coins of Alexander the Great and one of Philip Aridaeus in mint condition were found in the larger hoard and one gold coin of Diodotos in the smaller; the former should, therefore, have been deposited about 317 B.C. and the latter about 248 B.C. The number of marks occurring on the reverse being merely indicative of the period of active circulation, the coins have been classified on the basis of the fixed groups of marks on the obverse which are usually five and it has been suggested that another class of early punch-marked coins found elsewhere, which bears only four marks on the obverse, may be assigned to the pre-Mauryan kingdom of Kosala. Amongst the marks punched on the coins, some, according to Mr Walsh, indicate the authority issuing the coins, while others stand for hills, tanks, etc., distinctive of the localities from where they were issued.

Work of Botanical Survey of India

EFFORTS were made throughout the last year (1938-39) to secure specimens as are likely to be of public interest of medicinal plant products, plant materials used as vegetable insecticide, cereals, pulses, oil-seeds, commercial timbers, and samples of hand-made and machine-made paper of different qualities. The collected specimens have mostly been exhibited in the Gallery of the Industrial Section of the Indian Museum, Calcutta. Amongst the exhibits are various well-known commercial drugs, namely, Aconites, Artemisia (Kirmala), Podophyllum (Papra), Taraxacum, Colchicum, Digitalis, Belladonna, Jurinea (Dhup), Rheum (Revand Chini), Hyoscyamus (Khorasani Ajowan), Valerian, etc., which were collected from Kashmir. In the commercial side over Rs. 3,00,000 was realized from the sale of Government of India quinine. The year opened with a stock of 112,564 lbs. and closed with a balance of 97,071 lbs. The closing balance of bark was 256,106 lbs.

The Industrial Section has, in addition, been collecting information from various sources on many commercially important botanical products. Detailed information has been collected on hand-made paper, Kashmir drugs and vegetable insecticides and given publicity. Many correspondents in India and abroad have been supplied information on various economic plant products and specimens were procured for and supplied to many scientific workers. In one instance the result of research thus assisted is likely to be of great benefit to the cattle industry of India. Some packets of ripe and unripe seeds of linseed were supplied to Mr. W. Miller of Greenock (United Kingdom), who was studying the chemical properties of Indian linseed in connection with a case of cattle poisoning resulting from linseed oil-cake feed. Mr. Miller's investigation disclosed the presence of a small percentage of prussic acid

in Indian linseed. But it has been observed that if the linseed cakes are soaked in water for a few hours before the cattle are fed, there is no bad effect.

In systematic botany some 2,000 plant specimens have been collected and added to the Herbarium of the Royal Botanic Gardens, Sibpur and nearly 3,000 specimens have been identified for a large number of correspondents, the largest collections among those being from Sikkim, Baluchistan, Dehra Dun, Karachi and Burma. A large number of duplicate specimens has been distributed to several institutions in India and abroad and more than 3,000 sheets have been acquired in exchange, and about 4,000 sheets have been added to the Herbarium. The Herbarium has been of considerable assistance to a number of distinguished botanists, both Indian and foreign, who come to visit and work in it for identification and confirmation of doubtful plant specimens of different localities. Mention may be made of the investigations on poisonous plants of India conducted by the assistants of Col. Chopra for which all possible facilities and assistance were given.

Calcutta University Convocation

SIR Mirza Ismail, Dewan of Mysore, delivered an address to the graduates of the University of Calcutta at its last annual convocation. He referred to the admirable work of Sir Asutosh in creating the department of post-graduate studies which turned Calcutta University from a mere examining body to a corporation of teachers and students banded together in the pursuit of learning and for the expansion of the bounds of knowledge. Sir Mirza pointed out that in the matter of higher education and research, this university has rendered to the country a double service, first, by the fruitfulness of the work done here and second, by its firm emphasis on the necessity of such work and serving as a guide in these respects to other sister universities of India. The time is come now for the Indian universities to take common counsel and distribute courses of a highly specialised and advanced character on a regional basis and thus develop such reputed centres in our own country as would not only keep our students from going abroad in large numbers but even attract students from abroad. Turning to the question of the future of the graduates, Sir Mirza admits that in Bengal, as elsewhere in India, agriculture is the very foundation of the life of the province but that foundation has become perilously inadequate due to too much pressure on land.

There is but one remedy, the increase and improvement of the yield by improving the old agricultural methods. Here is an opportunity for university men, particularly those who would specialise in that line and Sir Mirza praised the recent efforts made in Bengal to spread the knowledge of scientific agriculture and hoped

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that before long there would be a faculty of agriculture in this university. But whatever attention is paid to the improvement of agriculture that will do very little to solve the problem of unemployment on a wide scale and the only possible solution would be to accept a policy of industrial expansion in the country.

"It is clear" says Sir Mirza "that this has been realised by the Government of India, who have declared that India is entitled to receive the utmost help that the Government can give in order that she may take her place as a leading manufacturing country. There is nothing to prevent the rapid attainment of this status, if governments and people are really to work with each other and are genuinely determined upon the utilisation of the vast resources of the country in power, raw materials and technical ability. Surely India's intelligence and India's enterprise are adequate to this task, the fulfilment of which means the redemption of India from her grave obsession of poverty." We accept every word of Sir Mirza, but cannot agree with him when he says that the Government has really realised the necessity and declared to give support to a progressive policy of industrialization of the country. If the Government were really sincere about their declarations and would make attempts to act up to their professions of anxiety for India's industrial development, the whole face of India would have been changed beyond recognition within a short time. As a matter of fact the Government has been at times responsible, either due to inaction or want of any planned scheme or policy, for impeding the growth of Indian industries.

The Vice-Chancellor, The Hon'ble Khan Bahadur Azizul Haque, also pointed out in his address the lack of any planned scheme of scientific research in this country and expressed regret that the University College and the science laboratories of Calcutta University have been very unfortunate in not getting substantial State grants and gifts from the generous public leaving aside the endowments of Ghosh, Palit, Khaira and Sir P. C.

Ray. If our students are to be equipped to take any responsible share in the industrial and economic development of the country, it is absolutely necessary that the laboratories of the College of Science should be expanded with extended scope for research on a larger scale and for this purpose generous grants should come from the State as well as from private persons and industrial concerns who have been and will be benefitted from the results of research done in this university.

Dr K. S. Krishnan, F.R.S.

AS we were going to press news had been received that Dr K. S. Krishnan, Mahendralal Sircar Research Professor at the Indian Association for the Cultivation of Science, Calcutta had been elected a fellow of the Royal Society, London. We offer our heartiest congratulations on his receiving this coveted distinction. In the last January issue of this journal we published a short life-sketch of Dr Krishnan on the occasion of the Madras session of the Indian Science Congress, where he presided over the physics section. It is gratifying to note that of the six Indians so far elected to the Royal Society of London four worked in one or the other Calcutta research institutions. Dr Krishnan has already made a great name, being associated with Sir C. V. Raman, in the discovery of the Raman Effect, but the work which has brought him the present distinction is entirely his own. He has chalked out a new and fruitful line for the investigation of magnetism of crystals, a full account of which is given in the *Report on Progress of Physics*, Vol. 5.

It is to be noted that even election to the highest honours in science does not mean any substantial increment to income in this country. The salary which Dr Krishnan gets is far less than that of many high grade clerks in the Government. It is to be hoped that the Government of India will see their way in increasing their grant to the Indian Association for the Cultivation of Science, so that Dr Krishnan's services may be retained, and the Association may continue to develop the great traditions of research work in physics, which it has already acquired.

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New Road Testing Apparatus

FOR the last two years the road research section of the engineering department of the National Physical Laboratory, has been conducting systematic investigations regarding the nature of wheel impact arising when heavy lorries and saloon cars pass over road obstacles or road irregularities. The impact force measurements were conducted on a variety of road surfaces and load gauges were designed to suit the different types of vehicles. This has necessitated the study of road surfaces. The factor of skidding has long been recognised and the study of this factor received attention to develop a satisfactory method of recording this quality of road surfaces. Last year a device of recording the surface characteristics of road has been evolved which is very similar to the method of offset printing. It reveals the very nature of surfaces due to traffic and thus gives an idea of the life of the road carpet. A few square inches of the road under examination are cleaned of dust and then carefully inked over either by an ordinary half-tone black printing ink diluted with paraffin or by water letter-press ink. A clean rubber roller of specified hardness is then run over the inked area and the impression taken by the roller is transferred to a sheet of white paper.

The *Road Research Bulletin*, No. 3 issued by the Department of Scientific and Industrial Research and the Ministry of Transport gives a description of the process and of the apparatus which could be packed up in a small suit-case. The impression obtained is remarkable for the wealth of detail showing even the finest particles on the surface about a thousandth of an inch in diameter. It shows the stones on the road surface appearing as in relief, the shading of the ink giving a stereoscopic effect. Though the interpretation of the prints requires experience, one can easily recognise whether a surface is likely to be slippery, but the relative slipperiness is more difficult to ascertain. The prints can be stored for comparison during successive trials at definite intervals.

—P. N. G.

Boiler and Turbine in One Unit

FOLLOWING the increasing trend towards reduced weight in steam power machinery, a rotative boiler-turbine has been developed by Fritz Huettner, which

combines a steam generator, with air heater and fan, and a steam turbine with condenser, in one compact unit, requiring virtually no external pipings or auxiliary machinery. The boiler consists of a number of radially arranged U tubes which carry concentric fins on the combustion chamber side and volute shaped fins on the exhaust side. Concentric fins serve merely to enlarge the heat transmitting surface while the volute fins transfer combustion gas by centrifugal pump action. The boiler furnace uses either liquid or gaseous fuel. The burners are arranged in a circle and fire into a refractory-lined combustion chamber. The combustion space stands still and the boiler tube system rotates with the turbine while operating. In each U tube, the ends of which are connected by ring shaped collectors, a state of equilibrium establishes itself between the water and the steam column. Water level in the tubes varies with circumferential speed, which in turn is dependent on steam pressure. With a constant rate of firing a continuous steam production is maintained. Steam formed goes into the collecting chamber and passes through a circle of nozzles directly into the turbine. Reaction effect of steam flowing through the nozzles makes the boiler rotate in a direction opposite to that of the turbine discs. The boiler shaft carries a centrifugal fan which draws in combustion air, forces it through pre-heater tubes and around the combustion chamber, where its temperature is further raised. Flue gas leaves boiler through stationary air heater tubes.

In this unit a jet arrangement condenses exhaust steam within the turbine housing. Cooling water introduced near the axis of rotation, has its pressure increased in the rotating vane chambers and is projected through the exhaust space taking with it any air that may be present. Excess water flows back over the rim of the water chamber. There is no superheater and the boiler operates on saturated steam. There is a multistage regenerative process which heats the feed water. Amount of incoming water corresponds at all times to volume of steam used, so there is no feed pump. The condensate always flows back to the boiler and so there is no condensate pump also.

A starting motor is required to speed up the turbine to about 10 per cent of operating speed. Water content is comparatively small as the same volume of water is

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evaporated several hundred times in one hour.. Average steaming capacity for a 100 kW machine has been found to be 50 lb per sq. ft. per hour. So far only 100 kW machines have been built and operated and the results seem satisfactory.

With higher capacities total weight of materials per installed kW will be low. Total weight of a 500 h.p. unit is estimated about 2.5 lb. per h.p. and that of a 2000 h.p. machine at about 1.7 lb. per h.p. Space requirements are said to be comparable to those of an electric motor of the same output. In a range of pressures of 300 to 700 lb. and with turbine efficiencies of 75-80 per cent and boiler efficiencies of 85-88 per cent., over-all thermal efficiency of 22-28 per cent is expected. While no serious mechanical difficulties have been experienced with units built so far it remains to be seen whether satisfactory continuous service can be obtained with large-scale rotative boiler-turbine combinations.

—N. K. S. G.

Deepest Oil-well

DEPEEST oil-well in the world has been drilled in America in a remarkably short period of time. This is also the deepest level below the surface of the earth that man has yet reached. This deep well in California has penetrated to a depth of 15,004 ft., and is producing oil from sand strata at 13,092 ft. to 13,175 ft. It was drilled to the full depth in 284 days and completed for production in 12 days more. A survey at 11,570 ft. showed a deviation of only 21 ft. from the vertical, and below that the maximum deviation is $2\frac{1}{2}$ deg. The temperature gradient ranges from 196°F. at 6,000 feet to 268°F. at 15,000 ft or an increase of 1 degree for every 125 ft. of depth. Sub-surface pressure ranges from 2,950 lb. per sq. in. at 5,000 ft., to 5,650 lb. at 13,175 ft. The $3\frac{1}{2}$ in. drill pipe used in this case weighs $15\frac{1}{2}$ lb. per ft. exclusive of joints. Total weight of the pipe line at the bottom is 126 tons.

—N. K. S. G.

Preserving Wooden Objects in Museum

FOR the preservation of wooden objects against insects the use of hydrocyanic (HCN) gas, carbon disulphide (CS_2) vapour and creosote solution is suggested. But as hydrocyanic gas is very poisonous it is hardly used in museum. The other two are found quite effective. A few technological specimens of the ethnographical museum of the anthropology department, Calcutta University, were selected for experimental treatment and preservation. The specimens were cleaned very carefully with 5 per cent carbolic soap and washing soda in the museum method laboratory and after drying them in

the sun for two hours carbon disulphide vapour was applied.

A big plywood wooden box rendered airtight by lining with black board cloth and thin brown paper, was used for this experiment. The box is of $3'\times 2'\times 2'$ in size. At a height of 9" from the bottom four brackets were fitted inside the box at four corners. A movable perforated tray was placed on the brackets. Two glass cups containing 3 oz. of CS_2 each, were placed in the box, and the Korkus' cattle bell, tomb post, and a grinding machine were placed in it. These articles were exposed to carbon disulphide vapour for two weeks. After this carbon disulphide treatment a solution containing 40 per cent shellac crystals and 2 per cent corrosive sublimate in methylated spirit was applied and the surfaces were thoroughly polished.

After about 2 years the articles were found to be in a good condition excepting the cattle bell on which fungus like white chalk had grown. The cattle bell was later treated with creosote solution containing 2 parts of kerosene and 1 part of creosote and after 3 days 40 per cent shellac solution was applied on it and the results have been quite satisfactory up till now as reported by the University Museum Method Laboratory at a meeting of the Calcutta University Anthropological Society.

—M. N. B.

Production of Hydroelectric Power

UP to 1938, the ten countries leading in developed water power, according to the estimates made by the Geological Survey of U.S.A., are as follows: United States—17,949,000 h.p.; Canada—8,191,000 h.p.; Italy—6,000,000 h.p.; France—5,400,000 h.p.; Japan—4,800,000 h.p.; Germany—4,000,000 h.p.; Norway—3,000,000 h.p.; Switzerland—2,800,000 h.p.; Sweden—2,200,000 h.p.; and Soviet Union—1,630,000 h.p.

However the installed capacity does not give a full picture. In such countries as Canada and Norway which have abundant resources, electrical output of water-wheels is greater per installed h.p. than in countries where demand for power and lack of resources lead to installations which operate for a small part of the year when only water power is available.

—N. K. S. G.

Tung Oil Industry

SPECIMENS of Tung oil seeds and of the extracted oil, known in commerce as "Chinese Wood Oil," have lately been placed on show in the Industrial Section of the Indian Museum, Calcutta, (Botanical Survey of India). The specimens have been acquired from various places in Assam, Bihar, Burma, Ceylon and China.

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Mixed with vermillion, American rosin esters or synthetic rosin, the oil gives the best varnish. It is also used in leather dressing and the manufacture of oil cloth, linoleum, soap, etc. and, in electrical industries, in the manufacture of certain insulating material. Aluminium tungate, formed by the action of the oil on aluminium oxide, serves as a good fire-proofing and water-proofing material. The oil was extensively used during the last Great War as an essential ingredient for aeroplane paints and varnishes. Automobile manufacturers use it as an undercoat in body-finishing of motor cars.

For a long time the industry was the monopoly of China. The United States of America made a start with Tung plantation nearly 40 years ago and has now over 100,000 acres of land under Tung. In India, Assam and Bihar are the provinces where the plant has been successfully grown. Experiments in Assam have been distinctly encouraging. More than 1,200 acres are under Tung at Naogaon, Assam and there are about 350 acres under Tung in several tea estates. There are also 10 acres under Tung near Ranchi in Bihar, besides about 7,000 trees in the local tea plantations. Efforts are also being made to introduce the plant in various other parts of the British Empire, where the climatic conditions are considered to be suitable.

Scientific Research into Industrial Problems

IT often happens that pure science opens up new possibilities which have far reaching consequences. And nowadays discoveries in one field of science not rarely lead to great improvements in technique and theories in other fields which are not obviously mutually related. The note on 'Oil from Subterranean Gas' elsewhere in this section illustrates the point. Once the nature of the properties looked for by the technician is understood correctly and the factors which control them have been worked out by the 'academic' scientist, the technician is better able on the basis of this knowledge to adjust his methods to suit his problems. He can always face the academic scientist with fresh problems which he comes across or which sets at nought in part or whole the theoretical picture which the other has constructed. The two act and react on each other with the result that science progresses. The progress of industry is also based on this advance of science. The part played by pure research institutions and therefore by the university research laboratories in the furtherance of industrial research is so well recognised that it should not be necessary to dwell on it. This recognition is however coming slowly into vogue in India. In fact it is rather surprising that this fruitful interaction has been so rare so far. We would point out in this connection the account of the gift of a donation by the Burmah Oil Company appearing in this section.

The academic worker taking up basic research relating to technical processes should have the problems placed before him. This is especially necessary when he is not himself already engaged in developing an industrial process of which he has made a detailed study. Otherwise he lies in the danger of being lost in the details and complexities of technical experience. There should also be an understanding of each others' problems and difficulties. The experienced academic worker should also have facilities such as, well-trained men and appliances and good reference libraries. When he has formulated his problems, he must be allowed to proceed in his own way guided by such inspiration as he can draw from his knowledge of the contents of scientific facts and theories relating to these problems. It will be difficult for him at this stage to say how far, if at all, his work is going to lead to a solution of the problems of the technician and to be of practical value. He feels that he must grasp those factors which would enable him to be of help to the technician. And this may lead him to enquiries which are not of immediate value to the solution of the problems of the technician. Fortunately even if he does not immediately solve the technical problem his methods of approach and of technique and of theoretical consideration often prove to be of great help to the technician.

Jute Research

THE staff at the Indian Central Jute Committee's research laboratories at Manipur Farm, Dacca, have completed a survey of previous work on jute in the agricultural field and have made satisfactory progress with their research programme. An important part of this work is the study of fungal and insect pests, including the comparative resistance of various strains of jute and the effect of various manurial treatments on resistance. The analysis of retting water from various districts is also in progress with the object of ascertaining which types of water yield the best results.

The Technological Research Laboratories at Tollygunge have made considerable progress with spinning tests under standard conditions of temperature and humidity and when sufficient data have been collected, it will be possible to judge very accurately the value of the fibre and its suitability for use in various types of yarn. A study is being made of the various measurable chemical and physical characters of the fibre and their relation to spinning quality, which will lead towards the establishment of scientific methods of grading. In co-operation with the Indian Jute Mills Association experiments are in progress to find out the moisture content of various types of Jute in equilibrium with atmospheres of various relative humidities. The result of this combined effort will, it is hoped, give the information required for specifying acceptable standard figures for moisture regain. It is under consideration whether the necessary

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Control of hydrostatic pressure is effected by adjusting the specific gravity of the mud. Heavy muds have been prepared by the addition of suitable quantities of loading material like barytes or haematite. Cuttings should be held in suspension during the temporary cessation of circulation and they have also to be carried away by the flowing mud to be dropped in settling ditches and tanks. The viscosity, if unnecessarily high, requires a very high pump pressure for circulation with its attendant disadvantages. It is consequently desirable that while on circulation the mud should possess a lower viscosity which will however be capable of an increase during the cessation of circulation and this change should be reversible. This property which is called thixotropy, or, in scientific language 'isothermal reversible sol-gel transformation,' is thus a very important and desirable property to be looked for in drilling muds. Control of viscous properties is thus an important item in the mud technician's work.

There are other properties which drilling muds should possess to meet various purposes. Exudation of water from the mud into the formation also requires to be controlled as it causes serious troubles. The sheath formed by the mud on the sides of the well should also have certain desirable properties. Too much loss of water results in thick mud sheaths, interferes with the flow of oil and may cause swelling and or disintegration or other unwanted changes of the strata or some of its mineral constituents. It is desirable that the mud should form a thin impervious sheath on the sides of the well and have certain mechanical properties with as little loss of water as possible. The sheath forming properties of drilling mud is thus of importance and appear to have some relation to its thixotropic properties. When drilling is effected through layers of gravel or through fractured formations, mud enters into the crevices and circulation is lost. In order to regain circulation some suitable material is mixed with the mud which may seal the pores of the formation. The problem of 'heaving' is most troublesome. It is generally encountered in the drilling of deep wells and efforts are being continually made to develop useful methods of combating it.

The mud technician is required to prepare and supply mud, so to speak, in order to suit the moods of the different layers of the formation, to prepare it economically and to redress it for repeated use. The produc-

tion and control of drilling mud to suit various purposes obviously requires full knowledge of their properties and the factors which determine them. A knowledge of the basic factors would also make it possible to prepare better muds to suit the purpose in view and try new material. The mud technician must have at his command not only the appliances for making mud but a laboratory trained staff to check its suitability and to test the effects of his prescriptions to correct its diseases. It often happens that he has to meet the situation immediately and he must rely on his own experience and knowledge and on those of others to do something without loss of time. He must have a fairly good library and a collection of relevant information at his disposal. It also often happens in the domain of applied science that the experimental trials of the technicians lead to the discovery of new facts which could not be easily predicted from the then knowledge available in the domain of pure science. To that extent however his methods are liable to be empirical. This element of empiricism can only be remedied by corresponding progress in the domain of pure science. But the technician is often at a disadvantage in that he has neither the time nor the facilities to undertake long range basic researches which are not of immediate utility to him. Nor has he the leisure to ransack continually the developments in pure science and to follow them in all aspects which are or may be of use to him. In these respects co-operation between the academic and the technical scientist has often proved to be useful.

The Burmah Oil Company suggested early in 1937 that an academic research on thixotropy and similar properties of drilling mud and its ingredients might be undertaken in the Physical Chemistry Laboratory at Calcutta. For this purpose and with the approval of the University of Calcutta, a research scholar was appointed by them under Prof. Mukherjee. The major part of the work so far done has been on thixotropy and in particular on the properties of bentonites. The scope of these researches has been recently extended and the Burmah Oil Company decided to appoint two additional research scholars from 1st June, 1939. Recently one of them has joined the Fields Laboratory at Digboi and another has been appointed in his place. This co-operation between a key industry and the university is of the greatest mutual benefit and the more such examples are followed by other industries, the better the chances of promotion of scientific research in the country.

Irrigation in India *

Crops worth over Rs. 114 crores are being raised in areas receiving State irrigation. From about 10½ million acres in 1878-79, the area annually irrigated by State works alone has now risen to about 32¼ million acres, over one-eighth of the total cultivated area in British India. The total capital outlay on irrigation and navigation works amounts to over Rs. 154 crores, the working expenses to about Rs. 5 crores and gross annual revenue to about Rs. 14½ crores, with a net return of 6.09 per cent. There are some 275 irrigation schemes in operation in British India of which 70 are of a major description. Nearly a third are classified as productive and the rest as unproductive, i.e., as works constructed primarily for the protection of tracts with precarious rainfall.

Of the Provinces with extensive irrigation works, Punjab is easily the first with an irrigated area of about 12 million acres. Madras comes second with over 7¼ million acres followed by Sind with 4½ million, and the United Provinces with nearly 4 million. But in the percentage of area irrigated to the total area sown, Sind leads with 86 followed by the Punjab with 36.5, Madras with 20 and the North-West Frontier with 17.

Details are given in the following tabular statement:—

Province	Area sown in acres	Area irrigated by Government irrigation works in acres	Percentage of area irrigated to total area sown	Capital cost of Government irrigation and navigation works to end of 1936-37 (in lakhs of rupees)	Estimated value of crops raised on areas receiving State irrigation (in lakhs of rupees)
Madras	36,597,400	7,327,600	20.02	2,016	2,017
Bombay	27,834,400	470,100	1.69	1,075	231
Bengal	29,403,400	201,700	0.68	531	111
United Provinces	35,538,000	3,836,900	10.8	2,861	2,013
Punjab	32,643,300	11,941,200	36.50	3,492	4,741
Burma	18,402,000	2,184,200	11.85	698	620
Bihar	24,487,300	675,500	2.7	356	254
Central Provinces (excluding Berar)	20,934,003	315,000	1.50	679	93
North-West Frontier Province	2,706,300	461,100	17.04	320	146
Orissa	6,496,300	314,600	4.85	329	132
Sind	5,218,500	4,486,500	86.02	2,975	1,058
Rajputana	365,600	19,900	5.45	36	4
Baluchistan	415,600	21,100	5.07	36	3
Total	241,029,100	32,256,100	13.38	15,404	11,423

* Summarised from the recently published annual Review of Irrigation in India, 1936-37.

As in previous years the Punjab got the largest return on capital invested in productive works, namely, 14.5 per cent followed by the North-West Frontier with 11.3, Bombay with 9.4, Madras with 7.8, Bihar with 7.1, and the United Provinces with 5.8.

MADRAS:—Of the important works completed mention may be made of the Kattalai Scheme in Madras, which cost over Rs. 37 lakhs and makes good the defective irrigation over a large area in the Trichinopoly district by the construction of a bed regulator across the Cauvery and excavation of canals. A large project for impounding the waters of the Tungabhadra has been held up, technical and financial difficulties and rival claims to the waters of the river standing in the way of execution. The general question of the allocation of the waters is now under examination and joint gaugings with Mysore and Hyderabad Governments have been completed. Experiments to determine water requirements for crops have been sanctioned by the Government of Madras and proceedings for land acquisition started.

PUNJAB:—In the Punjab, the Haveli Project, since completed at a cost of about Rs. 4½ crores, will provide perennial irrigation for over 513,300 acres and non-perennial irrigation for over 450,000 acres in the Haveli Canals tract. It will in addition irrigate 128,000 acres on the Montgomery Pakpattan link and over 38,000

acres on the Burala Branch extension. A net revenue of over Rs. 43 lakhs or a return of eight per cent is expected.

SCIENCE IN INDUSTRY

BENGAL:—A contour survey of far-reaching importance was continued in the central and western parts of Bengal. The survey was started in 1936 to determine the possibilities of extending irrigation and improving the drainage and sanitary conditions of the tracts by large schemes such as the More Reservoir Scheme and the Darakeswar Reservoir Scheme and thereby of developing the areas. The survey in connection with the Darakeswar Reservoir Scheme, which is intended to irrigate 180,000 acres, has been completed and borings taken. Dredging was undertaken in the lower Kumar river, a navigation channel of considerable importance in the Bhangor, Circular and Kristopore canals and in the Mangalpur and Barguni shoals of the Madhumati river.

BOMBAY:—The important works in hand in Bombay included the Nira Right Bank Canal Works, the remodeling of the Nira Left Bank Canal and of the Pravara Left Bank Canal and its Northern Branch.

The Nira Right Bank Canal Project comprises the Lloyd Dam at Bhatgar, impounding 24,200 million cubic feet of water and a canal 106½ miles long. The canal is designed to irrigate 132,000 acres in a tract notoriously liable to famine in Sholapur District. The dam and the works on the main canal and branches have been completed and the whole scheme is nearing completion. Considerable progress has also been made in the remodelling of the Nira Left Bank Canal which is expected to be completed by the end of 1940-41.

UNITED PROVINCES:—In the United Provinces, with improvement in maintenance and distribution and additional supply made available by pumping, the Mat and Hathras Branches of the Ganges Canal, which irrigate

some of the most precarious tracts of the Aligarh, Muttra and Agra districts, have now been remodelled to provide a greater annual supply of water and to extend irrigation to tracts which, though commendable, could not previously be given water on account of the uncertainty of the supply then obtainable. The branches have also been given a capacity which will enable them to take advantage of freshets and of possible slackening in demand elsewhere due to rainfall.

The proposals for the Nindeh Reservoir for the extension of irrigation on the Garai canal system in the Mirzapur district of the Province are being reviewed for development of electric power.

Investigations have also been made for extending into certain tracts of eastern Oudh, not commanded by the Sarda Canal, urban electricity and irrigation from canals fed by water pumped by electric power from rivers. As a preliminary measure a small scheme has been sanctioned for pumping 160 cusecs from the Gogra river and for the erection of a power house at Sohawal Railway Station to supply energy for working the pumps and electrifying Fyzabad town. The canal is designed to irrigate over 43,000 acres annually. Transmission lines and the canal system are nearing completion and about 7.40 lakhs has been spent.

N. W. F. P.:—In Baluchistan an important work nearing completion is the Quetta storm water drainage and embankment project designed to protect Quetta from the periodical damage caused by flood waters. The existing drainage channels passing through the town are being improved so as to increase their discharging capacity and the vents of the bridges are being widened to facilitate the passage of flood water through the town without damage. The total expenditure is about Rs. 2.06 lakhs.

SCIENCE IN INDUSTRY

cal resistance. The thickness of laminations generally used range from 0.014 to 0.018 inch according to the quality of steel used. The individual plates are insulated from one another by a thin coating of insuline. Formerly varnish or paper were used for insulation but the modern practice is to use a special mixture of starch and china clay which adheres perfectly to the plates when dry but gives a non-adhesive external surface. Thickness of insulation is about 0.001 inch. The insulating is done in a machine having a row of travelling chains over which the plates are placed. The plates pass through a continual spray of insuline and a series of gas burners and come out dry at the other end of the machine. The sheets are cut to necessary sizes for the type of core to be built up and punched for clamping bolts. They are then ready for assembly which is done by interleaving the core plates with the yoke ones. The usual practice for interleaving is to use three plates at a time for big cores and two at a time for smaller ones. When interleaving is complete, the top and bottom yokes are clamped with channel iron beams and the core legs taped up or bolted as the case may be. When the legs are to be bolted, the bolts must be properly insulated from the core plates. This is done by micanite tubes and bakelite washers. The channel iron clamping bolts are also insulated from the core. The core thus built up is checked for dimensions and weight and sent to the transformer assembly.

Coil Windings

The type of windings used in core type transformers are: (a) spiral type, (b) cross-over type, (c) section type, and (d) continuous disc type.

Spiral Type: This type is used for L. T. windings to carry heavy currents and is not used for currents less than 100 amps. The conductor used for the coil consists of a number of rectangular wires in parallel wound on their flat sides. The advantage of using multiple wires rather than one large conductor is the ease of handling wires of smaller section. Moreover uniform current distribution may be obtained by using cross-overs at specified intervals. Spiral coils for small transformers are wound on split cylindrical type of former while those for bigger ones are wound direct on the insulating cylinder. The winding proceeds in a spiral form from one end to the other. Such coils may consist of double layers one on the top of the other.

Cross-over Type: The H. T. windings of relatively small transformers are generally made up of such coils. Cross-over coils are suitable for currents up to about 20 amps. Each coil consists of a number of layers having a number of turns per layer. The whole winding is made up of a number of such coils in series. The

coils in position are separated from each other by fuller board washers andappings, if required, are brought out from central sections. Heavier insulation is used for winding the end coil as a protection against possible surges.

Section Type: This type of coils is mostly used for H. T. windings and consists of a number of flat circular sections or discs, each section being made up by winding a single or several rectangular wires in parallel on a special type of former, such that the winding proceeds radially outwards. The winding is done in pairs of sections, one starting at the bottom and finishing at the top while the other continuing the finish end of the first section proceeds radially inwards and finishes at the bottom. These pairs of sections connected in series form the entire winding. This winding in pairs of sections avoids all internal joints.

Continuous Disc Type: This type is exactly the same as the section type coils except that the coils are wound direct on the insulating cylinder and that the winding proceeds continuously from disc to disc. Transposition of wires at regular intervals is done in case of multiple wires as conductor.

When the coils required for the H. T. and L. T. windings are made, they are transferred to the coil assembly, where the coil sections are assembled together and their connections welded and taped according to instructions. The completed coil stacks are then spring-clamped and heated in drying oven alternately till there is no shrinkage. They are then vacuum impregnated according to standard practice. After impregnation the coils are baked dry whereupon they are finally inspected and sent to the transformer assembly shop. Both the coil assembly and coil treatment departments form part of the winding shop.

Switches

In order to obtain a certain percentage variation in the voltage ratio, transformers are generally equipped with a number ofappings on their high voltage sides. Suitable tapchanging switches are therefore provided which rest on the top yoke. Tap-changing switches may be on-load or off-load changing type according to the purpose for which it is intended. The off-load tap-changing switch consists of a bakelite tubing having a number of metal contacts fixed to it on its inner periphery. These fixed contacts are connected to the differentappings. A rod carrying the movable contacts passes right through the tubing and a handle is fitted to this rod by turning which the required tap-changing is performed.

Modern on-load tap-changing switches for transformers up to about 750 kVA consist of a number of mercury switches which can be tilted, to make and break different switch contacts, by means of motor-operated cam arrangements. Theappings are connected to these

Modern Manufacture of Electric Transformers

A. K. Chatterjee

Department of Electrical Engineering, College of Engineering & Technology, Jadavpur

Most of the modern electrical power generating systems transmit electrical energy at high pressure A.C. and distribute it at low pressure at the consumers' terminals. Owing to economic considerations, step-up and step-down transformers have now become one of the most essential requirements for such systems. The present paper is an endeavour to give one a general idea of the manufacture of modern transformers. As most of the modern power and distribution transformers are of core type, the present discussion will be confined only to the construction of the same.

The construction of different parts of the transformer, such as the core and yoke, primary and secondary coils, terminal bushing, tap-changing and other switches, the containing tank, etc., are carried out in different shops in accordance with the instructions given by the design office, whereupon they are assembled together and tested.

Building of Core and Yoke

The core and yoke are made up of laminations of high permeability silicon steel having also a high electri-

switches. The whole arrangement is situated on the top yoke. The tap-changing switches for big transformers are however, similar to the off-load changing switches described before except that the tap-changing is done automatically by a motor-operated mechanism. The on-load tap-changing switches of either type are connected through suitable reactor coils which limit the circulating current in the short circuited coil during tap-changing. Series switches are introduced in the tap-changing connection in big transformers to relieve the current breaking duty of the tap-switches. These series switches with the motor-driven mechanism are housed in the transformer tank. In both cases automatic operation is due to the astatic relay provided, which starts the motor in one or the other direction as soon as the line voltage exceeds the normal value by a certain per cent or falls below it.

Transformer Assembly

When all the parts of the transformer hitherto described has been built up, transformer assembly begins with unlacing the top yoke. The coil stacks are pushed over the core legs in accordance with the drawing office instructions. The yoke is replaced and clamped down. The H.T. and L.T. leads together with the star point, if any, are brought out. The tap-changing and other switches are now placed in position and their connections made. It is important that the drawing office instructions be followed during the whole procedure. After the assembly is complete the transformer is ready for tanking which also takes place in the assembly shop.

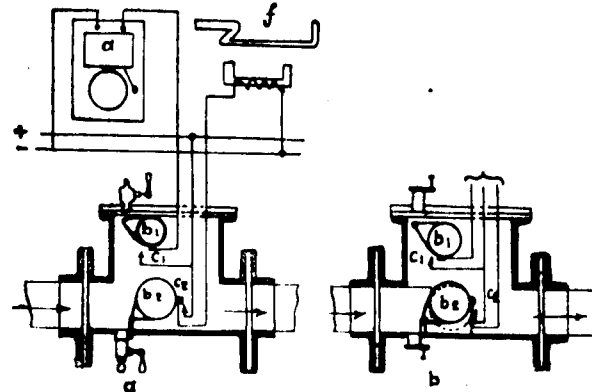
Tank Shop

By the time the transformer parts are built in different shops, the tank body is also in the making, so that it may be completed when the transformer is ready for tanking. Transformer tank is made up of a number of mild steel plates welded together to give the desired shape. Tank shop is divided into two sections, one for building small tanks the other for medium or big tanks requiring extra cooling arrangements.

When the tank is built to measurement given in the drawing and all the details fitted, it is inspected for quality of the welding and tested for any leak or weep with hot oil at a pressure of about of 7 lbs. per sq. in. The tank is then finished with oil proof varnish inside and weather-proof paint outside.

Big tanks are provided with conservator tank, emergency release and Bucholz protective relay. The emergency release consists of a bent pipe fitted with a glass piece at one end and connected with the transformer tank. Under abnormal conditions if the pressure in the tank rises above a predetermined value, the glass in the pipe breaks

down before any damage to other parts takes place. Bucholz protective device is a gas actuated device for the protection of transformers and similar liquid-insulated



apparatus. Fig. 1 shows a schematic representation of the device which is inserted between the transformer tank and the expansion vessel. When the apparatus is filled with oil, the two floats b_1 and b_2 stay, owing to their buoyancy, in the position marked such in Fig. 1. With a slight fault arising in the transformer small bubbles of gas are developed, and in seeking their way outwards are caught in the housing of the device, thus lowering the level of the oil in the apparatus. As a consequence b_1 sinks down and closes the contact c_1 for alarm device d . The lower float is not affected by such a slight fault, since the gas exceeding the volume of the upper float escapes through the pipe to the conservator tank.

When a heavy fault arises in the winding of the transformer large quantities of gas are generated at the faulty parts and a corresponding volume of oil must be displaced, causing a rush of oil in the pipe connecting transformer tank and the expansion vessel. The streaming oil affects the float b_2 in such a way as to close the contact c_2 of the releasing coil 'f' of the circuit breaker. Though simple in its construction, it is highly sensitive and has been proved very satisfactory in practice.

Tanking, Final Inspection and Test

The transformer assembly and the tank being completed, the assembly is thoroughly cleaned and dried in a heated oven. It is then carefully lowered in the tank and checked for correct alignment. The core and clamps are solidly earthed to the tank by copper connectors. The H. T. and L. T. terminal connections are made. The top cover is now put on. The transformer is now completed by filling the tank with hot transformer oil. The standard tests for polarity, voltage ratio, iron and copper losses, as well as the standard overpotential and pressure tests are now applied. Having passed the tests, the transformer is finally inspected for details and assembly when it is ready for installation.

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Vitamin E and Muscular Dystrophies

RINGSTED first observed neurological disturbances in adult rats fed on a diet deficient in vitamin E (*Biochem. J.*, 29, 3, 788, 1933). Morgulis, Wilder and Eppstein (*J. Nutrit.*, 16, 219, 1938) and Olcott (*ibid.*, 15, 221, 1938) observed that in several different kinds of animals primary muscular dystrophies occurred. Neurological disturbances and muscular dystrophies improved when the diets were supplemented with vitamin E in the form of wheat germ oil. It is suggested that vitamin E deficiency leads to muscular dystrophies in young and neurological disturbances in adult animals. Eimersah and Ringsted noted that the pathological picture observed in the spinal cord and muscles resembled closely the changes which are seen in human beings suffering from tabes dorsalis and progressive muscular atrophy. Goettsch and Ritzmann (*J. Nutrit.*, 17, 371, 1939) found that the myotrophic and neurotrophic factors though present in wheat germ oil are not identical with α tocopherol or the antisterility factor. Bicknell (*Lancet*, 1, 11, 1940) treated several cases of muscular dystrophies and amyotrophic lateral sclerosis with dried wheat germ. Great improvement was observed after a few days' treatment. Cases in which nervous degeneration is fairly advanced were not improved. The diseases like muscular dystrophies, amyotrophic lateral sclerosis, tabes dorsalis etc., therefore, may be classed as deficiency diseases.

—S. B.

Cortin and Vitamin C in Acute Confusional States

HOFF and Shaby (*Lancet*, 1, 27, 1940) have treated five cases of acute mental confusion during typhoid fever with suprarenal cortical hormone and vitamin C with success. Mental confusion which developed after prolonged and difficult labour and after severe haemorrhage after child birth is also improved by this treatment.

—S. B.

Forced Respiration

ONLY for lack of prolonged artificial respiration till very recently many patients suffering from disturbance in the functioning of respiratory muscles were

allowed to die. The most familiar example is the paralysis of the respiratory muscles which may occur as a result of epidemic infantile paralysis. Old methods of artificially expanding the thoracic cavity by movements with the arms of the patient, the muscles of the upper arm being connected with the chest and thus exerting a pulling force on the pectoral wall, could keep a patient alive for only a few hours. If there be a need to prolong this artificial respiration some sort of mechanical contrivance will be necessary and the "Iron Lung" is one such. The body of the patient is introduced into an airtight chamber of this mechanical "lung" with his head outside it. In order to give the convalescent patient more contact with his environment a mirror is mounted above his head which can be operated by the patient's hands inside the chamber. The patient's lungs by way of mouth remain connected with air at normal pressure outside the airtight space and inhalation and exhalation movement is caused by alternation of pressure on the chest and abdominal wall. The force of the iron lung is so great that it is practically impossible even for a healthy person to breath in opposition to the breathing of the "Iron Lung" by the use of his own respiratory muscles. The chamber of the "Iron Lung" is very large into which a doctor or a nurse can take his place beside the patient inside the chamber. Artificial respiration is therefore only interrupted for a few seconds when some treatment or other is necessary, only long enough to allow the entry of the person. The required alternations of pressure are accomplished by altering the volume of a pair of bellows. Magnitude of pressure differences and the rhythm are alterable according to the age and condition of the patient by means of adjustable arm of the bellows and the changeable diameter of the driving pulleys. About 45 litres of air are added to or removed from the chamber at each respiration and the extreme permissible difference between the highest and the lowest pressures has been arranged to amount to 0.03 atmosphere. During expansion from this pressure to atmospheric pressure the force is generally 50 kg. This energy is recovered by causing a weight to be raised during contraction and for driving the "lung" a $\frac{1}{4}$ h.p. motor is sufficient. This method of balancing the force makes it possible to work the bellows by hand without appreciable exertion, and it is a provision against failure of electric current. To make the chamber airtight round the neck of the patient there is a collar

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of thin rubber rings with leather supports. There is a 'leak' in the chamber wall more or less closed with a slide by means of which fine regulations of the pressure alteration and ventilation by successive inlet and outlet of air is maintained. The nurse when inside the chamber does not experience any discomfort excepting a slight "fluttering" of the ear drums. This can be avoided by swallowing air or putting cotton in the ears.

Gonadotrophic and Lactogenic Hormones

INTERNATIONAL standards for (a) the gonadotrophic substance of pregnant mares' serum and (b) the lactogenic (crop gland stimulating) substance of the anterior lobe of the pituitary gland (Prolactin, Galactin, Mammothrophin) are now available for distribution at the Biochemical Standardisation Laboratory, Calcutta. They have been prepared in accordance with the recommendations of the Third International Conference on the Standardisation of Hormones, held at Geneva in August, 1938. The Biochemical Standardisation Laboratory, which has been appointed by the Government of India as a "National Centre" for the distribution of standard preparations of biological products, holds these standards on behalf of the League of Nations and sends them on request free of charge to any bona-fide research institution or commercial organization. The Laboratory also gives all relevant information regarding the standards to those who are interested in their use.

Inferior Adrenalin Preparations

THE active principle of the medullary portions of the suprarenal glands, adrenaline, is now one of the drugs in daily use in medical and surgical practice. Its most important actions consist of a constriction of the blood vessels with consequent rise of blood pressure, sometimes slowing of the heart, a direct stimulant effect on the heart muscle and relaxation of the bronchial muscles. In the prevention of local haemorrhage, in local anaesthesia and in such conditions as shock, heart failure and asthma, adrenaline is extensively employed and is the mainstay of the physicians and surgeons.

Quite a fair proportion of adrenaline chloride solution sold in India has been found by the Biochemical Standardisation Laboratory of the Government of India to be below par in quality and sub-standard in strength as a result of the study of 30 samples of adrenaline chloride solution (1 in 100 strength) which have been tested biologically for their purity and potency in course of an all-India survey of the quality of drugs and medicinal chemicals undertaken by the Laboratory. Out of 30 samples analysed, as many as 12 specimens (or 40 per cent) were markedly below strength (i.e.,

less than 75 per cent in potency of a *known standard*). Amongst this lot, 7 samples showed a strength of less than 50 per cent. Two samples apparently contained only about 10 per cent of an adrenaline-like blood pressure raising principle. Only nine samples (or 30 per cent) were found to agree with the potency claimed by the manufacturers. The standardisation for the tests made in the Laboratory was carried out by the accepted biological method of comparing the "Pressor effect" (blood pressure raising property) of an unknown solution with that of a *known standard* in a decerebrated and pithed cat.

In the form of a 1 in 1,000 solution in which it is usually offered to the public, adrenaline, unlike other drugs such as digitalis, ergot, etc., does not rapidly lose its strength in the temperature and humidity existing in India. In the presence of alkali, however, adrenaline has been known to lose its strength, the deterioration being accompanied by a reddish or brownish discoloration. Excess of alkali is sometimes present in the glass of certain containers (phials, ampoules, etc.) in which adrenaline has been found stored, and it is highly probable that this factor is at least partly responsible for the deterioration of the adrenaline solutions contained.

Kasauli Research Institute

DURING the year 1938, the demand for cholera vaccine manufactured by the Central Research Institute, Kasauli, beat all the previous records since 1927. The epidemic conditions were chiefly responsible for the demand which was very heavy during the months of April to August. The Punjab and North-West Frontier Province and the contiguous Indian States and the army were the main clients. The supplies also went to Afghanistan and Egypt. The total issues of the prophylactic cholera vaccine approximated 2,000,000 c.c. Of this 1,984,486 c.c. were issued to indentors in India and 10,120 c.c. to foreign countries in the Near East. The issues of the 1938 were eight times as high as in the previous year.

The manufacture of vaccines and sera continued on a large scale; and issues were heavy during the year. Prophylactic cholera vaccine and T.A.B. vaccine were manufactured on the largest scale. The preparation and issue of anti-venom serum continued as in the previous year, with the difference that it also captured other markets such as Portuguese India and the Philippine Islands, in addition to the previous ones—Burma, Ceylon and Iran. The army in India remains one of the best buyers of the sera and vaccines of the Institute.

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Need of Medical Research in India

REFERRING to the great need of scientific medical research in this country, Sir P. C. Ray observed in his address on the Founder's day at Calcutta Medical College that both Indian and foreign systems of medicine arose empirically out of the needs of man, but during the last few centuries in the Western countries medicine has been steadily bursting the bounds of empiricism and developing into a science. The methodology of science and the conscious and systematic application of the discoveries in the exact sciences of chemistry and physics have led to phenomenal advances in medicine in both curative and preventive aspects. Louis Pasteur, who laid the foundations of bacteriology and immunology, was himself a chemist, who brought a supremely scientific mind and scientific methods to bear on the problems with which he was confronted. Leewenhoek's discovery of the microscope, again, made much of Pasteur's work possible, Roentgen's discovery of the rays which go by his name, the discovery of radium by Madame Curie, the discovery of artificial radioactivity by her daughter in collaboration with her husband within recent years—all these have led and are leading to great advances in the methods of diagnosis and therapy. The preparation of artificially radioactive elements by means of the cyclotron by Prof. Lawrence in California has led very recently to their use in studying complicated processes of metabolism. Sir Prafulla said that he had the feeling that some of the greatest advances in future will be in the direction of the application of discoveries in subatomic phenomena to biological processes. The baffling problem of life and cell-division still stands as a beleaguered fortress which may yield in future only to combined offensives on the physical and chemical fronts by the new strategy which is now being fashioned. He also referred to the great advances in medicine which have followed from researches in bio-chemistry in order to illustrate the benefits that have accrued to medicine from what may be called basic research.

But he regretted that in our country medical research had not yet attained the position that it ought to. In the daily routine of medical practice, medical men are apt to ignore the need of the constant supply of new knowledge, the need of maintaining the fountain of medical research as a perennial spring. This has been so in all countries and particularly so in this country where the

critical and curious research mind is all too absent. There have been a few medical men in India who have made important contributions to knowledge (and all honour is to them) but the tradition of medical research has hardly been built and the organisational and financial implications of medical research have not been adequately considered. The Rockefeller Foundation of America annually spends over 10 crores of rupees on research, most of which is medical, and in England donations like the princely benefactions of Lord Nuffield are fairly frequent. The Medical Research Council of Great Britain spends annually sums of the order of 25 lakhs of rupees, sanctioned by Parliament.

Organisation of Research

THE first step in organising research in this country will be, according to Sir Prafulla, to reorganise and broaden the Indian Research Fund Association on the lines of the British Medical Research Council and place much more funds at its disposal for financing researches, having direct or indirect medical application, to be carried on both in official and in non-official institutions. Medical research in this country does not receive the attention it deserves. It is time that the State, the constituted public bodies and the generous citizens of this country realised the paramount need of medical research for a nation's well-being and contributed adequate funds for its promotion on a vast scale on scientific lines. Medical research should not be understood only in the relatively narrow sense of clinical research, whose importance is undoubted, but should also embrace both basic and applied research in the fundamental sciences ancillary to medicine, including chemistry and physics.

Medical men, on the other hand, who have had the benefit of scientific training, which is denied to millions of our own people for no fault of their own, medical men who constitute the most loved profession in every civilised society, medical men who have been the torch-bearers of knowledge since the earliest times—such medical men owe it to society to utilise the personal contacts that they get from day to day in all strata of society for making the people civically and socially conscious, for imparting a scientific attitude of mind and for a general uplift of the cultural level. This education is of paramount importance and medical men have got exceptional opportunities in this regard. It has been truly said that there is only one temple of God on earth and that is the body of man. Medical men are the priests at the noble shrine.

Medicinal Plants *

With the advance of knowledge of the chemistry and pharmacology of plants, it appears to be certain that some correlation exists between the botanical classification of plants, their chemical constitution and physiological properties, and one is frequently struck with the remarkable resemblance exhibited by closely allied plants in this respect. For example, if a particular chemical constituent is found in one member of the genus, there is considerable likelihood of the presence of constituents with identical or similar physiological properties in other members of the genus or of the family. This does not, of course, mean that such similarity will not be found in other families or genera just as particular taxonomic characters may be spread over widely different families and genera. An ideal classification of plants would be the one which in addition to satisfying botanical criteria broadly provides an index to the nature of their chemical constituents and physiological properties. With our existing knowledge this is not possible. The very fact that some of the families and genera, as at present understood, are quite homogeneous in these respects, however, reflects a ray of hope that after all the problem is not so difficult as it appears at first sight. Considerable work on the chemistry of plants and the determination of the physiological properties of their active principles, however, will have to be carried out and thousands of new plants will have to be investigated before this is attained, or the attempt given up as hopeless. This should not, however, be understood to imply that I suggest that advances in the knowledge of chemistry and pharmacology should determine the botanical classification of plants. This is not possible, as such features cannot possibly serve as taxonomic characters. But I do hope that botanists, chemists and pharmacologists will collaborate in evolving a natural system of classification based on their combined efforts.

A brief review of the distribution of the more important and potent chemical constituents of the Indian flowering plants of widely different families and genera presents certain very interesting features. The alkaloids are distributed over about 40 families and there are a number of cases where the same alkaloid is found in closely allied genera and families. Thus, berberine has been recorded from six different families and twelve genera. Ephedrine, on the other hand, furnishes an ex-

*From Bt. Col. R. N. Chopra's Presidential Address at the annual meeting of the National Institute of Sciences of India at Madras in January last.

ample wherein a particular alkaloid may be found in plants belonging to widely different groups; it has been found in *Sida cordifolia* Linn. of Malvaceae (a family belonging to Agiospermae) and in *Ephedra* of Gnetaeae (a family belonging to Gymnospermae). Purines are found in three families. The glucosides form a large group and are much wider in occurrence than the alkaloids, occurring both in Dicotyledons and Monocotyledons; some of these are very toxic and occur in eight widely different families. Hydrocyanic acid yielding plants belong to ten families. A group of glucosides known as saponins is of very wide occurrence in the vegetable kingdom; saponins are known from at least 400 plants belonging to 50 different families occurring almost all over the world. Essential oils are of wide occurrence in the vegetable kingdom though certain families, such as Labiatae, Rutaceae, Umbelliferae, Myrtaceae, Lauraceae, Cruciferae and Coniferae are especially rich in these substances. The seeds of numerous plants contain albumins, but it is interesting to note certain plants, such as *Abrus precatorius* Linn. and *Ricinus communis* Linn. belonging to very different families (Leguminosae and Euphorbiaceae respectively) wherein the toxicity of these albumins is of a similar nature, both being essentially blood-poisons, and both similar in their immunity reactions if introduced into the body of animals in small and gradually increasing doses.

I do not propose to go into further details of several other chemical constituents, nor even of such toxic complexes as resins, phenolic compounds, etc. The few examples cited provide sufficient evidence in support of the now well-established theory of organic evolution. I repeat that there is a method in their occurrence; in several cases it is due to their descent from common ancestors while in others it is a result of parallel evolution. The facts described above cannot be explained on any other basis.

I will now cite a few examples of some families and genera to show the marked resemblances between their botanical, chemical and pharmacological aspects. Unless definitely proved as harmless it is advisable, for instance, to regard all members of Ranunculaceae as potentially poisonous, especially when fresh, both for human beings and livestock. Poisonous, acrid, vesicant, purgative and narcotic properties prevail in varying degree throughout the family. Species of *Anemone*, *Caltha*, *Clematis* and *Ranunculus* contain the lactone anemonin which has blistering properties. Most of the Aconites contain highly poisonous alkaloids which act mainly on the sensory

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nerves and on the medulla which they depress and ultimately paralyse. Species of *Delphinium* are used for the destruction of vermin and contain toxic alkaloids, some of which appear to act like aconitine, while others paralyse the motor nerves. Alkaloids are also known to occur in the genera *Coptis*, *Helleborus*, *Nigella*, *Isopyrum* and *Paeonia*. *Adonis* and *Helleborus* contain glucosides with a digitalis-like action. Saponins are found in the genera *Clematis*, *Ranunculus*, *Nigella* and *Cimicifuga*. Cyanogenetic compounds have been reported from some of the members of the family and the Indian representatives from which these principles have been reported belong to the genera *Clematis*, *Aquilegia*, *Isopyrum* and *Ranunculus*. Seeds of *Annona* of Annonaceae have insecticidal properties and are powerful irritants of the conjunctiva. Several species of *Berberis* contain active principles poisonous to fishes and dogs. Many species of *Papaver* have a juice with narcotic properties and contain powerful alkaloids. Narcotic properties are also possessed by some other members of the family Papaveraceae e.g., *Meconopsis*. Most Crucifers have pungent juices and many have glucosides in their seeds and produce very irritant essential oils; they possess stimulant properties. Several plants of Caryophyllaceae contain saponins. The family Rutaceae is characterized by the presence of essential oils some of which are toxic. Many plants belonging to Sapindaceae have saponins and a number of them are well known as fish poisons. Anacardiaceae are usually provided with more or less acrid resinous, sometimes milky juices; very many species of this family possess astringent properties. Plants of no less than twenty-seven genera of Leguminosae possess insecticidal or piscicidal properties. The poisonous properties of Rosaceae are generally due to the presence of cyanogenetic compounds. The presence of powerful bitter and purgative principles is the prevailing characteristic of the wild members of Cucurbitaceae. Aromatic members of Umbelliferae are usually carminative, while the non-aromatic members are often acrid and narcotic and should be taken with care. Alkaloids with similar physiological properties are the outstanding constituents of the genus *Cinchona*. Lobelias belonging to Campanulaceae yield an intensely acrid milky juice and the dust of the powdered herbs irritates the nostrils in the same way as tobacco; they contain alkaloids. Rhododendrons mask under the beauty of their flowers, very fatal active principles and the family Ericaceae to which they belong contains several insecticidal plants; the toxic substance andromedotoxin is very common in this family. Apocynaceae includes several plants which are highly poisonous, the properties of most of them are being due to glucosides with a digitalis-like action and physiologically active alkaloids. Many species of Asclepiadaceae contain acrid, bitter and poisonous juices. The genus *Strychnos* is rich in alkaloids which are violent

tetanic poisons. Many species of Convolvulaceae have acrid taste and contain active purgative principles. Mydriatic alkaloids such as atropine, hyoscyne and hyoscyamine are found in several species of Solanaceae while the glucosidal alkaloid solanin is found in many Solanums and some other genera as well; a very large number of wild plants of this family are poisonous. Labiatae is very uniform in the possession of essential oils, several of which are of medicinal value as carminatives and stimulants. Toxic resins are reported from a number of species belonging to Thymelaeaceae and animals avoid eating them. Several species of Euphorbiaceae contain more or less acrid and irritant juices and several species of Crotons contain highly irritant toxalbumins and are drastic purgatives. Urticating principles are found in four Indian genera of Urticaceae. The alkaloids ephedrine and pseudoephedrine are found in a number of Ephedras. Coniferae are characterized by containing essential oils which produce gastro-intestinal irritation and sometimes ulceration. Several species of Dioscoreaceae contain an acrid juice in their tubers and some are even poisonous. Quite a number of species of Araceae contain raphides of calcium oxalate and acrid juices; a number of these plants, if eaten, especially when in fresh condition, produce symptoms of irritant poisoning. Some of the Gramineae, especially when young, wilted or under drought conditions produce hydrocyanic acid and are fatal to livestock; no alkaloid has so far been isolated from members of this family.

Many more examples could be cited, but the brief review of the relationship which seems to exist between the botanical classification and the chemical and physiological characteristics of medicinal and poisonous plants should prove sufficient to show that in many of the families and genera these characteristics show a marked degree of correlation. I do hope that further work will produce increasing evidence of this relationship. The botanical characters, chemical constituents and properties exhibited by plants are all the results of organic evolution and a natural classification must embrace all these three aspects. There is, however, an element of disturbance in the case of plants. Climate, seasons, soil, cultivation, etc., have profoundly affected their chemical composition and hence their physiological characteristics, and it is for this reason also that closely related plants differ in their pharmacological properties.

Collaboration between botanists, chemists, pharmacologists and agriculturists in work of the type indicated in a country such as India, with all extremes of meteorological, climatic and topographical features resulting in very varied and luxuriant floras of all types is pregnant with possibilities which should not only be of very great scientific and academic interest but also prove of great practical importance to the country from the economic point of view.

RESEARCH NOTES

Calcium and Blood Coagulation

According to Morawitz and Juld, calcium is an indispensable factor for the coagulation of blood. At the beginning of this century Nolf (*Brit. Chem. Physiol. Path.*, 5, 133, 1904) suggested that calcium might not take any part in the coagulation of blood. He could experimentally show that oxalated plasma was coagulated by chloroform, etc. Stewart and Percival (*Biochem. J.*, 22b, 559, 1911; *ibid.*, 22a, 543) took up this interesting problem and concluded that though by the treatment of soluble oxalate the major portion of the calcium is precipitated out, it is the non-diffusible Ca which is responsible for the formation of clot as it is not removed by simple precipitation method. But Mills (*Amer. J. Med. Soc.*, 172, 501, 1926.) supported the view of Morawitz and Juld. According to him, thrombase is formed by the combination of prothrombase, cephalin and calcium. Mellanby (*Proc. Roy. Soc., B.*, 117, 352, 1935) pointed out that when thrombokinase content of a blood sample is high enough, a very small quantity of Ca activates coagulation even in the presence of 10-fold oxalate. He with his co-worker Pratt (*Proc. Roy. Soc. B.*, 125, 204, 1938) showed that trypsin could liberate thrombokinase which is free from calcium. Most recently they claim (*Proc. Roy. Soc., B.*, 128, 201, 1940) that the calcium content of fowl serum and plasma does not differ at all. Therefore calcium does not combine with fibrinogen in the formation of fibrin.

They claim that Ca has no influence on the rate of coagulation of plasma by thrombase. Precipitation of Ca from fowl plasma shows that 8-9 mg. per cent may be readily precipitated by a soluble oxalate. Some extra quantity of oxalate is required to precipitate the excess of Ca which remains after simple precipitation. The coagulation of fowl plasma is prevented when the Ca precipitated by oxalate is removed. A concentration of Ca ion of less than 0.3 mg. per cent is required for the coagulation of fowl plasma by thrombokinase. The rate of activation of prothrombase by thrombokinase is accelerated by calcium ion. The spontaneous

activation of thrombase in presence of water, acetic acid and oxalic acid shows that Ca ion increases the rate of the reaction but it is not essential for the reaction.

According to Mellanby and Pratt chloroform makes thrombokinase available in the necessary manner which clots blood even in absence of Ca. Calcium might be antagonistic to Na and K ions which act as the anti-coagulating factors in the system.

A. C. M.

Vitamin B Content of Foodstuffs

Many chemical methods for the determination of riboflavin are known. But most of them are of very limited application.

Hodson and Norris (*J. Biol. Chem.*, 131, 621, 1939) have developed a method which may be of more general application. This method depends on the fact that riboflavin (a) fluoresces green when irradiated with blue light, (b) is not destroyed by mild oxidation or by reduction, (c) can be reduced to a non-fluorescing form with Na-hydrosulphite and readily reoxidised by shaking with air, (d) is not reduced by stannous chloride. The intensity of riboflavin fluorescence is measured with a photoelectric cell.

In foodstuffs other pigments and fluorescing substances are usually present and accompany riboflavin on extraction. These interfering pigments can be got rid of by preliminary reduction with Na-hydrosulphite and stannous chloride. Hand fluorometer with some modification has been used and a great variety of foodstuffs have been successfully evaluated.

Good agreement was obtained between the results secured by the fluorometric method and the microbiological method of Snell and Strong, and the absorption photometric method of Sullivan and Norris.

H. N. B.

RESEARCH NOTES

Weather Changes from Day to Day

The phenomenon of day to day change of weather is believed to be connected with the transport of air masses from high to low pressure areas mostly in the upper regions of the atmospheres. But the real mechanism of this transport is entirely shrouded in mystery. Henryk Arctowski has recently contributed in the *Monthly Weather Review* of September, 1939 (pages 322 to 331) an important paper on the subject, where he tries to show that day to day weather change is not a local phenomenon but is an effect of a world-wide process of pressure transfer in the form of waves. Ekholm had shown that connected areas of increase and decrease of pressure on maps of isallobars show the extent of a wave. Arctowski suggests a name for these waves and calls *teron* or *barderon*. He also proposes the name *anoterons* to the areas of positive pressure differences and *katoterons* to those of pressure decrease. He also names waves of short duration as *bradeyterons*. From analysis of several isallobaric maps and comparing them with corresponding isotherms he feels inclined to conclude that 'lows' and 'highs' may be due to intercrossings of *katoterons* and *anoterons*, and also that the cold and warm fronts, and the shifting of wind directions, observed at the bottom of the atmosphere are the consequences and not the causes, of the pressure changes registered on weather maps.

He shows that isallobars for India are related to those of the Turkestan and Siberia, and observes that the most important wall of mountains in the world, separating Asiatic Russia from India, does not influence the distribution and displacement of *terons*—probably the lower atmospheric strata are affected mainly by the pressure changes occurring above. He concludes that changes of pressure from day to day in India must depend on those of Turkestan and Central Asia.

As to the origin of these pressure waves or *terons*, as he calls them, his answer is found in a form of interrogation—"Are the Equatorial waves, of small amplitudes, only an attenuation of these observed in polar regions?"

S. D.

Estimation and Distribution of Cytochrome Oxidase and Cytochrome C

Several of the vitamins have recently been identified with tissue respiratory catalysts. It is therefore necessary to have micromethods available for the estimation of these substances in tissues. E. Stotz (*J. Biol. Chem.*, 131, 555, 1939) has developed methods for the estimation of cytochrome oxidase and cytochrome C in tissues of normal white rats raised on Purina Dog Chow, all at 4 to 5 months of age. The methods involve (a) for the oxidase, grinding and dialysis of the tissue and measuring manometrically the rate of hydroquinone oxidation in the presence of an excess of pure cytochrome C, and (b) for the cytochrome, its partial isolation by quantitative procedures, followed by manometric measurement of hydroquinone oxidation in the presence of a beef heart oxidase preparation. These measurements have been compared with those obtained when known amounts of pure cytochrome C are added.

For cytochrome oxidase 150 to 350 mg. of tissue are ground in 15 cc. M/15 K_2HPO_4 , centrifuged and dialysed for 10 to 15 hours against 12 to 15 volumes of ice cold 0.1 M phosphate buffer (pH 7.2). The material is then ready for use manometrically.

For cytochrome C, 3 per cent trichloroacetic acid is added to the aqueous extract of whole rat organs to pH 3.4 to 3.5. After standing, the mixture is centrifuged and the supernatant fluid neutralised with NaOH. The cytochrome is precipitated with 5 per cent phosphotungstic acid. This precipitate is then dissolved in NH_4OH to which is then added phosphate buffer (pH 7.4) followed by 3 per cent $BaCl_2$. The precipitate formed on warming and standing is filtered from the brownish red filtrate which contains the cytochrome. By elution of the above precipitate with NH_4OH small amounts of cytochrome adsorbed on the precipitate is recovered. The combined filtrates are concentrated to very small volume in a vacuum desiccator over H_2SO_4 .

H. N. B.

UNIVERSITY AND ACADEMY NEWS

PROCEEDINGS AND PUBLICATIONS

Indian Physical Society and Indian Association for the Cultivation of Science

(Calcutta, December 1939, *Ind. Jour. Phy.*, Vol. XIII Pt. VI)

S. M. MITRA: Raman effect in arsenates and heat of dissociation of AsO_2 .

SACHINDRAMOHAN MITRA: On the influence of foreign substances on the absorption of the dyestuffs in solution.

RAJENDRALAL DE: A weak radio-active substance.

N. S. PANDYA AND P. D. PATHAK: A note on the maintenance of electron emission in Cossor valves after the low tension supply is disconnected.

G. P. DUBE AND H. K. DAS GUPTA: On the London-Van der Waals forces between two disc like particles.

D. S. SUBRAHMANYAM: Pressure waves and boundary surfaces in the free atmosphere.

(Miss) ASIMA MOOKERJEE AND JAGANNATH GUPTA: Raman spectra of coumarins and chromones.

S. K. KULKARNI JATKAR: Supersonic velocities in gases and vapours.

MD. SALARUDDIN AND B. G. NARAYAN: Unusual solar activity.

Entomological Society of India

(Bengal Branch, Calcutta, 15th February, 1940)

D. P. RAICHAUDHURI AND D. C. SARKAR: Determination of the percentage of mortality in Bengal silk-worm, *Bombyx mori* L. (Nistid variety) as the effect of seasonal changes.

Indian Chemical Society

(Calcutta, December 1939, *J. I. C.S.*, 16, 617-90, 1939)

PRIYADARANJAN RAY AND PHANINDRA NATH BAGCHI: Complex compounds of biguanide with bivalent metals. Part I. Copper biguanidines.

PRIYADARANJAN RAY AND NIHAR KUMAR DUTT: Complex compounds of biguanide with trivalent metals. Part VI. Cobaltic trisbiguanidines.

PRIYADARANJAN RAY AND HARIHAR PRASAD BHATTACHARYA: Complex compounds of biguanide with trivalent metals. Part VII. Cobaltic trisphenylbiguanidines.

B. N. GHOSH AND P. C. ROY: Comparison of the cataphoretic and electro-osmotic methods of measuring electrokinetic potential.

DUKHIAHARAN CHAKRAVARTI AND JYOTIRMOY DUTT: Synthetical experiments in the pyrone series. Attempted oxidation of chromanones with selenium dioxide. Part I.

P. M. BARVE, V. V. VORA AND B. N. DESAI: Mutual coagulation of colloidal solutions. Interaction of copper ferrocyanide with ferric hydroxide, thorium hydroxide and ceric hydroxide.

PRODOSH CHANDRA ROY CHAUDHURY: Chromium chromate.

BAIDYANATH GHOSH: Vitamin C and toxins. Part IV. The Effect of tetanus toxin on vitamin C metabolism.

K. M. CHAKRAVARTY: Catalytic formation of methane from carbon monoxide and hydrogen. Part VI. On the poisoning by carbon deposition.

JAGDISH SHANKER, PRABHAKAR N. BALJEKAR AND MATA PRASAD: Space group determination of the crystals of melamine.

P. C. MITTER AND PHANINDRA CHANDRA DUTTA: Studies in Longchain acids. Part II. On aleuritic acid (I).

UNIVERSITY AND ACADEMY NEWS

N. W. HIRWE (LATE) AND K. N. RANA: On chloralamides. The reaction of phosphorous pentachloride on chlorosalicylamides and their methyl ethers and the reactivity of the chlorine atom.

G. GOPALA RAO AND W. V. SUNDARA RAO: Mechanism of the microbiological oxidation of ammonia. Part II.

Society of Biological Chemists, India

(Bangalore, 30th January, 1940)

C. V. GANAPATI: Coagulation of milk by enzymes.

(Bangalore, 9th February, 1940)

B. ANANTHASWAMY RAO: Biological methods of malaria control.

(Bangalore, 4th March, 1940)

P. L. N. RAO: Chemotherapy of selenium and cellurium compounds.

P. R. VENKATARAMAN: Water-soluble nitrogen of garlic (*Allium sativum*).

C. V. GANAPATI: Nature of the milk-clotting enzyme in papain.

ANNOUNCEMENTS

During the next session of the Indian Science Congress to be held at Benares in January 1941, the Agricultural Sectional Committee proposes to hold discussions on (i) Drought resistance in plants, (ii) The need for the exploration of wild forms for the improvement of crops, and (iii) Quality in crops. Scientific workers in India who desire to contribute papers to these discussions are requested to communicate to Dr C. N. Acharya at the Indian Institute of Science, Bangalore.

Bihar and Orissa Research Society

Council for 1940.

President: His Excellency Sir Thomas Alexander Stewart; Vice-President: The Hon'ble Mr Justice Saiyid Fazl Ali; Secretary: Dr A. Banerji-Sastri; Treasurer: Mr Sham Bahadur; Librarian: Prof. Y. J. Taraporevala; Editorial Board: The Hon'ble Mr. Justice Saiyid Fazal Ali, Dr A. Banerji-Sastri; Members of the Council: The Hon'ble Mr Justice

S. P. Varma, The Rt. Rev. Dr S. Sullivan, S. J., Rai Bahadur Sarat Chandra Roy, Dr Hari Chand Sastri, Mr J. L. Hill, Dr S. C. Sarkar and Khan Bahadur Saiyid Md. Ismail.

Botanical Society of Bengal

President: Prof. S. P. Agharkar, Vice-Presidents: Prof. S. C. Mahalanobis, Prof. S. C. Banerji, Mr. S. N. Bal and Dr K. P. Biswas, Hon'y. Treasurer: Dr S. R. Sen Gupta, Hon'y. Secretaries: Mr. S. N. Banerji and Dr S. M. Sircar, Hon'y. Auditors: Mr K. G. Banerji and Mr. A. Sen, Members: Dr S. R. Bose, Mr. A. K. Ghosh, Mr. J. N. Bose, Prof. A. T. Dasgupta, Mr A. C. Dutta, Dr H. K. Nandi, Mr P. N. Majumdar, Mr R. M. Dutta and Miss S. Meyer.

RESEARCH WORK IN INDIA

Lucknow University

Investigations carried out by members of the staff and research students during the session 1938-39 comprise work mainly in the fields of morphology, systematic zoology and embryology.

Morphology: The work in this branch has extended over *Oligochaeta* (Earthworms), *Hirudinea* (Leeches), *Tunicata* (Ascidians), *Pisces* (Fishes), and *Insecta*. The enteronephric type of nephridial system, discovered twenty years ago in *Pheretima*, and later found in *Lampito* and *Woodwardia* has now been found in *Tonoscolex* also. The nephridial system of *Tonoscolex* has been completely worked out and it throws considerable light on the evolution of the nephridia in the earthworms as it shows a primitive type of enteronephridial system. The nephridial system of the Indian leech *Hirudinaria* has been worked out in great detail, and several problems of structure and function have been elucidated in the light of new findings. It has been shown that the undoubted connection of the funnel with the nephridium in the embryo is lost in the adult; and that the funnel (ciliated organ) helps to circulate the haemo-coelomic fluid (blood) in the body. The nephridial system of *Hirudo* (the European leech) has also been described side by side. The mode of cocoon formation and the role of the prostomium in cocoon laying have been worked out and described. In a memoir on *Herdmania*, the Indian Monascidian, the functions of the test were described as not only protective and adhesive, but also as sensitive and respiratory. This view which had been demonstrated by experiments has

BOOK REVIEW

THE RAMAN EFFECT AND ITS CHEMICAL APPLICATION
—by James Hibben. (American Chemical Society
Monograph Series, Reinhold Publishing Corporation,
New York) Pp. 544, 1939. Price \$11.00.

More than a decade has passed since the fundamental discovery associated with the name of Sir C. V. Raman was announced. The Raman Effect is essentially physical in nature and it can be utilised for the investigation of the behaviour of atoms and atomic groups within molecules and the nature of the valence forces which bind them together. The results obtained are largely independent of the state of aggregation of the molecules.

Owing to the importance of the results and the comparatively easy experimental technique by which they can be obtained, a very large number of investigations have been published on this effect, since the announcement of its discovery. But so far only three monographs have appeared on this subject of which the most important is Kohbrausch's book '*Der Smekal Raman Effekt*' published in 1931, to which a supplementary volume has been added in 1938. Sutherland's '*Infrared and Raman Spectra*' which appeared in 1935 in the Methuen's Physical Series is a useful introduction to the subject, but the need has been felt for a long time for a comprehensive monograph on Raman Effect in English. The publication of the above book by the Reinhold Publishing Corporation is therefore very welcome.

The author is a research physical chemist of the Geophysical Laboratory, Carnegie Institution, Washington, and Professor Teller has collaborated with him in writing a theoretical introduction to the subject. The book is meant essentially for the use of chemists, and so the theoretical discussion is kept to a minimum. It is divided into three parts, the first of which gives an introduction to the theoretical background of the Raman Effect and includes a chapter on the experimental methods employed for the study of the latter. The two remaining parts deal with the Raman spectra

of organic and inorganic compounds. In the case of the organic compounds the procedure has been to start with discussion from the simple to the more complicated type of compounds, from the saturated aliphatic hydrocarbons to the aromatic hydrocarbons, from the terpenes and non-heterocyclic compounds containing nitrogen to the heterocyclic compounds. The part on inorganic compound begins with the study of gases and leads on to study of silicon compounds, cyano- and complex compounds. The available experimental data are given in tabular form in each chapter. While diagrams illustrate the Raman spectra of the substitute products of the well-known typical compounds. An alphabetical bibliography is given containing 1757 references to all the important papers which have appeared till October 1938, and a supplement is added dealing chiefly with publication which have appeared while the book was being printed.

All the compounds which have so far been investigated have been arranged alphabetically, against each of which numbers are given from which by reference to the bibliography the names of authors and the publications dealing with them can be found out. Another numerical reference index helps the reader to find the pages in the text in which these compounds have been discussed. The method employed is no doubt very systematic, but the reviewer who is accustomed to the use of Kohbrausch's book finds it a little bewildering. The book is written primarily from the empirical standpoint of the chemists, but incidental discussions are given on subjects of more theoretical interest like the free rotation of atomic groups round valence bonds, the resonance effect in chemical bonds, chelation or hydrogen bonding, the structure of water and ice and of the silicate glasses. The addition of a subject index would have made the book more useful to persons interested in the theoretical aspect of the subject.

The book can be strongly recommended to all serious students as a comprehensive and up to date handbook on Raman Effect.

D. B.

BOOK REVIEW

EIN HALBES JAHRHUNDRET GRENZFLASCHEN
KATALYSE VON DAVY UND DOBEREINER BIS
DEACON—by A Mittasch and E. Theis. (Verlag
Chemie, G.M.B.H., Berlin). Pp. 279. Price in
foreign countries 6.75 gold marks.

It is a very happy sign indeed that the treatment of chemistry from the historical standpoint is evermore coming to the foreground. The advantages of such presentation, apart from its humanising factor, are manifold. The subject matter receives not only an additional charm but it becomes more instructive to follow up the development of branch of science. It accords one the opportunity of following step by step the growth of ideas in its continuity, which is not always at first sight apparent. This treatment of any scientific matter from a historical standpoint is not always easy, and the task of finding one's way through the vast ramifications of literature on the subject of surface catalysis of the last two centuries is indeed gigantic. The authors, Director Alwin Mittasch and Dr Erich Theis, must be congratulated for their very able presentation of the historic evolution of surface catalysis from the time of Davy and Dobereiner to that of Deacon. The period dealt has been very well chosen; beginning with the dawn of catalytic research we are led very ably through the amazing developments that theory and practice underwent during the last century to the crowning success of surface catalytic research, which has marked the beginning of the industrial heterogeneous catalytic processes. The book is not only a source of information, but it forms exceedingly delightful reading and as such should find place in every science library.

A. G.

INDUSTRIAL PLANNING: WHY AND HOW—by Naba-
gopal Das, Ph.D. (Econ.) I.C.S. (General Printers

and Publishers Limited, Calcutta) Pp. 141. 1940.
Price Rs. 2.

This is meant to be an introductory book for the "average men in the street." The author is well known through his studies on aspects of Indian industrialism to serious students of Indian economic problems. Mr Nalini Ranjan Sarkar, who contributes a suggestive foreword, rightly observes that Dr Das has very lucidly presented the various practical difficulties that confront the task of 'Planning' in the sphere of industries in India. There are interesting short chapters on the problems of industrial planning under the heads of raw materials, capital, labour, entrepreneurs, experts and skilled workers; on cottage industries and unemployment in the context of planning; and on the role of protectionism, transport development, industrial management, etc. The questionnaire of the Bengal Industrial Survey Committee and the General Questionnaire of the National Planning Committee are appended at the end.

This is a volume which can be recommended to any one who is interested in the problem, as a non-technical, able and short presentation of a complicated subject. There is an apparent bias both in Mr Sarker's foreword as well in the course of the text in favour of what in technical jargon is described as "Capitalist planning," and flings at the "Grandiose scheme of national economic reconstruction launched in Soviet Russia" and at the National Planning Committee whose scheme is sought to be contrasted in an unfavourable light with the Bengal Industrial Survey Committee which "frankly admits that a modest beginning is much better than a lot of grandiose planning" (p. 12). These should have been avoided, particularly to disarm any unfair comment on the merit of the work arising on the author's association as a public servant under the Bengal Government and Mr Sarker's lead in the appointment of the Bengal Committee.

B. N. B.

LETTERS TO THE EDITOR

Masters¹ records an instance of the production of a single supernumerary flower proceeding from the axil of a stamen in *Nymphaea lotus* Linn. Debbarman² records another instance in *Nymphaea rubra* Roxb.,

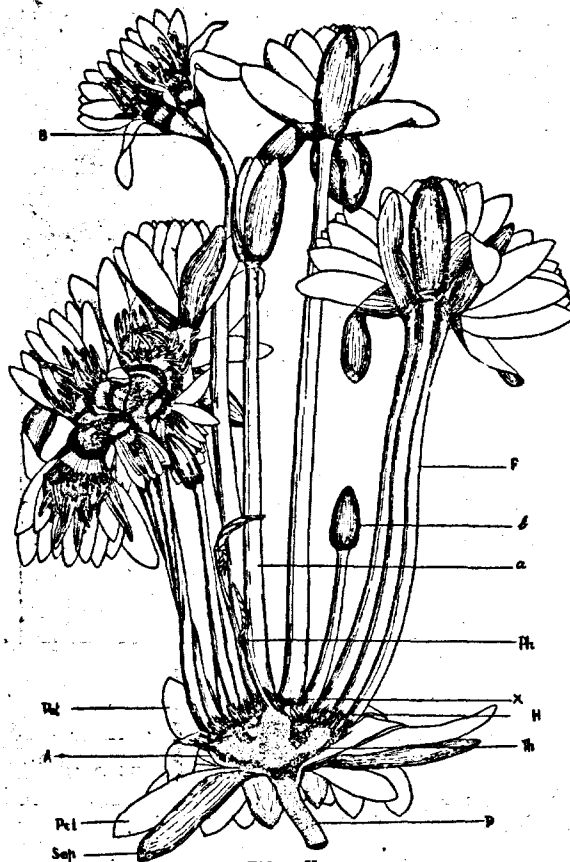


FIG - II.

A.—Median longitudinal section of the main flower; P.—Peduncle; Th.—Thalamus; H.—Hairs; Sep.—Sepal; Pet.—Petal; X.—Axil; Ph.—Transformed leafy stamens; F.—Fasciation of three flowers; a.—Supernumerary flower; b.—Supernumerary floral bud; B.—Longitudinal section of a supernumerary flower.

where not only a single supernumerary flower had emerged from the axil of one of the petals but the stamens had also become transformed into leaf-like structures, and that 'no trace of any ovary is visible.'

Abnormalities like the above, although freaks of nature, deserve to be recorded for their scientific interest. Axillary floral proliferation of the flower is of common occurrence, but the formation of a leaf bud in the axils of floral parts is not so. A floral bud, under abnormal conditions, may originate in the axil of any member of

the flower just as vegetative buds occur normally in the axils of the leaves of a vegetative shoot.

Praphulla Kumar Bose.

Botanical Laboratory,
Calcutta University,
Calcutta, 10-2-1940.

¹ Masters, M. T., *Vegetable Teratology*, (Roy Soc., Lond., 1868), p. 143-144, Fig. 65.

² Debbarman, P. M., *Jour. Ind. Bot. Soc.*, Vol. III, p. 66-67, May 1922—September 1923.

Devitrification of Vitreous Selenium at various Temperatures, and the Conversion of the monoclinic (α) Se into Hexagonal Modification

It has been previously reported¹ that vitreous selenium which gives three broad bands on X-ray powder analysis, devitrifies even in the absence of any mechanical tension if the thoroughly powdered specimens are heated continuously for two weeks at a temperature of 43°C. The devitrified mass gives sharp lines, the Bragg spacings corresponding to that of the hexagonal form; the lines can be divided into three distinct groups approximately coinciding with the positions of the three broad bands of vitreous selenium.

In order to study whether devitrification is possible at a still lower temperature, the powdered specimen was kept in an electric bath at 38°C and the heating was continued for a month. Following interesting points were noticed:

1. In the X-ray diffraction photograph, the sharp lines were faintly indicated with the sample heated for one hundred hours.
2. The back ground scattering of the film diminishes as the devitrification progresses.
3. The broad bands with superimposed lines were obtained even with specimens heated for two hundred hours. It has been noticed that the Bragg spacing corresponding to the band having the largest spacing diminishes as the period of the pre-heating of the specimen analysed increases.
4. Sharp and distinct lines were obtained with the devitrified mass heated for two hundred and fifty hours at 38°C, the Bragg spacings of which correspond both to the monoclinic (α) and the hexagonal form.

It has been possible to investigate the devitrification with samples at a still lower temperature viz., from -8° to 27°C. The sample of vitreous stick was supplied by Dr. Gripenberg of Masaby (Finland), and it was kept in his laboratory for 7 years. The temperature of

LETTERS TO THE EDITOR

that place throughout the year being from December to March below 0°C, from March to May below 10°C, and from June to September, the temperature lies between 20° to 27°C.

Immediately after the arrival of the stick the surface was scraped and on powder analysis, sharp lines corresponding only to the Se monoclinic (α) form were obtained; any line corresponding to the hexagonal form being altogether absent. The powder from the deeper layer of the stick gave broad bands, as is usual with vitreous selenium.

It was reported in *Nature* that monoclinic (α) Se converts into hexagonal form at 80°C when heated for 15 days. Further investigation showed that even at 65°C monoclinic selenium converts into hexagonal form when heated for 20 days.

K. Das Gupta.

Khaira Laboratory of Physics
University College of Science,
92, Upper Circular Road,
Calcutta, 4-3-1940.

¹ Das and Das Gupta, *Nature*, 143, 165, 1939.

On The Nomenclature of Some Soft X-Ray Lines.

Nowadays the X-ray emission lines are generally designated by the notations originally used by Siegbahn.¹ Thus the $K\alpha_1, \alpha_2$ lines arise from the transition $K \leftarrow L_{II}$, L_{III} levels the $K\beta_1, \beta_2$ from $K \leftarrow M_{II}$, M_{III} and so on. The energy difference between the M_{II} and M_{III} levels is so small in case of lower elements that only one line is obtained which is usually denoted by $K\beta_1$.

The effect of chemical combination on the X-ray emission lines of the lower elements has been observed by Ray, Backlin and others,² and it is now well known that the $K\alpha_1, \alpha_2$ lines excited from the compounds, suffer a shift towards the shorter wavelength side relative to the corresponding lines from the pure elements. Recently in connection with some measurements of the K-emission lines of the lower elements (11Na—15P) we have observed that the $K\beta$ lines from the oxides suffer a shift towards the longer wavelength side relative to the $K\beta$ lines from the pure elements. This peculiar shift of $K\beta$ lines in a direction opposite to that of the $K\alpha$ lines may also be clearly noticed in the photographs published by Karlsson and Siegbahn³ (in the case of Al and Al_2O_3 , also of Mg and MgO). We have also noticed this type of shift in all the elements from 11Na—15P.

As regards the nomenclature of the $K\beta$ lines from the pure elements, there is some anomaly in Siegbahn's book "*Spectroscopie der Röntgenstrahlen*," second edition, 1931. The lines from the pure elements are denoted by $K\beta_2$ (evidently meaning a transition from unknown level) whereas the lines from the oxides are denoted by $K\beta_1$. It seems that from the analogy of the $K\alpha$ -emission lines the longest lines among the β -group has been denoted by the regular notation β_1 , though it only appears in oxides of these elements. In my opinion the β lines from the pure elements, i.e., Siegbahn's β_2 should be regarded as the regular lines and termed by the notation β_1 , while the shifted β line excited only in the oxides of these elements should be termed as β_2 . The inability of explaining the shifts of $K\beta$ in a direction opposite to that of the $K\alpha$ lines, should not be the cause of changing the conventional nomenclature completely, as it apparently conceals an interesting fact in the soft X-ray emission spectra.

B. Bhowmik.

Khaira Laboratory of Physics,
92, Upper Circular Road,
University College of Science,
Calcutta, 7-3-1940.

¹ Siegbahn, *Spectroscopie der Röntgenstrahlen*, second edition, 1931.

² Karlsson and Siegbahn, *Zs. f. Physik*, 88, 1934.

The Secondary K-absorption Edges of Iron in Solutions of Iron Compounds

In a previous note¹ the author has shown that the secondary absorption edges of iron in colloidal solution of Fe_2O_3 extend to as much as 200 volts from the main edge. In continuation of the work, similar structures have also been found in ionic solutions of some iron compounds. It may be mentioned here that extended secondary structures of bromine on the short wavelength side of the principal edge in a very strong solution of $NaBrO_3$ have also been found by Hanawalt.² Recently Bagchi³ has made a systematic study of these secondary edges in solution of cobalt salts at different concentrations and observed interesting changes with regard to the position and width of the primary edge and also the secondary structures. A similar study of the secondary edges in solutions of iron compounds has been attempted. The maxima and minima extend to about 200 volts up to a concentration of 1N. The position, shift and width of the principal absorption edge of iron in ferric nitrate and ferric sulphate in solid and solutions only are tabulated below.

LETTERS TO THE EDITOR

TABLE I

(Showing the position, relative shift and width of the K-edge in $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$).

	λ in X.U.	D/R	$\delta\lambda$ in X.U.	δv in volts	Width of abs. edge in X.U.	Width of abs. edge in volts
$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ (solid)	1737.0	524.62	0	0	3.68	15.03
Soln. 1N	1737.1	524.59	.1	.41	5.13	21.03
Soln. .1N	1737.0	524.62	0	0	7.46	30.58

TABLE II

(Showing the position, relative shift and width of the K-edge in $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$).

	λ in X.U.	D/R	$\delta\lambda$ in X.U.	δv in Volts	Width of Abs. Edge in X.U.	Width of Abs. Edge in Volts
$\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ (Solid)	1736.7	524.71	0	0	5.47	22.39
Soln. 2.55N	1736.2	524.87	.5	2.05	5.76	23.59
Soln. 1N	1736.2	524.87	.5	2.05	6.0	24.57
Soln. .25N	1736.4	524.84	.3	1.23	6.1	24.98

From an inspection of the tables we note the following: (i) Up to the lowest concentration studied (.1N in sulphate and .25N in nitrate), the wavelength of the primary K-edge has not suffered any appreciable change.

(ii) The width of the principal edge has undergone a systematic widening with dilution; the change is smaller in the nitrate than in the sulphate.

Investigations are being carried on at still lower concentrations and the results will be published in due course.

S. SEN.

Khaira Laboratory of Physics,
University College of Science,
92, Upper Circular Road,
Calcutta, 6-3-1940.

¹ SCIENCE AND CULTURE 5, 563, 1940.
² J. D. Hanawalt, *Phys. Rev.* 37, 715, 1931.
³ N. Bagchi, Dissertation for M.Sc. degree. (Calcutta University 1939).

The presence of S_w in Colloidal Sulphur

It has been previously reported¹ that the diffraction rings obtained in the cases of sulphur coagulated by means of electrolytes from the colloidal solution and also of sulphur in colloidal suspension are similar to those of S_x . In order to investigate whether colloidal sulphur can also exist in the insoluble S_w form, the experiment was repeated. The colloidal solution of sulphur has been prepared by passing pure H_2S gas through a concentrated solution of SO_2 in water contained in a long narrow glass cylinder immersed wholly in an ice bath. The colloidal solution thus obtained was filtered twice through the double filter paper and was allowed to evaporate slowly in a flat basin at about 25°C in a moist atmosphere. A thin gummy rubber like membrane was obtained which can be torn to pieces.

The X-ray diffraction photograph was taken with these pieces, sample being changed every half an hour. A good powder pattern was obtained, the Bragg spacings of the rings corresponding to that of the insoluble white sulphur (S_w).

A small percentage of S_x is also present in the specimen giving only a faint indication of the intense ring of S_x .

K. Das Gupta.

Khaira Laboratory of Physics
University College of Science
92, Upper Circular Road,

¹ *Ind. Journ. Phys.* 12, 163, 1938 and 13, 91, 1939. Calcutta, 4-3-1940.

SCIENCE
AND
CULTURE

A Monthly Journal of Natural and Cultural Sciences

Scientific Research in National Planning

THE Great War of 1914 had at least one notable result. It brought home to the British people the unpleasant knowledge that even with half a century's start in industrial development they were badly beaten by the Germans in many fields of industrial activities.

The situation is summarised as follows in the Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1915-16:

"The outbreak of war found us unable to produce at home many essential materials and articles. We were making less than a couple of dozen kinds of optical glass out of over a hundred made by our enemies. We could hardly make a tithe of the various dye-stuffs needed for our textile industries with an annual output worth over £250,000,000 a year. We were dependent on Germany for magnetos, for countless drugs and pharmaceutical preparations, even for the tungsten used by our great steelmakers and for the zinc smelted from the ores which our own Empire produced. In the embarrassment of our many necessities, the Board of Trade appointed on August 25th, 1914, a Committee, under the chairmanship of Lord Haldane, "to consider and advise as to the best means of obtaining for the use of British industries sufficient supplies of chemical products, colours and dye-stuffs of kinds hitherto largely imported from countries with which we are at present at war". The Committee through its sub-committees, and in particular through that under the chairmanship of Lord Moulton, attacked the problem of dye-stuffs, besides other important matters. After much negotiation and discussion a company was

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floated for the manufacture of dye-stuffs with a possible ordinary share capital of £3,000,000 against which the Treasury undertook to make advances up to a limit of £1,500,000 secured by debentures. A grant of £100,000 for research was also promised to the company, the expenditure to be spread over a period of ten years."

Statesmen at the helm of affairs were frantic in enlisting the services of eminent scientists for solving urgent war problems. Prof. Sir William Bragg devised very sensitive instruments for detecting submarines. Dr Weismann discovered a method for manufacturing by fermentation acetone, an indispensable war chemical, and when Lloyd George offered to reward him for this conspicuous service he asked for a national home for his co-religionists, the Jews, in Palestine under British Protection—a request which was granted with consequences known to all. This example was quickly followed in Canada, Australia, New Zealand and South Africa, which set up Industrial Research Councils charged with similar duties. In the United States of America, a National Research Council was organised at the instance of President Wilson, by the National Academy of Sciences of Washington. It developed in 1934 into the National Resources Planning Board with affiliation covering the full gamut of all sciences. Thus in the countries which came out of the last Great War with their political and social systems practically intact, the conviction has grown up that only that nation can enjoy the benefits of science in the day to day progress of its industries

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which habitually applies to them scientific method and scientific knowledge. This much has become absolutely clear that science and industry have both prospered when brought together, and they will prosper all the more if there is a symbiosis between them like the common lichen on the rocks—a colourless fungus living together with a minute green organism, an alga—the green cells manufacturing food for both by photosynthesis from the air, and the colourless plant protecting in turn the food manufacturing unit—thanks to its tough and poisonous tissue. Scientific research should similarly foster industries and industries in turn endow research.

It was also fully realised that these individual efforts were not sufficient. It was felt that if British industries were to get the same measure of aid from planned scientific research as Germany was getting it was necessary to interest the State as well as the industries in one comprehensive scheme. Unfortunately it was not easy to rouse the stolid and individualistic British industrialists. The above Report observed in this connection:

"The Council have also repeatedly been told, when they have urged the necessity for expenditure upon research with a view to improvement and developments, that there is no security that new ventures will not be left, when peace comes, to shift for themselves as best as they may in face of the highly organised competition of our enemies. We do not need to be convinced of the reality of the danger, but we are inclined to doubt the efficiency of any single device for removing it. Organisation can only be fought by counter organisation, and so long as the Englishman treats his business house as his business castle adding to its original plan here and there as necessity or inclination directs, with his hand against the hand of every other baron in his trade and no personal interest in the foreign politics of his industry as a whole, it will be as impossible for the State to save him, whether by research or other means, as it would have been for King Stephen to conduct a campaign abroad. In the main the State can only effectively help those who help themselves."

British statesmen found that this state of passive attitude would be ruinous and they realised that to allay the undue fears about stabilising the industries in peace time conditions, the prime necessity must be to revise their commercial policy. Along with the change of trade policy, they went ahead with their plans for

building up a proper organisation for the utilisation of scientific inventions and discoveries to industries.

In 1916, the Parliament decreed the establishment of a Department of Scientific and Industrial Research (called D. S. I. R. for the sake of shortness) and voted a million Pounds for financing its activities. This was the first organised measure taken in Great Britain for helping industry through the application of science. Under the guidance of Lord Rutherford as chairman and other non-official eminent scientific men the activities of this Department grew enormously; to mention only a few of these, reference may be made to the very important researches on the designing of ships, on the stability of aeroplanes, on high-definition television, on the conversion of coal into oil, on the cold storage and transport of perishable food-stuffs from the antipodes, on new materials for roads and buildings, on synthetic plastics, artificial fibres etc., (for details, see the following article on the D.S.I.R.).

But the new orders that arose in the East and Middle Europe out of the ashes of the old empires went a step further. They were not content with mere symbiosis between research and industry. They took to deliberate and conscious industrial planning. Russia, like India, had just touched the fringe of industrial development when the Bolsheviks came into power. The conditions in pre-War Russia were in some respects parallel to those of our country. In fact, during the last World War Russia was no better than India. About 90 per cent of her population lived in villages and only 10 per cent in cities. Russia was dependent for all industrial products on foreign countries. The very small number of factories which existed in Russia were mostly controlled by foreign capitalists. This was one of the reasons why Russia collapsed in 1917. She could not get regular supplies from the West on account of the German blockade and her industrial life was utterly broken and supply of war materials could not be maintained. The Bolshevik leaders never forgot this lesson. They realised that thoroughgoing industrialisation was essential for the new life they had in view. They knew that industrial progress in advanced countries like England had been won step by step as knowledge had been gained through the toilsome efforts of thousands of men working for more than a century. They wanted to jump these stages of development with its numberless failures and the gradually cumulating successes, and wanted to land at the earliest possible moment in the Utopia of a highly developed industrial country. And for thirteen years, from 1926 onwards,

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the entire adult population of the country has planned and worked hard with the result that today the industrial production of Soviet Russia amounts to 120 billion roubles as against 16 billion roubles in 1926—a phenomenal increase of 7.5 times. They have demonstrated to the world without any doubt that the short cut to industrial progress lies in a careful and deliberate industrial planning backed by scientific and industrial research.

In Nazi Germany, Marshal Goering's four years' industrial plan was an integral part of the German war machine—the object being to make Germany independent of foreign supplies of raw materials, which are essential for waging successful wars for the expansion of the Germanic race. In this country, men of science have, in ever increasing numbers set themselves deliberately about the solving of specific industrial problems arising out of schemes for planned economic development and the meagre reports that filter through prove without any doubt that considerable success has crowned their efforts.

With this furious tempo of development and consolidation all round, where does India stand? Much was expected of the policy laid down by the Government of India in 1915, under the stress of the War; it was hoped that India would be entitled to demand the utmost help which her Government could afford to enable her to take her proper place in the world as a manufacturing country. But the lessons of the Great War were soon forgotten; and the recommendations of the Indian Industrial Commission which was set up during the War and which acted as a National Planning Committee under bureaucratic limitations were received with cold indifference and shelved altogether in 1924. This retrograde measure has been fraught with unfortunate results in times of peace and with disastrous consequences in times of war.

Indeed, in a recent broadcast, the Commander-in-Chief in India lamented that "the enormous cost of modern armaments had made it quite impossible for a poor country like India to keep pace with the wealthier nations. India's greatest asset is a large supply of the finest types of fighting men. Her great weaknesses are a low national income and a limited industrial development incapable as yet of supplying

the technical equipment of a modern army." History has amply shown that victory is not the prerogative of a large organisation swollen with ill-armed soldiery but rather of small well-equipped armies, modern for their period. This is even more true today than it was at any time before, and nowadays, large ill-equipped armies are nothing more than *kannonenfutter*, sheep for slaughter.

Nor should we forget that the Government of India had a strange ally in this extremely retrograde policy in some of our leaders of public opinion who have been so impressed by the evils of the modern capitalistic world that they have not hesitated to declare that the introduction into India of the scientific and technical methods of the West should be resisted. This attitude stiffened the Government in its view that it is no business of governments to subsidise higher industrial and scientific research. Those who employ scientific men and exploit their researches should pay for their training and provide them with facilities for work. The forces of public opinion and of Government rarely join hands in this country, but men of science found to their dismay that this miracle had happened in this instance. It was feared that human society in India would in the end crystallise into a community of artisans and peasants. It is therefore with great relief that we welcomed the resolution passed at the conference of the Provincial Ministers of Industries held at Delhi in October 1938, under the presidency of Mr Subhas Chandra Bose that the problems of poverty and unemployment, of national defence and economic regeneration in general cannot be solved without industrialisation; and as a step to such industrialisation, a National Planning Committee should be set up which will formulate comprehensive schemes for development of industries in India.

Indeed for any one who has followed the recent happenings in this world with any attention, this industrial planning for India would seem to be long over-due. Now, more than ever, a planning on all fronts would seem an urgent and immediate necessity. The rapid rise of countries organised in deadly earnest is patent to all but the oblivious Utopian. If a progressive and industrial India appeared a desirable necessity in 1915, how much more urgent and imperative must such a task of consolidation of her scientific and material resources appear to all in 1940. But we orientals often forget realities in our search for the ideal. The least delay in this urgent task may

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prove fatal and irreparable in the end. Let those, who hesitate, ponder deeply over the problem whether an industrially backward India with a large reserve of human population whose labour can be exploited is not in itself a menace to world peace, drawing, as she does to herself, the covetous eyes of the Hitlers and Mussolinis of the world. Already we are regrettably late in putting forth our best efforts in this direction—but now that world events have rudely awakened us to the dangers that our slackness has exposed us to, we should try to make up for lost time by forced marches in the path of progress, and by a resolute determination to pool all our abilities and resources to solve our urgent problems. It is obvious that such a tremendous task of the development of the economic conditions cannot be achieved by the isolated efforts of industrialists or by private enterprise. The utmost co-operation of the individual with the State will be necessary if any success is to be achieved. The magnitude of the task need not make us despair. The very creditable performance of India's sons in the different spheres of scientific, intellectual and industrial activity have amply demonstrated that with proper guidance and opportunities, India is capable of solving her own problems, and of maintaining her position and ideal with dignity and prestige. What is only wanted is prudence and foresight, resolute co-operation and efficient leadership.

A certain amount of ill-directed criticism is levelled against the universities, that they are turning out young men in science who cannot at once go into life and start industries. But if these critics take the trouble of studying the matter, they will find out that the fault does not lie with university training. Universities all over the world turn out just the same type of young men as Indian universities do but while there are fields for employment for young men in other countries, such facilities do not exist in this unfortunate country. The good seeds produced fail to germinate on account of the lack of right types of soil. And preparation of the soil, in other words, industrial planning should be the concern of the State, and if this is done, even the young men of Indian universities whom unemployment now stares in the face, would develop into valuable members of society. If it is admitted that industrialisation should make a *forced march* in the country, a *laissez-faire* policy is the least desirable. On the other hand there

should be a mobilisation of young talents turned out by the universities for converting the gifts of nature into the dynamic wealth of society.

In western countries there is no unemployment for university-trained men, and this is due to the demand for trained personnel to man the industrial development created by post-War conditions. Prof. Philips recently estimated that 12,000 graduates in chemistry are employed in industrial pursuits in England. Lord Rutherford even complained that the demand in England for well-trained researchers in physics had outrun the supply. Dr Hamor, Assistant Director of Mellon Institute for Industrial Research, has estimated that in 1938, America spent about 100 million dollars in scientific and industrial research; and though the expenditure is high, the results have more than fulfilled expectations, even if for a time, some of them may be kept secret. Thus in 1938, there were 1769 industrial research laboratories in the United States which employed about 30,000 scientists. The chemical industries employ more scientists and pay more for research than any other industries, while the electrical and communication industries come second in this list. This enormous expenditure only represents 2 per cent of the value of the products which these industries manufacture. Much more is spent for accounting and on legal advice. Such a consummation may be long in coming to India but every effort should be made to prepare the ground in advance.

It is a welcome sign of the times that the Indian industrialists are not all blind to the value of research as a means of improving production, and in consequence, of increasing the demand. The Tata Iron and Steel Works have led the way by the foundation of a magnificent laboratory at Jamshedpur for the study of alloys of iron and steel. The Lala Shri Ram Trust contemplates establishing soon at Delhi an Institute on the model of the Mellon Institute of America. The Luxminarayan bequest at Nagpur may soon begin to yield the beneficial results which the donor so ardently desired. But when one recalls that most of the industries in India are now sheltered by a tariff wall—call it revenue tariff or protective tariff as you like—and that a substantial part of the income of the Indian business magnates accrues to them because of this tariff, one has a right to expect a much wider recognition on their part of the need for co-operation between science and industry, and a greater readiness to endow industrial research with a view to cheapening production. Such research is considered, in all enlightened countries, as an insurance against the dark days; and

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today when the world seems so much out of joint, the Indian industrialists should do well to consider themselves only as servants of society—essentially moral beings whose main dividends are the benefits which they confer by providing employment, and by manufacturing commodities which are essential for the national well-being.

The Indian Science Congress that met in Madras only four months ago, resolved that as an indispensable unit of planned economy and industrial development, there should be set up an All-India Council of Scientific and Industrial Research with powers and functions similar to those entrusted to the Department of Industrial and Scientific Research in Great Britain. In India, however, men and things go under official control so easily and without question that it is desirable here to lay stress on the following observation of Lord Rutherford, "In Great Britain, the responsibility for planning the programme of research, even when the cost is directly borne by the Government, rests with research councils and committees whose members are not themselves State servants, but distinguished representatives of pure science and industry. It is to be hoped that if any comparable organisation were set up in India, there will be a proper representation of scientific men from the universities and also of the industries concerned."

At present, demands for war materials from the Empire and Allied countries and also for India's own requirements in this field have again called for an increase in industrial activities in India. Government have therefore decided that in order to enable India to make a fitting contribution to the war for all the Allies and to take this opportunity of stimulating her existing industries and of exploring the fresh field of development created by the war, research work should be conducted on a larger scale than at present. A Board

of Scientific and Industrial Research has been contemplated and about it a press report says,

"The Board will co-ordinate the work of the existing organizations already employed in this field. It will survey the work that is being done by them, invite proposals from all sources, initiate discussions and make recommendations to the Government, who will prescribe from time to time the general lines on which industrial research should be undertaken and pursued. The Board will also recommend to Government what specific problems should be assigned for investigation to the staff directly under the Board on the one hand and to the various scientific and research institutions in the country, including university laboratories, on the other.

"The composition of the Board has been so designed as to ensure that all proposals for research are examined and judged not only from the scientific but also from the commercial standpoint. The first board will consist of the following:—

Dr J. C. Ghosh, Dr Nazir Ahmad, Dr Meghnad Saha, Dr S. S. Bhatnagar, Sir H. P. Mody, Sir Syed Sultan Ahmad, Mr Kasturbhai Lalbhai, Lala Shri Ram, Mr P. F. G. Warren and Dr N. N. Law.

"The Commerce Member will be chairman of the Board, and the Chief Controller of Stores, India Stores Department, will be its first vice-chairman. Government have been able to secure the services of Dr Bhatnagar, head of the Punjab University Chemical Laboratories, as Director of Scientific and Industrial Research.

"The executive staff of the board will be attached to the Commerce Department. The chairman will have the power to co-opt from time to time such scientists or industrialists as he may consider necessary to help in the examination of particular problems which may come before the board. The board, which will meet at such places as its chairman may direct, is expected to meet once in two months.

"A sum of five lakhs of rupees has been provided in the next year's budget in connexion with the work of the board, of which about one lakh will be utilized by the board on its administrative side, and the balance will be available for other purposes, including distribution of grants, subsidies and scholarships."

Department of Scientific and Industrial Research of Great Britain

THE Department of Scientific and Industrial Research (called D. S. I. R. for the sake of shortness) was founded in May 1915, purely as a war measure. But it was found so useful that it was decided to continue it as a permanent organisation even after the conclusion of the World War in 1918. The Department is entrusted with the direction of Industrial Research of the Government of the United Kingdom. The work is distributed between (i) The Government Laboratories, and (ii) Industrial Research Associations. The total grant from H. M.'s exchequer was £637,200 in 1937-38, which was spent as follows:—

Organisation	Govt. Grant	Other Receipts	Total Expenditure
Headquarter's Administration	28,085	1,574	29,659
1. The National Physical Laboratory. (Teddington, Middlesex). Radio Research Station (Slough, Bucks) Taximeter Testing Substation.	110,907	141,302	252,209
2. Chemical Research Laboratory (Teddington, Middlesex)	23,340	3,986	27,346
3. Fuel Research Station (East Greenwich)	94,782	8,458	103,240
4. Food Investigation (a) Low Temperature Research (Downing St., Cambridge) (b) Covent Laboratory Garden (Kean St. London) (c) Torry Research Station (Aberdeen) (d) Ditton Laboratory (East Malling, Kent) (e) Smithfield Laboratory (91, Charter House, London)	45,407	9,302	54,709

Organisation	Govt. Grant	Other Receipts	Total Expenditure
5. Building and Road Research (a) Building Research Station (Garston, Herts) (b) Road Research Laboratory (West Drayton, Middlesex)	40,626	56,756	97,382
6. Forest Products Research (Aylesbury, Bucks)	38,841	3,013	41,854
7. Geological Survey and Museum Head Office, Kensington, London with stations at Newcastle, Manchester, York and Edinburgh	71,472	2,010	73,482
8. Water Pollution Research	5,421	3,713	9,134
9. Grants to Students	26,327	64	26,391
10. Research Associations	147,532	750	148,282

The headquarters organisation consists of a paid secretary and his staff which is almost completely scientific and technical. For a number of years, the secretary's office was occupied by Sir Frank Smith, who was the honorary secretary of the Royal Society and a distinguished scientist. On his retirement the post was filled by Prof. E. V. Appleton F.R.S., a noted physicist whose work on the Ionosphere is known all over the world. The secretary has always been a distinguished scientist. The work of the Department is controlled by an Advisory Council, assisted by a number of Industrial Research Committees and Boards. The Advisory Council consists of distinguished scientists, engineers and a few otherwise distinguished persons. The eminent physicist, Lord Rutherford, was the non-official Chairman for over eight years. The following was the personnel of the Advisory Council for 1937-38.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH OF GREAT BRITAIN

Lord Riverdale of Sheffield (Chairman).
 Sir William H. Bragg, O.M., K.B.E., D.Sc., LL.D., Pres. R.S.,
 Lord Cadman of Silverdale, G.C.M.G., D.Sc., F.R.S., LL.D.
 G. M. B. Dabson, Esq., D.Sc., F.R.S.
 Viscount Falmouth.
 Lt.-Col. J. H. M. Greenly, C.B.E., M.I. Mech. E., M.I.E.I.
 Sir James H. Jeans, D.Sc., LL.D., F.R.S.
 W. H. Mills, Esq., Sc.D., F.R.S.
 Prof. A. Robertson D.Sc., M. I. Mech. E., M. Inst. C.E.
 Prof. Sir Albert C. Seward, Sc.D., D.Sc., LL.D., F.R.S.
 Sir Henry B. Shackelton.
 S. K. Thomley, Esq.
 Sir Frank E. Smith, K.C.B., C.B.E., D.Sc., LL.D., Sec. R.S. (Secretary).

It may be pointed out that 9 out of 12 members are eminent scientists.
 The names of the research committees and boards under the Department are given below:

- Committees:**
- Local Committees of the Physical and Chemical Survey of the National Coal Resources.
 - Standing Committee on Heating and Ventilation.
 - Joint Committee with Medical Research Council on Research in Heating and Ventilation.
 - Lubrication Research Committee.
 - Committee on Testing Work for the Building Industry.
 - Joint Committee of the Executive Committee of the National Physical Laboratory and the Building Research Board on Architectural Acoustics.
 - Structures Investigation Committee.
 - Steel Structures Research Committee.
 - Fire Resistance Research Committee.
 - Corrosion of Metals Research Committee.
 - Committee on the Behaviour of Alloys at High Temperatures.
 - Physico-Chemical Committee.
 - Executive Committee of the National Physical Laboratory.
 - National Physical Laboratory Research Committee.

- Committee on the Application of X-ray Method to Industrial Research.
- Committee of Management, Low Temperature Station for Research in Biochemistry and Bio-physics, Cambridge.
- Gas Cylinders and Containers Committee.
- Illumination Research Committee.
- Atmospheric Pollution Research Committee.
- Road Tar Research Committee.
- Dental Investigation Committee.
- Wood Preservation Committee.
- Engineering Committee (Food Investigation Board).

Boards.

- Geological Survey Board.
- Fuel Research Board.
- Building Research Board.
- Road Research Board.
- Metallurgy Research Board.
- Chemistry Research Board.
- Radium Beam Therapy Research Board.
- Food Investigation Board.
- Water Pollution Research Board.
- Forest Products Research Board.
- Radio Research Board.

A short account of the working of the different laboratories is quoted from Bernal's "*The Social Function of Science*," p. 43-48. He has levelled certain criticisms against the workings of the different institutions but these do not detract the value of this account.

"Of the Government laboratories, far the most important is the National Physical Laboratory which combines the functions of a central bureau of standards of every kind of unit used in commerce and industry, and a research laboratory of industrial physics. It contains, in particular, large-scale hydrodynamic and aerodynamic equipment, such as tanks and wind tunnels essential for building ships and aeroplanes. It also contains the most complete equipment for testing the properties of materials under industrial conditions of use. Results of the work of the National Physical Laboratory are fully set out in its annual reports. The impression produced is that the work of routine examination occupies too dominating a place, and sterilizes, so to speak, the rest of its activities. Examination of materials or processes by a national laboratory is naturally directed towards finding defects, and the positive work

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of the laboratory seems to be limited to attempts to correct defects as they occur in practice. This work is, of course, of great importance; clearly, in any system of applying scientific research it must be undertaken. Yet it can reasonably be urged that the work of such an institution as the National Physical Laboratory should not be limited to such considerations and should be concerned just as much with the discovery of new possibilities as with the remedying of old defects. How well this could be done is shown by those parts of the Laboratory that are most closely in touch with the Services' research, that is, the aerodynamic and the wireless sections where new processes and positive developments are the directing considerations.

The National Chemical Laboratory has an even more restricted function; essentially it is an analytical laboratory assisting the Board of Trade in standardizing products from the chemical point of view. But the Government takes little positive action in directing chemical research.

Fuel Research.—Apart from these, the two main governmental institutes are the Fuel Research Board and the Food Investigation Board. The Fuel Research Board, on which almost as much money has been spent as on the National Physical Laboratory, has as its object the utilization of coal and in particular the production of petrol from coal, and the running of the country independently of foreign oil supplies. Its importance consequently in the scheme for national defence need not be emphasized. It is interesting, however, to note, in connection with the relation of Government research to industry, that the method of hydrogenation of coal developed in large part by the Fuel Research Board was not in fact operated by a Government factory, but was handed over to Imperial Chemical Industries for operation and even assisted by what amounted to a very large Government subsidy, for the petrol produced by this process was freed from a tax which accounted for four-fifths of its selling price (8 to 9d of Tax, the actual price being 3d.).

Food Investigation.—The Food Investigation Board is one of the most rapidly growing of the Government's Research Departments. It has been concerned almost exclusively with methods for the preservation of food products. Originally these were intended to be of assistance to home producers of food; actually it was found that the research introduced such effective methods of food preservation as to make transport of food from distant countries possible on a very much larger scale, and consequently to give a much larger differential advantage to Empire and foreign pro-

duce, an advantage only partly offset by tariff barriers. A very striking point about this type of research is the extreme effectiveness of science as applied to simple processes inherited from a pre-scientific age for the storage and treatment of food. It follows that biological engineering applied on an adequate scale is likely to have the most astonishing results, and, in collaboration with new agricultural methods, can solve, technically, the problem of food supplies of the world. What we still lack are the social and economic adjustments needed to realize these possibilities.

Forest Products and Building.—Two further institutes deserving of notice are the Forest Products and Building Research Institutes; both have considerable promise but are held up by bureaucratic restrictions and by the anarchic character of the industries they serve. How difficult is the position of timber research is shown clearly enough from their own report:—

"The investigatory work in the laboratory provides only the middle link of a chain of three which connects the forest in the Empire overseas with the timber user in the United Kingdom. The three links are: (a) information about supplies and prices, (b) information about the qualities of the timbers; (c) marketing promotion We feel it incumbent on us to take this opportunity of reiterating our views, so that with the disappearance of the Empire Marketing Board, whose sphere of work covered all three of the links, there may be no failure to provide adequately for the first and third of them no less than for the second. To continue the work at Princes Risborough on Empire Timbers without proper intelligence concerning supplies would be to build a house without foundations. To do so without a proper marketing organization would be to build one without doors and windows. . . ." (From the Report of the Advisory Council of the D.S.I.R., 1932-33).

Since then the creation of the Colonial Forest Resources Developing Department has done something to remove these anomalies but much still remains to be done.

The Building Research Station is unique in that in part it is concerned with the consumer as well as the producer. It has of recent years occupied itself with considerations of the convenience of dwelling-houses in respect to aspect, insulation and domestic convenience.

Research Associations.—The Research Associations of the Department of Scientific and Industrial Research were initiated towards the close of the War, with the definite objects of demonstrating to British industrialists the value of applied research and of preventing the repetition of the state of affairs in 1914, when British industry was caught napping by the more scientific industry of the Germans. A million pounds was subscribed by the Government and granted on the so-called "pound to pound" basis, i.e., for every pound

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subscribed by an industrial concern a pound was given by the Government. It was intended that by the time the million pounds were spent, industry would itself realize the value of research and no further assistance of this kind would be needed. As it turned out, these aims were only very partially achieved. About twenty Research Associations were set up, chiefly between the years 1918 and 1920, covering about 50 per cent. of the productive industry of the country. The other industries, for the most part old and traditional industries, thought they could get on perfectly well without science; in any case, if there was anything wrong, a protective tariff was a better help and cost nothing. After the first five years a system of diminishing Government grants was instituted but failed, whereupon a new "datum-line" system was introduced. A datum-line figure was fixed by experts for each branch of industry, and only after a sum corresponding to this figure was subscribed by the industry itself did the Government grant its "pound for pound" up to a limit of twice the datum-line figure. Thus, if full use was being made of the facility, the Government was contributing one-third of the total sum spent on industrial research. The million-pound fund was all spent, coming to an end in 1932 at the depth of the depression. There was nothing for it, if the whole of industrial research was not to be abandoned, as rubber research was for a while, but to continue the Government subvention. The situation is improving but is recognized to be still far from satisfactory. In the year ending 31st March, 1936, £346,479 were spent on the Research Associations, of which £108,951 were contributed by the Government.

The chief difficulties are those of finance, for reasons that will be discussed later. The industrial contributions to the Associations are small and erratic, naturally fluctuating much with the trade cycle; those of the Government are unfortunately apt to follow the same curve. The results are a very uncertain income which prevents long-range planning of research and necessitates concentration on immediate problems, often relatively trivial. This situation is well summed up in one of the reports (1933):

"Inadequate resources continue to hamper research associations in all directions. Problems await solution which are not formidable scientifically, provided the means exist for their appropriate approach by competent men of science. But as the means to employ sufficient staff and to provide them with the tools of their profession do not exist, the problems remain unsolved. . . ."

It is impossible to plan intelligently under uncertain conditions of finance, when the short view tends

invariably to prevail over the long, with the result that researches which are vitally important though not immediately productive tend to be crowded out by *ad hoc* inquiry. Research Associations in short cannot carry out effectively the researches which are required in the interests of industrial progress or make plans for important sections of their programmes of work unless they can offer prospects of reasonable financial security to their scientific staffs, and they can only hope to do this if they can be assured of financial support to enable them to develop their activities over a period of years. . . .

It is a scientific habit of mind and vigilant and continuous examination of manufacturing practice in the light of available technical knowledge that alone will ensure for industry the fullest advantage of new advances."

Since then, of course, the situation has greatly improved, and the income of the Research Associations, both from governmental and industrial sources, has increased rapidly. This has led to an attitude of complacency and to the assumption that all is for the best in British industrial science. The opportunity now exists for endowing research so as to preserve the work in progress from the effects of the next slump. But as the authorities either believe there never will be another slump or that the system will not survive it, the chances of anything being done are remote.

The work of the Research Associations is of a more immediate technical character than that of the National Physical Laboratory or its attendant institutes. The kind of problems tackled are mostly those connected with difficulties that turn up in the course of industrial operations, such as the weaknesses of metals under certain stresses or the origin of the matt appearance of chocolate kept after a certain time. Quite often, however, attention to such apparently minor problems leads to very large industrial savings. Thus an investigation into the quality of coke for iron smelting led to savings of fuel amounting to £800,000 per annum, and one on the bloom on frozen meat to savings of £300,000 per annum. These examples are cited to show that even when working on an extremely restricted scale and only attempting essentially negative problems, the direct application of science to industry can lead to economies out of all proportion to the cost of research.

The existing Research Associations fall roughly into six groups whose relative importance can be judged by the amount of money allocated to them. The greatest developments are recorded for the heavy industries, electrical industries and textiles. Engineering as such, shipbuilding, cement, brickmaking, glass and the brewing and tobacco industries are among those not represented. Many of the industries which have no Research Associations are old and traditional industries, in many cases divided into a large number of small firms which do not

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feel the need of scientific research or actually distrust it because they fear they will lose trade secrets.

The chemical industry is in a very different category though it also is not represented by a Research Association. Here it is rather a question of a large monopolist industry with wide international connections that prefers to manage its own research and does not require to share it with Government Departments.

Research Grants.—Besides the Associations, the Department of Scientific and Industrial Research finances a number of junior and senior grants to research students, mostly in universities. Here it is frankly taking on a task which the Ministry of Education has failed to fulfil. The number of grantees is small about eighty a year out of the two thousand honours graduates in science. Even then, however, so small is the demand for trained research workers that only a third of these go on into industrial research. This part of the Department's activities is of considerable assistance to fundamental research, for, small as the number of

students is, they form an appreciable addition to academic research. But the whole system is anomalous as there is no attempt at co-ordinating the work done or relating it to industrial problems. The grants themselves are so small as to produce real hardships, and it is very doubtful whether they fulfil the purpose for which they were intended.

It can be seen that there exists in Great Britain, through the Department of Scientific and Industrial Research, a framework covering, though very imperfectly, most industrial operations. Governmental scientific research is certainly closer to day-to-day problems than is university research. It may even be that with the present economic system it represents the best that can be done by the State to bring science into industry. One of its guiding principles has been that of conciliatory approach to industrialists, a tactful pointing-out of the advantages of research while giving full reassurances that in no case does the State wish to enter into competition with them. In this way, over the course of twenty years it has permeated the more advanced half of British industry. A more forthright policy would perhaps have failed, but it would be optimistic to claim that the results achieved fulfil anything like the requirements of a state science service even under capitalism."

Germany's Organization of Research

Nowhere is the beneficial effect of intimate contact and co-operation between men of ideas in science and men of ideas in industry is better exemplified than in the rapid development of the chemical industries in Germany at the close of the 19th century. The first synthetic dye was made in England by Perkin, but the industry soon found a congenial home in German soil, because the outlook of the German business men was enthused by the faith in scientific research which comes only with first hand knowledge. Twenty long years of painstaking research were necessary, at a cost of more than a crore of rupees, before Von Bayer's pure laboratory process for the synthesis of indigo out of coal tar products could be commercialised, but once it was done, the fate of natural indigo of Behar was sealed, and it disappeared from the world's market in another twenty years. Of great topical interest is that exciting venture of the late Prof. Haber in 1909 when he demonstrated before the engineers of the Badische Anilin and Soda Fabrik that it is possible to obtain small quantities of ammonia from nitrogen and hydrogen at high pressures with the aid of suitable catalysts. Millions of pounds were spent to

exploit this discovery commercially, with the result that when the war broke out in 1914, Germany was independent of her foreign supply of nitric acid which is the basic chemical for all ammunition industries. The quarter of a century that has passed since then has witnessed enormous developments, and today the fear of inadequate food supply to the increasing population of the world for lack of nitrogen fertilisers has vanished altogether. Apart from enlisting the active co-operation of her great industrialists, German Science could also enthuse the all-powerful State with its ideas of revolutionising human life with its new weapon. At the personal initiative of Kaiser Wilhelm II the German State and industries co-operated in founding about 20 research institutions (known as Kaiser Wilhelm Institutes, details of which were published in this journal, vol. I, pp. 161-4, 175-179 and 338-4) for utilising the knowledge of science by means of team work for solving industrial problems of national importance.

—From a public lecture by Dr J. C. Ghosh

The Board of Scientific and Industrial Research (Government of India)

A Comparison of its functions with those of the D. S. I. R.

IN a discussion of the Board of Scientific and Industrial Research set up by the Government of India, it is desirable that the policy underlying the work of the Department of Scientific and Industrial Research of Great Britain should be stressed to judge the fitness of the proposed Board for the present condition of the country and for making it the main agency for the industrialisation of our country. Conditions in no two countries are alike, least of all in the United Kingdom and India. The United Kingdom is a highly industrialised country and the object of the D.S.I.R. was and is even today to enable British industries to take advantage of the results of modern scientific discoveries and inventions for maintaining the commercial supremacy of the United Kingdom and to undertake research work in those essential needs of the nation, the supply of which may be cut off during a world conflagration, namely, foodstuff, liquid fuel etc. A further objective is to make the best use of those resources which belong to the nation as a whole, e.g., coal, iron and other minerals.

On the other hand, India is still mainly an agricultural country, her industrial production is only about one-third of its agricultural production and is far lower than the needs of a modern civilised country. It is well known that most of India's industrial needs are supplied from foreign countries and on the outbreak of the present war, the supply of heavy and fine chemicals, medicinal drugs, paper, glass, scientific instruments, machinery of all kinds has been jeopardized, and as matters stand now the condition is going to be worse later. Conditions in India are very similar to those in pre-1914 Russia which collapsed after two years' of War owing to her industrial backwardness. In addition to producing all industrial goods which are now imported from foreign countries there is also an urgent need for raising the condition of India's millions to a decent standard. The foremost need today is therefore for *Industrial Planning* which work has been undertaken by the National

Planning Committee. In the *communiqué* which has been issued by the Government of India after the meeting of the Board on April 1 last, no reference has been made to industrial planning, at all. The *communiqué* is quoted below:

"The Board of Industrial and Scientific Research held its first meeting on Monday evening in the Commerce Member's room in the Assembly Chamber. Sir A. Ramaswami Mudaliar, Chairman of the Board, presided and all members were present, as also the Secretary of the Commerce Department and the Economic Adviser to the Government of India.

The Chairman outlined the functions of the Board which he pointed out would be, firstly, to advise the Government on proposals for instituting specific researches; secondly, to help specific institutions in scientific study of problems affecting particular industries and trades; and, thirdly, to make proposals for the establishment of research studentships, scholarships and fellowships.

The Board would receive proposals from various research institutions and universities, from industries and trades, and would also initiate proposals at the instance of any member and these proposals would be considered at meetings of the Board and the Government would be advised whether these proposals were approved and if so what funds should be provided for carrying them out.

A discussion followed in which all members took part. It was agreed that the next meeting should be held on June 8. In the meanwhile, the Chairman undertook to circulate to members a survey of the present state of research in the country regarding industrial matters and of the institutions which at present are engaged in or can undertake such research as of all the proposals relating to research received in the meantime either from members or institutions or adumbrated by the Board's Director of Scientific and Industrial Research, Dr S. S. Bhatnagar.

The *communiqué* makes it clear that the measure is a purely wartime one and confined only to the ways

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and means of manufacturing those materials which are required for military and certain civil purposes and the supply of which may be cut off on account of the war. The only redeeming feature is that the government desires to make use of private agencies, notably the university laboratories, for carrying out some industrial researches. Even then the amount sanctioned for the purpose and the administrative machinery set up fall far below the expectation of the public and the needs of the country.

It is regrettable that the Government, like the proverbial blind men who went to see the elephant, are able only to touch a small part of the animal's body and are unable to see the whole. What is needed is first of all a clear cut Declaration of Policy that it will henceforth be the objective of the Government to raise India to the standard of a modern industrial country.* The next step should be to set up an industrial planning committee or to set up a body which will take over the available recommendations which are being submitted to the National Planning Committee by its various sub-committees and to take measures, political, fiscal, and administrative, for implementing them. Without proper planning and adoption of administrative measures to give effect to them, it is impossible to achieve anything substantial in this direction.

It is often thought in ill-informed quarters in this country that industries cannot be started simply because there are no experts and necessary researches for their development have not been carried out. While lack of experts and lack of scientific research are factors of some importance, other factors are of even greater import. These are the government policy, protective tariffs and other administrative measures. We can easily illustrate our case by taking the example of the sugar industry. This has been brought into existence by the protective tariff which was imposed on foreign imported sugar, as well as the research work which has been carried out for the breeding of improved varieties of cane, suited to the varied soils of the country. Before the protective tariff was imposed, there were of course a number of sugar factories in U. P. and Bihar, but they were mostly in

*Such a declaration was made in 1916, but the policy was never carried out.

a moribund state and never hoped to compete with Java. The measures of protection induced the Indian capitalists to come forward with their surplus money and establish in course of two years over 100 factories employing about 20 crores of rupees as capital. The industry had not to wait for the creation of a technical cadre. In fact, at first in most cases the higher technical staff was imported from foreign countries, but it has now been replaced mostly by Indian technicians.

The remarks which have been made with respect to the growth of the sugar industry hold equally, if not more forcibly, for many of the other industries which ought to be established in India. Take for example the manufacture of heavy chemicals like caustic soda, bleaching powder, sulphuric acid, fertilisers, etc. Almost all the essential raw materials for their manufacture exist in this country. What is wanted therefore is a country-wide survey of the occurrence of raw materials, of the sites of the industries and the methods of marketing the goods. These are the prime factors in the development of the industries and the National Planning Committee is expected to collect some useful information about them. Cheap power is an essential factor in the growth of industries but at present in many cases this is not available and its sources have not been properly surveyed. The second important factor is capital. The financiers are not sure whether the Government will continue protection of the industries after the war is over or leave them at the mercy of huge foreign syndicates commanding unlimited capital. If proper protection is guaranteed and steps be taken for the development of cheap power, as has been done in Madras, there should be no dearth of capital for the starting of several essential industries for which very little research is needed. The same remark applies to the starting of such industries as the automobile, and machinery manufacture. We are therefore afraid that by simply creating a Research Board without taking proper steps for planning of industries on a nation-wide scale the Government is ignoring the vital part of the country's problem.

The working of the Research Board, as far as we have been able to gather from the very brief Government *communiqué* leaves much to be desired. The proposed Board is to act purely as a consultative body. The officers working under the Board will continue to be recruited by the Government departments as usual. This procedure is absolutely different from that employed by the D.S.I.R. where all officials are recruited on the recommendations of the Advisory

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Council or some of its committees. We are of opinion that the Board should be a self-contained department attached to the Department of Commerce and its Advisory Body should be purely scientific and presided over by a distinguished non-official scientist. There may be one or two industrialists in it, but the main body of industrialists should be constituted into a separate board for planning and development. Further, the Advisory Body of Scientists should have the power of recommending to the Government the appointment of all officers directly employed by the Board and also help in directing the administration of all Government scientific laboratories, as is in the case of D.S.I.R. The recommendations of the B.S.I.R. should be mandatory. The Director of Scientific and Industrial Research whose duties, by the way, have been left beautifully vague, should be styled as the Secretary of the B.S.I.R. and its committees, and he should have direct access to the Member-in-charge of Commerce and be in administrative charge of the B.S.I.R., subject to control by its Advisory Board. The designation

'Director' should be reserved for those in actual charge of Government research laboratories.

The existing Government laboratories as well as those of the universities are not at all sufficient to cope with the amount of work which will have to be carried out if the problems are to be tackled in right earnest. It is necessary that several new research institutes be established with specific purposes, e.g., a National Physical Laboratory to standardize all instruments and meters used in commerce and industry, as well as to organise researches which require far costlier equipment than a normal university laboratory is expected to possess. In addition to the above, there are needs for a National Chemical Laboratory possessing both analytical and developmental sides. The Advisory Board should further be assisted by a number of standing committees for every important branch of industry, e.g., fuel technology, radio and communications, glass technology and many others which can easily be suggested by the Advisory Board after it has surveyed the needs of the country. In the work of the standing committees, scientific societies like the Indian Physical Society and the Indian Chemical Society etc. should be associated, and all possible scientific talents harnessed in the service of the country.

Equipment for Progress

We must confess that in the East our minds have dwelt more upon the peace of the Eternal One and not so much on the movement of its manifestation in the many. This mentality represents a kind of miserliness about one's spiritual wealth which tries to keep it secure by shutting it within a limited receptacle. Such narrow limitation of our world has produced in us a simplicity whose contents are small. It has given us long life, but not that vigour of life which is ready to earn a richness of experience in untried adventures. The river of Truth's ideals, which once sprang in the East from the ever wakeful personalities of great souls, has in course of centuries become stagnant, its flow of

inspiration choked by the reeds and rubbish of a lazy imagination.

* * * * *

Ideals of perfection have to be re-born age after age, taking new bodies and occupying new fields of life. Otherwise, if they end in mere thoughtless repetitions, human beings become puppets of the past with a ludicrous pride in the strings that produce perfectly correct gestures. Solemn doll's play of this kind could perhaps go on indefinitely if its stage were but secure from outward intrusion, and was not liable to be hustled out of gear by irreverent crowds who rudely snatch away its adornments for their own distant markets.

—Rabindranath Tagore.

A Resume of the Nature of our Globe

Hira Lal Roy

College of Engineering & Technology, Bengal, Jadavpur

Our knowledge is ever expanding and paradoxically we are every day becoming conscious of the limitations of our knowledge. At the end of the nineteenth century some prominent physicists, despaired of any further possibilities of probing into the mysteries of nature, advised experimentation for more accurate determination of the physical constants as the only avenue for further work. But within a decade the vast unknown region of subatomic phenomena began to reveal itself to the chemists and the physicists. Silent and helpless satisfaction with the Daltonic conception of atoms and molecules disappeared as if by a magic stroke and with the new knowledge acquired scientists became aware of the existence of still vaster regions of unknown.

From the dawn of human civilization different aspects of the natural phenomena around us are being observed. Gradually methods of observation have been improved and new facts accumulated. At every stage the inquisitive and philosophic minds tried to arrive at generalizations based on the facts so far gathered. But true scientists are Vedantic in their attitude, having no rigid attachment for the theories, and reject them as soon as they are found to be untenable according to new light. So theories are undergoing changes qualitatively as well as quantitatively. There is no finality because that means intellectual death of the human race.

The present theories regarding the composition of the earth are that it is composed of 92 different elements and their compounds, leaving aside their finer differentiations into subatomic particles and isotopes. In this article an attempt will be made to describe briefly our present knowledge about the distribution of these elements on the surface and the interior of the earth. It is as difficult to know the composition of the earth we live in as it is to know the distances of celestial bodies. The centre of the earth at a distance of only 4,000 miles from the surface is as unapproachable as stars at light-year distances. In both cases we are to depend on indirect evidences.

The first beginning of the material universe, if there be a beginning, is unknown and unthinkable. The limitedness as well as infiniteness of time and space are inconceivable, but we are to begin somewhere. With our present limited knowledge we may conveniently start from the origin of this tiny speck of material of somewhat spherical shape, which we call the earth. According to the latest generally accepted theory of Jeans and Jeffreys, the earth came into existence from the parent sun about 2,000 million years ago through tidal disruption by a passing star. For our present purpose, the importance of this theory lies in the supposition that the earth for a brief period after its creation was entirely in a molten condition, well stirred by convection and that the component substances were miscible in the liquid state, quite homogeneous in composition.

The period during which human intelligence has been observing the happenings on the earth's surface and its interior is infinitesimally short compared to its supposed age of 2,000 million years. Conditions existing in the interior is not open to direct observation; but mind of man is not to be baffled, what it cannot see directly it will see by inference. The picture of the changes that occurred during this vast period starting with a very hot liquid mass can be imagined from our knowledge of physics, chemistry and geology. It seems that the surface of this mass first solidified by cooling and then disrupted many times by eruption of hot gases and liquids from the interior. The crystallised and intricately distorted series of the oldest terrestrial rocks give evidence of an earth surface on which air and water played similiar parts as now.

The surface of the earth which could be studied directly is only a few thousand feet deep, one-fourth of which is land and three-fourths water. The solid below the bottom of the oceans has not yet been sufficiently studied except what could be gathered indirectly from geological studies of oceanic islands. The

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land surface could keep away fewer secrets because of its dissections by erosions into deep canyons. Scientists have studied these canyons at various depths and have been able to draw a more or less accurate picture of the rock masses that lie below the superficial layer of soil and sedimentary rocks. Underneath this comparatively thin crust there is mainly igneous rock, that is, rock that has solidified from molten magma. There is a very large variety of rocks as regards their composition and texture but yet a predominating amount of the visible igneous rock is either granitic or basaltic. According to the estimation of Clarke the outermost ten-mile depth of the earth's crust is composed of 95 per cent igneous rock, 4.0 per cent shale, 0.7 per cent sandstone and 0.25 per cent limestone. And though 90 out of the possible 92 elements have been discovered, only eleven of them form 99.5 per cent of the total weight of this crust. These eleven elements in the descending order of their abundance in the crust are—oxygen, silicon, aluminium, iron, calcium, sodium, potassium, magnesium, titanium, phosphorus and hydrogen with oxygen heading the list with about 50 per cent of the total weight of the crust. This estimate is based on the chemical analysis of about 10,000 samples of rocks.

Physical properties of the crust are more difficult to ascertain. The average density of the rocks forming the crust is found to be about 2.8 as determined from the densities of the rocks and minerals analysed and from their relative abundance. The temperature increases with the depth. The gradient may be determined from the theory of heat conduction if the following three factors are known:—(i) the age of the earth, (ii) the average amount of radioactive substances in the superficial rocks, and (iii) the temperature gradient at the surface.

The age of the earth, that is, the time that has elapsed since the solidification started is supposed to be about 2,000 million years. This is an approximate average of two results: astronomical considerations put the upper limit of the age at 3,000 million years and the lead-uranium ratio in the crust puts it at 1,500 million years. The very magnitude of these figures dispels any dissatisfaction at the percentage of accuracy of these values. The earth has been losing heat by conduction from the inner side to the surface and from there to outer space by conduction, convection and radiation.

This loss is being partially compensated by solar heat and heat generated by spontaneous disintegration of radioactive materials in the earth. The amount of radium in the rocks found at the surface is about three parts in a million million. The temperature gradient varies between wide limits from place to place; in some places it is 1°C per 18 metres and in others 1°C for 100 metres; the greatest depth in any boring is 12,800 feet (in Upton country, Texas, U. S. A.), the highest temperature that has been measured is 118°C in California at a depth of 9,000 feet. From all these observations the average temperature gradient in undisturbed regions is put at 0.03°C per metre. Based on these three studies (i), (ii) and (iii) the conclusion is drawn that below 300 kilometers (i.e., 186.3 miles) the temperature is nearly the same as it was originally; so the greater part of the earth is now as hot as it was when solidification first started.* The accessible portion of the crust is almost entirely crystalline, glassy or amorphous material being comparatively rare. About the physical structure of the deeper parts of the crust there is no complete agreement.

The description given above of the physical and chemical nature of the earth's crust has been drawn from more or less direct observation and inference. For a study of the conditions prevailing in regions below this thin crust we are to depend entirely on indirect evidence, though the conclusions drawn therefrom may not be less valid. The first idea was that the earth consists of a thin solid crust surrounding a molten interior. This notion of a true floating crust is now abandoned but the word (crust) is still used to designate the outer layer of about 30 miles depth with properties different from those of the materials below it. The most obvious and the first point in this connection was the difference between the average density of the earth as a whole and that of its surface layer. The value of the first was determined by Cavendish in the eighteenth century and the most recent determination of the same by Heyl puts the value at 5.52 whereas the average density of the surface layer as determined by Clarke and others is, as mentioned before, only 2.8. This fact clearly shows that the density of materials increases with depth, and at and around the centre of the earth

*After this article was written, it has been found in the January '40 issue of the *Colliery Guardian*, latest to hand, that the deepest drilling of an oilwell in California is 15,004 ft. The temperature gradient ranges from 196°F at 6,000 ft. to 268°F at 15,000 ft. or an increase of 1°F for every 125 ft. of depth.

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there must be materials with a density of 8, 10, or 12, depending on the thicknesses of the concentric layers. The question naturally arises whether the materials are of the same chemical composition but made denser and denser with the increasing pressure of the superincumbent layers or whether the materials are chemically different and denser. Experiments have been carried under pressures of more than 10,000 atmospheres on different kinds of igneous rocks but the compressibility even under these conditions cannot account for the great density of the materials in the interior of the earth. So the idea of chemical similarity of the materials in the surface layers and in the interior is ruled out. The present assumption based on the evidences to be described is that the core of the earth is composed of iron or rather iron-nickel alloy. In the order of abundance of elements in the surface layers iron occupies the fourth position. The analysis of meteorites, those strange visitors from the outer space, shows that they are mainly composed of impure iron and basic silicates approaching olivine in composition. Iron is also present in profuse quantities in the sun as shown by the spectroscope.

Of all sciences, pure mathematics is the most exact. In its applications to material bodies deviations are found because of variation of material bodies from the assumed ideal conditions but these deviations are minimum in the application of mathematics in astronomical calculations. This instrument of measurement has been utilized for the study of the interior of the earth. From the accurately known value of the constant of precession, moment of inertia of the earth about the polar axis is found to be 8.06×10^{44} gm. cm^2 . This is a quantity that depends on the distribution of density within the earth. For a given mass and for a given mean density, the moment of inertia depends on the distribution of light and heavy substances. A fly-wheel loaded at the centre, will spin less persistently than if the same load be distributed on the rim. Similarly from the known value of the moment of inertia of the earth, we can make a dependable guess at the distribution of density from the centre to the surface.

Volcanic eruptions and earthquakes are always dreadful and unwelcome, but they yield information which would be otherwise unavailable. The titanic forces of nature tear asunder the solid envelope called the crust and pour out hot gases and

molten lava from regions many miles underneath the surface which are inaccessible to us. These phenomena allow us to know the composition of these materials as well as the temperatures existing at these depths. By far the most direct and definite evidence concerning the interior of the earth is furnished by the earthquake waves in combination with the laboratory measurements on various rocks and minerals. When an earthquake occurs, elastic vibrations of various kinds are generated. One variety travels along the surface and is responsible for the damage caused by large earthquakes, *e.g.*, in Japan in 1923, in Bihar in 1933, and the last in Angora. More important for the present purpose are the two varieties that pass through the body of the earth. One of these "through waves" consists of longitudinal vibrations, analogous to ordinary sound waves in air; the other consists of transverse vibrations more nearly akin to light waves. Their formation is in accord with the conclusion from the theory of elasticity that any disturbance in an elastic isotropic material should give rise to the two kinds of vibrations, travelling with velocities depending only on the density and elastic constants of the material at each point. Earthquake waves, which have passed through the earth, are recorded by the delicate instruments of the seismologist, who is able to distinguish the different types of waves and to tell with high precision their time of arrival at various stations. From the observations we may construct for each kind of wave a "travel-time"-distance curve, which shows for any distance the time required for the vibrations to pass from the earthquake centre to the recording instrument. Subjecting the curve to a remarkable and intricate mathematical analysis, the mathematician finds the shape of the path along which the wave travels—it turns out to be curved—and finds also the velocity at each point of its path, that is, the velocity at various depths to which the waves have penetrated in their journey through the earth from focus to the recording station. The particular value of this velocity-depth relation lies in the fact that solely from laboratory measurements of the elastic constants of rocks we may calculate the wave velocity in various types of rock and thence, by comparison with the known velocities at several depths below the surface, make important deductions concerning the nature and composition of the material within the earth. The question was raised whether the rocks under high pressure and at high temperatures within the earth should not behave differently from rocks under ordinary conditions. As stated before, compressibility of rocks, change of their elasticity, and velocity of longitudinal and transverse vibrations under these abnormal conditions were

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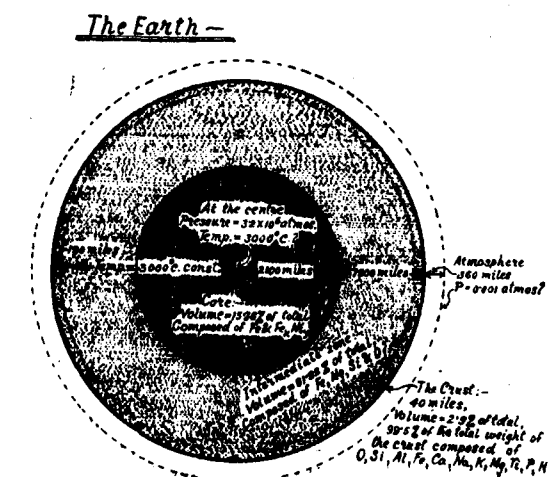
also studied in the laboratory and no reasons were found to doubt the conclusions stated in the previous paragraph.

These experimental studies and mathematical analyses indicate that the central core of the earth is composed of iron or an iron-nickel alloy with a diameter of about 4000 miles *i.e.*, about half the total diameter of the earth. This idea is confirmed by the moment of inertia determined by astronomical observations. This core is plastic rather than rigid, since it does not transmit transverse earthquake waves; it is non magnetic and therefore has no appreciable influence on the earth's magnetism; and the pressure at its centre, as is easily calculated, reaches the enormous value of 3,200,000 atmospheres. We know the core to be very hot, but the temperature at the centre cannot be easily determined with any satisfaction, but it is guessed to be about 3000°C. At about 768°C iron loses its strong magnetic properties, and it was suggested that the critical temperature of magnetisation may be increased by high pressures. But magnetic properties of iron and other ferromagnetic materials were studied at high temperatures under pressures ranging up to 4,000 atmospheres, and the final conclusion was that the effect of pressure on this critical temperature was practically nil.

In opposition to this conception of an iron, iron-nickel core there are other views expressed by some who think that the high central density is caused by the combination of atoms under the conditions of high pressure and temperature to form heavier atoms of various kinds. Others believe that under sufficiently high pressures the structure of all solids will collapse, leaving a material of the same chemical composition but of greatly increased density. On the other hand, various considerations indicate that the postulated transmutation of elements and collapse of crystal structure will take place only under pressures and temperatures of a higher order of magnitude than those existing in the earth, that is to say, in the interior of stars rather than in that of planets. (A very fascinating and instructive lecture on the "Constitution of the Stars" was delivered by Eddington at the Harvard Tercentenary Conference of Arts and Sciences).

Between the iron core and the surface crust lies the intermediate zone. The thickness of this region

is to be known from the study of the distribution of density required by the moment of inertia of the earth



and the change of velocity of the earthquake waves calculated by the mathematician from the seismographic records which point to a thickness of 2000 miles extending from the bottom of the crust to the top of the iron core. The striking features of this zone are the major discontinuities in the velocities of the earthquake waves at the upper and lower boundaries. Passing from the crust down through the upper surface of this region, longitudinal waves suddenly increase their speed to 8 kilometres per second. The laboratory measurements on the elasticity of rocks indicated that only two kinds of rock, dunite and eclogite, could support so high a velocity at the moderate pressures appropriate to a depth of about 30 miles. Weighty evidence showed that dunite is the more probable constituent of the intermediate zone. If this be true it would mean that the shell, *i.e.*, the intermediate zone is composed of this olivine rock, magnesium iron orthosilicate. The volumes of the earth as a whole excluding the gaseous envelope, its iron core, intermediate zone, and the crust are approximately in the ratio of 25.83: 3.943: 21.137: 0.75. So more than five-sixths of the earth's volume lies in the intermediate zone, and if this contains mainly dunite (magnesium iron orthosilicate) then the four elements Mg, Fe, Si, and O will predominantly form the total mass of the earth, other elements being present only in minor quantities. But this conclusion, granting virtual monopoly to these four elements in the mass of the earth, has been shattered by some recent experiments which show that another mineral, a diabase, also fulfils the requirements of the seismologic observations of the velocities of the earthquake waves. So the composition of the intermediate

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zone remains uncertain. From observations on the tidal deformation of the surface the earth has long been known to be as rigid as steel and the seismologic data indicate that the rigidity increases with depth. But it is not known with any certainty whether matter in the intermediate zone specially is glassy or crystalline.

From facts known up till now the early history of the earth seems to be as follows. The primitive molten magma consisting mainly of magnesium iron silicates with smaller amounts of other oxides including water together with a considerable amount of metallic iron, first separated into two layers—the molten iron below and the silicate magma above. The silicate magma then began to crystallize at the bottom. As the solid

layer increased in thickness, the minor constituents, including water, were concentrated in greater and greater extent in the remaining liquid. Finally, when the liquid layer had been reduced to a thickness of a few tens of kilometers, and was much richer in the originally minor constituents, the crust of the earth was formed. Innumerable chemical changes which must have taken place in that dim past on such a vast scale under abnormally high temperature and pressure conditions have not been reproduced for verification in the laboratory and the picture drawn above is only a tentative conjecture.*

*Most of the experimental work from which these conclusions have been drawn has been carried out in the U.S.A. in the Geophysical Laboratory of the Carnegie Institution, Department of Geological Survey at Washington and at Harvard University, the workers being Clarke, Adams, Barrell, Piggot, Coker, Birch, Francis, Dow, Bancroft, Repetti and others.

Joint Easter Session of Scientific Associations at Bangalore

A JOINT Easter Session of seven scientific associations, (1) The Association of Technologists, Bangalore, (2) The Indian Academy of Sciences, (3) The Indian Chemical Society (Madras Branch), (4) The Institute of Chemistry of Great Britain and Ireland (Indian Section), (5) The Society of Biological Chemists, (6) The South Indian Science Association, and (7) The Technical Association, Bhadravati—was held in Bangalore during Easter week from the 22nd to the 26th March, 1940.

The Session was presided over by Sir C. V. Raman, Kt., F.R.S., N.L., who delivered an inaugural address on Friday, the 22nd March on an important discovery he had made recently in collaboration with Mr P. Nilakantan in the physics laboratory of the Indian Institute of Science. Sir C. V. Raman said that the thermal agitation in solids and liquids can be conceived to consist of sound waves of high frequency traversing the medium. The presence of such waves

can be demonstrated by their effect on a beam of light, which is scattered with a small change in its frequency on account of the movement of the sound waves having a vibration frequency of about a thousand million per second. Using X-rays in a corresponding experiment, the presence of such thermal sound waves with vibrations five thousand times quicker still, has now been established. The reflection of X-rays by these sound waves gives on a photographic plate, observable spots whose intensity increases when the crystal is heated. These sound waves tend to congregate in layers parallel to the cleavage faces of the crystal. This important discovery opens out a wholly new method of approach to studies of the solid state and the fundamental nature of the vibrations of the particles constituting it.

The inaugural address was followed by a symposium on High Temperature Technique in Industry. Dr J. C. Ghosh, Director, Indian Institute of Science, opened the symposium with a paper on gaseous fuels

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in which he dealt with the catalysts which had been successfully developed to increase the calorific value of water gas. Dr Ghosh also made some suggestions for the utilisation of the three thousand tons of oxygen released as a waste product by the Mysore Chemicals and Fertilisers at Belagola near Mysore. In a paper on Modern Trends in Heat Insulators and Refractories Mr B. Viswanath, General Manager, Mysore Iron & Steel Works, Bhadravati, gave an interesting account of the experiments made in his works on the production of various kinds of refractories, such as are bricks etc., used in the production of iron and steel. Dr M. A. Govinda Rau of the Indian Institute of Science presented a paper on heat balance in furnaces in which the economics of the technique of heat production within an enclosed space were discussed. The theoretical and practical aspects of the measurement and control of high temperatures were described by Dr K. S. G. Doss of the chemistry department, Central College, Bangalore and Mr M. B. Shankar of the Mysore Iron & Steel Works. Mr N. V. Junnarkar of the department of electrical technology, Indian Institute of Science gave an account of the principles and construction of industrial electric furnaces. An interesting paper on high temperature furnaces in the glass industry was presented by Mr G. P. Ogale of the Mysore Glass & Enamel Works in which the author discussed the economics of the various types of furnaces used in the glass industry. Mr Ogale suggested that in a State like Mysore where cheap electric power is available, the possibility of using electric furnaces in the glass industry should be very seriously considered. Mr H. N. Ramachandra Rao of the Government Porcelain Factory gave an interesting account of an electric tunnel kiln in course of construction in his factory. He discussed the relative advantages of the electric tunnel kiln and the ordinary coal-fired kiln used hitherto. Among other papers presented at the symposium were interesting accounts of high temperature technique as applied to the manufacture of cement, paper and cast iron mouldings.

Prof. B. Sahni F.R.S., presided over a scientific meeting on Saturday morning at which original papers on biological sciences were read. A group of papers on fossil algae by Prof. L. Rama Rao and his students roused a good deal of interest. On the evening of the same day Dr H. J. Bhabha gave a very interesting public lecture on "Stellar Chemistry."

On Sunday, the 24th March, a scientific meeting was held with Sir C. V. Raman in the chair at which original papers on physical sciences were read. Dr H. J. Bhabha gave an important paper on the effect of the spin of an electron on electro-magnetic radiation. Mr B. Viswanath, General Manager, Mysore Iron and Steel Works, Bhadravati, delivered an excellent public lecture on "Iron and Steel Industry in Mysore" in the course of which he gave a very graphic account of the history of the Mysore Iron and Steel Works, Bhadravati.

On Monday morning Rajamantrapravina N. Madhava Rao, B.A., B.L., First Member of Council, opened an exhibition of industrial machinery and scientific instruments manufactured in the Mysore State. The object of this exhibition was to take stock of the potentialities and facilities for the manufacture of scientific instruments and industrial plant in the State. A number of local firms and institutions took part in the exhibition which was very much appreciated by all industrialists. Among the exhibits may be mentioned the castings and sugar crushers made by Messrs. P. M. Madurai Mudaliar & Sons, Bangalore, the drilling machine, lathe, steriliser, presses etc., manufactured by the Government Electric Factory, Bangalore, the textile machinery made by Messrs. The Mysore Leo Engineering Co., Bangalore, the laboratory glassware produced by the Mysore Scientific Instruments Syndicate, "The Flying Flee" (an aeroplane) and the precision electric clock designed and manufactured in the department of electrical technology, Indian Institute of Science and various pieces of scientific apparatus made in the physics department, Central College, Bangalore. The exhibition was open on the 25th and the 26th March, 1940.

A convention of technologists was also opened on Monday morning by Rajamantrapravina N. Madhava Rao. Dr. D. A. Rama Rao, Officer-in-charge, Wood Preservation Plant, Bhadravati, read an interesting paper on "The Ascu Process." Dr Rama Rao said that though it was too early to give a final opinion about the process, his experience had been that it was very promising and well-worth trying out. Reports of work done during the past year by the Association of Technologists, Bangalore and the Technical Association, Bhadravati, were read by the general secretary and office-bearers were elected for the ensuing year.

The Session concluded with a delightful popular lecture on the "Romance of Glass" by Sir C. V. Raman.

C. Varadhan

Electrical Rhythm from the Human Brain*

Basu Kumar Bagchi

Bose Research Institute

THE recording of spontaneous electrical oscillations of the human brain off different parts of the unopened skull, first accomplished by Berger (1929), has been made possible by the increasing perfection of electrical instruments such as galvanometers, oscillographs and also thermionic valves. Electroencephalography—the recording of brain potentials—comes under electrophysiology which was born accidentally in Galvani's laboratory in 1786. It is a discipline in which physics has been pressed into the service of biology and which has incidentally furnished another instance of the fruit of co-operation between two branches of science. With an improved technique it is comparatively simple to record action potentials of peripheral nerves, as these nerves can be usually isolated for the purpose. Brain cells on the other hand being much more complicated in their structural configuration and functional inter-relationship almost defy individual study. Hence most of the attention has been devoted to the investigation of peripheral nerves.

Recording From Peripheral Nerves

Let us mention one or two points regarding their electrical response before passing on to that of the brain cells. If two places on the surface of a peripheral nerve† are connected by electrodes to the ends of a galvanometer, no current will flow between them, they will be equipotential. But if any point on its surface and one on its cut-end are thus connected there will be a steady potential of about 50 mv., the cut-end being negative to the surface. Now if that potential is balanced out with the help of a potentiometer and some sort of a stimulus is applied to the nerve surface and the response recorded on an oscillograph, there will be a monophasic potential which will attain its peak (called alpha spike) of about 2.5 milli-

volts from the base line in less than half a millisecond and after a small beta and gamma hump (these three together being called A response) will come down almost to the base line, rising again to a very small B hump and a C hump, all in less than 300 milliseconds (Erlanger and Gasser). These potentials correspond to the responses of three types of nerve fibres composing a nerve and having different diameters and speeds of conduction. If, instead of one point on the surface of the nerve and one on the cut-end, two points on its surface, a few centimeters from each other, are connected to the recording instrument and the nerve is stimulated, we shall have not a monophasic but a diphasic response which masks the above details. This response is the electrical accompaniment of a nerve impulse. And yet, unlike an electrical current, a nerve impulse has a very limited speed, about 300 ft. a second (for a mammal's medullated nerve at 37°C). Moreover, it is not caused by the movement of free electrons over a conductor as in the case of the electric current. A nerve impulse is considered to be due to the progressive depolarization by a stimulus of its semipermeable membrane, the outer and the inner surfaces (the electrical double-layer) of which are, under ordinary circumstances, positively and negatively charged respectively because of its differential permeability to ions (K, Na, Cl). To put it in an oversimplified way, a nerve fibre is a large number of cylindrical condensers, or rather rings of condensers, placed one after the other and joined by semiconductive material, which under ordinary conditions have their outer and inner plates positively and negatively charged to about 50 millivolts; a stimulus coming in contact with the first ring makes its plates, separated by the semipermeable membrane (the dielectric), discharge; which discharge acts as a stimulus for further discharging of other plates in the successive rings of condensers down the fibre, thus giving rise to the sweeping wave of the nerve impulse (Hill). A nerve impulse may be likened to a stream of discontinuous shots from a machine gun or to a train of burning gun powder, and not to a steady flow of water from a water hose (Adrian).

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Spontaneous Discharges

Isolated nerve cells produce spontaneous repetitive discharges following injury (Adrian, Gasser). Again without the apparent presence of a stimulus or injury, which is a form of stimulus too, some autonomic ganglion cells are also known to give out oscillating potentials spontaneously e.g., the cell body in the *Limulus* heart ganglion (Heinbecker). Nerve cells of the brain may be supposed to behave spontaneously in some such way though there are obvious differences. It is not known definitely whether the potential difference develops between the two adjacent surfaces of the cell body or the cell body and the cell fibre, nor is it known how it develops and distributes itself through the inside and outside of the skull. What is known however is that the electrical rhythm that is recorded is a composite picture of the potentials of a large number of cells, Berger says, of the whole brain, and Adrian says, of the visual part (back part of the brain), working in phase. Lately Adrian (*Proc. Roy. Soc., B.*, 126, 433, 1939) seems to have slightly modified his view. It is becoming quite evident that different parts of the brain, and not simply the visual part, give rise to this rhythm with some definite local variations and that the sub-cortical centres probably make some contributions to its performance (vide review by Bagchi in *Calcutta Medical Journal*, 36, 334, 1939). Although these facts are new, the study of brain potential is not altogether new. In 1875 Caton first observed a potential difference in a rabbit's brain on a galvanometer and other workers as late as 1924 observed such phenomena on operated animal brains, but the lack of sufficient thermionic amplification was in part responsible for their missing a great deal of detail of the response. Even to-day it cannot be said that our knowledge of the electrical response of the brain has made more than just a beginning.

Procedure

With the exception of minor details the procedures used in different laboratories for leading off potentials from unanaesthetized human beings are fundamentally the same. We shall mention here a few details of the method we are following in our work at the Institute. The subject is comfortably seated in a dark, specially constructed semi-soundproof, electrically shielded room. Several electrodes made of solder pellets

(1 cm.×1 cm.×1 mm.) are securely fastened on the surface of different parts of the skull and connected to the input terminals. One of the electrodes is on an inactive region like the ear or mastoid bone. The potentials are amplified about a million times by means of a specially built balanced input 4 stage push-pull low frequency amplifier and recorded by means of a dynamic ink-writer on a uniformly moving paper tape outside of the subject's room (Bagchi and Roy, details to be published later). A cathode ray oscillograph can easily be used at the output instead of the ink-writer. By means of a switch board operated from the outside, recording can be done from any pair of electrode combinations. The time constant of the amplifier is .5 sec., with the coupling condensers as large as 4 μ fd. The frequency response is dependable from 1 to 40 cycles per second. The use of large cathode resistors is quite helpful in neutralizing extraneous signals to the grid (Loomis, Harvey and Hobart).

Characteristics of Brain Rhythm

When a subject is relaxed physically and mentally, the 9 to 10 per second waves, called the alpha waves,

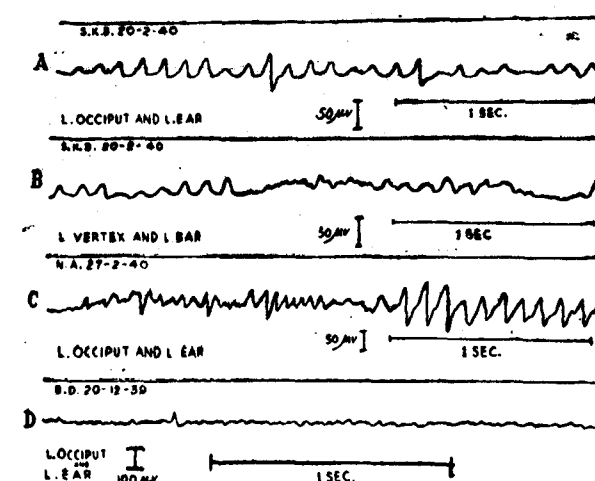


Fig. 1. Electroencephalograms of three human subjects. See Text. Time in seconds is marked by horizontal lines and 50 and 100 microvolt calibrations by vertical lines. This and the succeeding figures are to be read from left to right.

with an amplitude (size) between 20 to 100 microvolts can be recorded (See Fig.1-A,-B,-C). But their occurrence per unit time (say 3 minutes) varies with individuals. Some have alphas 100 per cent of the time, some less than 5 per cent of the time, and others

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anywhere between 5 per cent and 100 per cent of the time. The amplitude, pattern and modulation of the waves are different between one person and another (compare Fig. 1-A with 1-C). Like a person's voice his brain waves are characteristic of him (Davis). Identical twins have identical brain wave patterns. What is called beta waves having in this instance a frequency of about 17 per second and an amplitude from 10 to 70 microvolts and also alpha waves having a frequency of about ten per second are seen in Fig. 1-C. Subject B.D. who is a rare alpha type shows only beta waves of low amplitude with a frequency of about 22 or more per second in Fig. 1-D. Usually the occiput (the back part of the brain) gives waves of higher amplitude than the vertex (top of the head). Compare A with B in Fig 1. Light is the most effective stimulus in reducing or obliterating the alpha rhythm.

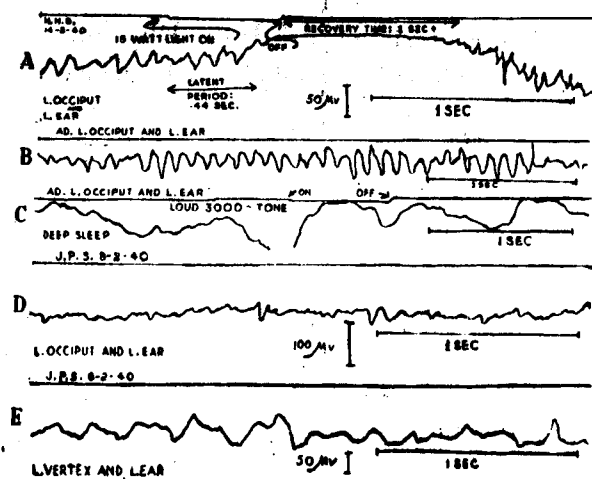


Fig. 2. Human electroencephalograms under different conditions. See Text. Time, calibrations and other details are noted on pictures.

In Fig. 2-A a 15-watt light completely abolishes the waves within .44 sec. which is called the latent period or lag. Despite a good explanation by Adrian it is difficult to evaluate in detail the occurrences in the brain within this short latent period after the stimulus has been presented and during the disturbance of the rhythm that follows. Within about a second after the light is off the waves come back again with an "off" effect. One second may be called the recovery time which sometimes stretches to 8 sec. There is no relationship (Bagchi, *Science and Culture*, 5, 559, 1940) between the latent period and the recovery time

(number of cases: 64, Pearson's product of moment correlation: -.24). Concentrated thinking, apprehension, startle, strong emotion and objective stimuli of other modalities than vision also affect the rhythm.

The brain rhythm can get accustomed or adapted, more or less, to a continuous stimulus attack (Bagchi, *Jour. Psychol.*, 3, 463, 1937). Fig. 3 shows how in the presence of a steady 500 cycle



Fig. 3. The effect of a continuous tone (500 cycles) on a human electroencephalogram. 25-cycle time line is on top. Brain wave line is in the middle. The moment of stimulation by the tone which is kept on is noted at the bottom. A Westinghouse Duddell Type of Oscillograph was used.

tone the brain rhythm after the usual latent period (A to B) and a depression (B to C) regains and in this case exceeds its prestimulus amplitude. This happens also in the presence of a continuous light, though in a slightly different way. Fig. 4 shows how an unexpected loud call of the subject's name at first disturbs his alpha rhythm and how after the 16th call, and particularly after the 36th,

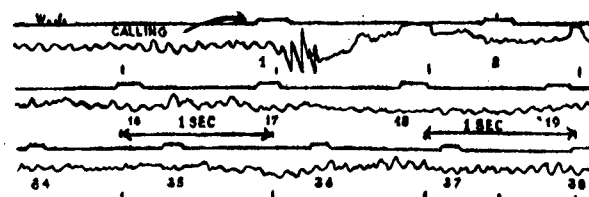


Fig. 4. The effect of repeated calling of a subject's name on his electroencephalogram. It shows the phenomenon of amplitude adaptation as in Fig. 3. See Text.

his brain waves remain apparently unaffected by the call. All this indicates that the brain can reassert its normal moving equilibrium at a high excitation level which must accompany a continuous disturbance and which could not be present before that disturbance began.

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Sleep invariably changes brain waves (Loomis, Harvey, and Hobart; Blake and Gerard; Jasper; Bagchi). The waking waves of a subject are seen in Fig. 2-B; within about half an hour the subject is in deep sleep (Fig. 2-C) when his irregular potentials of high amplitude are seen coming with a recognizable frequency of $1\frac{1}{4}$ to $1\frac{1}{2}$ per second. A loud 3,000 cycle tone can not wake him up or change his waves substantially. Sometimes all parts of the brain do not go to "sleep" at the same time (Loomis *et al*).

Overventilation of the lungs with O_2 and N_2 pushes the waves to the slow side of the cortical frequency spectrum (Gibbs, Gibbs and Lennox). A dead man's brain or an animal brain which is denuded of blood supply or whose blood sugar has been reduced to less than 23 mgm per 100 c.c. practically shows no waves (Maddock, Hawkins and Holmes). Stutterers' non-stuttering speech reveals significant brain wave changes over those of normal human beings' speech

(Travis). Two sides of the brain of left-handed and ambidexterous persons electrically work out of phase and have unilateral blocking more than is the case with right-handed persons (Lindsley). By characteristic changes on the electroencephalogram brain tumors or brain lesions can be localized (Walter; Williams and Gibbs). Nervous and mental cases can also be fruitfully studied from the brain wave angle. Important work along this line is being done by several workers. In Fig. 2-D are found an epileptic's brain waves recorded from the occiput during a non-seizure period. The waves are perfectly normal, being of the alpha type with a few slow waves coming in now and then which are not shown here. But from his vertex (Fig. 2-E) are coming many slow and large waves which can not be usually found in normal persons. If the epileptic had a seizure during the time of recording, he would have shown a very definite pattern of brain waves found in such and no other cases.

This brief account seeks no more than to indicate that electroencephalography has opened a new chapter in electrophysiology, physiological psychology and clinical medicine. Its uses and possibilities can be increasingly demonstrated only by further research.

Search for Truth

It is true that he who wants to realise truth, not merely through self-control, but also through freedom, is assailed by dangers and difficulties; but as a brook finds its voice more fully as it trips over its bed of flints and stones, this very resistance brings a richer music into his life. For those who are in love with a serene slothfulness, with whom every movement in

the direction of active creative effort weighs as an offence against the ancient dignity of tradition,—their being is smothered under exuberant growths of disease and distress, poverty, insult and defeat. They are punished with the deprivation of freedom because they try to keep Truth fettered.

—Rabindranath Tagore.

Animals and Demons in Indian Cave Art

M. E. and D. H. Gordon

REPRESENTATIONS of animals in Indian cave art are every whit as numerous as those of human beings. In the shelters of the Mahadeo Hills we find a large selection of animals, in depicting which the artists followed the same successive styles as they employed in producing the human figures.

The range of animals to be found on the walls of the shelters is considerable. By far the most common are sambhur stags and does, these appear in the 1st Series and are frequent in all Series down to the fifth. These animals are and must always have been, extremely common in the local jungles, and have formed a notable part of the domestic economy of that period. The same may be said for the ox which is the next in popularity as an animal subject. The ox makes its appearance with the Early 2nd Series as does the horse, though the latter does not become common until the Early 3rd. The elephant is the next most common, and in addition the following animals find their place—tiger, panther, spotted deer, monkeys, bear, wild boar, hare, crocodile, porcupine, and possibly hyena. Of the domestic animals there are, besides the horse and the ox, the goat and the dog. Birds are also depicted, particularly the peacock and the jungle cock, and fish also make their appearance.

A strange omission is the snake. Considering the part that snakes played and play in the ritual and belief of most primitive and many more sophisticated peoples, it seems incredible that in this welter of paintings one should not be able to point to a single example which depicts unequivocally a snake. In two instances only is there a possibility of there being a snake intended; one is an object, which is shown in Plate XIII d, *Indian Art and Letters* No. 1, 1936, which may be a cobra but might just as well be a lotus or some such plant; the other shows what may be a man holding a snake, but it is even more doubtful.

From the available material we have selected what we believe to be a very representative series of animals. Plate 1 shows animals of the 1st and 2nd Series, and comparison may be made with the animals shown in a previous issue of the journal (*SCIENCE*

AND CULTURE 5, 269, 1939). Interesting comparisons may also be made with the animals from Khobar shelter, Mirzapur, shown on the same page. The bull in the bottom left corner has the same style of triangular legs as is found in some of the rare Early 1st Series, and the sambhur doe, fig. e, shows the early 2nd Series in its most primitive form. Remark has already been made in a previous article on the examples of sambhur does with elongated necks, these are sufficiently common for one to be quite certain of their identification.

Plate 2 starts off with examples, more common in the second series than in any others, of men in conflict with wild beasts. These are followed by a series of strange animals all quite definitely, by colour and association, of the Early 3rd Series. It is quite impossible to identify the strange animal in the cartouche and the same applies in an even greater degree to the curious creature with a long tail and projections all over its head. One thing quite certain is that this latter is not a survival from the Miocene or even more remote geological periods, but merely an eccentricity of the artist. It is unlikely also that fig. e is a man-headed animal; if it is, it is the sole example, and as no single human figure is of this bearded type, the attribution of bison is as likely to be correct as any other. Fig. f is almost certainly hyena, an animal quite common in the neighbourhood; we can think of no other more plausible identification. Fig. h is interesting, there is something very upper palaeolithic about the high-humped forequarters of this animal. Nothing can however alter the fact that it is of the Early 3rd Series and dates from possibly about the 2nd or 3rd century A.D.

At the top of Plate 3 are two figures illustrating interesting artistic conventions. The horned animal on the left is formed by two lines one within the other, the upper forming the back and indicating two of the legs and the lower the under side of the animal and its other two legs. This convention is extremely wide spread, being found all over North Africa, and also in Southern Arabia and Chili. Origin by diffusion

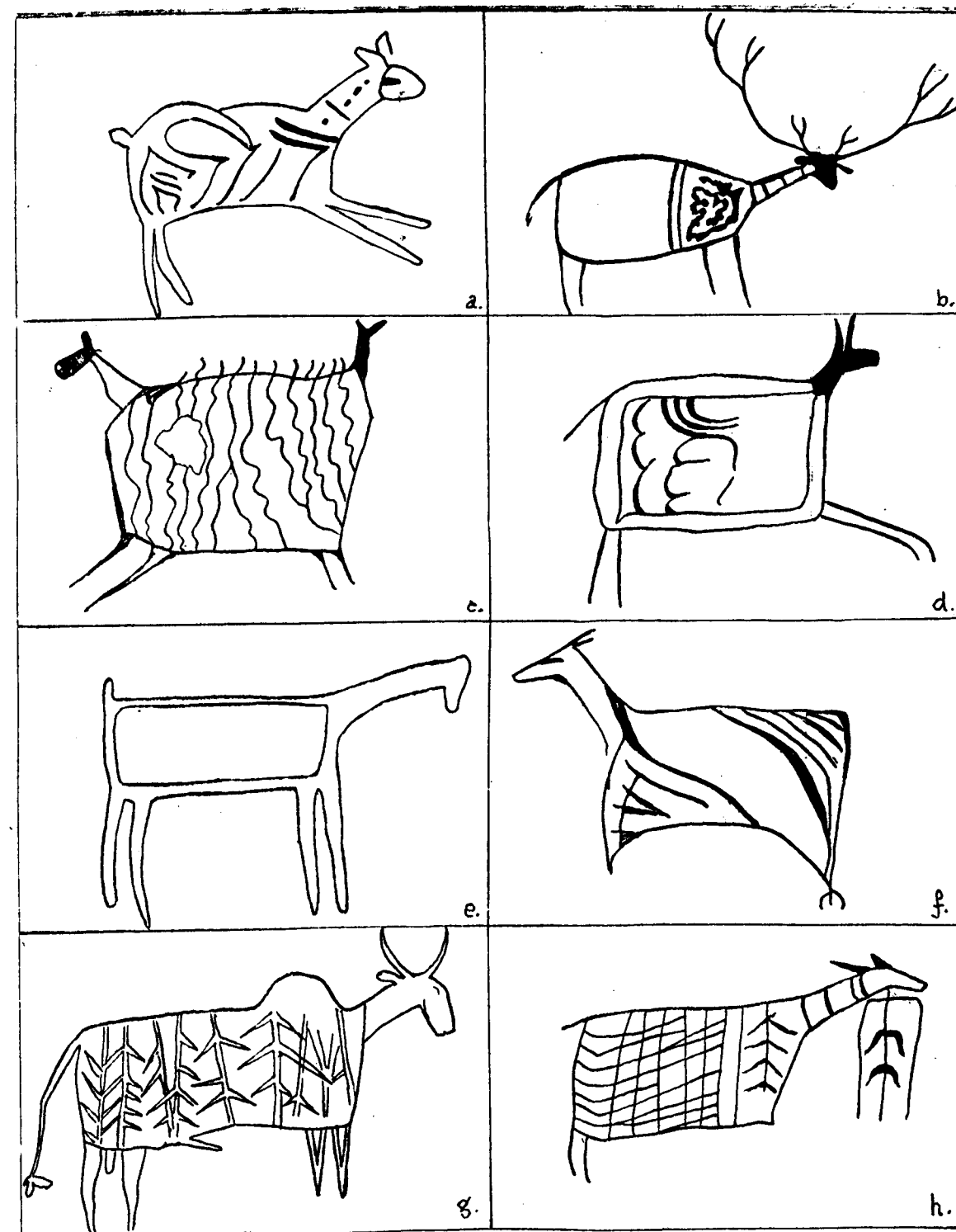


PLATE 1.—(a) Sambhur doe, red and cream, Early 1st Series, Dorothy Deep Cave. (b) Sambhur stag, red, Late 1st, Monte Rosa No. 4. (c) Sambhur doe, dark purplish red, Late 1st, Son Bhadra. (d) Sambhur doe, Dark Maroon, Late 1st, Tamia. (e) Sambhur doe, grey, Early 2nd, Jhalai. (f & h) Sambhur does from Khobar shelter, Mirzapur Dist. (g) Bull, Early 2nd Series, Greyish Yellow, Jambu Dwip No. 1.

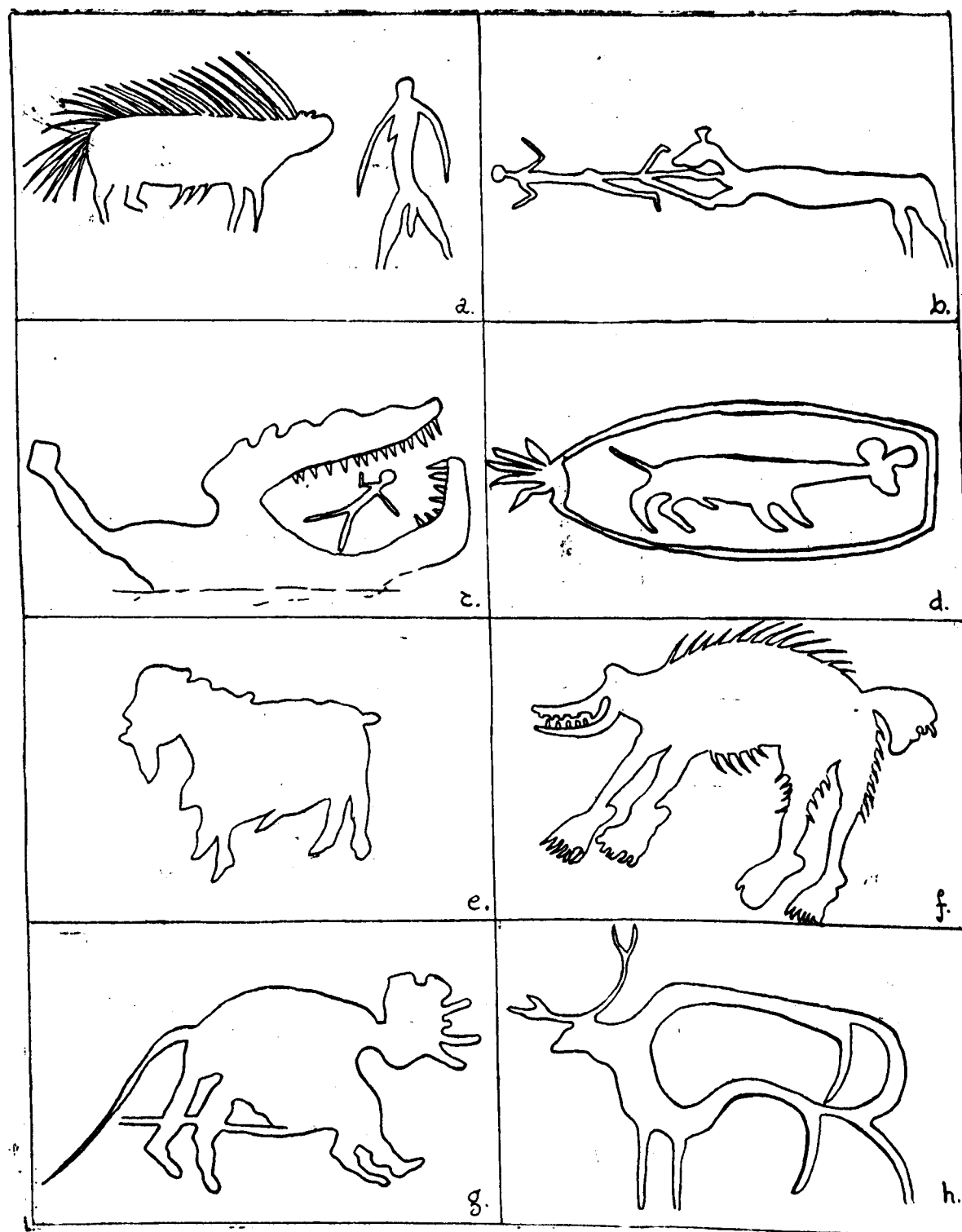


PLATE 2.—(a) Man confronting giant porcupine, cream, Early 2nd. Jambu Dwip No. 4. (b) Man siezed by tiger, grey, Early 2nd. Bee Nullah No. 2. (c) Crocodile, White, Late 2nd, Marodeo 2nd Group, No. 1. (d) Unknown animal, Pink, Early 3rd. Mahadeo cave. (e) Bison (?), dark red, Early 3rd. Jambu Dwip No. 3. (f) Hyena (?), dark red, Early 3rd. Jambu Dwip No. 4. (g) Unknown animal, Pink, Early 3rd, Jambu Dwip No. 4. (h) Sambhur Stag, Pink, Early 3rd Maghew Peep Cave.

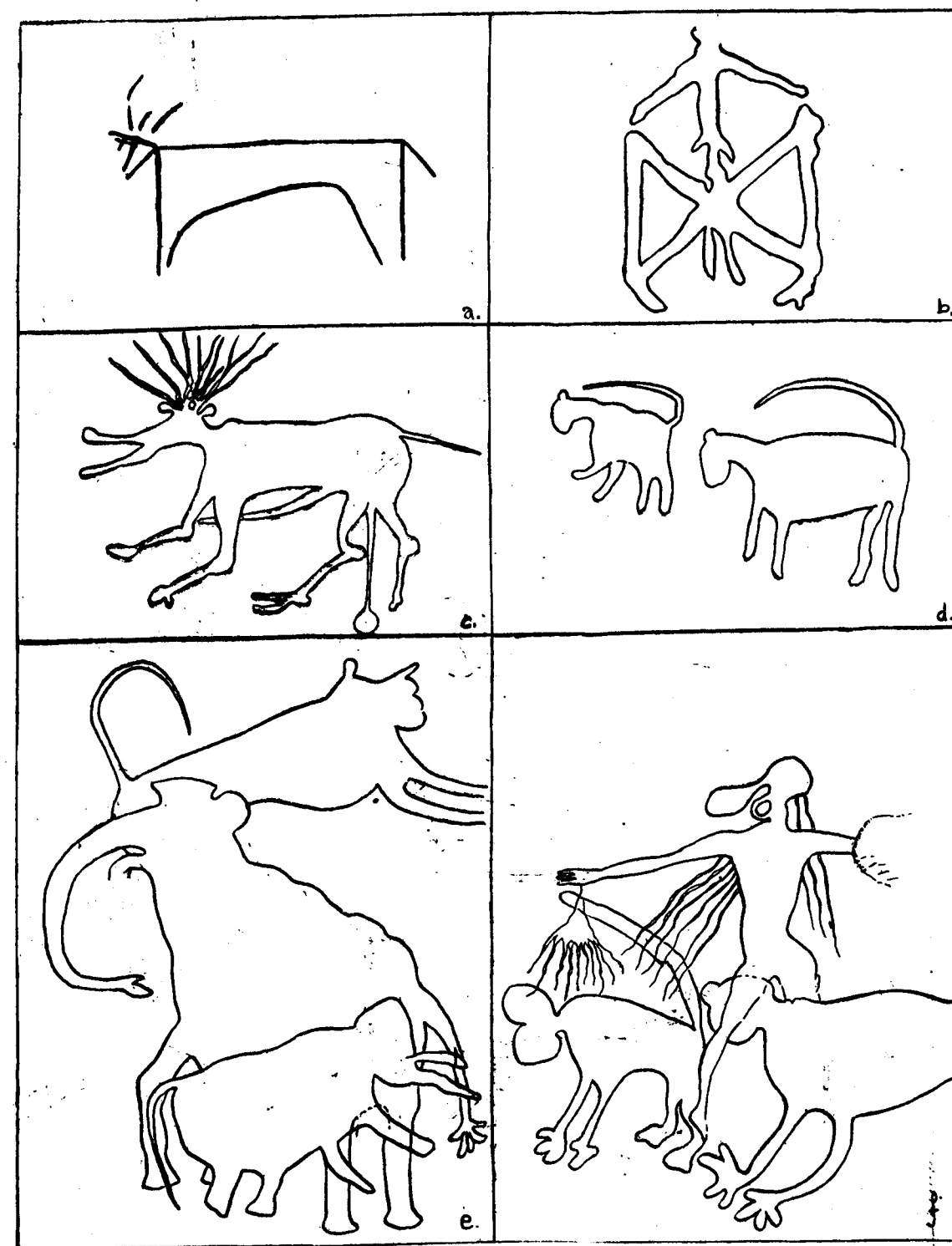


PLATE 3.—(a) Ox (?), dark red, Early 3rd. Jambu Dwip No. 4. (b) Stylised horse and rider, pinkish mauve, Early 3rd. Mahadeo Cave. (c) Grotesque Sambhur Stag, Creamy white, Late 3rd, Marodeo 1st Group No. 3. (d) Panthers, Likhunia shelter, Mirzapur. (e) Two elephants, the larger one Early 3rd. superimposed on Tiger, Late 2nd, Jambu Dwip No. 4. (f) White figure Late 3rd, superimposed on two panthers, cream, Late 2nd, Jambu Dwip No. 3.

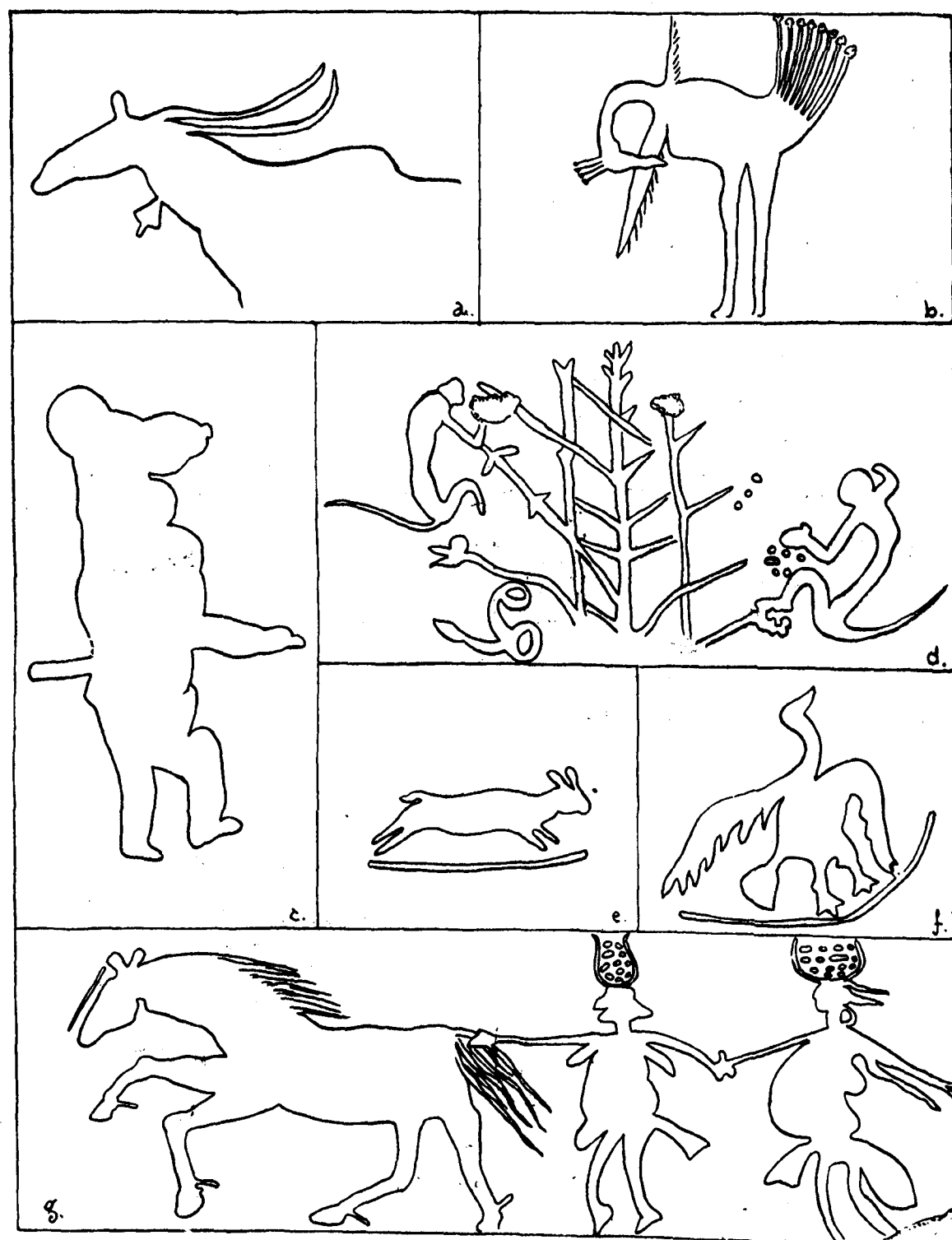


PLATE 4.—(a) Ox with bell, white, Late 3rd, Mahadeo Cave. (b) Peacock, White with red outline, mediaeval, Son Bhadra. (c) Dancing Bear, white, Late 3rd, Marodeo 1st Group No. 2. (d) Monkeys, cream, Late 2nd, Monte Rosa No. 1. (e & f) Hare and Bird, white, Late 3rd, Mahadeo Cave. (g) Horse and Women, white, Late 3rd, Chhota Mahadeo Cave.

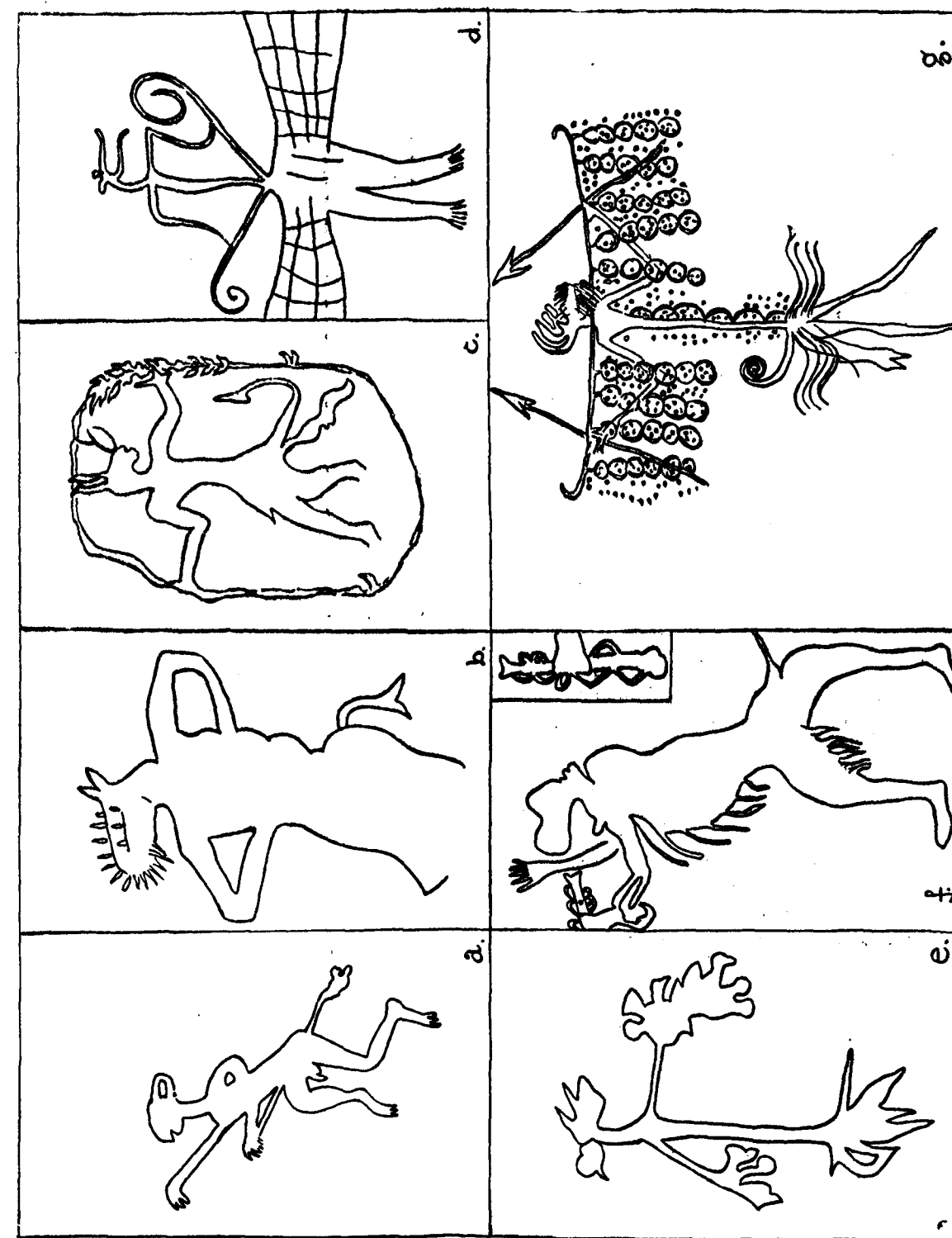


PLATE 5.—(a) Leaping demon, pink, Early 3rd, Jambu Dwip No. 4. (b) Horse headed demon, white, Late 3rd, Marodeo 1st Group No. 2. (c) Horned demon, white with red outline, Early 4th, Jambu Dwip No. 4. (d) Demon grasping tails of tigers, red outline, Late 4th, Jambu Dwip No. 7. (e) Grotesque horned demon, pinkish white, Early 3rd, Monte Rosa No. 1. (f) A piping Ape-figure, greyish white, Late 3rd, Upper Dorothy Deep. (g) Horned demon, cream, Late, Bori.

ANIMALS AND DEMONS IN INDIAN CAVE ART

appears to be extremely improbable. The figure on the right shows a rider on a horse; here conventionalisation has been carried to extremes. Examples of other somewhat less conventionalised "X-pattern" horses are to be seen at Adamgarh Quarry, Hoshangabad, and Nimbu Boj Cave, Pachmarhi.

The grotesque sambhur stag from No. 3 cave Marodeo 1st Group may quite possibly be a fertility figure, though, from a survey of the paintings as a whole, we feel that this is probably not the case and that it indicates a form of crude humour. While on this subject it may not be wholly out of place to state that we consider that the outlook of early and possibly primitive peoples has been strangely assessed, in default of the possibility of certain knowledge. It is probable that to a considerable extent they lead lives of some hardship, though even this may be exaggerated, but even so, why all their artistic products should have been an adjunct of ritual, connected with ideas of religious awe and the reproductive principles of nature is hard to comprehend. We feel that exaggeration in some cases is due to the appeal that the grotesque makes to even the most rudimentary sense of humour.

The panthers from Likhunia Shelter, Mirzapur, have a strong family likeness to those from Pachmarhi shown below, and date possibly from the 1st Century B. C. to 1st Century A. D. The remaining animal figures are self-explanatory examples of the animal art of these caves. The peacock on Plate 4 is interesting as it depicts this bird performing its courting dance. This is however one of the many paintings in the two Son Bhadra caves which may date from the 14th

Century or later, and be associated with the ruined fort which exists on the hill immediately above the caves.

In *Memoir* No. 24 of the Archaeological Survey of India, Manoranjan Ghosh quotes an earlier authority as saying that painting of rhinoceros exists in the Mirzapur caves, it appears however that he himself and his collaborators were unable to confirm this assertion as they neither record nor reproduce any such painting. In view of the importance and interest that such a painting would have, it is hard to believe that they would have failed to record it had it in fact been present. Discoveries of this nature require careful verification before they are committed to publication. In this connection the instance of what appeared to be rhinoceros depicted in one of the Son Bhadra shelters is worthy of mention. This painting certainly on more than casual inspection appeared to be that of an rhinoceros, its legs however were much too thin, and a more prolonged inspection revealed that it was a wild boar, one tusk being shown pointing upwards in the exact position for the horn of a rhinoceros and the other, which was very indistinct, pointing downwards below the snout.

The horned and animal-headed Demon figures are not present in any great numbers. They are interesting however as being the only paintings which appear in any way to have a bearing on the beliefs of the people who executed them. They are mostly Late rather than Early, there being so far no such figures which one can place earlier than the Early 3rd Series. There is none of them which is outstandingly phallic in character, in fact the phallic element is conspicuous only by its absence throughout the whole range of rock paintings in India.

Migration of Birds *

M. L. Roonwal

Zoological Survey of India, Calcutta.

Method of Study

THE first method to study bird migration is observational. We observe year after year that birds of species A are common in Bengal only in winter and are not found in this province during summer or the rains. The birds must be going somewhere outside Bengal. Other observers find that these birds are found in summer in Siberia and nowhere else, and that they breed there. And so we conclude that birds of species A are migratory in habit—they breed in Siberia, and visit us in winter. Such places as lie in the path of the migration routes of the birds are naturally more suitable than others for the study of migration. The classic example of the Migration Observatory on Heligoland in the south-eastern corner of the North Sea deserves special mention. It was made famous towards the end of the last century by the life-long observations of the German ornithologist, Heinrich Gätke. The Germans have

another station at Rossitten on an East Prussian isthmus near Königsberg and jutting out into the Baltic Sea. The British have an observatory on Faire Isle, midway between the Orkney and Shetland groups of islands north of Scotland. A large amount of work is also done on the mainland both in Europe and in America. India, unfortunately, has no Migration Observatory, nor is any organised work being done. But, should the time come when we could have observatories of our own, some of the islands in the western half of the Indian Ocean would prove suitable for the study of migrations to and from Africa, while one of the few islands on the southern coast of Baluchistan would be invaluable for the study of migrants coming from Arabia and ultimately from Southern Europe and North Africa.

The second method of study is by bird-marking. Light aluminium rings (Fig. 1), bearing the name and address of the observer and a serial number, are placed on the legs of the birds (Fig. 2) when they are



Fig. 1.—Samples of marking-rings used for bird-marking. A suitable legend giving the address of the ringer and the serial number of the bird is embossed on or punched into the ring. [From A. L. Thomson (1936), 'Bird Migration.']



Fig. 2.—Ringing a Chaffinch. Note the ring on the leg of the bird. [From A. L. Thomson (1936), 'Bird Migration.']

*Public lecture delivered at the Indian Museum, Calcutta, on February 9, 1940.

Published with the permission of the Director, Zoological Survey of India. The writer is indebted to Dr Bains Prashad, D.Sc., for kindly going through the manuscript and suggesting many useful changes.

Vol. V No. 11
May 1940

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studied. No doubt the majority of birds ringed are never heard of, and recoveries are usually not more than 2 to 3 per cent. Numerous marking schemes have been in operation in Europe since the last 50 years, and in North America bird-ringing has been done on an enormous scale since 1920 with the official support of the United States Biological Survey. In India bird-ringing was first started by the Maharaja of Dhar (Central India) in 1926, and was subsequently taken up by the Bombay Natural History Society from 1929-31. The results were interesting as we shall see later, but the scheme, small as it was, is no longer in operation. It is desirable that we should start a big scheme of bird-marking in our country under a single, preferably Government, control, as in the United States.

Definition of Migration

It is not birds alone that are migratory. Regular migrations occur in many other animals also. Several insects are migratory. We have all heard of, if not actually seen, periodic migrations of locusts. Roughly every ten or twelve years, visitations of the Desert Locust cause enormous damage to agriculture in North-West India. Apart from these visitations, the Desert Locust shows another kind of annual movement as we were able to show a few years ago. Every year locusts of the *solitaria* phase migrate to Rajputana and South Punjab to spend the rains and the autumn (June to middle November). In winter they return to Baluchistan, Mekran, South Persia and probably Arabia. This movement to and fro occurs every year.

Some of the fishes undergo extensive migrations. *Hilsa* and other fishes of the family feed and grow in the Bay of Bengal but go up the rivers Ganges and Brahmaputra for breeding. The young *Hilsa*, after hatching from eggs, return to the sea. Eels migrate in the reverse manner. They breed in the depths of the ocean, and the young eels return to fresh water (rivers) where they feed and grow.

Human beings also migrate, that is, apart from sporadic political migrations such as the migration of the Indian Moslems during the Khilafat agitation days and that of the Germanic people in Central Europe today. The nomads of Arabia, along with their sheep, migrate from pasture to pasture, and their migration

usually is correlated with the seasons. In Mekran (Southern Baruchistan) the nomadic Mekranis come with their goats and sheep to the coastal areas in winter to take advantage of the winter rains, and return to the hinterland in summer to benefit from the summer rains.

Every movement, however, is not migration. Firstly there are purely *local movements*. For example, birds of species A living in Calcutta, and finding no suitable place of nesting, may wander ten miles away for that purpose. Secondly, there are more extensive movements known as *dispersals or wanderings*. The guillemots normally living and breeding in the British Isles may in small numbers wander in winter as far north as Norway and Sweden and as far south as Spain. But the majority still remain in the British Isles. The concentration of individuals remains greatest near the point of origin. Thirdly, there are *true migrations* in which the centre of numerical concentration is changed, and there is a great deal of regularity, frequently of a seasonal nature, in the change.

Geographical Aspects of Migration

True migration is not necessarily very extensive in range, although in many cases it is so. Many types of migration are distinguishable.

Vertical migration.—The white-capped Redstart, *Chaimmarornis leucocephala* (Vigors) belonging to the family Turdidae, is a small bird found near rivers and streams in the Himalayas. It breeds in summer between the altitudes 8000 to 14000 feet above sea-level. In winter it descends to adjacent foot-hills between 2000 and 8000 feet.

Nearby horizontal migration.—In this case, the birds may migrate in a "horizontal plane", and the two areas, the breeding area and the over-wintering area, are not distantly separated but are adjoin *Examples: (a)* The Fieldfare, *Turdus pilaris* (Linnaeus), breeds in Northern Europe and winters in Southern Europe and extreme Northern Africa. *(b)* The Indian Rufous Turtle Dove, *Streptopelia orientalis orientalis* (Latham), breeds in Central Siberia, Manchukuo, Japan, North and Central China, and Tibet down to the Himalayas, including Nepal, Sikkim and North Assam. In winter it migrates southwards, being found in the whole of Eastern India as far south as the Deccan.

Distant horizontal migration.—In this case, the breeding and the wintering areas may lie far apart. It is this category which provides some of the

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most striking examples of migration. *Examples: (a)* An excellent example is furnished by some of those active little birds, the Wagtails (Hindi: *Khanjan*) which we can always see by the water's edge in winter, constantly moving their tails up and down when on the ground. Swinhoe's White Wagtail, *Motacilla alba baicalensis* Swinhoe, breeds in Eastern Siberia, from Lake Baikal to Manchukuo. It spends the winter in Eastern China, Tibet, and the Himalayan foot-hills from Eastern Assam to as far west as Kashmir and Afghanistan¹. *(b)* The Brown Shrike, *Lanius crista-*

tus cristatus Linnaeus is, in summer, found breeding throughout Eastern Siberia. In winter it migrates to India and Ceylon, some two to three thousand miles away. *(c)* Geese are familiar examples of distant migrants. The Widgeon, *Mareca penelope* (Linnaeus), breeds in the palaearctic region (Northern Europe, Siberia, etc.). In the bird-marking experiments performed in India by the Maharaja of Dhar and by the Bombay National History Society, many kinds of Geese (Widgeons, Gadwells, Pochards and Shovellers) ringed and released in Dhar State (Central India) and near Manchar Lake in Sind were recovered from Siberia, a distance of over 2,000 miles

TABLE I.
Some of the Results of Bird-Ringing Schemes of the Maharaja of Dhar and the Bombay Natural History Society.

Name of bird.	Ringing.		Recovery.		Approximate distance flown (miles).	Duration between ringing and recovery (days).
	Date.	Place.	Date.	Place.		
1. Widgeon, <i>Mareca penelope</i> (L.). Female.	23.1.29.	Manchar Lake (Larkana Dist., Sind).	20.9.29.	Tobolsk Dist., (Siberia).	2300	240
2. " " Male.	25.1.29.	"	7.5.29.	Village Yary Iino (Region Kalpach, Evsk Circuit, Tomsk, Siberia).	2300	102
3. " " Female.	23.1.29.	"	28.3.29	Near Syr Daria (Russian Turkestan), 45° 10' N. and 65° 15' E.	1325	64
4. Gadwell, <i>Chauleasmus streperus</i> (Bonap.). Female.	23.1.29.	"	9.8.31.	Region of Usty-nissk, near village Kotchardysk, 54° 25' N. and 60° E. (U.S.S.R.).	2600	928
5. " " Female.	23.1.29.	"	9.3.31.	Ust-Yuish Region, 54° 5' E. and 64° 20' N. (U.S.S.R.).	2700	775
6. Red-crested Pochard, <i>Netta rufina</i> (Pallas).	30.12.29.	Kambar (Sind).	9.7.32.	Lake Baikal (Siberia).	2300	922
7. Shoveller, <i>Spatula clypeata</i> (L.).	11.12.31.	Marchar Lake (Sind).	5.1.32.	Singam (N.Gujrat).	300	25
8. Teal (species not mentioned). Male.	23.2.29.	Dhar State (Central India).	6.10.31.	Near R. Vasugana (Tomsk Dist., Siberia).	2300	355

¹ Roohwal, M. L. (1939). *Rec. Ind. Mus.* XLI pp. 298-300.

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have been known to return year after year not only to the same locality but also to the same nest!

Migration routes.—In many migrants the routes are roughly constant, but not absolutely so. Bad weather, such as fog, sandstorms and the like, may compel the migrants to alter their routes. It has often been noticed in Europe that in foggy weather migrating birds come and dash against lighthouses in large numbers, being attracted by the dazzling effect of the rays in such weather. The Stork, *Ciconia ciconia* Linnaeus, crosses the Mediterranean (from Europe to Africa) at the narrowest points—on the east and on the west.

An interesting result of the constancy of routes has been the springing up of certain industries. In the Mediterranean countries to-day, there is a regular industry in the capturing of the Quail, *Coturnix coturnix* (Linnaeus), for the market, out of the vast numbers that pass through at the seasons of migration. These birds breed in England, Europe and North Africa, and winter in South Africa and east up to India.

Migration by night.—Surprising as it might seem, much of the migration actually takes place by night and thus escapes popular observation. Nocturnal migration, especially of large birds is often detected more readily by the ear than by the eye. We may sometimes hear at night, during winter months, a low humming noise accompanied by a cackling sound coming from somewhere high up. It is due to the flapping of wings and the continuous cackling of a flock of geese during flight. Attraction of migrating birds to lighthouses in foggy weather is another proof of nocturnal migration. It is noteworthy that white light alone attracts birds to lighthouses; coloured lights fail to do so. Among nocturnal migrants are: Warblers, Wheaters, Redstarts and Pipits.

Migration by day.—Although much of the migration is nocturnal, many species travel habitually by day, and geese may migrate either by day or by night. Among day-migrating birds are: Song-thrushes, Black-birds, Rooks and Hooded Crows.

Method of migration.—Whether migrating by day or night, migrants do not necessarily fly in great hordes. Some species fly in very small numbers or even singly

so that we can hardly say, by looking at those birds, that they are on their migratory flight. Others migrate in small flocks; still others, like geese, in big flocks which we can clearly observe during day-time. Sometimes, when after a spell of foul weather it suddenly turns fine, there is a great "rush" of migratory birds which had taken shelter during inclement weather. Such "rushes" are best noticeable on islands. Those who have been fortunate enough to witness them are unanimous in the opinion that they are impressive sights. Throughout the day, hour after hour, the birds may pass by at the rate of a flock a minute, and cover the entire space over the island.

Altitude and duration of flight.—At one time it was believed that migrants commonly travelled at very great heights—20000 feet or more above ground—even when they were flying over flat country. Systematic observations have proved that this belief is fallacious. We know to-day that for most birds the altitude of migratory flight is not above 3000 feet, and is usually much lower. Of course when the land itself is very high, the absolute altitude is correspondingly increased, and many migrants cross high mountain ranges.

The belief held by some that birds do not fly very high because of difficulties in respiration in rarified air at high altitudes, does not appear to be well supported; for, birds have been known to live comfortably at very high altitudes where man would require the aid of artificial supply of oxygen. In one of the Everest expeditions some Choughs of the family Corvidae followed the climbers even up to 27000 feet without showing any signs of discomfort.

Ordinarily, birds when migrating over land move in hops. They migrate throughout the day and stop during the night for rest and feeding. The reverse is the case in night-migrating birds. Some may go in a more leisurely fashion, stopping on the way for a week or so. Long distances, even up to 2000 miles or more, are sometimes covered at a stretch, as for example when the geese, gulls and terns cross the Atlantic. In this case, given an average flight-speed of, say, 50 miles an hour, the birds fly non-stop for 40 hours or more. Such feats naturally involve an enormous expenditure of energy.

"Speed of flight" and "speed of migration."—At one time the belief held sway that birds on their migratory flight move at enormous speeds. This again has been proved wrong by actual observations. Some

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years ago, Col. Meinertzhagen, a well-known ornithologist who has studied the birds of Kashmir, Afghanistan, the Near East and Egypt, calculated from observations the flight velocities of birds during migratory flights. His figures (Table 3) are:—

TABLE 3.
Flight speed of some birds during Migratory Flights.

Birds.	Speed (miles per hour).
Small Song Birds.	20-37 m. p. h.
Cranes.	31-45 m. p. h.
Falcons.	40-48 m. p. h.
Geese.	42-55 m. p. h.
Ducks.	44-59 m. p. h.

Swallows have been known to keep pace with an aeroplane doing 68 miles an hour.

These figures have been arrived at after making due correction for wind-speed. They are what are known as "absolute velocities" or "air speeds". The "speed of migration" is different from the speed of flight, and is the average speed at which the bird undertakes the *entire* migratory flight (as contrasted with individual daily flights), taking into account the halts on the way.

Utility of Migration

We have seen that migration is a regular phenomenon in the lives of many birds. Usually it takes place between two fixed areas, often distant from each other. Its regularity and constancy make it one of the most striking phenomena of nature.

But what, after all, is the use of migration? Why should birds undertake enormous risks, both of life and of expenditure of energy? Why should the American Golden Plover migrate from the Arctic North of America to the Pampas of South America, 6000 miles away, when it can well exploit both for food and suitable temperature an equally good area in, say, the southern parts of the United States or in Central America? Unless migration brought about some great advantages which more than compensated for the great losses birds suffer during migration, the species would die out.

No doubt climate has something to do with migrations, but it does not explain everything. Birds

do move away from colder regions to warmer regions. It is also the rule that migratory birds breed in the coldest part of their range, the breeding season being, of course, summer.

Other explanations have been suggested. It is asserted that by migration birds are able to exploit two areas. As we might say, they have the best of both the worlds, although their second world is not in Heaven but on Earth! Summer in northern latitudes provides plentiful food in the shape of insects, flowering plants, etc., and also many hours of day-light. In winter in the same area the temperature is low, days are short and food scarce. And so the birds migrate south where they get warmth, abundant food and plenty of day-light during which to feed.

For birds migrating wholly within the Tropics, the above explanations cannot apply. We are concerned in this belt not with cold and warm seasons, but with dry and wet seasons. Dry and wet conditions are also important in movements to and from desert regions. Birds have also been known to avoid very high temperatures as was shown by Dr Kendeigh in America some years ago.

Another explanation put forth is that birds return to their breeding sites since the right type of nesting sites are available there. We know that all animals are conservative in their reproductive behaviour, and birds tend to be rather exacting in their nesting requirements. This factor might, therefore, be quite important although it cannot fully explain migration.

On the whole, we can say that no single explanation of utility is all-embracing. The truth probably is that a whole set of factors are involved, and for each species there is a different set.

Origin and Causes of Migration

The origin.—Since we are unable satisfactorily to explain migration on the basis of climate or of available food, it is natural to seek elsewhere the causes of its origin. In some way the origin of migration is bound up with the evolution of the various species that exhibit migration.

According to one speculation, the birds concerned were at first resident throughout the year in whatever area they inhabited. Then, some slow change in the climate of that area occurred. According to some it was the Glacial Epoch which for a time drove the birds altogether from their original home. When warmer times gradually returned the birds

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remembered their old home which they started re-visiting for purposes of breeding.

An alternative view assumes that the original area was relatively small, and that migration was evolved as a result of the gradual spread into regions suited to the life of the species during only a part of the year. There is no solid proof for either of these explanations which are based on speculation alone.

The causes.—Whatever the historical origin of migration, let us see what are the immediate or primary causes which make the migratory birds start on their migratory flights.

The seasons, when invoked directly, fail to explain the start of migration. We know that typical migrants leave a locality long before conditions become intolerable. Furthermore, the journey continues beyond the range of intolerable conditions. In short, we are unable to attribute the causation to temperature, food or other such external conditions. The conclusion seems to be forced upon us that migrants *must* migrate. Or, in a different language, they have a migratory instinct, and it is, therefore, *necessary* for them to migrate. It amounts to saying that the faculty of explosion is inherent in a dynamite-loaded cartridge, and so it must explode.

Granted this explanation (which is by no means satisfactory), yet another question needs an answer. The dynamite-loaded cartridge will not explode unless the trigger is pressed. What is the nature of the trigger and its release, the pressing of which is the *immediate* cause of migration?

Fine weather is certainly one of the causes which releases the pent up forces of the migratory instinct. It has frequently been noticed that the tendency to depart is greatest when the barometer is high and least when a depression holds sway. Again we notice that birds are not driven out by adverse weather.

Temperature too is concerned in the process of release. In autumn a fall in temperature favours the tendency to migrate, in spring a rise in temperature. Humidity is another important immediate factor in certain areas, but we do not know much about it.

Wind is *not* a direct causative factor in the inception of migration. Birds have been repeatedly

known to start on migratory flights in the face of adverse wind.

That was the situation until 1929 when Prof. Rowan started a series of experiments in Alberta (Canada) which go to show that weather is not the *primary* stimulus initiating migration.

These experiments suggest two kinds of *inter-connected* primary stimuli as follows:—

- The decrease of day-light in autumn and its increase in spring. The birds somehow perceive this decrease or increase, and depart.
- The other suggestion is that the primary stimulus is of a physiological nature, coming from within as a result of changes within the body.

Rowan's first experiments were with Juncos or American Snowbirds, *Junco hyemalis* (Linnaeus), which belongs to the same family as the House Sparrow *vis.*, Fringillidae. These little birds are purely summer visitors in Alberta where they breed. In winter they move south. Rowan observed that Juncos can survive the Canadian winter in out-door aviaries provided they are well-fed. Free birds leave Alberta in the beginning of autumn (about September). The aviary birds if kept until November—when the sex-glands (ovaries and testes) had dwindled to a minimum size—had lost the urge to migrate: on liberation they showed no inclination to depart. These birds were the "controls" of the experiment. Juncos kept in another aviary were subjected to electric light turned on at dusk and kept lit for a period which was increased by a few minutes every day. Thus while the autumn days were naturally shortening, the days in the aviary were apparently lengthening. As a result of the treatment, the sex glands of the birds developed *again* in early winter as if it was already spring (this was proved by dissections). When these birds were liberated, they left the neighbourhood (unlike the "controls"), and were, therefore, thought to have at least attempted migration. Rowan concluded that the stimulus to migrate is a result of the increase of sex glands caused by the (artificial) lengthening of day light.

Several such experiments have been conducted, confirming, in the main, Rowan's results, and adding some more to them. The position to-day is roughly this: The birds leave their winter quarters in spring

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as a result of the *increase* in the size of the sex-glands; the *decrease* in the size of the glands cause them to leave their summer quarters where they had bred. This explanation fails in the Tropics where the day-light is of constant duration.

What Guides Migration

Whatever the primary stimulus, let us assume that the birds have started on their migratory flight. During the days immediately preceding the start of the migratory flight, the birds exhibit a considerable amount of restlessness both during day and night

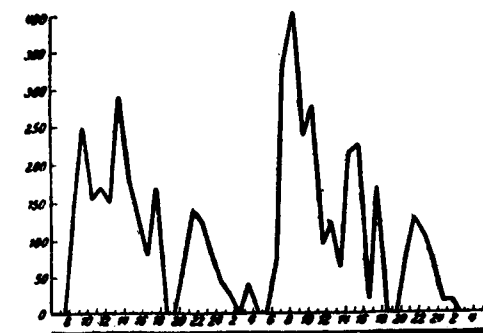


Fig. 4.—Graph showing the restlessness of the Continental Song-Thrush, *Turdus philomelos philomelos* Brehm, immediately previous to migration. — daylight; ■ darkness (night).

Note that: (i) Birds are very restive during day. (ii) At the onset of night they are calm, but towards midnight they again become restive. (iii) Towards dawn they are calm again. Birds not migrating are, as a rule, calm throughout the night [From Stresemann (1933), 'Handb. d. Zool., Aves.']

(Fig. 4). Some species, like the House Martin, exhibit a tendency to congregate together in some numbers before they depart. But once they have started on the flight, how do the birds find their way to the destination?

Magnetic theory.—One view is that birds are in some way attuned to the magnetic characteristics of a locality and when removed from it, they are able to return to it by flying in the direction which increasingly gives them the proper magnetic values. While it is true that every locality has its own characteristic magnetic declination and dip, the above suggestion is not based on any positive proof and is merely speculative. Furthermore, the bird will have to be attuned to

magnetic values of *two* localities—the breeding area and the overwintering area.

Visual recognition.—It has been suggested that birds follow definite land-marks, and this is probably true to a certain extent. Much migration follows definite geographical features such as coast-lines and river valleys. It has been repeatedly noticed by observers that migrating flocks of some species follow the coast-line fairly closely. When there is a bend in the coast-line the flock also wheels round to keep to the line. Again, Chaffinches (Family Fringillidae) flying over-land have been known to change their direction to avoid crossing stretches of water.

That vision is important in migratory flight is shown in another way. Fogs are apt to stop migration or to make birds lose their way, although some sea birds seems to be little affected by fog. Completely dark nights are also said to hold up migration.

Flight without land-marks.—In several cases migration is not concentrated along particular routes or lines. In ocean crossings the migrants move on a broad front and there are no routes to follow. Penguins while swimming the sea during migration have no land-marks to guide them except the crest of the waves which admittedly are not very reliable as land-marks.

Homing powers.—The question of orientation may be approached from another angle, namely, by studying the "homing" powers shown by some birds. In this connection, carrier pigeons come at once to the mind. Their example, however, should be applied with caution, for, these pigeons are carefully trained and selected.

The Swallow, however, furnishes an excellent example. Swallows taken at their nest in Germany and removed by train or aeroplane to Croydon near London, successfully returned to their German home 300-400 miles away, within a few days. The best record was 255 miles in 26 hours. These Swallows had no previous training, nor did they see any land-marks on their outward journey. Their successful return can be attributed only to a "homing" instinct, whatever that may mean. These experiments show that birds have remarkable "homing" powers, but what those powers are we do not yet know.

Bird Migration in Ancient Indian Literature

Although the scientific study of bird migration is a growth of the last 50 years, the phenomenon was

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well-known to the ancients. Some years ago, Dr S. C. Law wrote two articles about "Kalidasa and Bird Migration" (*Journ. As. Soc. Bengal* XX, 1924, pp. 253-260 and 261-273) in which he clearly showed that Kalidasa knew a good deal about bird migration. Almost everywhere in Sanskrit literature, *Manasa* (=Mansarovar Lake) and *Rajhansa* occur together. *Rajhansa* is today the Hindi name for three different birds—two kinds of geese and the flamingo—all migratory, and we are often uncertain which of these birds is referred to by the Sanskrit writers. In many places Kalidasa expresses that *Hansas* (geese) are restless to migrate to *Manasa* at the first appearance of clouds which heralds the commencement of the rains. He was thus aware of the fact known to ornithologists to-day that migratory birds are very restless during the days (and nights) immediately preceding the start of migration.

In *Ritusamhara* (*Song of the Seasons*) he does not mention at all ducks and geese when characterising the summer and the rainy seasons. But these birds receive ample attention in autumn, and in his very first canto on that season he writes:—

"Behold the autumn has arrived like a lovely newly-wed bride; the full-blown lotus represents her beautiful face, the *kasas** are her apparel, the half-ripe rice-plants represent her slim and lithe limbs and the cackling of the geese are the tinkling of her anklets."

This and many other passages show that Kalidasa's understanding of bird-life was considerably intimate and accurate. Geese in fact do migrate north

*A kind of tall grass.

to Siberia in summer—we do not know whether they go to *Manasa*—and return in autumn to spend the winter in India.

The two birds most frequently mentioned by Kalidasa are *Kadamba* and *Rajhansa*. Dr Law identifies *Kadamba* as the Grey Lag Goose, *Anser anser* Elinacus (Hindi; *Hansa*; *Kar Hansa*; *Rajhansa*), and, I think, with sufficient justification. The *Rajhansa* of Kalidasa, Dr Law identifies as the Flamingo, *Phoenicopterus ruber antiquorum* Temminck (Hindi: *Rajhansa*), but this identification is rather doubtful and the bird might be one of the geese. Kalidasa makes his *Rajhansas* go to *Manasa*. We, however, know to-day that the Flamingo migrates from India to the west (not north), mainly to Africa. The breeding and migrating areas of the Flamingo have not yet been adequately defined; their breeding grounds have been found in Southern Spain, South Africa (including Cape Verde Island), Iraq, Persian Gulf area, and the Rann of Cutch in India (see McCann, C. *Journ. Bombay Nat. Hist. Soc.* XLJ, 1939, pp. 12-38). In Gujrat they have been noted to arrive about the middle of April and leave at the end of June (Acharya, M. N., *Journ. Bombay Nat. Hist. Soc.* XXXIX, 1936, p. 182). Dr Law thinks that since the *Manasa* region has never been properly explored ornithologically, Flamingoes might yet be discovered to be migrating there and Kalidasa proved correct.

Again, in *Meghaduta* (*Cloud Messenger*) Kalidasa describes the city of Dasarna as *अतिपद्मविहारा* i.e., Dasarna where *Hansas* tarry but for a few days. The poet was thus aware of a well known phase in bird-migration, namely, that during migration birds often tarry awhile on the way either for rest or for food.

Rainfall in the Punjab*

J. B. Seth

Professor of Physics, Government College, Lahore.

I DO NOT know if I owe an apology to the professional meteorologist for submitting a paper encroaching into their domain. But like many a lay man I have been always interested in meteorological data like temperature and rainfall and as a sort of hobby I started keeping and collecting first of all records of temperatures of Lahore and then of rainfall. In my attempts to get these data as far back as possible, I found that the records of the local meteorological observatory went back only to 1879. In the library of the Punjab Government Secretariat I found meteorological records from 1866 to 1874, and from there I was led to the Record Office located in what is known as the Tomb of Anarkali. I found that meteorological data began to be published in the *Punjab Government Gazette*, soon after its foundation. The first number of the Gazette is dated Saturday, the 15th August, 1857, and the first mention of a meteorological nature occurs in the third supplement to the Gazette of Wednesday, the 12th December, 1860, as a report on the Dalhousie Sanatorium.

While turning through the pages of these early Gazettes I came across, in the supplement to the Gazette of Saturday, the 19th December, 1863, the details of a report to Government on the Rainfall in the Punjab, By Mr. Edward Prinsep, the then Commissioner of Settlements in the Amritsar division. Mr Prinsep had, previously, while the settlement officer of Sialkot, "ascertained that there existed, in that district, parallel zones of equal average rainfall, running parallel with the outer range of the Himalayas." Thinking "that the same phenomenon would be found to exist throughout the Punjab on a still more extended scale, Mr Prinsep applied for and collected all the available rainfall figures of as many stations as he could and, showing them on a map, found to his natural gratification that, (to use his own words), 'as anticipated by me it is now put beyond all doubt that the gradations of rainfall in the Punjab are susceptible of

being ranged into zones, running parallel with the Himalayas."

The total number of rain gauge station records made available to Mr Prinsep was 199. He could exhibit only 150 of these on his map, as "the exact position of the remainder could not be determined." A copy of a photograph of the copy of the map printed in the aforesaid Gazette of 75 years ago, is shown in Figure 1. The thinner and thicker parallel dotted lines show the zone divisions by Mr Prinsep, where I have only stressed by the thick lines the principal zones. From this map I was able to get the rainfall figures for only 135, instead of 150, stations—as there are a few stations given in the map without such figures.

On coming across Mr Prinsep's report it occurred to me to examine his conclusion in light of the much more extensive data that must now be available. Mr Prinsep had to base his conclusions on observations extending over, on an average, five years, with a minimum of 1¼ years for a couple of stations in what is now the North-West Frontier Province and a maximum of 10 years in a couple of places (Shahpur and Bhera) in what is now the Shahpur district.

It may be thought that conclusions based on such meagre data may not be trustworthy. But only a little consideration will show that the general conclusion cannot but be correct. For it must be that the rainfall would be quite heavy in the hills and that the further a station is from them, the less rainfall it must get, generally speaking; so that the whole country must be capable of division into zones which must be, roughly, parallel to the hills, which are all, of course, on the outer range of the Himalayas.

I was helped in my task very considerably by the published *Memoirs* of the Indian Meteorological Department, a good many of which were available in the local observatory and one rather old number was kindly lent me from the Departmental library at Poona. The latest comprehensive figures available on the subject are these compiled by the Meteorological

*A paper read before the physics section of the Indian Science Congress at Lahore in January, 1939.

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Department and published under the name of Dr Gilbert Walker in Vol. XXIII, part 7, (1924), of the

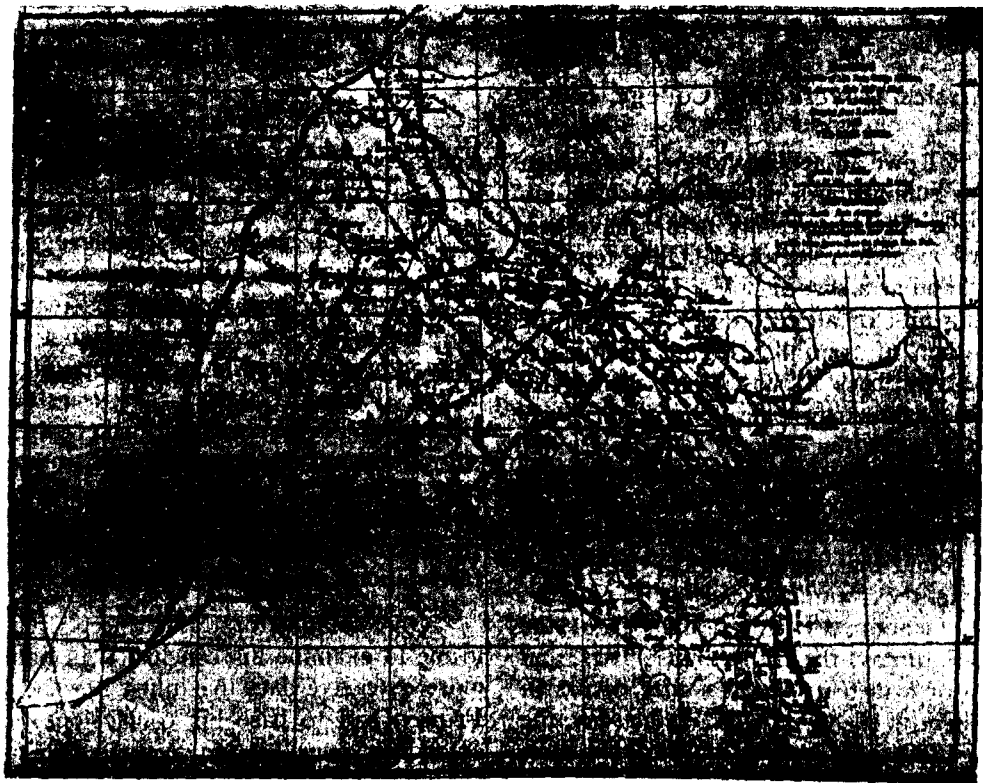


Fig. 1 Prinsep's Map showing the 'zone' divisions by the thick and thin dotted lines running across the river Indus.

Memoirs of the Indian Meteorological Department. This paper gives the average rainfall, computed up to 1920, of 197 stations in the Punjab. This number does not include any stations in the N. W. F. P., whereas the 135 stations giving the rainfall averages in Mr Prinsep's map contain 12 such stations. Of these 197 places, 13 are hill stations or in hilly tracts and have not been taken into account by me. For all except 10 of these stations, the average has been recorded for at least 20 years. The maximum number of years for which an average has been recorded is 55 and there are 122 stations for which the average is for 50 years or over. The minimum number of years for which an average has been recorded for the stations given in the meteorological Memoirs is 9 years for a place (Hasanpur) in Gurgaon district and 7 for one in Lyallpur district (Jaranwala).

For the sake of ready reference and comparison I have drawn up a table giving what I may call the Prinsep and the Walker figures. It has been seen that, in the first instance, quite a number of the Prinsep

stations are not found in the Walker ones, and vice versa. Again, in quite a number of cases there is a great disparity between the two sets of figures. The most notable of such cases are the figures for stations near about Multan and Rohtak on the one hand, where the Prinsep figures are very considerably lower than the Walker figures, and, on the other hand, places like Rava in the Sialkot district, Ajnala in Amritsar district, Batala, Pathankote and Karnal, where the Prinsep figures are distinctly higher than the Walker figures.

All the places occurring in Prinsep's maps or in the meteorological list could not be located by me, helped as I was by Mr A.N.Kapur, a lecturer in geography in Government College, Lahore and a large Survey of India's Map of the Punjab which he kindly placed at my disposal. I have shown in these maps

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(figs. 2a and 2b) the rainfall in round numbers, Fig 2a is a map of the punjab in which are marked



Fig. 2a. showing the 'zone' division according to the rainfall in round numbers from Prinsep's figures.

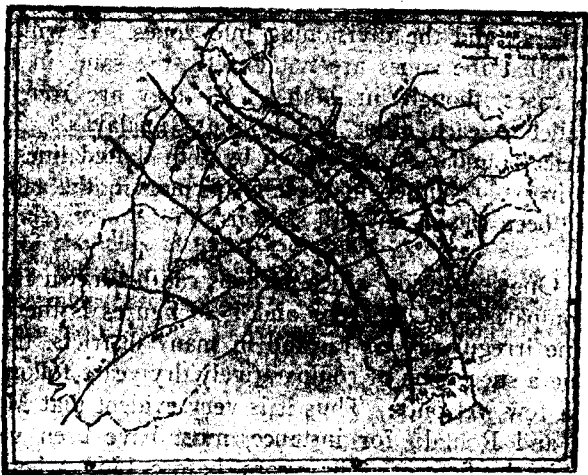


Fig. 2b. showing the 'zone' division according to the rainfall in round numbers from Walker's figures.

TABLE II.

No.	Station	AVERAGE ANNUAL RAINFALL giving (within brackets) the number of years for which the average has been struck UP TO				First year of Record according to I. M. M. Vol. XIV (1902)
		1863 from map in Punjab Gazette of 19-12-63	1900 from I. M. M. Vol. XIV (1902)	1910 from I. M. M. Vol. XXII. Pt I (1913)	1920 from I. M. M. Vol. XXIII PtVII (1924)	
1.	Dera Gazi Khan	5.5 (7)	6.39 (38)	5.82 (41)	5.95 (54)	1862
2.	Muzaffar Garh	4.9 (5)	5.78 (41)	5.68 (41)	5.95 (54)	1860
3.	Multan	0.91 (5)	7.11 (39)	6.53 (42)	6.79 (32)	1862
4.	Montgomery	...	9.84 (41)	10.05 (44)	10.14 (55)	1860
5.	Jhang	4.0 (3)	10.23 (39)	9.98 (42)	10.17 (54)	1862
6.	Shahpur	15.2 (10)	14.29 (47)	13.76 (40)	13.98 (55)	1854
7.	Rawalpindi	31.72 (5)	33.36 (42)	32.33 (42)	32.57 (53)	1852
8.	Jhelum	17.46 (5)	26.38 (40)	25.69 (41)	26.06 (55)	1861
9.	Gujrat	29.39 (34)	27.84 (39)	26.35 (42)	26.39 (54)	1862
10.	Gujranwala	23.34 (5)	24.18 (39)	23.27 (44)	23.45 (55)	1862
11.	Sialkot	29.27 (5)	35.22 (42)	33.08 (44)	32.23 (55)	1852
12.	Gurdaspur	31.5 (7)	34.94 (44)	34.02 (45)	33.86 (55)	1857
13.	Hoshiarpur	30. (5)	35.92 (5)	35.45 (44)	35.51 (54)	1857
14.	Ambala	28.6 (7)	35.07 (50)	31.74 (44)	31.55 (54)	1850
15.	Karnal	17.6 (5)	30.55 (45)	29.64 (44)	29.38 (54)	1844
16.	Delhi	22.8 (41)	27.70 (52)	26.71 (44)	26.78 (55)	1844
17.	Gurgaon	23. (4)	25.90 (50)	24.86 (44)	25.12 (55)	1844
18.	Rohtak	3. (4)	21.22 (49)	19.67 (44)	19.68 (54)	1844
19.	Hissar	9.67 (5)	16.01 (50)	16.06 (44)	15.99 (54)	1844
20.	Sirsa	15.53 (41)	14.43 (49)	13.30 (44)	13.54 (54)	1844
21.	Ferozepore	18.0 (5)	20.61 (51)	17.22 (42)	17.38 (52)	1844
22.	Lahore	18.84 (5)	20.70 (43)	17.73 (44)	18.08 (55)	1851
23.	Amritsar	23.51 (7)	24.92 (41)	25.75 (42)	23.54 (55)	1860
24.	Jullunder	25.68 (9)	27.64 (49)	26.80 (43)	26.96 (54)	1852
25.	Ludhiana	23.8 (5)	28.25 (43)	26.23 (44)	26.21 (55)	1850

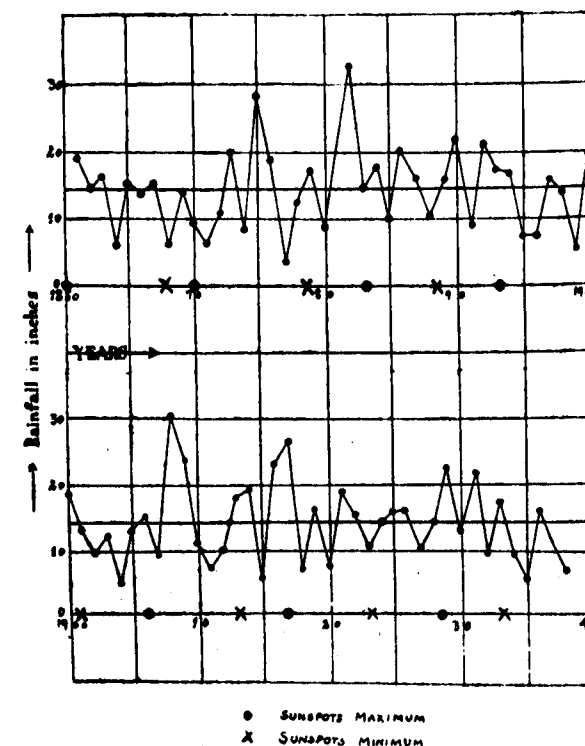
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as done by me, is also shown. The map in figure 2b gives the various "locatable stations of the meteorological *Memoir* giving the rainfall (in round numbers) and the divisioning into zones. It will be seen that the zones are not exactly the same in the two cases, though in both cases they are roughly parallel to each other and to the Himalayas. The district boundaries are shown by thin dotted lines in the maps. Neither in these maps nor in the tables have been shown any hill stations.

One conclusion which perhaps can be drawn from a comparison of the 1863 and 1920 figures is the extreme irregularity of rainfall in many districts, there being a succession of comparatively dry years followed by a few wet ones. Thus it is very evident that Multan and Rohtak, for instance, must have been very dry in the five or four years before 1863, whereas Pathankote and Ajnala must have been rather wet. These differences become pronounced if the average is struck for short periods, but when the average is struck over long periods, they naturally tend to disappear.

There is a popular belief prevalent in the province that the rainfall, of late, is more scanty than in the "good old" days. With a view to examine that belief I have drawn up a table (Table I) giving the average annual rainfall for 25 of the district towns of the Punjab, the average having been recorded up to 1863, 1900, 1910 and 1920. The number of years for which each average has been recorded is given within brackets. As will be seen the table does not show, to any marked extent, any change in the average rainfall for the various periods. It must be acknowledged, however, that such a table can hardly show any marked variations. To gauge such a variation, it would be necessary to find the averages for each successive period of 10 or 15 years, a task requiring not only time but also access to the actual records of each place from which the Meteorological Department must have computed the various averages.

It may be interesting in this connection to examine a graph given in Fig. 3 showing the amount of rainfall



during the four monsoon months, June—September, for the last 78 years at Lahore.

Addendum, nearly a year after the Reading of the Paper

The records mentioned in the penultimate paragraph have now been obtained from the old issues of the *Punjab Government Gazette* and *Memoirs* of the Meteorological Department, and will form the basis of another analysis. The Lahore rainfall figures and Fig. 3 have been subjected to a close scrutiny to discover the kind of periodicity mentioned in an article "Solar Radiation and the Weather" by Dr C. G. Abbott *Nature*, 143 705, April 29, 1939). No such or any other periodicity, however, can be found.

NOTES AND NEWS

Quinquennial Review of Education

THE *Quinquennial Review on the Progress of Education in India, 1932-37* just published by the Educational Commissioner with the Government of India reveals that there has been a livelier interest in and concern for the future of education during the years under review. Reports from all quarters disclose a widespread dissatisfaction with the present system of education and there are indications of energetic action in the direction of reorganization and reform. Some of the shortcomings in the present system, to which attention is called, are the tendency of the prevalent type of secondary education to encourage the drift of unsuitable pupils towards higher literary education, the huge wastage in primary schools which retards progress towards the attainment of literacy, the too frequent lack of adequate control by Provincial Governments over the educational activities of local bodies and finally the absence of effective co-ordination of educational activities. The Central Advisory Board of Education, which had been abolished in 1923 as a result of the recommendation of the Indian Retrenchment Committee, was revived in August 1935 and has since been engaged in advising the Central and Provincial Governments as to the lines which educational reorganisation should follow.

Despite financial depression almost throughout the quinquennium, existing facilities for education were generally maintained and some progress made as a result of consolidation. While there were only 255, 709 institutions, recognized as well as unrecognized, in 1937 as against 257,792 in 1932, the total number of pupils had increased from nearly 12,767,000 in 1932 to 14,146,000 in 1937. The percentage of the total population receiving instruction in all institutions rose from 4.7 in 1932 to 5.2 in 1937.

The total expenditure on education in 1936-37, was 28.05 crores of rupees of which less than half was contributed from Government funds. The total educational expenditure increased by only Rs. 87 lakhs during the quinquennium.

The most striking feature of university education in India was its rapid numerical expansion. From over 61,000 in 1917, the total enrolment rose to 105,000 in

1932 and stood at 129,000 in 1937. While this increase may to a certain extent be due to a growing appreciation of the cultural and social value of university education, the absence of any avenues for high-grade technical training or of attractive openings for employment after the matriculation stage appears to be mainly responsible.

There were 12,975 secondary schools in 1936-37 with an enrolment of 2,222,000. The corresponding figures for 1931-32 were 12,570 and 2,093,000 respectively. The total expenditure on secondary education increased by Rs. 50,25,000 from a little less than Rs. 7,00,00,000 in 1931-32 to Rs. 7,50,00,000 in 1936-37, even though the period as a whole was one of financial depression. Results of experiments in the way of making Indian languages the media of instruction at the secondary school stage are being watched with interest and difficulties are being experienced due to the lack of suitable literature and text books, the multiplicity of languages in the same area and the diversity of scripts. The total number of primary schools for boys in India decreased from 168,835 in 1931-32 to 164,894 in 1936-37; but the total enrolment advanced from 8,155,000 to 9,047,000. The expenditure on primary schools for boys increased by about Rs. 17,00,000 to a little less than Rs. 7,00,00,000. Although the total number of boys who reached Class IV, the lowest stage at which they can be assumed to attain literacy, steadily increased from 4,186,00 in 1927-32 to 4,933,000 in 1932-37, wastage continued to be as high as 72 per cent. The principal cause is the premature withdrawal from schools of many children as soon as they became of economic value to the household. There was an increase in the number of areas under compulsion, but the results were not encouraging, mainly on account of the large number of "over-age" children in the various standards.

As regards girls' education, the prejudices which hindered progress in the past seem to be gradually dying out. Child marriage had become illegal and there was some relaxation of the purdah system. The total enrolment advanced by 25.9 per cent from 2,493,000 in 1932 to 3,138,000 in 1937. There was an increase in the number of all types of institutions for girls, except primary schools which showed a decrease, largely attributable to a policy of consolidation and the weeding out

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of inefficient and superfluous schools. The expenditure on girls' education increased from over Rs. 2,39,00,000 in 1931-32 to Rs. 2,69,00,000 in 1936-37. In many provinces co-education continued to be popular and the number of girls reading in boys' institutions was on the increase. Out of the 3,138,000 girls under instruction in 1936-37, 1,362,000 were studying in boys' institutions.

The impression that vocational education is on a lower plane than literary education is gradually, though slowly, disappearing and there was an increase in the number of commercial, technical, craft and industrial schools as well as in their enrolment. There were 2,016 schools for male adults with a total enrolment of 63,000 in 1936-37. The corresponding figures for females were 11 and 946 respectively. Adult education was carried on mostly by voluntary effort. Considerable progress was made in physical training in rural as well as in urban areas. Games were better organized, new methods of physical training were introduced and interest was aroused in the indigenous games. The scouts and the girl guides movements continued to grow in popularity.

There was however some deterioration both in the quality and quantity of the inspectorate, no adequate provision having been made to keep pace with the expansion of education.

Work at Central Hydrodynamic Research Station

A LARGE variety of problems, both basic and specific, ranging from the training of river courses to the control of silt deposit was investigated at the Central Hydrodynamic Research Station at Khadakvasla, Poona, and advice given on a number of subjects referred to the Station, according to its latest annual report.

The meandering tendency of rivers carrying silt in an alluvial plain was investigated on a small model of the Ganges and three of its tributaries which reproduced qualitatively conditions obtaining in Bihar. The object of its experiments was to determine whether the wide variations in the positions of the rivers—over a width of as much as 60 miles—could be ascribed mainly to the construction of flood embankments or was natural. The conclusions reached were that the wide movements of the Bihar rivers were natural and that, while the embankments intensified the severity of the changes, they would occur in any case, though more gradually and continuously.

In Bombay, when the dam across the Pravara River was completed in 1926, which stores water for the Pravara Canals, the capacity of Lake Arthur Hill, which was created thereby, was in excess of the demand for

water; but ten years later, i.e. about four years ago, water requirements exceeded the capacity of the Lake. The matter was referred to the Central Hydrodynamic Research Station who, after a series of experiments, suggested that instead of automatic gates or siphon spillways, a wall might be constructed across the waste weir cut, the sectional profile being so shaped as to induce a high discharge for small head over the crest. With the adoption of the solution suggested at a cost of Rs. 15,500 an additional annual revenue of Rs. 94,000 is anticipated.

When the Rahuri Causeway on the Ahmednagar-Manmad Road was built, the ferry on the Mula River at that place was moved up-stream, but the conditions in the river changed to such an extent as to render the ferry unsafe. Two alternative solutions have been suggested; one to construct a spur, shaped like a hockey stick, projecting from the convex bank to deflect the main flow round the bend so as to create satisfactory flow conditions at the ferry, and the other, to build a slab bridge on the Causeway which would be open to traffic during normal floods, but would be overtopped for a few hours during severe floods. The latter method eliminates the necessity for a ferry.

Another experiment related to the Faizwah, which takes off from the West Feeder in Khairpur State, Sind. The Canal was silting and the object was to determine the steps which should be taken to exclude excess silt. The construction of a new silt-excluding regulator at the site of the existing Regulator was recommended and this solution was adopted. To prevent cross flow above the barrage at Banbassa on the Sarda River, several alternative proposals for changing the river above the barrage were studied on models and it was predicted that the river would breach through the Central Island. This occurred; and a groyne to protect the Right Flank embankment was recommended and has since been constructed.

Founded in 1925, the Station has been progressing steadily. Located downstream of Lake Fife, which it adjoins, the Station has exceptional natural facilities for hydrodynamic research. Water is clear for nearly ten months and contains only very fine colloidal silt during the rest of the year. Favoured by an equable climate and fed by water drawn from a deep lake, there is little variation in temperature throughout the year and scarcely any from day to day. No pumping is required and as the slope of the country is steep, and the head available is up to 60 feet, full-scale experiments with sluices, etc., are possible. The Station covers an area of six acres, with 14 experimental channels; and six to ten experiments are generally in progress at the same time. During the fair season the water, after passing through the models, is discharged into the Mutha Right Bank Canal; but during the flood season excess water is returned to the river.

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Air Survey in India

OVER 13,000 square miles were surveyed by Indian Air Survey and Transport Ltd. in 1938-39, the operations extending from Burma to Baluchistan. In the east the bases were at Chittagong, Akyab and Dacca, while in the west the work was carried out from Quetta and Karachi. Surveys were made for geological research, town-planning, harbour development, irrigation, river control and power line development and much of this work entailed photography on large scales.

The science of air survey is developing in India with notable success. More than 83,000 square miles in India and Burma have been surveyed since operations began in 1924. Air survey is guided largely by the economic factor and the great saving of time over surface methods. Forestry and delta surveys first engaged the air surveyors' attention because of the excessive cost of surveying such difficult terrain by normal means. The second step forward was the revision of large scale maps of agricultural districts where the most important factor was the tremendous saving in time and the avoidance of disputes. In town surveys, which were undertaken next, both advantages apply to a marked degree.

Prior to 1928 little was known about air survey. More or less pioneering work was done in Burma, the Federated Malaya States and Borneo in compiling early maps of forest areas, rivers, coast lines and deltas which would have been practically impossible to map by surface means owing to cost. Experience gained here was put to use in producing in 1927-28 as an experimental measure a map of the Chittagong District of Bengal to the very large scale of 16 inches to the mile. Prior to that, a scale of 6 inches to the mile was considered ambitious. The work was continued, due largely to encouragement given by the Survey of India and the Bengal Government and during the succeeding eight years four complete districts of Bengal and 4,000 square miles in the United Provinces were mapped from the air. Air survey found further application in the revision of out of date town maps.

Engineers responsible for harbour engineering and for devising protective measures against seasonal floods of rivers have found the information provided by air photography of very great assistance. Photographs of Karnafuli river taken under conditions of high and low water springs and high and lower water neaps disclosed the locality of banks beneath the surface by the location of an eddy or a tail of silt in suspension. River photography shows up erosions and siltation by the condition of the banks, as well as by their curvature and the directions of water flow. The cause of devastating

floods which occur almost every year in Orissa has been shown by air photographs of the coast. It is found that the many outlets of rivers along the coast are subjected not only to stoppage by silt but more so by sea-washed sand. The deterioration of cultivable lands in the Punjab through saline saturation was investigated experimentally by the air camera. It was shown that photography, if carried out at the right time, would give much valuable data. In winter the salt that has reached the surface shows white in the photograph, rendering easy a calculation of the extent of the area thus saturated and the degree of deterioration of the less affected areas.

Yet another aspect of air photography is photo-geology which is the best means available to the geologist for getting information rapidly. This entails the use of the stereoscope which gives him the exact representation of the ground in relief. Stereoscopic photographs are taken into the field and examined in this manner. After correlating the geological data obtained on the ground, large tracts can be geologically mapped in the office with rapidity and accuracy of detail. Oil prospecting in Baluchistan was advanced by air photography when more than 1,000 square miles of land were surveyed. Important geological surveys have also been carried out in Bengal and Burma.

A Guide to Rajgir

THE glories of Rajagriha or ancient Rajgir are recalled in a guide to the place, just brought out in the series of interesting and useful guide books to ancient places by the Archaeological Survey of India. A sacred place of pilgrimage for the Buddhists, the Jains, the Hindus and the Muslims alike, Rajgir is situated on the south-eastern corner of the Patna district. Enclosed by hills on all sides, which give it natural fortification, Rajgir was an ideal place for a capital city in ancient days. It was the capital of Magadha (South Bihar) from mythical days down to the fifth century B.C. On the tops of its hills runs a huge cyclopean wall extending over a length of twenty-five to thirty miles, which, prior to the Indus Civilization, was regarded as the only surviving pre-Mauryan structure in India.

An important centre of Buddhism, Rajagriha was the scene of many of Buddha's sermons and of many an incident in his life, of which a long period he spent here. Buddha lived in different localities of the city, but his favourite resort was the *Gridhrakuta* or the 'Vulture's Peak'. After his death Ajatasatru, the king of Magadha, brought his share of the corporal relics of the Master to Rajagriha and enshrined them inside a *stupa*. A few months later, when the Buddhist monks decided to hold a council to from a corpus of the teachings of Buddha, Ajatasatru accommodated them in a large hall in front of the *Saptaparni* cave specially built for the purpose.

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Most of the places in the locality associated with Buddha can still be identified. Asoka erected at Rajagriha in the third century B.C. a stupa and a pillar with an elephant capital.

Mahavira, the last of the Jaina Tirthankaras, too, lived in this place and its suburb, Nalanda, for a long time. The Jainas hold the place sacred also on account of its being the birth place of their twentieth Tirthankara, Muni Suvrata. The modern religious importance of the place is due to the Jainas, who have built temples on the top of almost all the hills. These temples, though not claiming great antiquity, attract pilgrims from distant parts of India. In comparatively recent times, Makhdum Sharfuddin, the great Muslim saint of Bihar, spent twelve years in the jungles and hills of Rajgir in meditation and austerities. Ancient relics at the place are many. The archaeological monuments consist of extensive stone fortifications, civil residences, religious buildings, caves—natural and man-made, stupas, monasteries, shrines, inscriptions etc.

Indic Studies at the Washington Library of Congress

A DEPARTMENT of Indic studies has recently been established at the Library of Congress, Washington, Columbia, U.S.A. for the study of literature, philosophy, religion, law, the sciences, art, archaeology, history, anthropology, social institutions, linguistics, and current political developments of India proper and all neighbouring territories where the influence of Indian culture has been marked, viz., Burmah, Ceylon, Siam, Indo-China, Java, Sumatra, Bali, Central Asia and Tibet. The function of the department will begin by exploring the existing Indic materials now available in the Library of Congress and attempting to fill in the gaps. The department will establish contact with the agencies of publication in India and elsewhere for the purpose of establishing an American centre for the collection, systematization and dissemination of bibliographical data and it will co-operate with other scientific bodies and individual scholars in the Indic field elsewhere. We hope the department of Indic studies at the Library of Congress will further American scholarship in this field and promote in America a more intelligent interest in and appreciation for the culture of the Indic World.

Dr Horace I. Poleman, director of Indic studies in the Library of Congress is now in Calcutta collecting and micro-filming rare manuscripts in the possession of different societies, libraries and museums in the city. So far Dr Poleman has collected about 300 copies of manuscripts of 400 years old and has micro-filmed about 4,800 pages. Of the many manuscripts that he has

microfilmed, the illustrated "Saundaryya-Lahari"—found at Baroda, seemed to him to be the most beautiful. Among the 8,000 original Indian manuscripts collected in America, the oldest, according to Dr Poleman, was a 14th century Jain document in the possession of Harvard University.

Annual Report of the India Society, 1938

DURING the year the outstanding feature of the India Society's work was the expansion of the lecture programme with a two-fold view, first, to appeal to a wider public and secondly to attract scholars and specialists engaged on similar activities in allied fields. A series of popular lectures on Indian art and literature were arranged in collaboration with the Royal Empire Society and the Overseas League. A second series of lectures under the general title "Comparative studies in Indian Art" meant mainly for research workers were arranged under the joint auspices of the Society and the Warburg Institute. Some of these lectures are a valuable contribution to the comparative study of Asiatic art and will be published in the Indian Art and Letters. A number of exhibits depicting paintings and other objects representative of Indian art of different periods were held at the Council Chamber in India House. In addition to its customary publication of the half yearly numbers of the Society's journal, *Indian Arts and Letters*, the Society brought out two important publications, "*Studies in Chinese Art and Some Indian influences*" and "*Revealing India's Past*," which is a survey of the work of the Archaeological Survey of India and has been written entirely by past and present officers of the Survey. Both the books have been favourably received by the press and appreciative reviews of them have appeared in British, Indian, American and Continental papers and magazines.

The Fauna of British India

A SERIES of volumes under the title "*Fauna of British India*" has been published during the last fifty years under the patronage of the Secretary of State for India with the object of making properly known the rich varied fauna of this great sub-continent and affording authoritative means of its identification. The first volume Blandford's '*Mammals of British India*' was published in 1888. The latest volume, published only last year, also deals with mammalia and embodies a vast amount of additional knowledge on the subject gained during the last half century. Throughout this period one or more volumes have been issued almost every year and the publication was not stopped even during the last Great War. The volumes have proved to be highly useful to persons connected with Indian universities, colleges and museums and also scientific staffs of Government departments connected with agriculture, fisheries and forestry etc. In view of the importance of accurate

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identification which forms the basis upon which further study depends, some of the earlier volumes which have grown out of date need revision in the light of increased knowledge. The Secretary of State, it is understood, has decided to stop the publication of the series during the period of the present war on grounds of economy. The decision is to be regretted as there is every chance of zoological progress in this country being hampered as a result of this step. We have always discouraged any policy directed towards curtailing useful scientific activities in the name of economy, as the outcome in such cases in the long run always counterbalances the small monetary savings effected. From the point of view of interest of scientific knowledge in the important branch of zoology, combined efforts should be made to discourage any policy directed towards the cessation of the publication and see that the long-established publication is continued.

Discovery Ceases Publication

IT is a matter of extreme regret that the monthly journal, '*Discovery*,' started after the last War and lately taken over by the Cambridge University Press has decided to cease publication from April, 1940. That its end has been hastened primarily because of financial considerations in a country like Great Britain is rather shocking. We hope with the sponsors of the journal that it will be revived after the cessation of the present war. The disappearance of a fine journal which had practically a common aim with us and which devoted itself to awaken interest in science among the lay public has raised anxious questions in our mind. The questions raised by the editor of *Discovery* in his closing note have been engaging our attention for sometime past. In this country even the intelligent public is a long way from possessing a rational scientific outlook or making a scientific approach to everyday ways of life. But there are signs of a gradual awakening. Inclusion of scientific tit bits in daily papers or appearance of occasional articles on scientific subjects in periodicals point to a public taste for up to date scientific knowledge and information. It is also a gratification to us that our journal is gradually gaining a wider circle of readers and an increasing number of subscribers. But we have yet to go a long way to make the public interested in the movement of science and have to see that it is properly provided for. This raises a difficult question regarding the standard of our journal which would suit a large body of readers some of whom are scientific workers and specialists but others take only an intelligent interest in the development of various branches of science. Our journal has served its readers by publishing timely reviews and surveys of important progress made in different branches of pure and applied science.

It has also rendered useful service to scientific workers and researchers by quick publication of notes bearing on their original investigations, which would have been much delayed if they were to be published in foreign journals or even in Indian periodicals devoted to specialised branches. Opinions have been expressed now and then that the contents of our journal are a mixture of semipopular articles too elementary for the specialist and highly specialised articles and notes which are terrifying to the average readers. But in the present circumstances that cannot be altogether avoided in this country as our journal has to provide for a large circle of readers ranging from research workers engaged in specialised branches to persons who take only a detached interest in the progress of science.

The fact that '*Discovery*' had to discontinue publication due to financial difficulties in a country like Great Britain, makes obvious how very difficult it is in this country to conduct a journal such as ours. While expressing our debt of gratitude to the numerous subscribers, donors and advertisers with whose ready response it has been possible for us to publish our journal for the last five years, we venture to express the hope that in future we shall have in a greater measure the co-operation of all leading scientists and a much larger circle of readers and subscribers in the country. Such co-operation will make it possible to achieve in a fuller measure what SCIENCE AND CULTURE stands for.

Announcements

THE following is the list of new fellows of the Royal Society: Dr W. T. Astbury, reader in textile physics, University of Leeds, Dr G. R. De Beer, reader in embryology, University College, London, Dr O. M. B. Bulman, University lecturer in palaeozoology, Cambridge, Lord Cadman of Silverdale, emeritus professor of mining and petroleum technology, University of Birmingham and Chairman of the Anglo-Iranian Oil Co., Prof. G. Cook, Regius professor of civil engineering and mechanics, University of Glasgow, Dr H. Davenport, lecturer in mathematics University of Manchester, Dr. C. F. Goodeve, reader in physical chemistry, University College, London, Prof. F. G. Gregory, professor of plant physiology, Imperial College, London, Prof. A. C. Hardy, professor of zoology and oceanography, University College, Hull, Dr C. H. Kellaway, director of the Hall Institute for Medical Research, Melbourne, Australia, Prof. K. S. Krishnan, Mahendralal Sircar research professor of physics, Indian Association for the Cultivation of Science, Calcutta, Prof. R. P. Linstead, professor of organic chemistry, Harvard University, Prof. O. Maass, MacDonald professor of physical chemistry, McGill University, Montreal, Prof. H. S. W. Massey, Goldsmid professor of mathematics, University College, London, Dr B. H. C. Matthews, assistant director of

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the total capacity. At the present rate of production this means twelve years' supply from the U.S.A., without keeping however any allowance for discovery of more oilfields in future. India and Burma contributed 0.52 per cent of the total production in 1938. Search for oil in all parts of the world is therefore more active at the present day than before.

In the search for oil attention is solely directed to areas having a cover of sedimentary rocks. Igneous or metamorphic rocks cannot have any strata favourable for formation of oil. These rocks, according to their origin, cannot provide suitable porous rocks to act as oil reservoirs and folds to allow accumulation of oil which is produced by slow chemical or biochemical decomposition of the remains of lowly forms of organic life buried underneath the surface of the earth. Generally marine and estuarine conditions prevent complete decomposition of these organic materials before burial and alluvial plains are now therefore being tapped for probable oil wells.

Oil geologists in exploration work first look for outward indications of the existence of petroleum as given by gravimetric, seismic and electric observations. The sensitive gravity instruments measure minute differences of force of gravity throughout a given area. A large anticline or a fold in the earth's crust, has in its core rocks of higher specific gravity than its flanks and shows at the surface a slight increase in the value of gravity as compared with the surroundings. In the seismic method a type of echo sounding is used. The results are correlated and depicted in the form of contour maps which show the structural attitude of the various reflecting layers. The electrical method measures the relative resistivity and conductivity of the various groups of rocks and provides a contour map of their structure. Many difficulties in interpretation of the results are however encountered but these results assist greatly in locating exploration wells. During recent years small quantities of surface rocks or soils are being analysed for their hydrocarbon gas content, and very minute escapes of gas, not detectable by ordinary means, sometimes give a clue to underground oil accumulation. This method is yet to be established for routine application.

At the present moment, exploration in countries other than in North and South America and Europe is most active in Egypt, Sinai, Palestine, Syria, Arabia, Iraq, Iran, Afghanistan, Asiatic U.S.S.R., India, Burma, Dutch East Indies, Borneo, Sarawak, Dutch New Guinea, British Mandated New Guinea and Papua, Australia, and New Zealand. Oil exploration work is a lengthy and expensive undertaking and before the oilfield is developed it may cost many millions of rupees in money and five

to ten years in time. Shell Company abandoned its work in Papua in New Guinea after £433,000 had been spent while on the other hand an American Company at Bahrein, an island in the Persian Gulf, has gained in a short time spectacular success. Sedimentary basins frequently fall in lowlying areas or alluvial plains and the rock structure is completely obscured from view by alluvium and vegetation. The physical methods of investigating the subsurface structure or geophysics have been of great help nowadays for prospecting work and so extensive fields are being explored all over the world. It is unfortunate that not a single Indian firm or combine has collected energy and set free some of their hoarded money for this valuable work, which not only will provide the enterprising men with monetary returns but will also satisfy India's industrial needs.

Generally about 20 to 30 per cent of the total oil reserves are produced by ordinary means and more is obtained with a natural or artificial water flush or drive during operation. Too rapid oil production particularly whose reservoir rock is a limestone draws water up the tissues and ruins the field. Oil is generally drained from the interstices between the sand grains or from grains or fissures of a limestone and a large amount of oil still remains wetting the surfaces of these grains. It may therefore be economical to mine the oil sands of exhausted fields to recover the residual oil. This process is now in operation at Wietze in Germany and is being aided by huge protection from the State. Though oil supply is very limited in the world, the situation should not alarm us because substitutes of the oil are already being synthesised from coal and other sources and signs are not wanting to find hitherto untapped sources of power. Experiments are also on foot to harness new forces of nature, as for example, solar heat.

Detection of Icebergs

ICEBERGS are a menace to ships in the North Atlantic. These drift sometimes at astonishing speed and melting very fast under water turn over allowing the ships very little time to avoid collision. Very swift and sure manoeuvring of ships is therefore necessary to avoid accidents. Huge icebergs showing 300 ft. above water having 25000 ft. under water have been seen. The *Meccano Magazine* estimates that 32,000,000,000 tons of ice float around in the Atlantic every year, which apart from the direct hits cause obstructions by rains, fogs and snow in the path of the ships. There are also flocs which sometimes measure half a mile by two miles. Icebergs in this area are originally glaciers of Greenland which move slowly down to the sea and during movement the bottom is gradually scraped and they float. Once in the sea, they are caught by north-south current towards the temperate waters. The earth's rotation (more than 1500 ft. per second at the equator) steers these towards the North American coast.

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Unless an iceberg is detected six miles off, a ship may not get sufficient time to escape from it. By means of a thermo-electric battery or a special electric eye located at the focus of an oscillating parabolic mirror, the sudden drop of temperature at the approach of an iceberg was formerly used as an alarm. This was later substituted by a vibrating piezo-electric quartz producing echoes. A sound too fine for the human ear is directed horizontally and the interference of the sound waves by submerged rocks and the bases of icebergs gives the indication of the danger ahead. But recently a French company claims to have designed a more complete and efficient method by means of the infrared rays. At the bow of the ship two parabolic mirrors are placed for projecting and receiving the rays. These oscillate synchronously by means of electric connection with a cathodic oscillograph or television tube. In case of obstruction the mirror turns in that direction, the alarm sounds and a luminous spot on the oscillograph can accurately indicate the distance and the direction of the iceberg.

Measurement of Gloss, Transparency and Colour

A NEW apparatus for the measurement of gloss, transparency and colour has been devised at the Indian Lac Research Institute, Ranchi. The details of the apparatus and the method of using it have been described in the recently published *Bulletin No. 37* of the Indian Lac Research Institute.

The source of light and the device for measuring the reflected light in this apparatus are located in fixed positions, and they subtend a right angle at the centre of the test surface, which can be rotated so as to vary the angle of incidence. Measurements taken at various angles of incidence, therefore, consist of light valves for specularly reflected light at 45° angle of incidence as well as diffused light in a direction perpendicular to the incident beam at other angles of incidence. When these light values are plotted against the angles of incidence, curves similar to those obtained with gonio-photometers are obtained. The shape of these curves depends upon the gloss of the test surface. An arrangement for self recording such curves has also been devised by connecting the axis of the test panel with that of a clock or motor-driven drum camera. The procedure for measuring the transparency of varnish films and for colour and colorimetric measurements have also been described. The chief advantage of the instrument is that it combines three instruments in one, and for the measurement of gloss it follows the procedure common to most people in the visual judgment of gloss.

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New Wind Indicators for Flying

A 'SMOKE TRAIL' wind indicator is being installed at Juhu aerodrome, Bombay, as the latest of the experiments made by the Civil Aviation Department to determine the most satisfactory form of wind indicator for use under Indian conditions.

Installed in the centre of the aerodrome, flush with the surface, the 'smoke trail' wind indicator burns oil on an electrically heated plate and discharges a plume of dense white smoke which gives a reliable indication of the wind direction across the ground. An indicator of this type will be particularly valuable at those aerodromes where irregular light winds are frequent and the phenomenon of two wind sleeves flying at variance with one another is not unusual.

An illuminated wind sleeve consisting of a fabric cone of conventional type illuminated from above is giving effective results in trials for night flying at Karachi. An illuminated wind indicator formed of plastic material and lighted internally has also been tried out. This flies with the wind like a wind sleeve but is less sensitive and therefore less suitable for the particular conditions experienced in India. Another device which has been tested and is now in service at Karachi Airport is a remotely-controlled illuminated landing 'T' which indicates to pilots the direction of landing and take-off. Under conditions of 'no wind,' the Aerodrome Officer sets the 'T' in the prescribed direction by electric operation from switches in the control room.

Growth of Paper Industry

WRITING in the *Technology Review* Dr Dard Hunter, who has recently organised a Paper Museum showing the evolution of papermaking at the Massachusetts Institute of Technology after good deal of travel and search all over the world, observes that a modern criterion of the civilization of a country is its per capita consumption of paper. Dissemination of news and views and education of citizens are operations readily measured in terms of the consumption of paper. The latest per capita consumption figures (for 1938) for America are 245 pounds and for India less than a pound. In America the first paper mill was started in 1690 but the art of paper making was known in India much earlier than that.

He incidentally refers to his interview with Mahatma Gandhi in India, who said to him, "Of all the inventions of civilisation the two most useful and indispensable are the crafts of clothweaving and papermaking. But he wants that people should produce these essential commodities by personal efforts in the cottages and here Dr Hunter observes: "While the Sage of India seems able to do with but little woven cloth for his own personal

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fitted up in the chemical section of the Indian Lac Research Institute. A large number of commercial samples of all grades of lac have been analysed and the results will form a basis for drawing up grade specifications which are being circulated to the trade for opinion. The object is to obtain, if possible, complete understanding and agreement among all the trade interests as to the quality of the products they handle. A black baking enamel of satisfactory quality has been prepared from refuse lac at a cheap cost. Semi-commercial scale preparations of shellac moulding powders and moulded articles therefrom have been successful.

The Development of Vacuum Flask

ALMOST every household nowadays uses vacuum flasks to keep a drink hot or cold. Though it is a very common thing and appears very simple from the constructional viewpoint, behind its development there is a long history of research and experiment. The common vacuum flasks are made of two glass vessels, one placed inside the other and the air entangled between them is pumped out. The inner surfaces of this evacuated space are silvered.

The theory underlying the construction of vacuum flasks is as follows: there are three methods for transference of heat from one place to another, first, convection, i.e., the mass movement of heat with flowing particles, secondly conduction, i.e., transference of heat from particle to particle through collisions and thirdly radiation, where no material medium is needed. To maintain a substance at a temperature for a long period all the above three causes of heat transfer must be eliminated as completely as possible. Convection ceases in an evacuated space as soon as the number of molecules of gas become insufficient for their movement in streams or masses; but since conduction occurs through the successive collisions of molecules, this persists so long as the mean free path of the molecules of the gas is definitely less than the dimensions of the evacuated space. At pressures below atmospheric convection ceases almost completely, but the heat flow by conduction is the same up to a pressure of 1 millimeter of mercury. Below this pressure the transference takes place only by radiation. So it is only at this lowest pressure i.e., at 1 mm. of mercury that a vacuum flask is effective. Heat flow by radiation is fully stopped by silvering the inner surfaces of the vacuum vessel, the heat being simply reflected back from the polished surfaces.

The researches which led to the development had their beginning at the end of the eighteenth century, when the problem of the true nature of heat was being discussed. Herschel had shown that heat was trans-

mitted by rays beyond the red end of the visible spectrum and that these rays can be focussed by a lens. Leslie opposed the theory of heat as a mode of motion and sought to prove that it was a fluid. In an attempt to settle this controversy and to discover the truth about the nature of heat, Count Rumford, one of the founders of the Royal Institution, began a series of experiments on heat transference. In the course of these, he placed a thermometer bulb in a vacuum vessel as also in an air-filled vessel and compared the time taken by the thermometer to rise to a certain fixed temperature. Rumford's results were not so satisfactory as those of the later workers, since the Torricellian vacuum, which was the best he could obtain, was insufficient to prevent conduction entirely, but these investigations led to other fields and practical results.

The practical application of this theory was largely due to Sir James Dewar (after whose name a vacuum flask is called a Dewar flask). Dewar worked out no new principle or law but applied to the solution of a practical difficulty on the results of previous investigators who worked about a century before his time. Dewar was studying the behaviour of gases below the temperature at which they liquefied. The temperatures at which he worked was about 200°C, below the freezing point of water, so the liquefied gases boiled away very rapidly if placed in ordinary vessels. Further the intense cold led to the formation on the exterior of the vessels of a deposit of frost which prevented the behaviour of the contents from being observed. The formation of frost was prevented by placing the liquid in the innermost of a series of vessels through which the evaporating gas was led in regular order, all being protected by an outer vessel containing some dehydrating material. This arrangement also served to slow down evaporation, as the liquid gas at the centre was surrounded by several jackets of gas at low temperature. Examples of such vessels are still preserved at the Royal Institution, (where Sir William Bragg recently traced the evolution of vacuum flasks) where Dewar's work on low temperature was carried on. Evaporation from these vessels was still far too rapid to permit experiments of long duration to be performed. The solution of this problem was only reached with the development of the high efficiency vacuum flask.

The silvered glass vacuum vessels are satisfactory for laboratory handling of small quantity of liquefied gases or for other uses on small scale. The industrial use of the vacuum vessels on large scale handlings introduced a new problem. For the storage of liquefied gases, the most efficient size of the vacuum vessel is one of about 5 gallons capacity. This, however, is considerably larger than that can conveniently be made of glass, and further, when it is necessary to transport the gases a material less fragile than glass must be employed.

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These requirements led to the development of metal vacuum vessels. With metal vessels a new difficulty was encountered; it was not possible to produce such a high vacuum in a metal-walled vessel as in a glass one, since a certain amount of gas was occluded in the metal, and as this slowly escaped, the vacuum gradually deteriorated. This final problem was solved by Dewar by the use of charcoal, which is a powerful adsorbent of gases, its efficiency being conveniently increased at low temperatures.

By taking advantage of this property of charcoal very efficient metal vacuum vessels are made. The charcoal is placed in a capsule or tube open to the vacuum space and attached to the inner vessel, and therefore, its efficiency is utilised when the vessel is in use, and the temperature of the inner vessel and that of the charcoal is lowered to that of the liquid gas in the vessel. The charcoal thus cools rapidly, condenses the traces of gas that has escaped from the metal walls and so maintains the vacuum at its required value. The useful property of the container is further increased by giving a high polish to the metal surface of the interior of the vacuum shell before assembling it.

—N. K. S. G.

An Automatic Cleanness Defect Counter for Testing Raw Silk

B. Roy

Officer-in-Charge, Bengal Government Silk Conditioning House, Howrah.

The Silk Conditioning House at Howrah was started in 1938 by the Bengal Government as one of the elements of a comprehensive scheme for the revival of the silk industry of Bengal. The standardisation of the quality of Bengal silk and facilitating fair trade by gradually enforcing the internationally accepted system of classification and regulated marketing is the object of this institution. Before describing the Counter made in this institution, it will be worth while to enumerate the defects ordinarily found in raw silk.

Defects

Best silk is that which allows the highest speed of the loom. Factors detrimental to efficient weaving are counted as defects. The following properties are looked for by the manufacturer to give a complete picture of the lot of raw silk:

- (i) Colour, lustre, feel, nature, gum-spots, lot-uniformity.
- (ii) Quality: (a) Evenness: average (Seriplane), (b) Low panels: average, (c) Cleanness, (d) Neatness, (e) Size-deviation, (f) Maximum-deviation, (g) Wind-ing breaks per hour per 50 skeins, (h) Strength, (i) Elongation per cent and (j) Cohesion.
- (iii) Percentage of moisture, and
- (iv) Percentage of gum.

Detailed discussions regarding the relative importance of the aforesaid properties in fixing the grade for

valuation is beyond the scope of the present work. Readers interested in the subject may consult the publications of the Joint Committee of the American Silk Association, *Serivator* for valuation of raw silk etc. The present note is concerned with property of cleanness for understanding the working of the electrically driven counter.

During the process of reeling due to defective cooking of cocoons, the quality of cocoons and unskilled reeling, the raw silk may be affected in such a manner as to contain large or small defects as (a) (1) Wastes, (2) Bad casts, (3) Large slugs, (4) Very long knots, (5) Heavy Corkscrews; and (b) (1) Small slugs, (2) Long knots, (3) Small Corkscrews, (4) Loops (long).

These are known as cleanness defects. They hamper efficient weaving by breaking the thread whenever they are arrested by the reed and when the threads do not break, the presence of these defects make the cloth of a low grade which entails a loss to the manufacturer. The defects in the group (a) are known as major defects and those in group (b) are known as minor defects (figs. A and B). The difference is practically on the basis of size of the defects in relation to the average size of the yarn. The definition of cleanness percentage as recommended by the Joint Committee of the American Silk Association is given below:—

The percentage of cleanness is determined and certified by deducting a penalty of 30 per cent of the number

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of major defects and 10 per cent of the minor defects over 45 kilometers (100 Panels). For example, if the records show major defects to be 20, and minor defects to be 50, then the total penalty is equal to $6 + 5 = 11$, and the cleanness per cent is $100 - 11 = 89$.

Testing Methods

For testing cleanness, the yarn is wound round a black rectangular board in such a manner that the thread remains side by side with exactly equal spacing. The machine employed for this is known as seriplane, the rectangular boards are termed as seriplane boards. A panel is a section of the winding on the boards 5" wide. Ten panels are wound on the same board. For

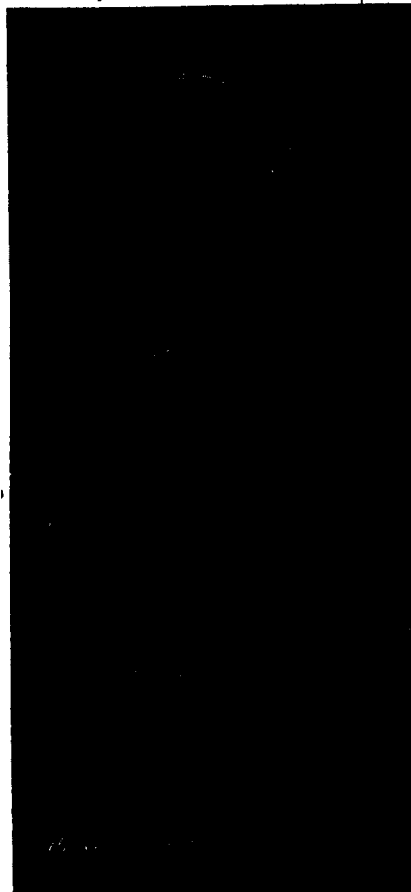


Fig. A. Major Defects.

testing for cleanness, the boards are removed to a dark room with special arrangements of illumination. The panels are placed in a vertical plane, in front of the estimator, who views them by artificial light scattered by the silk threads. The source of light is on the top of the boards and fitted with the reflectors which throw the light more or less tangentially on the panels. This is

to make the defective spots clearly visible. The estimator records the number of defects of each type in 100 panels, for testing a lot of 10 bales of raw silk. The 100 panels are wound from 50 skeins drawn from the lot taking 5 hanks at random from each bale. Differentiation is to be done between major and minor defects, by comparing the defects with standard cleanness photographs placed near by. But the experience of the estimator is ultimately relied upon. The personal factor involved is serious. After finishing the counting of the defects, the total number of major defects and the total number of minor defects in 100 panels are computed.

New Automatic Counter

The author of this paper has successfully mechanised the operation of counting and registering the percentage of cleanness without going through visual counting.

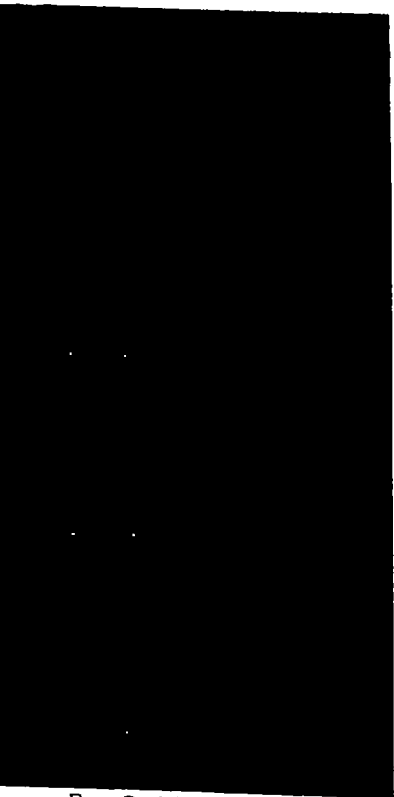
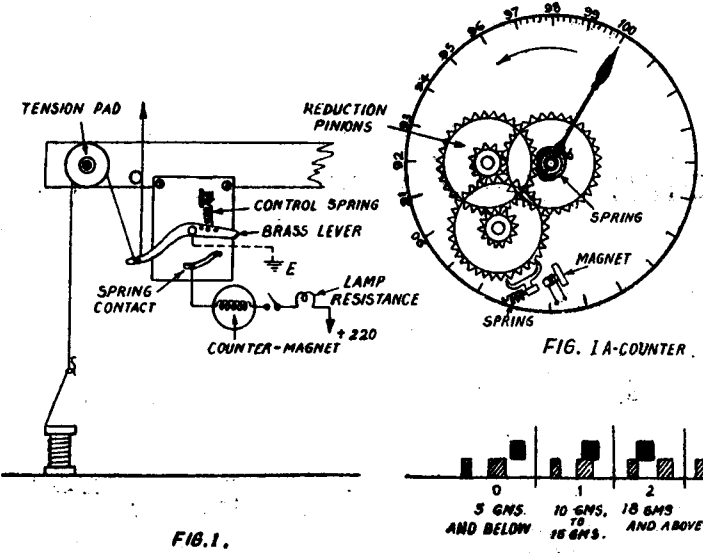


Fig. B. Minor Defects.

The operation of the counter is based on the sudden increase of tension of the thread due to a cleanness defect, while winding it from the bobbin through spring tension pads in the seriplane machine. No seriplane board is necessary for cleanness counting by this method, but as the seriplane panels are to be wound for other tests also, the Defect Counter has been fitted to the seriplane. The thread passes from the bobbin through the tension pad as in fig. 1 and then through spring-controlled lever fitted with a thread guide at the end. The

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spring is adjustable to the three holes in the lever according to the average size of the thread (13|15, 20|22 or 28|30 denier). The lever of brass is earth-connected and fitted with contact points at the end away from the thread-guide. Below this end, a brass strip of the shape given in the figure is bent in such a manner as to make one contact for a tension between 5 to 10 grammes and



make 3 contacts for tension more than 18 grammes (fig. 1B).

By several trials with major defects the spring was adjusted to a particular tension for 13|15 denier. The two other holes to increase the leverage was spaced by trials with 20|22 and 28|30 denier (average size). The lower brass strip is connected to the electromagnet of the counter, whose circuit is completed when the lever makes contact with the lower brass strip and the counter switch. The electromagnet operates a specially designed spring-controlled counter, the dial of which registers one division every time a contact is made. For a major defect, the tension is such that the lever is pressed down to the lower end of the brass strip and when released makes three contacts registering 3 divisions on the dial. When a minor defect passes, the tension is not sufficient to press the lever below the first contact point and the pointer moves only one division. The lower brass spring is such that either 1 or 3 contacts can be made. The dial is marked 100, 90, 80, and 70 with interdivisions. Seventy per cent cleanness corresponds to the lowest grade. After winding 100 panels the reading of the pointer gives the cleanness percentage directly.

The advantages of this Automatic Defect Counter are: (i) the personal factor is eliminated, (ii) the work of the estimator and special arrangement for illumination is dispensed with, (iii) the device is very cheap, costing not more than 50 rupees for one seriplane, and (iv) the accuracy, if not very high, is not below what is necessary for commercial purposes, and (v) manipulation is simple. But the device fails completely for any badly wound bobbin, faulty tension pad and dislocated

thread-guides. Though the total cleanness percentage is obtained, the number of each type of defects remains unknown by this method.

A Table showing the comparative cleanness tests as recorded in Defect Counter and as found by visual counting is given below

No. of Test	No. of Panels	Total penalty recorded in Defect Counter	Cleanness % Obtained	Total penalty obtained by visual counting	Cleanness % obtained
1.	5.	3.0	97.0	2.7	97.3
2.	5.	3.5	96.5	4.2	95.8
3.	5.	4.0	96.0	3.8	96.2
4.	5.	2.4	97.6	2.2	97.8
5.	5.	3.6	96.4	3.4	96.6
6.	5.	2.5	97.5	3.2	96.8
7.	5.	3.2	96.8	3.7	96.3
8.	5.	2.5	97.5	2.5	97.5
Totals:	40 Panels	24.7	—	25.7	—
Cleanness% =		75.3%	—	74.3%	—

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Therefore, the difference between visual counting and counting in Defect Counter is 1 in 75.3 i.e. 1.3%.

Considering the fact that counting of defects for large number of panels is subject to personal error, this difference may be allowed. The special advantage claimed by this device is in the elimination of personal factor, and errors, if any, will not involve differential

treatment between samples. It removes any doubt regarding the bias of the estimator, and an impartial certificate of cleanness is ensured. It is also an important factor that the test is made under conditions similar to the passage of the threads through the fine dents of reeds during weaving.

I acknowledge my thanks to the Director of Industries, Bengal, for giving me scope for the work and the Deputy Director of Sericulture, Bengal, for his encouragement and guidance.

Rectified Spirit as Motor Fuel

S. Dutt

Chemistry Department, Allahabad University

Manufacture of Rectified Spirit

Rectified spirit or Patent Still alcohol is a colourless highly inflammable liquid with a characteristic pleasant smell and a specific gravity of 0.81 to 0.82 at 60°F. It contains 92 to 96 per cent of alcohol by volume, the remainder being water. It is manufactured all over the world by fermentation of starchy or saccharine materials like rice, barley, maize, potato, grape juice, cane sugar, gur and molasses in dilute aqueous solution by microscopic organisms or bacteria known as yeast, and subsequent distillation of the fermented liquid or "wash" in a patented continuous distillation apparatus known as Coffee Still or Patent Still. The following are the average yields of rectified spirit obtained from various raw materials, one ton of which is taken in each case:

Raw Material	Yield of Spirit
1 Ton Rice	104-107 gallons
" Barley	98 "
" Wheat	78 "
" Potato	31 "
" Cane sugar	114 "
" Gur	85-94 "
" Grape juice	28-32 "
" Molasses	63 "

Alcohol has unlimited uses as solvent for paints, varnishes, enamels, perfumery materials, dyes, drugs, resins, etc., and also as fuel in stoves, burners, lamps, water heaters, radiators and internal combustion motors. It is one of the useful substances in the common employment of men and a powerful preservative for perishable materials. But it is not available at a cheap rate on account of the fact that it is a powerful intoxicant when

taken internally, and is the narcotic principle of all wines and spirit. It is under very strict excise regulations in almost all the countries of the world, and in India alone the excise duty on a gallon of rectified spirit is about Rs. 6|10|- whereas the cost of production of the same quantity of the spirit rarely exceeds annas eight per gallon. Due to this lamentable drawback, rectified spirit has not achieved the wide application that it deserves. Although after being denatured or rendered unfit for drinking by the addition of some obnoxious or poisonous chemicals, it is sold as "methylated spirit," which is used in a few arts and industries and also in the household for solvent and heating purposes, yet such uses are very limited in their scope and extent for obvious reasons. In the present article, I shall only deal with the scope of use of rectified spirit as a motor fuel, particularly in view of the present serious emergency of the European war and the possibility of petrol becoming scarce and very dear. With 163 sugar factories in India, producing amongst them nearly 200,000 tons of molasses every year, which they do not know how to dispose of and which are potentially capable of yielding at least 120 million gallons of alcohol, sufficient to meet the present motoring needs of India, it is really a subject of anxiety why India should be entirely dependent on foreign supplies of petrol. In this unfortunate country everything seems to be going amiss and to waste, and so are also these tremendous resources of motor power. How long are we to coldly see this colossal waste going on?

Characteristics of Rectified Spirit

Rectified spirit is an excellent motor fuel, and unlike petrol, it burns clean without depositing soot in the exhaust pipe or silencer or carbonising the piston-tops or

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cylinder-heads. The thermal efficiency of a properly constructed alcohol motor is greater than that of the petrol motor as less heat is thrown away in the exhaust gases and in the water jacket. The exhaust gases of the petrol motor are generally thrown out at a pressure of nearly 45 pounds to the square inch and the temperature of the exhaust is often as high as 350°C, whereas in an alcohol motor the exhaust pressure is 15-18 lbs. and the exhaust temperature 125-150°C. From the point of view of chemical or combustion efficiency also, an alcohol motor is superior to petrol motor, as the exhaust gases of a petrol engine contain nearly 10 per cent of carbon-monoxide and 3 per cent of acetylene still capable of undergoing further combustion, whereas the exhaust gases of an alcohol motor do not contain any such unburnt fuel. The mixture of alcohol vapour and air stands a much higher compression than one of petrol vapour and air without pre-ignition or premature explosion, and this is one of the main factors of giving the alcohol motor a greater efficiency. Although the calorific value of petrol (10700 units) is much greater than the calorific value of alcohol (6500 units), yet there is less heat dissipation and consequently more conservation of energy for doing useful work as much less air (6 vols.) is needed to burn alcohol than petrol (20 vols). Taking every thing into consideration, from the theoretical point of view, a properly constructed alcohol motor should be almost as efficient as a petrol motor. From actual experimental evidence it is found that an alcohol motor generates over 90 per cent of the power generated by a petrol motor of the same capacity.

The question now arises as to how to convert an existing petrol motor into an alcohol burning motor with a high degree of efficiency, particularly in view of the fact that alcohol burning motors are not manufactured by the motor car manufacturers for the obvious reason that alcohol as a motor fuel has never been available in sufficiently large quantities, firstly for want of a sufficiently cheap raw material and secondly for too stringent excise regulations. If we can convert our petrol burning motor car engines into alcohol burning engines with a minimum of trouble and expenditure, at least a part of the problem of cheap fuel supply for our cars will be solved.

Defects of Rectified Spirit and Remedies

Alcohol as a motor fuel as compared to petrol has however certain disadvantages: (i) Higher specific gravity, (ii) Lower vapour pressure at any particular temperature, (iii) Lower velocity of ignition or detonation of alcohol vapour-air mixture, and (iv) Less air necessary for combustion.

On account of defect no (i), the alcohol level in the jet chamber of the carburettor of the car remains at a lower level than with petrol, and consequently there is less delivery and atomisation of the alcohol fuel. This defect however can be easily remedied by loading the float (fig. 1) with bits of solder until the fuel level rises

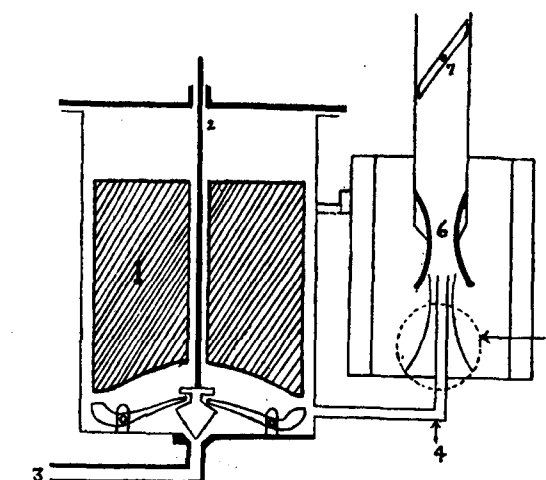


Fig. 1. The Carburettor.

1. Carburettor float, 2. Needle valve, 3. Petrol supply, 4. Jet, 5. Air intake pipe to carburettor, 6. Venturi, 7. Throttle valve.

to within 2 mm. of the jet orifice, which is the correct fuel level in the jet for alcohol. The delivery and atomisation of the fuel then proceeds normally.

On account of defect no (ii), it is difficult to start a petrol engine with alcohol on a very cold winter morning, particularly in northern India. This difficulty can be got over by fitting a simple petrol injector (fig. 2)

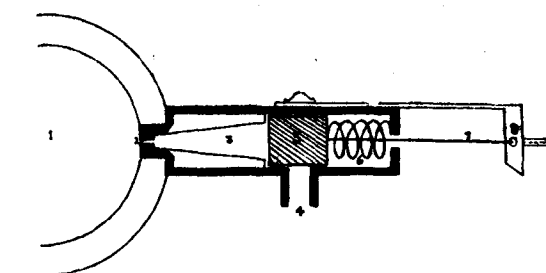


Fig. 2. The Petrol Injector.

—Dutt's design.

1. Inlet manifold centre, 2. Injector jet, 3. Injector cone, 4. Petrol supply, 5. Ground in piston, 6. Recoil spring to piston, 7. Bowden cable, 8. Bowden cable thrust plate.

fed by a small cowl tank, to the inlet manifold of the engine, the governing cock of which can be operated

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from the dash-board. The engine is started with petrol and as soon as it is revolving smoothly, it is switched over to alcohol fuel by shutting off the petrol supply. This will hardly require more than a few seconds. Alternatively a small duplex petrol carburettor can also be fitted to the inlet manifold. But this will mean much more expense.

On account of defect no (iii), the efficiency of alcohol fuel in a petrol burning motor is rather low. This important defect can be remedied by increasing the compression ratio in the cylinder-heads, so as to give a higher final pressure to the explosive charge before ignition. This can be done by any of the following methods:

(a) By putting an extra-thin gasket between the cylinder-head and the cylinder block instead of the regular one. Ordinary gaskets of this type made of copper-asbestos are about 4 mm. thick. By putting in a

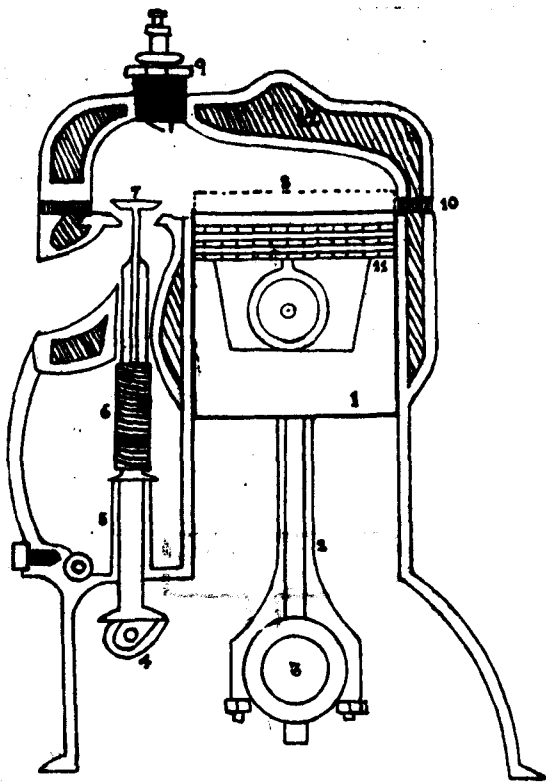


Fig. 3. The Engine.

1. Piston, 2. Connecting rod, 3. Crank shaft, 4. Cam shaft, 5. Tappet, 6. Valve spring, 7. Valve, 8. Upper cylinder space; the dotted line indicates the out-line of the high head piston, 9. Spark plug, 10. Cylinder-head gasket, 11. Piston rings, 12. Water jacket.

soft sheet copper gasket of 0.5 mm. thickness, the compression of a four cylinder 3-litre engine is often increased by 12-15 lbs. per square inch.

(b) By substituting higher pistons, that is pistons, that will partially project into the cylinder-head instead of remaining flush with the cylinder block, as is always the case with the vast majority of engines (fig. 3). By a quarter inch projection of the pistons in a three-litre four cylinder engine, the compression is increased by about 25 lbs., and a half inch projection increases it by about 65 lbs. The degree of projection will however be determined by the contour of the upper cylinder space. Instead of installing new pistons, the original pistons may be increased in height by rivetting circular discs of metal on top of them, taking care however to put the same weight of metal on each piston.

(c) By installing long connecting rods (fig. 3). This will have the same effect as that of increasing the height of the pistons, but this is a more difficult thing to carry out, and will be more expensive, particularly in view of the fact that a connecting rod has two bearings to be machined and fitted, whereas a piston has only one. The connecting rod being made of high quality steel requires to be forged, while the piston being made of aluminum is easily cast. The length of the connecting rod should be increased to such an extent that at the end of the upward stroke of the piston, the topmost piston ring does not spring out clear of the cylinder. In 90 per cent of the motor car engines, the connecting rod may be lengthened by a quarter to a half inch without producing any complications, and with highly increased compression.

(d) By filling in the upper cylinder space by welding or brazing metal on the inside of the cylinder-head or blowing in atomised metal from an oxyacetylene blow torch. This is rather a difficult operation and cannot be conducted in an ordinary workshop.

(e) By installing a high-compression cylinder-head often obtainable from the makers of the car or from a big spare-part manufacturing concern. This is the most satisfactory arrangement for increasing the compression of the engine, since in this the upper cylinder space has already been reduced during the casting process. But this is comparatively expensive and the high-compression cylinder-head cannot also be obtained for every make of car.

As regards defect no (iv), it is easiest to remedy. This is done by cutting off 2/5th of the air supply to the carburettor with the help of a circular device (Fig. 4) fitted to the air intake pipe of the carburettor or the air cleaner. Alternatively, the choke valve of the carburettor can be so adjusted that it will supply only 2/5th of the original quantity of air in the fully "open" position.

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The best conditions for getting the maximum efficiency out of a petrol engine with alcohol fuel are:

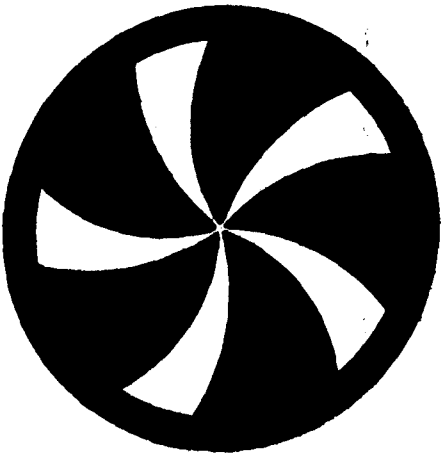


Fig. 4. Carburettor Air-intake Baffle Gasket. —Dutt's design.

(i) Compression ratio at 8.5: 1, that is, about 125 lbs. to the square inch, (ii) Carburettor float adjusted to the higher specific gravity of the alcohol fuel, and (iii) Air supply to the carburettor reduced to 3/5th of the original. Nothing else is necessary, and with the above conditions satisfied, a petrol engine runs with alcohol with over 90 per cent of the efficiency available with petrol.

Experimental Results.

The following experiments conducted by the present author will clearly bring this out.

Experiment 1. Model 1926 Douglas motor cycle. Air cooled twin-cylinder engine; four stroke. Capacity 345 c.c. Compression 60 lbs. Weight 210 lbs. Petrol consumption 96 miles per gallon. Maximum speed 58 miles per hour.

The engine was altered for alcohol fuel by adjustment of the carburettor and the compression was increased to 118 lbs. by method (d) mentioned above. Rectified spirit of 93.2 per cent was used as the fuel. Fuel consumption was found to be 90 miles per gallon and the maximum speed 53.5 miles per hour.

Experiment 2. Ford 1928, Model A, Saloon car. Four cylinder water-cooled engine. Capacity 3100 c.c. Compression 65 lbs. per square inch. Weight 2575 lbs. Petrol consumption 23.5 miles per gallon. Maximum speed 62 miles per hour.

After conversion for alcohol, the compression was increased to 123 lbs. by method (b), and a petrol injector was fitted to the inlet manifold for easy starting. Rectified spirit of 94.2 per cent was used as the fuel. Fuel consumption was found to be 23 miles per gallon, and the maximum speed 59.5 miles per hour.

Experiment 3. Baby Austin touring car, 1926 model. Four cylinder water-cooled engine. Capacity 743 c.c. Compression 60 lbs. per square inch. Weight 1340 lbs. Petrol consumption 42 miles per gallon. Maximum speed 46 miles per hour.

After alteration of the carburettor and increasing the compression to 112 lbs by methods (a) and (e), the car was tried out for alcohol fuel. With alcohol of 95.0 per cent strength the consumption was found to be 40.2 miles per gallon and the maximum speed 42 miles per hour.

Without any alteration at all, a petrol engine will certainly run with alcohol fuel, but with much less efficiency as the following experiment by the present author will show:

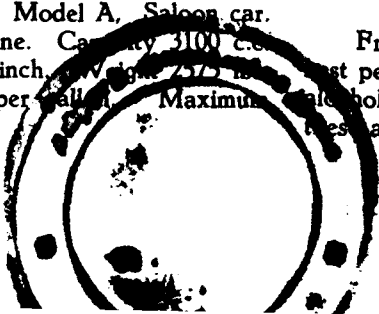
Experiment 4. Chrysler, Model 1933, Saloon car. Six cylinder water-cooled engine. Capacity 2984 c.c. Compression, 85 lbs per square inch. Weight 3220 lbs. Petrol consumption 19.6 miles per gallon. Maximum speed 76 miles per hour.

With 95.5 per cent alcohol, the car ran 15.2 miles per gallon and the maximum speed was 69 miles per hour.

The following are the results obtained by Prof. Wawrzynic while experimenting with standard petrol engines, using rectified spirit of 96 per cent as the motor fuel:

Name of motor Vehicle	Engine Capacity in C. C.	No. of Cylinders	Compression (lbs. per sq. in.)	Effective Power at 1000 R.P.M. with Petrol	Effective Power at 1000 R.P.M. with Alcohol	Fuel Consumption Litre / H.P. / hr.
Daimler lorry	5550	6	60	31.25	27.1	P=0.44 A=0.63
Adler car	2620	4	65	13.85	11.7	P=0.59 A=0.79
Elite car	3140	6	83	18.5	15.6	P=0.46 A=0.63

From the above data, it can be easily seen that for best performance, a petrol engine has to be adapted for alcohol fuel by slight mechanical alterations. Most of these alterations can be easily carried out in a good and



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well equipped workshop. The expenses for such alterations will be approximately Rs. 110/- for a 4 cylinder, 10 H. P. car, as is shown below:

1. Charge for opening the cylinder-head and putting it back again, including all necessary operations for changing pistons ..	Rs. 10
2. Extra-thin gasket of soft copper ..	Rs. 3
3. Four new high-head pistons, cast, machined and polished to specification, using the original rings ..	Rs. 48
4. Adjusting the carburettor float with solder ..	Rs. 2
5. Adjusting the choke valve of carburettor to 3/5th of the original air intake, or putting a baffle gasket for the same purpose ..	Rs. 10
6. Boring and tapping the inlet manifold for petrol injector ..	Rs. 2
7. Petrol injector ..	Rs. 5
8. Small cowl petrol tank ..	Rs. 5
9. Copper pipe line from petrol injector to cowl tank ..	Rs. 5
10. Valve in pipe line with Bowden cable operation from dashboard or steering column ..	Rs. 10
11. Fitting charges ..	Rs. 10
Total	Rs. 110

Hence the price of alteration will work out to be approximately Rs. 27/8/- per cylinder. For larger engines, the cost will be approximately Rs. 30 per cylinder, which can be taken as the general basis for the calculation of the cost of alteration. The benefit that will result from

the above alteration of the engine to suit alcohol fuel can be calculated as under:

Retail price of alcohol per gallon ..	Rs. 0 6 6
Fuel tax* (Central Government) ..	Rs. 0 10 0
Fuel tax (Provincial Government) ..	Rs. 0 2 0
Total Price	Rs. 1 2 0
	per gallon.

Taking the average efficiency of the alcohol fuel in the altered petrol engine to be 90 per cent of that of petrol fuel, 1.1 gallon of alcohol costing approximately Rs. 1-4 will be equivalent to one gallon of petrol costing Rs. 1-11-6. Hence for every gallon of fuel consumed, there will be a saving of Re. 0-7-6. Assuming that the average motorist consumes about 16 gallons of motor fuel in a month, his monthly saving will thus come to Rs. 7-8, and in 15 months time he will save the cost of alteration of the engine. All these savings will result without curtailing the motoring pleasure or utility of the owner, or in any way touching the revenue of the Central or Provincial Governments. The general adoption of alcohol as a motor fuel in India will thus be an important source of national wealth, particularly by the utilisation of a huge waste product of sugar factories, which will give a tremendous fillip to a new industry.

Unfortunately, methylated spirit as it is constituted now, cannot be used for this purposes for the obvious reason that the denaturants used in its preparation, namely, pyridine and catchouchine, have a deleterious action on the metallic parts of the engine, producing extensive pitting and corrosion of the pistons and the gumming of the valves. But if rectified spirit is denatured with the addition of only about 2 per cent of castor oil, the excise difficulties can be overcome, and yet the denaturant will not only be harmless, but actually beneficial to the engine. Can the Government of our progressive country still afford to neglect this important source of national wealth, which is literally going to waste, particularly at the present grave emergency?

*After the article was submitted for publication, this tax has been increased to twelve annas per gallon.

MEDICINE AND PUBLIC HEALTH

Examination of Stomach

TEN years ago, regular clinical examinations of the interior of a patient's stomach would have been impossible unless the patient underwent an abdominal operation. But today, a small flexible tube—less than a yard long and encasing a complex system of fine optical lenses smaller than a dime—is making such examinations in leading hospitals of the U. S. A.

The gastroscope, as the instrument is called, is a small tube about 30 inches long and smaller in diameter than a man's little finger, which encases a series of 48 lenses, each of which must be optically perfect. The tube can be bent to angle of 30° and still present a clear picture of the object. Also within this small space is an air passage, allowing the examiner to inflate the stomach for examination; and wires carrying current to the tiny electric bulb at the head of the tube.

Dr Rudolf Schindler of the University of Chicago has so perfected the technique of gastroscope that the entire examination takes just three minutes. He personally makes from fifteen to twenty examinations a week. Dr Schindler began experimenting with the instrument looking for some better method of stomach examination when he was a physician in a hospital in Munich, Germany, about twelve years ago. He had heard of a rigid gastroscope and procured one and with the assistance of a lens maker, he developed the flexible gastroscope, with lenses placed in the tube at short intervals. Dr Schindler joined the University of Chicago faculty in 1934. Since perfecting the device, hailed by specialists as the most important development in gastropathic medicine since the perfection of the X-ray, Dr Schindler has devoted the major part of his time to teaching its use to doctors specializing in internal medicine and surgery. As a result of his work, after six years of the introduction of this instrument, specialists using gastrosopic examination to diagnose stomach ailments in the United States will total more than 225 by the end of this year.

The new device makes possible the routine diagnosis and treatment of chronic gastritis, which for more than

thirty years baffled scientists because it was impossible to diagnose. "Many patients who are tired, nervous, and weak have hitherto been diagnosed as suffering from a mental disorder known as psychoneurosis," Dr Schindler explained. "Use of the gastroscope has shown that such patients in many cases are really suffering from a chronic inflammation of the delicate mucous membrane which lines the stomach. Such a diagnosis enables the physician to treat the patient specifically for gastritis."

The gastroscope is of major importance in diagnosing cancer in its early stages, according to Dr Schindler. It reveals the cancerous tissue with complete faithfulness, transmitting not only the colour and shape of the lesion but its texture as well. When detected this way, the cancer may be treated early and cured thoroughly in a shorter time than would ordinarily be required with X-ray examination, he said. The gastroscope has also revealed (but it is yet to be confirmed) that there are many different types of gastric cancer. The gastroscope has also disclosed the close connection between diseases of the blood and stomach inflammations. The gastroscope, though invaluable, does not replace the X-ray, Dr Schindler emphasized. Through close correlation with the X-ray department of the University of Chicago clinics, the two methods have been found to supplement each other in presenting as complete and accurate a picture of the stomach as man has ever seen.

Vitamin A and Diabetes Mellitus

WHITE and Gordon observed (*J. Lab. & Clin. Med.*, 17, 53, 1931) high values of carotene in the blood of patients suffering from diabetes mellitus. Ralli et al (*J. A. M. A.*, 106, 1975, 1936) studied the effect of daily administration of carotene on the blood-carotene of normal and diabetic individuals. They observed that the carotene content of blood increased more rapidly with the high carotene diet and fell more slowly when the diet was discontinued than in the normal group. The carotene contents of the livers of diabetic patients were also found by them to be very high. They therefore suggested that in diabetes the liver cannot convert carotene into vitamin A. Moore (*J. Biol. Chem.*, 31, 155, 1937) however observed that the vitamin A reserves of the livers of patients who died of diabetes were above normal. He



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therefore questioned the theory that the liver of a diabetic patient is unable to convert carotene into vitamin A. Brazer *et al* (*Arch. Int. Med.*, 65, 90, 1940) thought that if the liver of a diabetic patient could not metabolise carotene into vitamin A, a state of vitamin A deficiency might develop in the patient in spite of an adequate intake of carotene. They studied the vitamin A nutrition of 20 patients suffering from diabetes with the biophotometer. All the patients studied were found to have poor light adaptation. The light adaptation was not affected even after administration of 60,000 units of vitamin A in the form of crystalline carotene, but when the same amount of vitamin A in the form of fish liver oil was used, the light adaptation returned to normal or nearly normal. This observation supports the view of Ralli *et al* (*loc. cit.*) that diabetic liver can not convert carotene into vitamin A.

S. B.

Treatment of Multiple Sclerosis

SATISFACTORY treatment of multiple sclerosis is not known. Partial improvement sometimes occurs after the application of fever therapy in its various forms (malaria, typhoid vaccine, etc.) owing possibly to the resultant hyperemia and an increased flow of blood in nerve tissue. Moore (*Arch. Int. Med.*, 65, 1, 1940) observed that vasodilatation of the skin of the face, neck, chest, extremities and also of the brain and spinal cord took place after parenteral administration of nicotinic acid. He therefore thought that nicotinic acid might be useful in the treatment of multiple sclerosis. Five cases of advanced multiple sclerosis which did not respond to any treatment were successfully treated with parenteral use of nicotinic acid and vitamin B₁.

S. B.

Vitamin B-complex for Eczema

KRISTENSEN *et al* (*Lancet*, 1, 170, 1940) have treated a series of more than 100 unselected cases of eczema with preparations of vitamin B-complex. 12 tablets each containing 5g. of yeast were administered daily. The patients were cured within a very short time.

S. B.

Anterior Pituitary and Pancreatic Insulin

ANSEL *et al* (*Klin. Wschr.* 12, 1245, 1933) showed that the injection of extracts of the anterior lobe of the pituitary into normal rats induced an increase in the number and size of the islets of Langerhans. Mark *et al* (*Chem. Ind. Rev.* 58, 652, 1939) observed that the

increase in the amount of islet tissues in rats, by daily treatment with a crude anterior lobe extracts, was associated with a simultaneous increase in the amount of insulin in the pancreas. When experimented on dogs, the pituitary extract caused a diminution in the secretion of insulin. Mark *et al* (*Lancet*, 1, 493, 1940) studied the relationship existing between the diabetogenic, insulin increasing and growth promoting principles of ox anterior pituitary extracts. They found that the insulin increasing or pancreotropic substance is different from the diabetogenic and growth promoting principles. The pancreotropic action of a crude fresh anterior lobe extract may be obscured in the dog by the operation of the diabetogenic action of the extract.

S. B.

Medical Work of the League of Nations

THE growing complexity of the modern world has for many years made increasingly clear the need for intelligent co-ordination of various activities and the pooling of information and experience in many fields. The League of Nations has been responsible for the development of mutual exchange and discussion of ideas and methods in many fields of humanitarian and scientific endeavour.

At present, in spite of the political disturbances the Health Committee of the League of Nations has decided at its meeting recently to continue the permanent services, namely the Epidemiological Intelligence Service Singapore Bureau and Biological Standardisation. The annual Epidemiological Report, published at Geneva contains data for 1,960 million inhabitants, or about 93 per cent of the total world population. The data relating to mortality cover 397 large cities, with a population of 155 millions. The Singapore Bureau is in constant contact with 180 ports in East Africa, Asia and Australia. An Epidemiological Bulletin for the health administrations is published by the Singapore Bureau, broadcast first of all by the high-power stations at Saigon, Bandoeng and Singapore, and subsequently retransmitted over a net work of secondary stations. The distribution of international standards by the Copenhagen and Hampstead Institutes continued normally and that the number of institutes using these standards was increasing. As regards tuberculin, the Committee has been informed that the Copenhagen Institute has undertaken the preparation of the purified tuberculin standard which the Permanent Commission on Biological Standardisation decided to establish. Desirous of giving effect to the proposal put forward at the meeting of the General Advisory Health Council in May 1939, the Committee is of opinion that, in order to establish the extent of the tuberculinisation of populations, research work should be carried out on parallel lines in a number of countries.

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using the same tuberculin and identical methods. The Committee understands that it can already rely on the support of the Ankara, Bucharest, Budapest, Copenhagen, Jassy and Washington Institutes in this research work, and hopes that other institutes will also give their assistance.

Considerable progress has been made in the enquiry into the radiological treatment of cancer of the *cervix uteri*, the preparation of the unification of the various national pharmacopoeiae, in the studies undertaken by the Malaria Commission on malaria immunity and the biology of certain strains of plasmodium, the co-ordination of investigations into nutrition in the East

entrusted to the Coonoor Laboratories (India), and the analysis of the annual statistics of rabies. In this last connection, the Committee wishes the Health Section to extend the scope of its enquiry to include the anti-rabic vaccination of dogs. Some of the international conferences have however been postponed due to the war. The Health Committee which has been made acquainted unofficially with the report of the committee appointed to study methods of developing the technical work of the League of Nations has urged that the Central Committee on Economic and Social Questions, which is to control the technical commissions, may be constituted without undue delay. For this body to be able to deal adequately with questions of health, it is hoped that a reasonable proportion of its members should have technical qualifications in this field.

Madam Curie and Radium*

S. G. Galstaun

Department of Radiology and Electro-Therapeutics, Medical College, Calcutta

Marie Sklodowska Curie is one of the outstanding figures in the history of the world. Born in Warsaw in November, 1867, she was the youngest daughter of Vladislav Skoldovski, professor of physics at the Warsaw High School for boys. Her mother conducted a select girls' school. Marie Sklodowska was born at an unfortunate period of Poland's history. It was indeed a cruel fate to be a Pole in those days, very much a Russian subject—the emphasis being on the word "subject"—and particularly so to belong to that vibrant intelligentsia whose nerves are always so near the surface; among them revolt was ever brooding, and they suffered more painfully than any other class in society from the servitude imposed on them.

Exactly a century before, greedy sovereigns, the powerful neighbours of a greatly weakened State had decided Poland's ruin, just as two great powers repeated the process a very short time ago. Three successive partitions had dismembered the country into fragments; each became officially German, Russia and Austrian. Several times the Poles rose against their oppressors, each rising being met by the most bloody reprisals with mass executions, imprisonment and confiscation of property. It is curious how history has a habit of repeating itself!

*Adapted from a lecture at the Calcutta Rotary Club, delivered on March, 12.

Despite these obvious drawbacks, Marie Sklodowska had a brilliant career at school and later at the State Gymnasium. She would have continued her studies at the University of Warsaw, where her elder brother Joseph was studying medicine but the Russian authorities at the time barred women entrance to the University.

Marie's sister Bronya, also a brilliant girl, and similarly being barred entrance to the University of Warsaw wished to go to Paris to study medicine. The family funds were low, particularly so as Pere Sklodowska had on the advice of a relative indulged in an unfortunate speculation which had lost him almost his entire savings. Marie with her usual unselfishness immediately decided to help her sister by taking a job as governess. For two years this intrepid girl worked as such, first for a family in Warsaw and then in a beet growing district. Even at this time when she was only eighteen years old, she showed strong sociological instincts. She and her young pupil secretly used to teach peasant children to read and write, a thing strictly forbidden by the Czarist regime. During this period Marie was already a voracious reader. Not content with digesting the contents of such text books as Daniel's *Physics*, Spencer's *Sociology*, Paul Bers' *Lessons in Anatomy and Physiology* and several text books on chemistry, she at the same time carried on an intensive correspondence course with her father in mathematics.

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Meanwhile she sent half her salary home to help her sister Bronya in Paris. This young lady while pursuing her studies at the Sorbonne had become engaged to a Polish medical student, afterwards Dr Dluski. These two invited Marie to come to Paris to stay with them. After some hesitation she packed up one small suitcase and went to Paris in fourth class. Anybody who has travelled fourth class in Europe can well imagine what this means!

Marie registered as a student at the Faculty of Science at the Sorbonne and threw herself into her work without delay. She stayed with her sister for a very short time and then went into a dismal attic in the Latin quarter where for the next three years she lived with the most stringent economy, often starving herself and allowing only three francs a day for her domestic budget. She was once discovered in an unconscious state by the Dluskis who insisted upon taking her to their home, where however she only stayed for a few days, afterwards returning to her attic.

At the end of three years she obtained her master's degree in physics and mathematics standing first in the University in physics and second in mathematics. The Sklodovskis in Warsaw had often asked Marie to return for a holiday but this was the first occasion she would do so. While there, the attention of the Alexandrovitch trustees was drawn to her success and she was awarded a scholarship. It was in keeping with the quixotic nature of this girl to repay this scholarship to the Foundation some years later. On Marie's return to Paris after three months' vacation, the Society for the Encouragement of National Industry ordered from her a study on the magnetic property of steels. In spite of her now considerably better finances, Marie still occupied an attic in the Latin quarter. This was ill furnished and had no heating facilities of any description. In the winter the water frequently used to freeze in her pitcher.

Marie's first meeting with Pierre Curie, a fellow scientist of considerable distinction, took place in 1894. To quote from Eve Curie's biography of her mother, "The attraction he felt from the first moment for the foreign girl who spoke so little was doubled by intense curiosity. This Mlle Sklodovska was truly a rather astonishing person. . . . She was Polish, come from Warsaw to study at the Sorbonne, had passed first in the physics examination last year, would pass her mathematics examination in a few months. . . . And if between her ashen-gray eyes a little preoccupied wrinkle appeared, was it not because she did not know where to install her apparatus for the study of magnetism in steel?"

"The conversation, at first general, was soon reduced to a scientific dialogue between Pierre Curie and Marie Sklodovska. Marie, with a shade of timidity

and deference, asked questions and listened to Pierre's suggestions. He in turn explained his plans, and described the phenomena of crystallography which fascinated him and upon which he was now engaged in research. How strange it was, the physicist thought, to talk to a woman of the work one loves, using technical terms, complicated formulae, and to see that woman, charming and young, become animated, understand, even discuss certain details with an infallible clear-sightedness. How sweet it was!" She married him at the City Hall of Sceaux at the end of July 1895. There was no religious ceremony, ring or wedding breakfast—just the simple civil ceremony. The honeymoon was spent on a three weeks' cycling tour after which both Pierre and Marie returned to their respective researches. A daughter, Irene, a future Nobel prize winner, was born in September, 1897 after Marie had completed her work on magnetic steel.

Not satisfied with her past successes Marie Curie now decided to obtain her degree of doctor of science. To this effect she decided to pursue some researches on the nature of uranium rays already discovered by Becquerel. The Science College gave Marie a cold, draughty and leaky room, an old storeroom at the School of Physics, for her experimental work. Despite some doubts about her health at this time she carried on under these difficult circumstances. Her first studies were on the power of ionisation of uranium rays. To this effect she constructed her own electro-meter based on the same idea as the more modern ionto-quantimeters, the principle of which was elucidated by Pierre and Jacques Curie sometime previously. In this instrument lay the key to the success of her experiments.

Marie found that the incomprehensible radiation of uranium rays was an atomic property and so concluded that there might be some other substances apart from the uranium concerned in this phenomenon. The indefatigable girl proceeded further and investigated all known atomic substances and found that among these thorium also emitted spontaneous rays similar to those of uranium. She therefore suggested the name "radioactivity" and called all elements having this property radioactive elements. Feminine curiosity led her to examine minerals from the School of Physics collection. Where she found any radioactive properties among these, she measured its amount. While doing these experiments it was dramatically revealed to her that the radioactivity in some of these minerals was a great deal stronger than could have been foreseen from the uranium or thorium they contained. Thinking she had made an error she repeated the experiment. Not satisfied with the result she repeated it twenty times and obtained the same figures, which made her conclude what she had all along suspected, that these minerals contained a small quantity of much more powerfully radioactive substance than uranium or thorium—probably a new element. Marie

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Curie announced in the proceedings of the Academy of Science the probable presence of a new element in an ore called pitchblende, which she found endowed with powerful radioactive properties. This was in April 1898.

Pierre Curie was so attracted by his wife's researches that he abandoned his own important work in crystallography to collaborate with her—a collaboration which was to last for eight years. Further joint work on the extraction of pitchblende confirmed the Curies' suspicion that not one but two radioactive elements were present in this ore. The one Marie Curie named after her native land "Polonium" and the other, which was discovered by her shortly after, she called "Radium."

The extraordinary properties of this new radioactive element upset all existing fundamental theories of atomic nature. Pierre and Marie were fortunate in getting a further large supply of so-called useless pitchblende residue after the extraction of uranium salts from the Joachimsthal mines in Bohemia. The pair continued their work in an abandoned shed placed at their disposal in the School of Physics. This was even colder and more leaky than their previous laboratory—the only advantage it possessed was that of increased space. It must have been most exhausting work carrying out piecemeal extraction of radium from these residues. Experimental work carried on at the same time by the Curies led them to publish a report on the discovery of induced radioactivity and another on the electric charge carried by the rays. They were associated in this work with Andre Debierne, the discoverer of actinium, and Georges Sagnae.

In 1902, nearly four years after the discovery of the probable existence of radium, Marie prepared a decigramme of pure radium and estimated its atomic weight which was found to be one of the highest of all known elements. When they visited their shed at night and found their tiny amount of radium in glass containers glowing with a bluish phosphorescence, it was indeed a magic evening!

After the birth of Irene Curie in 1898 lack of money to continue their experiments presented some difficulties. Pierre tried to get a professorship at the Sorbonne but was unsuccessful as he would not bring himself to do the usual calling on the powers that be; neither of the Curies were ever given to bowing and scraping and the usual processes inherent with many such appointments. Later he obtained a post as a tutor at a Polytechnic School. He was offered a post as professor of physics at Geneva, but refused because of the interruption this would cause in his researches on radium. Marie in the meantime obtained a professorship at the Higher

Normal School for girls at Sevres, which work she carried on in addition to her researches. Pierre next tried for the chair of mineralogy at the Sorbonne. He was again unsuccessful for the same reasons as before. Later, Professor Mascart induced Pierre against his will to try for election to the Academy of Science. Again his refusal to do the usual obeisances defeated him. Shortly after this he was informed that his name was about to be presented for the Legion of Honor. He declined this.

Pierre and Marie now managed to obtain eight tons of pitchblende residue from which they extracted a gramme of radium. The Academy of Science awarded them a prize of 20,000 francs "for the extraction of radioactive matter." They were offered a laboratory by Armet de Lisle to make radium and furnish it to the medical profession who had already begun to find its extraordinary effect on cancers. Incidentally, the price of radium at this time was about £30,000 a gramme. In trying out the effects of radium, both Pierre and Marie received curious burns on their skins. Their friend Henri Becquerel who was carrying about a small quantity of radium in his pocket received similar burns. These were the first recorded instances of radium burns..

In June 1903 Marie Curie appeared at the Sorbonne for the doctorate examination, having already sent her examiners her thesis on researches on "Radioactive substances." She obtained the doctorate with the highest honours. Shortly after, she was invited to lecture at the Royal Institution in London, the first woman ever to do so. Following this came the award to the Curies of half the Nobel prize in Physics. Prizes now began to be showered on them including the coveted Osiris prize accompanied by 50,000 francs. In 1911 Marie Curie was awarded the Nobel prize for the second time, on this occasion for chemistry, another unique distinction.

Eight years after her marriage with Pierre Curie came tragedy. Pierre was killed by being run over by a dray. Messages of sympathy came from kings, ministers, scientists and great men all over the world. He was awarded a State funeral. The Faculty of Science at the Sorbonne unanimously appointed Marie to take Pierre's professorship, a thing unique in the history of French education.

The Curies always fought shy of social functions or of any kind of display. Their friends were few but sincere. Among their intimates were such personalities as Rodin, Paderewski and Briand.

It was characteristic of this extraordinary woman that during the last war, at age when she could have retired at the head of the great Fondation Curie, which

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had emerged under her guidance to conduct further researches on radioactivity and at the same time under medical experts to make these properties available for the treatment of cancer, she gave up everything to organise radiological services for the French army. She personally drove an X-ray ambulance of which the entire work was done by herself and one assistant.

The life of Marie Curie is a remarkable story of success under most unpromising circumstances. Her natural intellectual brilliance combined with superabundant energy and indomitable courage in the face of adversity surmounted all obstacles and is a shining example to students of all time.

Properties of Radium

Radium is a heavy metal which exhibits radioactive properties. It undergoes a continuous process of spontaneous disintegration in the process of which the atomic nucleus ejects three separate things. They are:—

(a) *Alpha rays* consisting of positively charged helium nuclei. These are given off at a velocity of 18,000 miles per second. It has been estimated that one milligramme of radium gives off 136 million particles of helium each second. The penetrating powers of these rays is very small, they can be stopped by a sheet of paper. They have an intense ionising power.

(b) *Beta rays*, which are similar to cathode rays. They consist of negatively charged electrons given off at a velocity varying from 60,000 to 180,000 miles per second. They have a much greater penetration than the alpha rays. It takes half a millimetre of aluminium to absorb 50 per cent of the rays and 0.6 millimetres of platinum to absorb 99.9 per cent.

(c) *Gamma rays*, which present 4.8 per cent of the total energy. They are very penetrating rays which are not deviated by a magnetic field. They consist of pure radiation and not of matter, being at the extreme short end of the electro-magnetic spectrum. They have a wave length of approximately 10^{-10} centimetres. They are exceedingly penetrating and can produce ionisation even through 20 cms. of lead. They have the same velocity as light. These are the rays largely used in the treatment of cancer, the others usually being filtered off by suitable metallic screens, usually of platinum.

The spontaneous emission of energy by radioactive elements is accompanied by changes in these substances. The first product of disintegration of radium is a gas called "radon" or "radium emanation." This gas itself, after a short period of latency, gives off rays similar to those of radium and is used therapeutically. But whereas

the rate of disintegration of radium is such that it reaches half its value in 1690 years, radon's half value period is 3.85 days. As ordinarily prepared, radium is made either as a bromide or sulphate salt. The latter is used for the ordinary applications of radium, and the former in solution for the production of radon.

The use of radium in the treatment of cancer has made very considerable advances in the past few years. We are beginning to learn something of the proper dosage to be given to various types of tumours with increasingly good results. Unfortunately however, the cancer problem is still far from solved, there being some cases that resist all forms of treatment. Radium may be used in the treatment of cancer either in the form of surface applicators, or "needles" suitably screened, embedded in the tissues, or by radon used in the same way. Within the past few years a new form of radium treatment known as tele-curie-therapy has made considerable advances. This form of treatment consists of applications of large quantities of radium, from one to twenty grammes being used in specially constructed containers at distances far greater than before. This form of treatment has produced very encouraging results, particularly in cancer of the mouth.

It must be realised that the whole subject of the treatment of cancer by radiation either by means of radium or X-rays is still in its infancy. We have as yet only had some thirty years of experience in this form of treatment. It is not too much to hope that the next thirty years may produce very far-reaching results.

Sources of Radium

The chief sources of radium, known at present, are as follows:—

Europe

Czechoslovakia.—The pitchblende veins in the Jachymow (Joachimsthal) district.

England.—Veins in the Camborne district of Cornwall.

Portugal.—The Autunite and Torbernite deposits of the Serra D'Estrella region.

U. S. A.—Both the Carnotite deposits situated in Colorado and Utah and the pitchblende deposits of Colorado.

Africa

Central Africa.—The deposits of pitchblende and its alteration products in Belgian Congo.

Madagascar.—The Pegmatitic minerals, both Euxenite and Befaite, as well as the Autunite deposits.

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Australia

South Australia.—The Autunite and Torbernite deposits of Mount Painter.

Asia

Russian Turkestan.—The Tyuyamunite deposits.

Up to recently the deposits in the Katanga district of Belgian Congo produced most of the world's supply. More recently however very rich deposits have been discovered in Canada, the working of which has resulted in halving the price of radium which at one time, about a year ago, touched the low level of £5 a milligramme.

The history of these deposits is a romance in itself. A young Canadian prospector, Gilbert LaBine, from his early boyhood had dreams of vast wealth through the discovery of radium. In his earliest prospecting days, curiously enough, LaBine found some deposits of pitchblende. These, however, were too small to be of any commercial value. LaBine later made an important discovery of silver deposits and made a considerable fortune from this mine. Unfortunately he lost the greater part of this in a gold mine, also of his own discovery, which petered out very quickly. In 1930, LaBine had himself flown to the eastern shores of the Great Bear Lake in the Canadian sub-arctic region. Here he came on really rich deposits of pitchblende, not to mention silver in the same place.

Pitchblende, which is essentially uranium oxide (U_3O_8), and generally a mixture of two oxides, UO_2 and UO_3 , is the richest ore of uranium (and consequently of radium) known. Theoretically in the pure state, i.e., 100 per cent U_3O_8 , it should contain an equivalent of 260 milligrams of radium per ton, or a little over one gram in four tons. Mixed with gangue minerals, as it invariably is, the usual grade as mined, seldom runs half as high as this figure and generally much lower. Under very favourable economic conditions, the lowest U_3O_8 content for a commercial ore, without resorting to concentration, would probably be in the region of 15 to 20 per cent. For years, the Czechoslovakian State refinery

ran on hand-picked cobbled ore, of which some 50 tons per annum were treated, giving a yield of about 2 grams of radium. Latterly, modern concentration methods have been employed, but the grade attained is not known.

Concentration methods are not always effective, owing to the brittle nature of the mineral, and its tendency to slime during fine grinding in order to free it of its intergrown gangue, usually of a hard, siliceous nature. Slimes cannot be successfully tabled, and pitchblende does not respond to flotation methods. As far as tonnage-grade-of-ore is concerned, the Great Bear Lake pitchblende is generally believed to be the richest known. Samples taken from surface pits over a vein length of 1,400 feet shewed as high as 62 per cent U_3O_8 on analysis. Cobbing and hand-picking would probably produce an average of between 40 and 50 per cent. Recent reports from the Eldorado mill at LaBine Point, which came into operation early in 1934, show that a steady production of table concentrates containing around 60 per cent U_3O_8 is being achieved. These concentrates run from 10 to 20 mesh, but a satisfactory means of treating the slimes made, completely to unlock the pitchblende from its admixed gangue has not yet been found, though this problem is being studied and hopes are entertained for its successful solution. Shipments of ore are made to the Eldorado Company's refinery at Port Hope, Ontario, 1500 miles away. The concentrates are transported during the summer months by means of waterways and in winter by aircraft. The production of Canadian radium has now almost reached the same figures as the Congo. Gilbert LaBine's early dreams have materialized. The extraction of radium from pitchblende is a long process involving many stages. The final processes of purification must be done by highly trained scientists. For this reason alone radium will always be an expensive commodity.

In Britain there exists a Radium Commission which has a large quantity of the element at its disposal which is wisely distributed to various centres for the treatment of cancer. This Commission has done most valuable work not only in loaning radium, but also in co-ordinating research in the methods of its use in combating disease.

RESEARCH NOTES

Early Man in China

The results of a series of very fruitful field researches for several years in North China, discussed in reviews by P. Teilhard De Chardin, Prof. F. Weidenreich, W. C. Pei and others in their respective spheres of researches, and summarised in *Nature* throw a flood of new light on the ancient East, particularly on China, and call for new conceptions of humanity. Teilhard De Chardin's researches provide a new diagnosis for the debated problem of the plio-pleistocene demarcations. His diagnosis is that there is a marked faunal and physiographic break between the final Pliocene (Nihowan) and the true lower pleistocene (Choukoutien) of North China. This change corresponds to a positive epeirogenic movement which has rejuvenated the entire pliocene topography, giving rise to a modernised landscape characterised by the appearance of man in the form of the *Sinanthropus*.

Prof. Weidenreich's researches on the human fossils in the Cave of Choukoutien are also of great import and call for an altogether new conception of human evolution. His contention is that the Darwin-Lamarckian conceptions are of no importance here, the contributing factor being an independent progressive differentiation of the type itself. According to him, while human development has been orthogenetic, it has also been polycentric (four centres of the genesis of *Hominidae* have been distinguished). Again Prof. Weidenreich's remarkable diagnosis of three racial types—Eskimoid, Mongoloid and Melanesian among the skeletal remains in the Upper Cave of Choukoutien, which is assigned to the upper palaeolithic and where cultural remains are also found in association, would also call for a reorientation of the racial theory at large.

Who was the forerunner of the *Sinanthropus*? This question has been also answered in a brilliant study by the eminent professor. According to him, it was an anthropoid primate closely resembling the *Australopithecus* and when viewed in general among

all anthropoids, living or fossils, the *Australopithecus* seems to be the closest relative of *Sinanthropus* and his assumed forerunner.

The cultural evidences of the existence of man in the upper cave site of Choukoutien discussed by Mr. Pei reveal the character of the culture, the technique of workmanship and the relationship of this culture with that of Europe. Geologically though this culture is late pleistocene and as such comparable with the upper palaeolithic of Europe, the cultural relation is still open. The objects collected,—the choppers, bipolar tools, flake tools, bone tools, bone ornaments, perforated and painted (red) canines (of deer and small carnivores) and a host of other artifacts speak of the cultural wealth and the capacity of the human races. Other cultural evidences include a form of burial (in the cave) where haematite powder was found scattered around the bodies, some type of clothing with ornaments as suggested by bone needles and perforated objects, use of fire, suggested by charcoal and layers of ash, and fishing and hunting suggested by the remains of fish and mammals in the cave.

D. S.

Localization of Brain Lesions by Electroencephalography

Despite skilful neurological examinations, ventriculography, arteriography, encephalography, and the study of chemistry and hydrodynamics of the cerebrospinal fluid, it is often difficult to localize tumors, abscesses and other lesions of the brain. Electroencephalography, however, has been proving of late to be of distinct service in this regard. In 1937 Walter predicted by this method the location of cortical damage in 12 cases in which tumor was subsequently seen. In 26 cases in which cerebral tumors were suspected on clinical grounds, only normal cortical potentials were found. Subsequent investigation and progress of the cases showed that no tumor had been present.

Following Walter's electroencephalographic technique of simultaneous recording from two adjacent places

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and his interpretation of the occurrence of slow waves and reversed phase relationship as between normal brain tissue and diseased brain tissue surrounding the lesion, Williams and Gibbs (*New England Journal of Medicine*, 218, 998-1002, 1938) examined 86 patients referred by the Neurological and Neurosurgical Units of several hospitals. The authors took their brain waves before they investigated their previous clinical findings. 17 cases showed no electrical abnormality of the cortex, 13 had records characteristic of epilepsy without any constant focus of abnormal electrical discharge, and 50 had abnormal focal discharge in the brain. Of the 50 cases 13 did not give definite enough data meriting operation. In the

remaining 37 cases the position of the organic lesion was located by evidences of electrical abnormality. The position of the lesion was verified later mainly by operation or autopsy, and in a few cases by unequivocal clinical findings and radiological evidence. In 6 cases electroencephalography and no other method localized the lesion, and in 7 cases a negative E. E. G. diagnosis in the face of clinical evidence to the contrary was subsequently shown to be correct. Of the 37 cases, tumors numbered 15, abscesses 6, traumatic lesions 6, subdural hematomas 4, porencephalic defects 2, Paget's disease of the skull causing localized pressure 1, idiopathic local cortical atrophy 1, Schilder's disease 1, and tuberculoma 1.

B. K. B.

Kerosene-fermenting Bacteria

A series of mysterious explosions of gasoline and kerosene storage tanks in England, at first thought to be the result of sabotage, now appears to have been due to bacterial action. Kerosene-fermenting organisms have been discovered living in the kerosene and capable of converting it into 10 per cent ethane and 90 per cent methane—both explosive gases. It is virtually certain that the gasoline explosions are due

to a similar action. Although such a discovery is surprising, organisms have long been known which are capable of fermenting carbolic and benzoic acid.

It may be that the discovery will lead ultimately to beneficial practical applications inasmuch as ethane and methane can be the starting point for a great number of chemical syntheses.

—*The Agricultural Gazette*.

BOOK REVIEW

RUTHERFORD—by A. S. Eve. (Cambridge University Press) Price 21sh.

Although written as a biography and presumably intended for general reading as distinct from serious scientific study, this book will, I think, prove one of the most valuable guides to advanced students of modern physics that can be found.

The author very efficiently uses the method of letter extracts to give us a picture of Rutherford from his childhood days to his all too early death. The impression left is that of a man of clear insight with great powers of logical deduction. A man of unrivalled skill in the use of laboratory apparatus with a genius for interpreting results that can seldom have been equalled. His capacity for detailed work was great. These gifts combined with an unusual ability to consider logically the facts as he found them, unprejudiced by the restricting effects of existing theories and beliefs, made possible the revolutionary changes in scientific concepts which the world owes to him.

His life story as told in the book is a fascinating and coherent exposition of the evolution of modern theories of atomic structure. It is also a fascinating study of a human and lovable personality. One wonders, for example, what would have been his life history if the 1851 Exhibition which made it possible for him to go to Cambridge had been accepted by the first nominee. That his would not have been a life of obscurity is certain. His dominant personality and extraordinary powers would have left their mark in whatever sphere of life his activities had found an outlet. Almost certainly New Zealand would have had a great politician, educationist or business man, but at what a loss to the world of science!

Fortunately marriage proved a greater attraction to the person to whom the Exhibition was awarded than advanced study abroad. Fortunately also Rutherford became the first of a remarkable body of research workers whom Sir J. J. Thomson gathered around

him at the Cavendish Laboratory. The reaction of Rutherford's keen and developing mind to Thomson's stimulating personality is well brought out in the book. At this time Rutherford's work was in connection with magnetic detection of wireless waves and again one is led to wonder what would have happened had his interests and work continued in this direction for his work won immediate recognition and admiration. Rutherford was one of the first to break down the conservatism of the older universities in recognising the merit of the products of the colonial and more modern ones. A valuable scholarship was awarded to him and he was thus enabled to combine his research. In spite of the brilliance of the work and the promise of his future, no fellowship came to him until much later in life and the offer of the Montreal Professorship of Physics at McGill University was financially too attractive to refuse. His work at McGill and his relationships with his colleagues there—all happy ones—make interesting reading. During these years his well-known radio-activity theories were developed and experiment after experiment devised to test those theories. Today these theories are accepted as common place facts of modern scientific knowledge. It is difficult for us to realise how revolutionary they were and how hard it was to shake the belief in the indestructible atom.

Rutherford won over all opponents and that without making enemies—no mean achievement. Young as he was, his skill and fame were world known and enquiring research students from other lands counted themselves lucky to be allowed to learn under him in Canada. Rutherford seems to have had a clear conception of his life's work, and the way in which it could best be achieved from the beginning. Tempting offers from wealthy American universities were refused for he had made up his mind that far-reaching and effective scientific work depended not only upon well equipped laboratories but also upon close contacts with other great scientists and movements. He knew that his work would benefit more by residence nearer Europe rather than further west. Consequently when

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the offer of the Chair at Manchester came he had no hesitation in accepting it. At Manchester his work was as inspiring as it had been at McGill. His theories of atomic structure developed by Bohr and of course modified in details by subsequent workers are models of scientific concepts. With unerring insight he seems by a sixth sense to have realised what was fundamental and from these fundamentals to have inspired speculative thinking that was to be fruitful in many directions. When Thomson resigned from his professorship at the Cavendish, there was no room for doubt as to who should succeed him and Rutherford became not the least distinguished holder of what is admittedly the most famous chair of physics in the world. During all these years scientific honours were being showered upon him lavishly. There is no high distinction open to physicists which he did not receive, and none of these seem to have spoiled him. Rutherford the research student—Professor Rutherford—Lord Rutherford—throughout his upward progress scientifically and socially he retained the capacity for friendly comradeship and human contacts. His letters are intensely human and natural and the occasional insights into his domestic and family life which the biography gives show a normal personality happy in normal relationships. There are none of the littlenesses of mind revealed that all too frequently mar the achievements of certain great intellects, and even to those who never met him personally, reading this biography must leave the thought, I should like to have met him, not only as a scientist but as a friend.

His versatility found expression in the war work that he was called upon to do. When the war was over he left Manchester and went to Cambridge where with renewed vigour, he organised the research work at the Cavendish. For many years there was a remarkable output of work from that laboratory culminating in the discovery of the proton, the splitting of the nucleus of the atom and other now well-known achievements.

Rutherford died suddenly and unexpectedly. We in India were particularly unfortunate for in the normal course of events he was to have visited India as President of the Silver Jubilee Session of the Indian Science Congress where a large number of delegates from the British Association participated. His body lies near that of Newton and Lord Kelvin in Westminster Abbey and none can justly question his right to lasting fame amongst the greatest sons of Greater Britain.

This book should be read as a scientific education as well as that of a biography of a scientist. I should like personally to see a smaller non-technically scientific biography written showing the development and growth of a man great in spirit as he was in science.

W. A. Jenkins.

TWO DIMENSIONAL POTENTIAL PROBLEMS CONNECTED WITH RECTILINEAR BOUNDARIES—by B. R. Seth (Lucknow University Studies, Faculty of Science, Edited by B. Sahni, Sc.D., F.R.S., Series No. XIII). Pp. 118. Price not mentioned.

This book forms the result of a course of lectures delivered by the author at the University of Lucknow in January 1939, and was published in December of the same year. It deals with a few two-dimensional potential problems having rectilinear boundaries from the standpoint of hydrodynamics and theory of elasticity. The topics treated in the book do not admit of, apparently, any physical applications, and we do not think such fancy problems are of any interest in these days. Barring some historical interest, which can be traced from the times of Saint-Venant (1855), Kelvin (1848) and other mathematicians, the engineers and technically minded people would hardly find any physical interest in such problems. But the students of pure mathematics, we have every reason to believe, will derive some benefit from the analysis given in the book, and the author claims some original contributions to the field surveyed in his lectures.

K. B.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

The Distribution of the Root-Mean Square of the Multiple Correlation Co-efficient on the Multivariate Normal Hypothesis

It was found by Professor Fisher in 1928 and is now well known that for samples of size n drawn from a p -variate normal population the co-efficient of multiple correlation of one variate with the $(p-1)$ other variates is distributed (under well known restrictions) in the form

$$\text{Const. } R^{p-2} (1-R^2)^{\frac{n-p-2}{2}} dR \times {}_1F_1 \left(\frac{n-1}{2}; \frac{n-1}{2}; \frac{n\beta^2}{1-\beta^2} R^2 \right) \quad (1)$$

where R is the (sample) multiple correlation of one variate on $p-1$ other variates and β is the corresponding population parameter and ${}_1F_1$ is a well known type of hyper-geometric function. It has recently been found by the authors of this note that if we consider m samples each of size n from the same p -variate normal population and if we put

$$m \bar{R}^2 = \sum_{i=1}^m R_i^2 \quad (2)$$

where R_i denotes the multiple correlation co-efficient for the i -th sample then $\bar{R}$ is distributed in the form,

$$\text{Const. } (\bar{R})^{m(p-1)} (1-\bar{R}^2)^{\frac{m(n-p-1)}{2}} d\bar{R} \times {}_1F_1 \left[\frac{m}{2} (n-1); \frac{m}{2} (p-1); \frac{n\beta^2}{1-\beta^2} m \bar{R}^2 \right] \quad (3)$$

This shows that the root mean square of R is distributed in the same general manner (with only change of parameters) as R itself; that is to say, the type of the distribution is conserved when we proceed to the distribution of the mean.

In a paper¹ published in the *Proceedings* of the Science Congress held in 1939 by one of the present authors jointly with Mr R. C. Bose the distribution of

the Studentised D^2 -statistic for $(p-1)$ characters (when the mean differences are based on two samples of sizes n_1 and n_2 and the variances and covariances are based on k samples of sizes $n_1, n_2, \dots, n_k$) was obtained in the form

$$\text{Const. } D^{N-2} \left(1 + \frac{(p-1)\bar{n}}{2N} D^2 \right)^{-(N-k+1)/2} dD \times {}_1F_1 \left(\frac{N-k+1}{2}; \frac{p-1}{2}; \frac{(p-1)^2 \bar{n}^2 \Delta^2 D^2}{8N+4(p-1)\bar{n} D^2} \right) \quad (4)$$

where $N = n_1 + n_2 + \dots + n_k$ and $\bar{n}$ is the harmonic mean of n_1 and n_2 . If we put

$$R^2 = \frac{(p-1)\bar{n} D^2}{2N + (p-1)\bar{n} D^2} \quad (5)$$

$$\text{and } \frac{n\beta^2}{1-\beta^2} = \frac{(p-1)\bar{n} \Delta^2}{4}$$

then it is easily seen from a comparison of (1) and (4) that (4) goes over to (1) with the substitutions (5) and the substitution of n for $N-k+2$.

If we now take D^2 from m such sets and denote by D_i^2 the D^2 corresponding to the i -th set and if we put

$$m \xi^2 = (p-1)\bar{n} \sum_{i=1}^m D_i^2 \quad (6)$$

Then from (3) it is evident that ξ is distributed as

$$\text{Const. } (\xi)^{m(p-1)} (1-\xi^2)^{\frac{m(N-k-p+1)-1}{2}} d\xi \times {}_1F_1 \left[\frac{m}{2} (N-k+1); \frac{m}{2} (p-1); \beta^2 m \xi^2 \right] \quad (7)$$

If we now make k (and accordingly N) large then relation (6) changes over to

$$m \xi^2 = \frac{(p-1)\bar{n}}{2N} \sum_{i=1}^m D_i^2$$

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$$\text{or to } \xi^2 = \frac{1}{m} \sum_{i=1}^m \frac{(p-1)\bar{n}}{2N} \bar{D}_i^2, \quad (8)$$

$$\text{where } \bar{D}^2 = \frac{1}{m} \sum_{i=1}^m D_i^2$$

and substituting from (8) in (7) and making k (and N) large we get the distribution of D^2 in the form:

$$\text{Const. } \frac{m\bar{n}}{e} \frac{(p-1)\bar{D}^2}{4} (D^2)^{\frac{m(p-1)-2}{4}} d(\bar{D}^2) \times \frac{I_{m(p-1)/2}(e^2 \Delta m \bar{D}^2)}{2} \quad (9)$$

$$\text{where } e^2 = \frac{n(p-1)}{2}$$

This, of course, agrees with the distribution of the root mean square of D (for the classical case) obtained by R. C. Bose² in 1938.

Statistical Laboratory
Presidency College
Calcutta, 7-4-1940.

S. N. Roy
Purnendu Bose

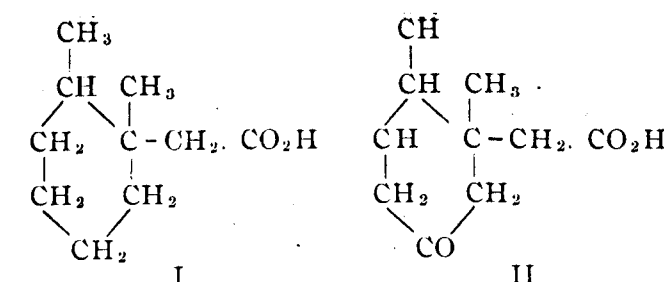
¹ S. N. Roy and R. C. Bose: The use and distribution of Studentized D^2 -statistic when the variances and covariances are based on k -samples. *Sankhya: Proceedings of the Second Indian Statistical Conference* 1939.

² R. C. Bose: On the distribution of the means of samples drawn from a Bessel Function population. (*Sankhya*: Vol. 3, Pp. 262-264).

Synthetic Experiments in the Terpene Series

From the oil of *Eremophila Mitchelli*, Simonsen and co-workers¹ first isolated a crystalline ketone $C_{18}H_{32}O$ and two other closely related solid hydroxyketones $C_{18}H_{32}O_2$ and $C_{18}H_{34}O_2$ and these were named eremophilone, 2-hydroxyeremophilone and 2-hydroxy-1:2 dihydroeremophilone respectively. By the oxidation of the benzoate of 2-hydroxy-eremophilone, Bradfield, Hellstrom Penfold and Simonsen² obtained a solid keto-acid $C_{10}H_{18}O_3$ and also a liquid acid $C_{10}H_{18}O_3$ by the reduction of the above keto-acid by the Clemmensen method. Formulae (I) and (II) have been suggested by Simonsen³ as representing the probable structures of the reduced acid and the keto-acid respectively.

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Following experiments have been carried out with a view to synthesising the reduced acid (I).

Ethyl- δ -acetyl-n-valerate was condensed⁴ with ethylcyanoacetate to yield ethyl-1-cyano-2-methyl- Δ_1 hexane-1:6-dicarboxylate, b.p. 170-178°/6.5-7 m.m. 167-171°/4 m.m. The crude dicyanoester, obtained by the addition of potassium cyanide to the above unsaturated cyanoester, was hydrolysed to yield 2-methyl-hexane-1:2:6-tricarboxylic acid m.p. 119-120°. The triethyl ester of the above acid b.p. 183-185°/8 m.m., on cyclisation by sodium in benzene solution gave ethyl-2-methyl-6-carbomethoxy cyclohexanone-2-acetate, b.p. 155-160°/6.5 m.m., which on hydrolysis yielded 2-methyl-cyclohexanone-2-acetic acid b.p. 150-155°/5.5 m.m. (Semicarbazone m.p. 181-181.5°). The ethyl ester of the above keto-acid b.p. 122°/7.5 m.m. (Semicarbazone m.p. 132°), on treatment with methyl-magnesium-iodide yielded the lactone of 1,2-dimethyl-2-hydroxy-cyclohexane-1-acetic acid b.p. 114-115°/6 m.m. Unusual difficulty is however being encountered in the reduction by usual methods of the above lactone which is expected to yield the acid (I) as the final product.

My grateful thanks are due to Prof. P. C. Mitter for his advice and encouragement during the progress of this work. My thanks are also due to Mr. N. Ghosh for carrying out microanalysis of some of the compounds.

D. K. Banerjee.

Palit Laboratory of Chemistry
University College of Science
Calcutta, 7-4-1940.

¹ J.C.S., 2744, 1932.

² Ibid, 767, 1938.

³ Ibid, 87, 1939.

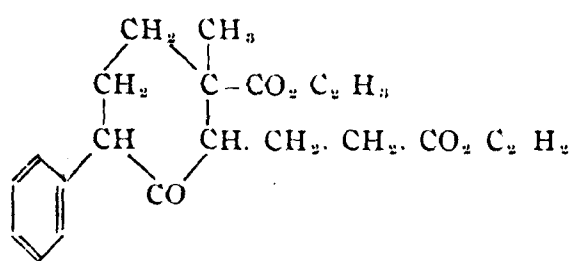
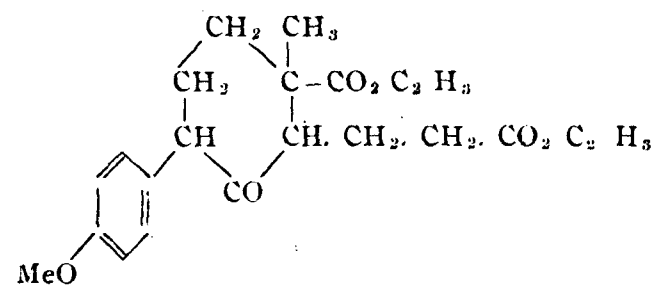
⁴ Linstead et al, J.C.S., 1977, 1937.

Synthesis of 2-phenyl-cyclohexanone Derivatives

In continuation of the work on the synthesis of oestric and homo-oestric acid, following success has been achieved in the preparation of keto esters (I) and

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(II) by a method similar to that described in this journal.¹



II

Ethyl-(p-methoxyphenyl)-cyanoacetate² was condensed with β -chloro-ethyl-methyl ketone to yield ethyl- α -cyano- α -(p-methoxyphenyl)- γ -acetyl butyrate b.p. 192-194°/3 m.m. (Semicarbazone m.p. 145.5°). α -(p-methoxyphenyl)- γ -acetyl-butyric acid b.p. 204-208°/4 m.m. was obtained by hydrolysis of the above cyanoester. The ethyl ester of the above keto acid b.p. 162-163°/2-3 m.m. (Semicarbazone m.p. 119°), on condensation with ethyl-cyanoacetate yielded ethyl-1-cyano-2-methyl-5-(p-methoxyphenyl)- Δ^1 -pentene-1:5-dicarboxylate b.p. 216-218°/2 m.m. The crude tricarboxylic acid, obtained by the addition of potassium cyanide to the unsaturated cyanoester followed by hydrolysis of the resulting dicyanoester, was esterified to yield diethyl-2-methyl-2-carbomethoxy-5-(p-methoxyphenyl)-pimelate b.p. 220-225°/3.5 m.m. The product, obtained by cyclisation of the above tricarboxylic ester by Diekmann's condensation, on treatment with ethyl- β -chloro-propionate and subsequent hydrolysis and esterification of the resulting condensation product, is expected to yield ethyl-3-methyl-3-carbomethoxy-6-(p-methoxyphenyl)-cyclo-hexanone-2- β propionate (I). Similar condensation of ethyl- β -chloropropionate with ethyl-3-methyl-6-phenyl-cyclohexanone-2:3-dicarboxylate,¹ followed by hydrolysis and esterification of the resulting condensation product, yielded ethyl-3-methyl-3-carbomethoxy-6-phenyl-cyclohexanone-2- β propionate (II) b.p. 186-190°/1.6 m.m.

The work in connection with the completion of the scheme, by the application of Cook's method of phenan-

therene synthesis³ to the above two 2-phenyl-cyclohexanone derivatives is in progress.

My best thanks are due to Prof. P. C. Mitter for advice and the keen interest he has taken during the progress of the work. My thanks are also due to Mr N. Ghosh for carrying out microanalysis of some of the compounds.

D. K. Banerjee.

Palit Laboratory of Chemistry
University College of Science
Calcutta, 7-4-1940.

¹ SCIENCE AND CULTURE, 5, 565, 1940.

² J. A. C. S., 1901, 1937.

³ J. C. S., 76, 1936.

The H. F. Conductivity of an Ionised Medium in the Presence of an External Transverse Magnetic Field

The H. F. conductivity of an ionised medium for c.m. waves of given angular frequency (p) attains its maximum value when the collision frequency (ν) of the ions is equal to the angular frequency,¹ whatever be the value of the ionic density (N). In the presence of an external magnetic field, however, the above result alters considerably for the extraordinary wave. Appleton and Boohariwalla² have shown that both in the case of longitudinal as well as transverse magnetic fields, the value of collision frequency for which conductivity becomes maximum depends upon the strength of the external magnetic field and for the gyro-frequency value of the latter, the maximum value of conductivity is attained when collision frequency is zero. In the case of the transverse magnetic field, they have considered the approximate expression for the conductivity by assum-

ing the ionic density to be very small (i.e., $p_0^2 \ll p^2$), and have verified their results experimentally.

But as has been admitted by the above authors also,

the condition $p_0^2 \ll p^2$ does not always hold good in ionosphere and so it would be interesting to see how far the results obtained by them would be modified if the complete expression for the conductivity be considered. The conductivity (σ) of an ionised medium in the presence of an external transverse magnetic field is given by

$$\sigma = \frac{p_0^2}{4\pi} \frac{\nu(p^2 + p_0^2 + \nu^2) + p_0^4 + p^2\nu^2 - 2p^2p_0^2}{\{p^2(p^2 - p_0^2) - 2p^2p_0^2(p^2 - p_0^2) - p^2\nu^2(p^2 + 2p_0^2) + (p^2 - \nu^2)(p_0^4 + p^2\nu^2) - 2p^2p_0^2\nu^2\}} \quad (1)$$

where $p_0^2 = \frac{4\pi Ne^2}{m}$

$$p_T = \frac{H_T e}{mc}$$

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e = charge on the electron.

m = mass of the electron.

c = velocity of light in vacuum.

H_T = intensity of the transverse magnetic field.

If $p_0^2 \ll p^2$, the above expression reduces to

$$\sigma = \frac{p_0^2}{4\pi} \frac{\nu(p^2 + p_0^2 + \nu^2)}{\{p^2(p^2 - p_0^2) + \nu^2(p^2 + 2p_0^2) + \nu^2(p^2 + \nu^2)\}} \quad (2)$$

From this latter expression and using a graphical method, Appleton and Boohariwalla obtained the theoretical curve

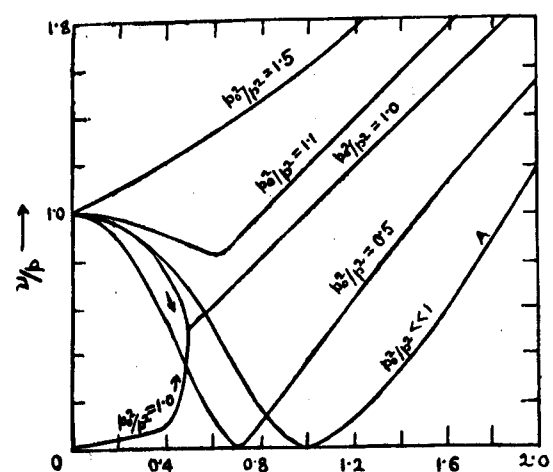


Fig. 1.

A, reproduced in fig. 1. This curve depicts the values of collision frequency giving maximum conductivity for different values of p_T , both being expressed as fractions of the angular frequency p . The other curves shown in fig. 1 have been drawn by ourselves using the complete expression as given by (1), and following a tedious graphical method, as the critical values of collision frequency (ν) giving maximum conductivity cannot be obtained in a tractable algebraic expression. Four different values of p_0^2/p^2 viz. 0.5, 1.0, 1.1 and 1.5 have been taken and corresponding curves drawn. The following important features of the curves may be noted.

(1) For values of $p_0^2/p^2 < 1$, the greater the value of p_0^2 , the smaller is the value of ν_T for which conductivity becomes maximum at collision frequency equal to zero.

(2) For $p_0^2/p^2 = 1$, when $p_T/p < \frac{1}{2}$, we get two values of collision frequency giving maximum conductivity. It would be interesting to investigate which of them gives greater conductivity and whether this double value of

collision frequency giving maximum conductivity occurs only for $p_0^2/p^2 = 1$ or for certain range on both sides of this value.

(3) For values of $p_0^2/p^2 \gg 1$, the conductivity never becomes maximum for zero values of the collision frequency.

(4) For $p_0^2/p^2 > 1$, the conductivity becomes maximum for higher values of collision frequency and after certain value of p_0^2/p^2 the nature of curve changes, the downward bend disappears and a continuous increase is indicated.

It may be further observed that conductivity of the ionised medium in the present case attains infinite values only when it is maximum at collision frequency equal to zero. For given value of p_T (lying between 0 and p^2) this occurs when $p_T^2 = p^2 - p_0^2$. This expression when put as $p_0^2 = p^2 - p_T^2$ corresponds to the fourth condition of reflection pointed out by R. N. Rai.³ For this value of p_0^2 , in the presence of a transverse magnetic field the conductivity of the ionised medium would be infinity, if the collision frequency is zero. Even if the collision frequency is not actually zero, but has got a small value, the conductivity would be sufficiently great to resemble the case of metallic reflection. Under these conditions the smaller the value of collision frequency, the greater will be the conductivity of the ionised medium and hence better the chances of reflection.

Physics Department,
Science College,
Patna, 9-3-1940.

B. N. Singh.

B. D. Sinha.

¹ Appleton, E. V. and Chapman, F. W., *Phys. Soc., Proc.* 44, 246, 1932.

² Appleton, E. V. and Boohariwalla, D. B., *Phys. Soc., Proc.*, 47, 1074, 1935.

³ Rai, R. N., *Proc. Nat. Inst. Sc.* See Bajpai, R. R. and Mathur, K. B., *Ind. Jour. Phy.*, 11, 165, 1937.

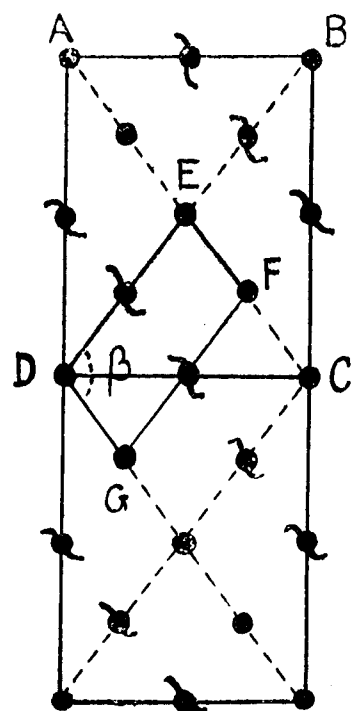
Crystal Structure of Anthraquinone

Hertel and Romer,¹ Caspari,² Banerjee and Guha,³ Guha⁴ have investigated the structure of anthraquinone crystals by the X-ray method, but have arrived at no conclusive results. They have always assumed the crystal to be orthorhombic after Groth's⁵ data. It now appears, that the crystal is really monoclinic. In fact, if X-ray rotation photographs are taken about two diagonal axes (110) and (110), on the old nomenclature, the pictures are quite different, thus definitely contradicting the orthorhombic hypothesis. The elementary translations in these two directions come out as 15.85Å and 7.92Å respectively. The translations in the direction of the old axes are however 19.68Å, 24.59Å and

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3.98A. The translation distances in the old (110) and (1 $\bar{1}$ 0) thus appear more fundamental than the earlier chosen directions. The pseudo-orthorhombic character of the crystal has been really due to the accidental circumstance that 15.85 is almost exactly double 7.92. Thus the correct (monoclinic) unit cell has the elements $a=15.85\text{\AA}$, $b=3.98\text{\AA}$, $c=7.92\text{\AA}$ and $\beta=102^\circ 43'$, the c -axis of the old system being the b -axis of the new system.

The following net in the old ab -plane accounts for the confusion of the earlier workers.



ABCD represents the old ab -face of the cell.
DEFG represents the new ac -face of the cell.
 $AD=24.59\text{\AA}$ $DE=15.85\text{\AA}$
 $DC=19.68\text{\AA}$ $DG=7.92\text{\AA}$
 $\beta=102^\circ 43'$

The fact that the crystal develops very few faces has also contributed to the confusion. By careful goniometric measurements of all the faces, as well as by a re-measurement of the old angles in a large number of crystals, the X-ray evidence could be corroborated at all points. The following crystallographic data revises

the old values (axial ratios being taken from X-ray measurement).

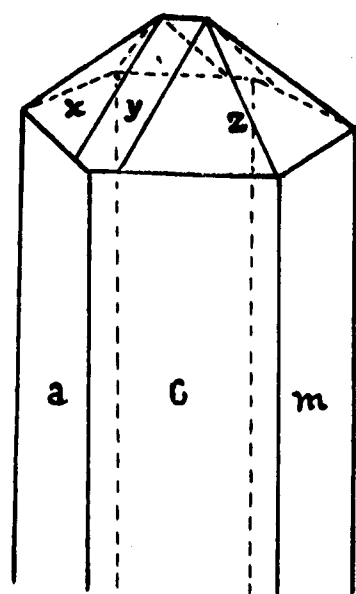


TABLE I

Faces	New Indices	Calculated	Observed
$a:c = (100) : (001) =$		—	$77^\circ 17'$
$c:m = (001) : (201) =$		$51^\circ 20'$	$51^\circ 14'$
$m:a = (201) : (100) =$		$51^\circ 22'$	$51^\circ 29'$
$a:x = (100) : (110) =$		$75^\circ 34'$	$75^\circ 40'$
$c:z = (001) : (011) =$		$62^\circ 45'$	$62^\circ 45'$
$x:z = (110) : (011) =$		$27^\circ 36'$	$27^\circ 36'$
$y:z = (111) : (011) =$		$12^\circ 30'$	$12^\circ 37'$

The optical extinction directions in the ab -plane have been found to differ from the old crystallographic directions by about 16° confirming the monoclinic character.

The new unit cell contains 2 molecules instead of 8 according to the old orthorhombic cell. Thus the previous unit cell being much bigger than the correct fundamental cell, the absent spectra showed symmetries greater than those required by any of the orthorhombic space-groups. This was the chief difficulty in the determination of space-group experienced by early workers. The new configuration explains all the absent spectra observed in the older notations. All relevant data in X-ray measurement can now be clearly correlated to a definite space-group which conforms to $C_{2h}^2, P\bar{1}/a$.

LETTERS TO THE EDITOR

Detailed paper on the subject including the electron configuration by Fourier Summation method will be shortly published elsewhere.

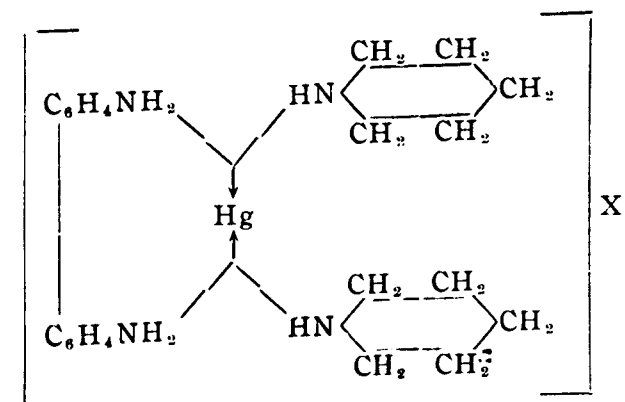
Physics Laboratory
Dacca University
Dacca, 26-3-1940.

S. N. Sen

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- P. Groth, *Chem. Krist.* Vol. V, p. 442.

4-Co-ordinated Mercuric Salts and Gravimetric Estimation of Mercury as Benzidine Compound

Mercury does not appear to form stable 4-co-ordinated compounds. An exception has been found in the present experiment where benzidine compounds of mercuric salts form 4-co-ordinated compounds with piperidine. Mercuric salts yield only mono-compounds with benzidine, co-ordination valency being two. The benzidine compounds are insoluble in water, alcohol and many organic solvents but dissolve readily in piperidine to give clear solutions. When water is added to such a solution, a precipitate having the composition $\text{Hg}(\text{C}_6\text{H}_4\text{NH}_2)_2(\text{C}_6\text{H}_{11}\text{N})_2\text{X}_2$ ($\text{X}=\text{Cl}, \text{Br}, \text{NO}_3$ or CH_3CO_2) is obtained. It is evidently a 4-co-ordinated compound and may be represented as



This reaction was suggested by a similar course of action observed previously in the case of cupric salts.¹ These were found to form mono-compounds of benzidine but dissolved in piperidine and on addition of water precipitated 4-co-ordinated benzidine-piperidine cupric compounds. Copper, it was noted, (*loc. cit.*) could be

estimated gravimetrically as benzidine compound from neutral solutions. It is here observed that mercury too, can be estimated gravimetrically as benzidine compound in a similar way. The method is very simple. Benzidine, slightly in excess of one molecular proportion is dissolved in alcohol and added to a molecule of aqueous or alcoholic solution of any mercuric salt. The precipitate formed, is at once filtered through a weighed filter. It is washed with alcohol and ether, dried in an ordinary desiccator and then weighed. The method is accurate and comparable as regards results to the standard sulphide method of estimating mercury quantitatively. Details will appear elsewhere.

Department of Chemistry,
Presidency College,
Calcutta, 27-3-1940.

Kanai Lal Mandal

- Mandal, *SCIENCE AND CULTURE*, 5, 394, 1940.

A Note on a Method of Determining Refractive Index by Microscope

Many simple methods are available for the determination of the refractive index. One of the commonest methods makes use of a travelling microscope to find the apparent change in the distance of an object when a parallel slab of the material whose refractive index is to be determined is interposed between the object and the microscope. In this method as the distance to be measured is along the axis of the microscope itself we cannot make use of the eyepiece graticule or the micrometer eyepiece; and in fact it cannot be considered an accurate method. In this paper a simple microscope method is described which depends on the measurement of the lateral shift (*i.e.*, shift at right angles to the microscope axis) which in general takes place when a ray traverses a parallel slab or a pile of parallel slabs made of different media. The method is suitable for liquids as well as solids (and gasses) and gives reasonably accurate results. Using an ordinary student-type set-up the accuracy is about one per cent.

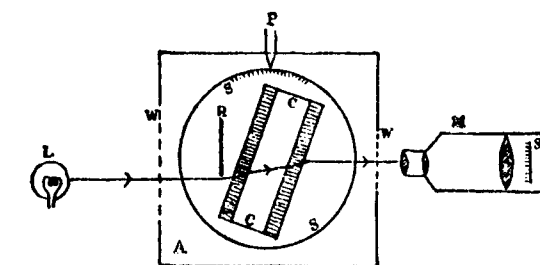


Fig. 1 (a).

In figure 1 (a) is shown the arrangement suitable for liquids. A is a vessel which has two windows of plate glass on opposite sides. The microscope is placed

LETTERS TO THE EDITOR

with its axis perpendicular to the windows W. The microscope eyepiece carries a graduated scale of 100 divisions whose one division is equivalent to .05 mm. CC is a glass cell whose parallel sides are about 5 mm. in thickness. The glass cell CC can be filled with any liquid when required. R is a razor blade whose edge serves as the object. The image of R is seen in the microscope. The cell can be rotated about an axis which is at right angles to the plane of the figure. The angle of rotation can be measured with the help of the graduated scale SS.

Initially the plane sides of the cell are normal to the axis of the microscope. In this position the cell produces no shift and the image of the razor edge occupies the same position as in the absence of the cell. The cell is now rotated through an angle say i which is measured on the graduated circle SS. Obviously the ray which after refraction through the cell travels along (or parallel to the) the axis of the microscope will be incident on the cell at the angle i . This rotation of the cell will produce a shift in the image of the razor edge as seen through the microscope. The amount of the shift is measured by the help of the scale in the eyepiece.

The relation connecting shift and the angle of rotation i can be easily worked out.

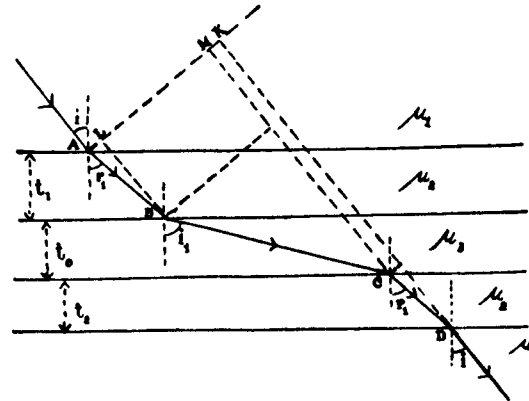


Fig. 1 (b).

Let us consider a ray passing successively through three parallel slabs of refractive indices μ_2 , μ_3 and μ_2 respectively. The first and last medium surrounding the cell is the same and of refractive index μ_1 . The thicknesses of the media are shown in fig. 1 (b).*

* A glass cell containing air is a special case of the above formula where μ_2 stands for the refractive index of glass and μ_3 the refractive index of air. If the cell is surrounded by water then μ_1 is the refractive index of water.

Let A K represent the total shift. This is made up of shifts AL, LM and MK, where L and M denote the points where the perpendiculars on A K from B and C meet A K. We have, as is evident from the fig. 1 (b).

$AL = AB \sin (r_1 - i) = t_1 \sec r_1 \sin (r_1 - i)$, and similarly $MK = t_2 \sec r_1 \sin (r_1 - i)$ and $LM = t_0 \sec i_1 \sin (i_1 - i)$, and hence $AK = (t_1 + t_2) \sec r_1 \sin (r_1 - i) + t_0 \sec i \sin (i_1 - i)$ (1)

Again, $\mu_2/\mu_1 = \frac{\sin i}{\sin r_1}$, $\mu_2/\mu_3 = \frac{\sin i_1}{\sin r_1}$, and hence $\frac{\sin i_1}{\sin i} = \mu_1/\mu_3$. (2)

Considering formulae (1) and (2) it follows that the total shift can be regarded as made up of:—

(i) Shift when light passes through a slab of thickness t_0 and of refractive index μ_3 immersed in a medium of refractive index μ_1 , and

(ii) Shift when light passes through a slab of thickness $(t_1 + t_2)$ and of refractive index μ_2 immersed in a medium of refractive index μ_1 .

To obtain the total shift, (2) is to be added to (1) when $\mu_1 > \mu_2$ and is to be subtracted from (1) when $\mu_2 > \mu_1$.

The experiment consisted in determining the shift for different values of the angle of incidence i , firstly with the cell empty and the vessel full of water, and

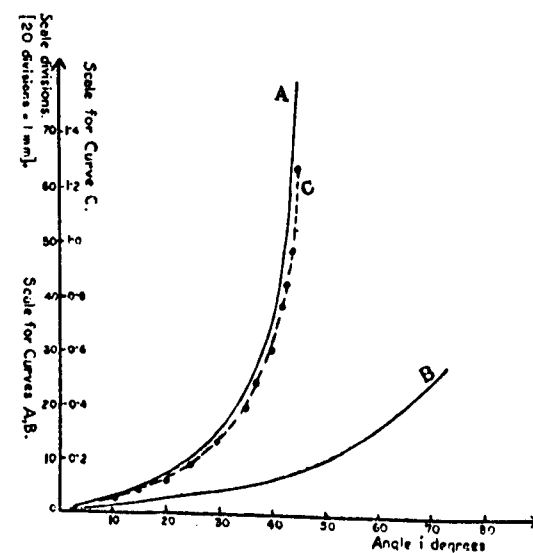


Fig. 2.

secondly with the cell also containing water. The shifts in the two cases were in the opposite directions. The results are shown in fig. 2 by the curves A and B respectively.

LETTERS TO THE EDITOR

From what has been said above it follows that if to any shift observed with the empty cell we add the shift for the same angle i but with the cell full of water, we obtain a shift which would take place in the case of a ray which suffered refraction from water directly into an air film of thickness t_0 and angle of incidence i . The broken line curve C in fig. 2 represents the shift per unit thickness of the air film plotted against i using the relation, $\text{shift} = t_0 \sec i \sin (i_1 - i)$,

where $\frac{\sin i_1}{\sin i} = \frac{\mu_1}{\mu_3} = \mu_1$ is to be taken equal to 1.33. It may be noted that as the critical angle is

approached the shift becomes very large (and theoretically is infinite at the critical angle).

As will be seen from the figure the observed points, obtained by adding to the shift with empty cell the corresponding shift with cell full of water and then dividing by the thickness t_0 of the air film ($t_0 = 3.4$ mm.), all lie on the curve C.

It seems possible that with a little refinement the method could be used to determine the temperature variation of the refractive index. My thanks are due to Dr D. S. Kothari for his interest in this work.

Anglo-Arabic College,
University of Delhi

A. G. Chowdri.

Delhi 2-4-1940.

SCIENCE AND CULTURE

JUNE 1940

VOL. V NO. 12

A Monthly Journal of Natural and Cultural Sciences

Social and Organisational Aspects of the Nutrition Problem

PUBLIC interest in the problem of nutrition even in the more advanced western countries is largely a post-war phenomenon for which there are several contributory factors. Firstly, the newer knowledge of nutrition particularly with reference to vitamins, which makes the question of dietetics more complex, has been evolved, relatively recently, in fact, during the last three decades. Secondly, the war necessitated planning of food production and specially of food distribution in the belligerent countries on the basis of the available scientific knowledge regarding nutrition. Thirdly, the aftermath of the war aggravated by the harsh conditions of the Versailles Treaty produced such a low level of nutrition in the Central European countries that public conscience throughout the world was stirred. Fourthly, the League of Nations (though failing in its main declared function of producing a real league of nations) directed attention to the health problems in various countries and during the last decade took an active interest in the nutritional problems of some of them, belonging to different continents.

The special interest taken by the League of Nations in the problem of nutrition was largely occasioned by the economic depression which set in in 1930. The international economic chaos (for no

milder expression can be used for the situation), was nowhere more exemplified as in the field of food production and food distribution. In order to keep up prices, private owners all over the world resorted to a wanton destruction of food-stuffs, almost unparalleled in history. Coffee was burnt in Brazil, wheat was destroyed in Canada, oranges were made to perish in Spain, when millions of people throughout the world had to go without these foodstuffs. These are only a few examples; for a more complete account the reader may be referred to Stuart Chase's book, *"The Tragedy of Waste."*

At the same time, systematic enquiries conducted by nutrition experts revealed a most alarming situation in even the more wealthy countries of the world. It was for the first time established by scientific enquiry, that at least 50 per cent of the population of Great Britain were either undernourished or malnourished, when judged according to accepted nutritional standards. Similar observations were made in various other European countries and in America. If such is the state of affairs in a country like Great Britain, which is considered to be a very prosperous country having many colonies to draw upon, what the state of affairs in a colonial country like India is can better be left to imagination. We should not be surprised if

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scientific enquiries would reveal that 95 per cent. of the Indian people suffer from chronic undernourishment and malnourishment. A recent enquiry conducted under the auspices of the Students' Welfare Committee of Calcutta University showed that the diets consumed by college students in the hostels in Calcutta were deficient in several respects: in protein, calcium and available iron. Their diets, however, are considerably superior to those consumed by average middle-class families in Calcutta. The working classes suffer far more from both quantitative and qualitative deficiency. A fallacy is often entertained that the peasantry, being a rural population, are much better off. This is not the case, as dietary surveys in different parts of Bengal and Assam have shown. This is because of the poverty of the peasantry, who have to sell the milk, the eggs and fish (the so-called protective food-stuffs), in addition to the cereals they grow, to the urban population in order to procure the wherewithal for essential requirements like clothes, fuel, maintenance of the homestead however modest, besides the inevitable rent and payment of debts.

The obvious anomaly between the destruction of foodstuffs and the low level of nutrition of vast masses of people throughout the world has naturally attracted attention. Even the League of Nations, which is usually conservative in its opinion, has been constrained to observe as follows:

"Poverty and ignorance remain formidable obstacles to progress; the disparity between food prices and incomes increases the difficulty experienced by the poorer sections of the community in obtaining an adequate supply of the proper foods. In countries of the most diverse economic structure and general level of consumption, appreciable sections of the population are, for one reason or other, failing to secure the food which is essential to their health and efficiency. Millions of people in all parts of the globe are either suffering from inadequate physical development or from disease due to malnutrition, or are living in a state of subnormal health, which could be improved if they consumed more or different food. That this situation can exist in a world in which agricultural resources are so abundant and the arts of agriculture have been so improved that supply frequently tends to outstrip effective demand remains an outstanding challenge to constructive statesmanship and international co-operation."

It was not discreet for the League of Nations to go beyond this, as it is clear that the "challenge" referred to cannot indeed be effectively met until the production is motivated by the good of the community instead of by private profit. This would, however, mean the extinction of vested interests which at the moment rule a major portion of the world. When the production of food-stuffs and their distribution to the different sections of the community—the children, the workers, the pregnant and nursing women, etc., according to their different nutritive needs, are carried out on a planned basis in the light of the requirements of the community and not in the interest of private owners, then alone can the lunacy of destroying food-stuffs when people are starving be finally stopped. Neither Mr. H. G. Wells' "Declaration of the Rights of Man" nor other *ad hoc* remedies prompted by present dangers can effectively help. They usually reveal an escapist mind, which ostrich-like, is not willing to face the issue, as it involves the ruthless sacrifice of those vested interests which have now grown into a cancerous tissue of the body-politic, which nothing but a surgical operation can remove. A new social order involving the communal ownership of the means of production and distribution can alone provide a lasting solution.

In India, a common question that is raised with reference to the nutrition problem is that of population. Is not over-population in India outstripping her food supply—it is asked. While there are very good reasons for restricting the birth rate in India, it should be clear that the low level of economic development, the primitive methods of agriculture and the serious maladjustment between agriculture and industry, which have been caused by the domination of powerful exploiting forces, constitute the main obstacle in improving the level of nutrition. It has been considered by certain authorities that by the application of the known scientific methods of agriculture, the world could maintain several times its present population. Food, it may be remarked in passing, has already been produced from wood and there is no inherent impossibility in its production from air. The problem before India, therefore, is primarily that of planned economic development, which would produce a greatly increased general income level. This would enable the purchase of the protective food-stuffs like milk, eggs, fish, meat, fruits and vegetables, which are more costly than cereals like rice, wheat, etc. As the League of Nations itself has realised, nutrition is very largely a social problem and is inseparably associated with the economic level of

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people. People do not eat better food because they simply cannot afford to. Sir John Orr in England served that the level of nutrition went strikingly hand-in-hand with the income level of the different social groups.

In spite, however, of the unsatisfactory socio-economic frame-work in which we live, it is urgent that we should take whatever practical steps we can to ameliorate the present situation. The Governments of many European and American countries have been moved by public and scientific opinion to take measures for improving the general level of nutrition in those countries. It is essential that we in India should make a survey of such organisational efforts in other countries and devise our own concrete measures for nutritional improvement. Incidentally, it may be mentioned that attempts have been made in this country to fix higher nutritional standards than those accepted internationally. There is no scientific evidence to warrant the lowering of the standard except perhaps with reference to calories and our attempts should be directed towards attaining an optimum standard of nutrition.

The feeding of infants and of pregnant and nursing women is an exceedingly important question, as deficiencies in the growing period cannot be made good later in life. The Maternity and Child Welfare Act which was passed in England in 1918 enables the County and Borough Councils to provide extra nourishment to expectant and nursing mothers and to children under 5 years. At the end of 1934 there were in Britain over 400 maternity and child welfare centres, most of which were supplying milk to the infants and nursing mothers. In the United States the Federal Children's Bureau provides milk and other nutritive foodstuffs in different parts of the country.

In the Soviet Union they work according to the principle that nutrition should be governed by the needs and not by the income of the individual. In the towns of the Soviet Union over 90 per cent of the infants are regularly examined at the infant welfare centres, and food centres and milk-kitchens are distributed throughout the country.

The feeding of school-going children is a highly important problem. They are growing rapidly both

physically and mentally and therefore need the greatest attention. In the Soviet Union all these children are provided in the institutions with meals, at least twice a day. About 20 per cent meals are given free and the rest at a very low price. In France, the municipalities are playing an important role by running milk-kitchens which are largely free during school hours. In Britain, the Education Act of 1906 provides that all undernourished children should be supplied with a school meal, sold at cost price to those, who can afford to pay, and given free to those who cannot. The cost of such meals in Great Britain in 1934 was about 70 lakhs of rupees. The Milk Marketing Board of Great Britain has been subsidised by the Government in order to provide cheap milk to children, about 3 millions of children getting the benefit now. The Milk Marketing Board, however, has come in for a lot of criticism, owing to its good effect being considerably nullified by vested interests concerned with milk production (*vide* address by Sir Arthur Salter in *Nutrition and the Public Health*—Proceedings of a National Conference on the Wider Aspects of Nutrition, 1939).

In the matter of adult feeding the Soviet Union alone seems to have adopted planned measures. The "Narpit" or the People's Food Board has provided for centres of social feeding or communal restaurants. Meals are served here, which are prepared under scientific guidance with due regard to nutritive quality, palatability and variety, in "kitchen factories" on a large scale, which are co-ordinated with the food factories, called the "combinats". The combinats produce the main foodstuffs, bread, milk, meat, etc., and the kitchen factories prepare the meals from them which are served in the communal dining halls at a very low price. The meal is said to cost less than it would if prepared at home and at the same time women are released from much drudgery. There is thus economy of labour, time and resources. An examination of the "time budget," for instance, showed that in the preparation of meals on a family basis for 1,000 persons, 1,370 working hours were spent as against only 120 working hours if the same number of persons were served in the dining halls. There are now communal restaurants in factories and collective farms which are under the control of committees of workers. A scientific and thorough-going approach to a problem is truly a feature of Soviet government and Soviet life. At the same time, there is no rigidity and there is a profusion of social experiments going on and there is no prejudice against family meals either.

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Another aspect of the nutritional question should be referred to, namely the question of nutritional research. All advanced countries realise that nutritional research is essential for planning of dietaries on scientific lines. The discovery of fundamental facts of nutrition during the last few decades has revolutionised our concept of nutrition. In this research, Britain, America, U. S. S. R. and Japan are making tremendous progress. The Soviet Union has a Central Institute of Nutrition at Moscow and about ten other institutes in other cities. The Moscow Institute alone receives an annual grant of 2.5 million roubles from the Soviet Government.

In the light of the foregoing survey some concrete proposals may be made, which should receive the immediate attention of the central and provincial governments, of the municipalities and of the public.

(1) Regional Nutrition Advisory Boards should be set up to advise the provincial governments on all matters affecting the proper nourishment of the men, women and children of the zone concerned, much in the same way as the Advisory Board of Nutrition in Great Britain advises the British Ministry of Health. These regional boards are necessary for giving directions with due regard to local conditions which vary greatly from region to region in India, and these boards

should be linked up through a co-ordinating Central Nutrition Advisory Board.

(2) In the chief cities of the populous zones, Nutrition Research Institutes should be established both for basic nutritional research and for research with reference to local problems.

(3) The provincial governments, in co-operation with local bodies, should undertake a policy of giving free or very cheap meals of high nutritional value to school-going children. If the Governments do not move, the municipalities like Calcutta Corporation can take initiative in the matter on the lines of the French municipalities.

(4) There should be a large number of infant and maternity welfare centres, which should run free milk-kitchens and distribute other nutritive food like eggs at a low price.

(5) The Government or public bodies or both in co-operation should establish and run communal kitchens and restaurants, particularly in the congested and busy areas where meals would be prepared under scientific guidance with due regard to nutritional value, variety, palatability and aesthetics. The meals should be served at cost price to the public.

We would urge that the Government and the municipalities including those of the mofussil should set up committees to go into the financial and other details concerning the above proposals.

Function of Science

As surely as night follows day, the problem of postwar production in the face of delayed industrial reemployment of discharged soldiers will tax the ingenuity and financial power of Western civilization. We cannot talk of "gradual adjustment": A man may starve in less than a fortnight. Taxation and relief (or its substitute, war industries) have limits to which Europe is dangerously close. To stop war industries and not start a substitute is to invite disorder if not disaster. If peace were possible tomorrow, could the world afford to stop its war program without having a peace program ready for adoption?

Confronted with these difficulties ought not the power States to be about the business of creating new industries, surveying and appraising underdeveloped

land that might provide not mere additions to world surpluses but support for largely self-contained economic units producing wanted exports, closing the gap between full productive power and our present deficient consumption? In these processes science is indispensable. It is ready to go. A sum equal to the cost of one battleship would give it enormously increased motive power. Reparations and armistice terms will not supply that motive power, nor will loans, tariff adjustments, shipping pools and currency stabilization schemes supply it, helpful as some of these arrangements may be. What is wanted is something deep down, not an arrangement but an addition.

—Isaiah Bowman in *The Scientific Monthly*.

SCIENCE &
CULTURE

The Indian Museum *

B. Prashad

Director, Zoological Survey of India, Calcutta

History and Organisation

THE late Sir Asutosh Mookerjee as the Chairman of the Trustees of the Indian Museum, Calcutta, inaugurated the first series of the Museum Lectures in November, 1913 with an address on *The History of the Indian Museum*. I do not propose today to deal with its history on the lines of the address of Sir Asutosh, but in order to understand the work and constitution of this great institution it is essential to realize that it is not a single homogeneous organism, but an association of scientific and artistic sections. The only common aim of the different departments which are responsible for the various sections is the maintenance of the several public show-galleries, but otherwise they have very different functions to perform and are even under the administrative charges of different departments of the Government of India.

The significance of the word "Museum" or Temple of Muses has changed a great deal since early times. The first recorded institution which bore the name "Museum" was founded by Ptolemy Soter at Alexandria about 300 B.C. This institution was not a museum in the modern sense, but in accordance with its etymology, it was a place dedicated to the cultivation of learning, and frequented by a society or academy of learned men who devoted themselves to philosophical studies and improvement of knowledge.

In the earlier ages certain great monarchs, such as Solomon of Jerusalem and Augustus of Rome, assembled together in their palaces curiosities received from different parts of the world, but no records for the existence of any permanent or public collections of natural objects for those times have been traced. The nearest approach to such collections is perhaps to be found in the preservation of remarkable specimens, sometimes associated with superstitious veneration, sometimes with strange legendary stories, in buildings

*Public Lecture delivered at the Indian Museum on March, 1, 1940.

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devoted to public worship. As an example of this type may be mentioned the skins of gorillas brought by the navigator Hanno from the West Coast of Africa, which were hung in the temple at Carthage. With the revival of learning in the Middle Ages the collecting instinct, which is inborn in peoples of various nations, but which had not shown itself in any tangible shape so far, suddenly came to the fore, and museums or collections of miscellaneous objects, antiquities as well as natural curiosities, and often having associated with them galleries of sculpture and painting, became fashionable appendages of the establishments of many cultured and wealthy people. All these earlier collections were formed and maintained by private individuals, mostly following the dictates of fashion, but sometimes physicians with a natural taste for biological sciences amassed collections of animals and plants for study. In some cases great merchant princes with trading connections in foreign lands and even ruling princes in their private capacity obtained from foreign countries objects which might be considered curios and displayed them in their houses or palaces. In almost all such cases, however, these collections were maintained for the gratification of the possessor or his personal friends, and rarely, if ever, were associated with any systematic teaching or were available for public benefit. Later when societies for the advancement of knowledge came into existence, they frequently in their corporate capacity included the establishment of a museum as a part of their functions, and the foundation of the Indian Museum in the earlier stages comes under this head.

This great institution was started as a subsidiary activity of the Asiatic Society, Calcutta (now known as the Royal Asiatic Society of Bengal) in 1814 and has gradually developed into not only a single repository for exhibits which in other countries are scattered in museums of natural history, archaeology, economical products and art, but it has played a very important part in the advancement of knowledge in various branches in the country. Its popular name "Nia

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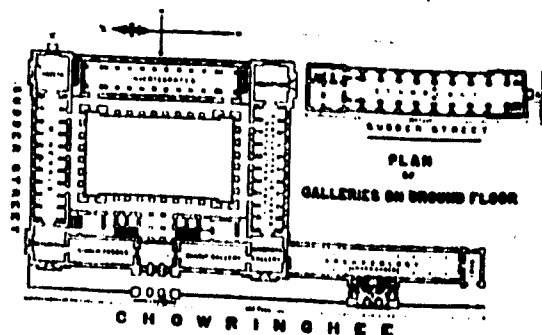
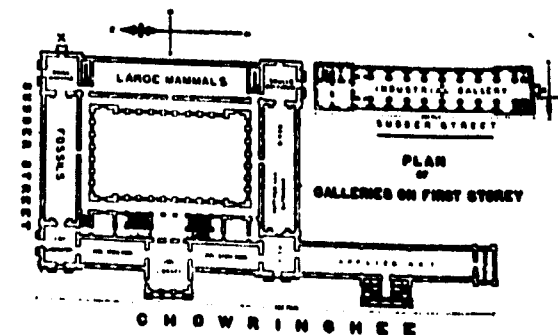
Jadughar indicates its relationship with the Royal Asiatic Society of Bengal which is still generally known as the "*Purana Jadughar*". Incidentally it may be mentioned that "*Jadughar*," as applied to a museum, is a misnomer, for this name in other parts of the country is generally restricted to Masonic lodges.

Briefly the Indian Museum may be described as the national repository of collections of Indian antiquities, of the natural history of the country and in fact of most parts of Asia, of the economic products, and the arts and crafts of India. In addition it houses probably the finest collection of Indian pictures of the various Hindu and Mohammedan schools, as also some representative paintings of modern Indian art. It will thus be seen that the Indian Museum corresponds not only to the British Museum, London, before its natural history sections were transferred from Bloomsbury to their present quarters in South Kensington, but also includes within its domains the National Picture Gallery of the country as well.

The Indian Museum at present consists of the following sections: (i) Zoological and Anthropological (anthropology is given a very wide scope, as it includes within its domain physical and cultural anthropology and ethnology); (ii) Geological and Palaeontological; (iii) Archaeological; (iv) Economic section, including the botanical department; and (v) the Art section. The general management of the Indian Museum, which is vested in a board of trustees, is carried out by the honorary secretary with the help of a Committee of Management constituted by the Heads of the various sections of the Museum. There is no separate Director of the whole Museum, and the different sections are managed respectively by the Director of the Zoological Survey of India, the Director of the Geological Survey of India, the Superintendent of the Archaeological Section (an officer of the Archaeological Survey of India), the Officer in charge of the Economic Section (an officer of the Botanical Survey of India), and the Principal of the Government School of Art, Calcutta.

The main Museum building, was occupied in 1875, although it was not completed till 1877. It is a quadrangular building in Greek style, and is built of red bricks overlaid with a sandy-grey plaster. The western wing with the main entrance extends for over 500 feet along the Chowringhee and faces the famous Maidan of the city, while its eastern wing abuts on

the Sudder Street. It is a very imposing building, of great simplicity and charm, and occupies one of the most central and conspicuous sites in the City of Palaces, as Calcutta is often styled. The four sides of this quadrangular building consist of public galleries on the first two floors, and on each floor there is a broad passage or corridor, enclosed by a colonnade in the Italian style and overlooking the turfed, rectangular open plot of the quadrangle in the centre. A third storey was later added on the top of the western wing for the laboratories and collections of the natural history section, now the Zoological Survey of India, and the Lecture Hall of the Museum. In addition to this main building there is the three-storied new wing built in continuation of the western part on its south side, which now houses the public galleries of pre-historic archaeology and art on its ground and first floors respectively, and the offices of the Archaeological Section and the picture gallery and office of the Art Section on the top floor. There is similarly a block on the north-east side of the quadrangle for the ethnological and industrial galleries and the herbarium. Both these wings were built long after the main building and are not quite in harmony with its style, but, as a result of the care exercised by the architects planning them, they do not in any way detract from the majestic simplicity of the main building. The



A Plan of the Indian Museum

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offices and reserve collection of the Geological Survey of India are in a separate building, which is situated in the same compound to the east of the main Museum.

I now propose to take you round the various galleries of the Indian Museum with a view to giving you a general idea of their layout and the arrangement of the exhibits, and finally to indicate the very rich nature of its collection. Before doing so, however, it would be useful to refer to two outstanding facts in connection with this great institution.

Normally nearly 3,000 persons daily visit the Indian Museum, but on holidays and other festive occasions this number is increased several-fold. The second point, strange as it may seem, is the most attractive exhibit in the Museum, at least for the great majority of visitors from rural areas, upcountry and places where Western civilization has not had time to penetrate, is the lift. This modern convenience, which is not really an exhibit of the Museum, serves a very urgent need for the staff of certain sections whose offices are situated on the top storey of the very high building of the Indian Museum and for whom it is essential to have a quick means of access. All the same, the lift is a great attraction, and such large crowds gather round its entrances on the ground and first floors that it has been found necessary to employ two special durwans to keep the passages clear.

Archaeology Section

The visitor enters the Entrance Hall of the Indian Museum by the main entrance on the Chowringhee where are exhibited some of the best-known schools of sculpture that developed under the patronage of the great Mauryan emperor Asoka during the 3rd century B. C.; there are the Rampurwa Lion and Bull Capitals and the Sarnath Lion Capital, as also the Copper Bolt which connected the Lion Capital with its monolithic shaft, and finally the *Kalpadruma* or "The wish-fulfilling tree" from Besnagar, which is early Sunga or post-Mauryan. In the next bay are erected two big *Yaksha* statues with the peculiar "Mauryan polish," from the site of Pataliputra, a colossal female statue from Besnagar, and a plaster cast of the Parkham statue in the Mathura Museum, all of which are to be assigned to the later Mauryan or early Sunga period. It is not proposed to discuss here the artistic qualities of either the great Asokan or the later Sunga Art, but it may be noted that the highly realistic modelling

and anatomical treatment of these statues are ample proofs of the great skill of the artisans, while the lost art of the extraordinary polish of these specimens has always been a source of admiration.

From the Entrance Hall the visitor enters the Bharhut Gallery on the right. Here are exhibited a large number of sculptures of the Sunga period of the 2nd and 1st centuries B. C. Several of these are also exhibited in the western corridor of the ground floor, while two of them have recently been placed on the sides of the entrance to this gallery in the main hall. Among these the most notable are the elaborately carved red sandstone rail pillars, cross bars and copings belonging to the great rail round the Buddhist stupa at Bharhut in the Nogod State, Central India, erected during the 1st and 2nd centuries. On the bas-reliefs on these pillars and rails are carved stories (*Jatakas*) relating to Gautama Buddha's pre-births and incidents in his last birth. In this gallery is also exhibited a part of the old railing of Bodhi Gaya, dating from about the 1st century and plaster casts of friezes of the Jaina cave temples of Udayagiri in Orissa and of a few bas-reliefs of stupas I and II of Sanchi, also of the same date. Some figures of griffins and remains of wooden palisades excavated from Pataliputra are also exhibited in this gallery.

In the next gallery, the Gandhara, in the same line is exhibited a very fine collection of Graeco-Buddhist sculptures and architectural pieces from Gandhara, dating from the 2nd to the 4th century A. D. In addition to images of the Buddha that appear in this school for the first time, the most notable specimens are the bas-reliefs illustrating various events in the life of Buddha, while a votive stupa is placed in the centre of the room; stupas of this type of varying dimensions are a common feature of the Graeco-Buddhist architecture. The large number of images of Buddhas and Bodhisattvas and architectural pieces show very clearly the Graeco-Roman influence on the Gandharan art which resulted from the contact between India and the Roman Empire from the 1st century B. C. onwards.

The next gallery on the same line is the Prehistoric Gallery. In its southern section are exhibited implements of the palaeolithic and neolithic or the Stone Age, consisting of numerous specimens of polished celts and small points and knives found in different provinces of India. For comparative purposes some foreign specimens are also shown. The

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Neolithic period was succeeded by the Copper Age culture which seems to have extended in Northern India to almost all the provinces from Kurram in the north-west to Midnapur in the east. A new phase of the Indian Copper Age or the Chalcolithic culture when both copper and stone implements were in use, was discovered in 1922 in Sind. Examples of seals bearing pictographic legends, copper implements, painted pottery, terracotta figurines, shells and other objects excavated from various Sind sites exhibited in this gallery show distinct affinities with similar objects discovered at Susa and Kish and have enabled scholars to date the strata where these antiquities were found to about 3000 B. C. The civilization appears to have been so similar to the contemporaneous Sumerian civilization that one is tempted to postulate the derivation of the one from the other. No evidence of the existence of a Copper Age has been discovered in South India so far, but antiquities of the Iron Age, pottery and implements mostly from prehistoric sites in Coorg and various districts in the Madras Presidency are exhibited. Some rare Egyptian, Babylonian and Athenian antiquities are also displayed in this section, and an Egyptian mummy adorns the centre of the gallery. Among the miscellaneous antiquities of the historical period is a huge stone box excavated from Piprahwa in the Basti District of the United Provinces, which contained the relics of the Lord Buddha preserved in a very fine crystal bowl, and various objects found with it. Antiquities excavated at Taxila, Bhita, Bodhi Gaya, etc., are also exhibited. In two central cases is a representative collection of South Indian bronzes, while a few select plaques from Paharpur and Mahasthan are displayed in two wall-cases. In another case are shown antiquities from Assam and Burma, and a few metal images of the mediaeval and later periods from Tibet and Nepal are exhibited in a wall-case. Sanskrit and Prakrit inscriptions showing the evolution and development of these scripts ranging from about the beginning of the Christian era to the 16th century are placed at the southern end of this hall.

The unique collection of the Indian coins in the Indian Museum is stored in a specially designed mezzanine room at the south end of this gallery. This room also houses the very valuable Emerald Bow-ring and Cup of the Emperor Shah Jahan, together with a fine collection of Greek, Roman, Persian and Indian

engraved gems from India, Assyrian cylinder seals and Persian and Sassanian gems from Persia and Mesopotamia. The Coin Room is not normally open to the public, but *bonafide* students and visitors are allowed to inspect the collections by special arrangement with the Superintendent, Archaeological Section.

We have now to retrace our steps to the Gandhara Gallery and from there pass on to another extensive gallery of the Archaeological Section, known as the Long Gallery, which occupies the ground floor of the southern wing of the Museum building. In its successive bays are arranged, in chronological order, specimens of sculptures produced by different schools that flourished in India and Indonesia from the beginning of the Christian era to about 1200 A. D. Here are to be seen sculptures of the Mathura School up to the 5th century A. D., some examples of the remarkable Amravati marbles from the 1st to the 3rd century A. D., Gupta sculptures of 5th and 6th centuries, mediaeval sculptures from Sarnath, Benares, Mathura and Sutna, Buddhist sculptures of the Pala period from 8th to 12th century, Bengal sculpture belonging to the Pala and Sena periods, etc. More delicate and valuable sculptures and bronzes are displayed in show-cases in the centre of the gallery. Select specimens of the Bihar and Orissa schools of sculpture are exhibited on masonry benches in the southern corridor of the ground floor outside this gallery, which a few have had to be shown in the first floor corridor. At the end of the Long Gallery to the east is the Moslem Gallery containing a large collection of Arabic and Persian inscriptions, farmans, sanads, architectural pieces, enamelled tiles, etc. This finishes the survey of the Archaeological Section.

Zoology Section

We will now pass on to the Zoological section. The first gallery on the ground floor which forms the east wing of the main building, is the Invertebrate gallery which the visitor enters by the south-east door next to the staircase. It is one of the most up-to-date galleries of the Museum in regard to exhibits, labels and show-cases. In it are exhibited examples of all classes of invertebrates or animals without a backbone. Along the western wall beginning with the most simply organised unicellular protozoa there are arranged the relatively more complex multicellular sponges, jelly-fishes, corals, sea-anemones, sea-pens, moss-animalcules, lamp-shells, clams, mussels, oysters, etc. Along the eastern side are exhibited a great variety of snails and

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slugs, squids and cuttle-fishes, lobsters, prawns and crabs. The wall-cases at the south end contain exhibits of the main types of segmented worms, *viz.*, earth-worms, leeches, etc., while three cases in the southern half of the central row contain exhibits illustrating the external and internal organisation of the exclusively marine group of animals consisting of star-fishes, brittle-stars, sea-urchins, cake-urchins, sea-cucumbers, etc. Among special features of this gallery may be mentioned (i) the large central case in which are displayed a great variety of forms of the reef-forming corals, (ii) a group of four cases illustrating associations of certain animals with others either for mutual benefit or of one living at the expense of the other. Descriptive drawings of the main features of the life-histories of some of the more important human parasites causing disease in man and various animals are also exhibited here, (iii) a case of Indian molluscs of economic value and containing in addition to others examples of the pearl-producing oysters, the window-pane oyster and the right-handed *chank* which is so highly valued by the pious Hindus, (iv) two good examples of the giant clam of the Indian seas, (v) the common Indian edible prawn and lobster in natural colours, (vi) various Indian crabs also painted in their natural colours, (vii) Neptune's Cup Sponges, and (viii) the giant crab of Japan. Two small illuminated habitat groups of sea-anemones and other forms of marine life have also been installed recently on two of the pillars in this gallery.

From this gallery the visitor goes to the Insect Gallery which is located in a small room in the north-east corner of the main building, and in which are exhibited a great variety of Indian insects, spiders, millipedes, centipedes, etc. Exhibits of crop-pests, useful insects, natural enemies of mosquito larvae, plant-galls, sound-producing organs and secondary sexual characters of insects, etc., are arranged in wall-cases. In the centre of the room there are in two cases good specimens of the nest of a common hornet and a mound of the common white ant of Bengal. Another set of exhibits in this gallery consists of models and specimens for illustrating the life-histories of (i) insects such as mosquito, bedbug, etc., which are directly responsible for transmitting diseases of man and animals, and (ii) those which are useful to man in connection with such products as silk, lac, etc.

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Ethnographical Gallery

From this gallery the visitor passes into the Ethnographical Gallery which is situated on the first floor of the extension of the north block of the main building. In this gallery there are various exhibits illustrating the life and habits of the primitive tribes of India and also those pertaining to particular aspects of Indian life and culture. Under the former group are ethnographical objects of the Andamanese, the Nicobarese and various hill-tribes of Assam. This part of the gallery is being reorganised, and life-size figures of each tribe with their dresses, agricultural implements, fighting weapons, etc., are exhibited in separate cases in the centre and in some of the bays. In the east half are cases of various agricultural and fishing implements, specimens of head and foot gear, musical instruments, ornaments, weapons, etc. In this gallery is also exhibited the most complete collection of Indian musical instruments. In the western half are shown various types of weaving apparatus, toys, articles of religious rites, baskets, pottery, domestic utensils, grinding and winnowing apparatus, models of mills, etc. Recently a very representative series of bronzes of the heads of different tribes of India prepared by a well known English artist, Miss Milward, has been acquired for this gallery. These are temporarily exhibited in wall-cases at the east end, but it is hoped that it would before long be possible to arrange them in suitable cases with proper labels when it would be possible for both students and the visiting public to study them properly.

Geological Collections

The visitor must now turn back to the corridor through the Insect gallery and climb up to the first floor by the staircase in the north-east corner of the quadrangle. The first gallery to be visited on this floor is the Invertebrate Fossil gallery of the Geological Survey of India, which forms the major part of the north wing of the building. In this gallery fossil invertebrates from various sites in India are arranged stratigraphically, while foreign species belonging to the well-known Klipstein collection are displayed in accordance with their zoological position. The very rich collection of fossil plants from the Gondwana system, the Productus Limestone fossils from the Salt Range and other areas, and (for want of space in the Vertebrate fossil gallery on the ground floor) two very large vertebrate fossils of a land turtle and the large Pleistocene Irish elk are also exhibited in this gallery.

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More Zoological Collections

The next gallery to be visited is the Small Mammal Gallery which is situated immediately above the Insect Gallery. In this are exhibited a large variety of small mammals such as porcupines, squirrels, marmots, guinea-pigs, rats, mice, shrews, moles, and the only representative of ant-eaters found in India. There are also specimens of the more primitive forms of mammals, such as duck-bill, spiny ant-eater, kangaroos, opossum, etc., none of which are found in India. In the centre in a large case are exhibits illustrating differences in the structure of the skulls and skeletons of some of the more important families of mammals.

Industrial Gallery

The visitor next passes over a bridge into the large gallery of the Industrial Section which occupies the second floor of the Sudder Street wing over the Ethnological Gallery. In this gallery are exhibited specimens of commercial and industrial interest arranged under the following headings:—

1. Food and fodder which include cereals, pulses and spices, vegetables, fruits, etc.;
2. Medicinal plants and indigenous medicines of vegetable origin;
3. Vegetable fibres and silk;
4. Timbers;
5. Oilseeds and industrial oils;
6. Gums, resins, gutta-percha, rubber, etc.;
7. Dyes and tanning materials;
8. Tea and coffee; and
9. Miscellaneous products, such as lac, paper manufacture materials, matches, Papier-mache, etc.

Special attention may be directed to the exhibits of indigenous vegetable drugs, as also their alkaloids and other active principles while vegetable fibres such as cotton, jute, etc., whether used for cordage, for weaving or for other purposes are also exhibited together with exhibits of the processes for the manufacture of the final products. Exhibits of silk, as produced in various parts of India, tea, lac, raw materials for paper manufacture, specimens of oilseeds and finally selected wood samples of 30 of the more important commercial timbers of the country deserve special mention.

Further Zoological Exhibits

From here the visitor must turn back through the Small Mammal Gallery and pass through the north entrance next to the staircase into the Large Mammal Gallery which occupies the whole of the eastern wing of the main building. In this gallery are exhibited representatives of all the larger groups, such as the cat tribe, the hoofed mammals, the monkeys and man, while in a railed enclosure down the centre are exhibited the skeletons of various mammals. In the centre of the enclosure is a square show-case containing casts and models of whales, the marine porpoises and the freshwater Gangetic porpoise. Hanging from the ceiling over this case is the skeleton of the rare smaller Indian fin-whale, while south of it is exhibited an albino tiger. East of it along the wall are arranged various animals of the cat-group, such as tiger, lion, panther, cats, etc. At the north end of the centre is a group of skeletons of three Indian elephants, one of which is the largest known specimen, while next to it is the skeleton of the elephant which was used by Lord Curzon in the Delhi Durbar of 1902. A stuffed specimen of a young female elephant from the Assam forests is also placed next to them. Along the northern side of the gallery are exhibited a series of marine carnivores such as the seal and the walrus. A very good stuffed specimen of a rhinoceros from Nepal is exhibited in one of the cases along the western wall. In cases in the same row are exhibited various types of hoofed mammals. On the walls are exhibited horns and antlers of cattle, deer and other ungulates, several of which are of record size.

Leaving this Gallery by its south gate and passing along the corridor the visitor next enters the Bird, Reptile and Amphibian Gallery. In the east half of this gallery are displayed various Indian species of birds; a few foreign specimens are also included to complete a survey of the bird kingdom. A new method of mounting birds on panels for exhibition has recently been adopted in this gallery. At the east end of the gallery is a specially designed and illuminated habitat group of storks found in the United Provinces, which was set up after careful studies in the field and which makes it possible to visualize the conditions under which these storks live. Habitat groups of this kind are a very attractive feature of the modern museums, but besides being expensive a great deal of skill and time is necessary for their preparation. In the centre of this gallery there is a block of show-cases containing exhibits of (i) a lammergeyer which can fly, and a cassowary which is devoid of the power

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of flight, (ii) various races of domesticated fowls and pigeons, (iii) a series of mounted specimens illustrating the characteristic poses, display of colour, etc., of birds during courtship, (iv) a cockpheasant's courtship dance, and (v) birds common in the Darjeeling district. In the western half of the gallery on the northern side are exhibited the various kinds of frogs, toads, etc., or amphibians, including the giant salamander of Japan and the only tailed amphibian of India. Various kinds of turtles, lizards and gekkoes are also exhibited along this wall, while the wall-case on the southern side contains exhibits of various terrestrial, freshwater and marine snakes, including the large python and the highly dreaded king-cobra. On a board are exhibited a large number of bangles, rings, etc., all of which, forming a mass weighing 15 lbs. 14 ozs., were found in the stomach of a man-eating crocodile near Cuttack in Orissa. In the centre are exhibited fine examples of gharials and true muggers and a leathery turtle. Next to these is a wall-case containing several specimens of the large Indian rays.

From the western end of the Bird, Reptile and Amphibian Gallery the visitor passes into the Fish Gallery which is situated directly above the Gandhara Gallery. In the centre is a striking exhibit consisting of some of the largest known examples of sharks, skates and rays known from the Indian waters, including the man-eating shark of the Gangetic Delta, the hammer-headed shark and saw-fish. The small desk cases contain special exhibits of various types of specialised fishes, fishes of the deep sea, fishes of hill-streams and aquarium fishes. In the wall-case to the east are exhibited various representatives of the primitive chiropteres, including the worm-like *balanoglossus*, the bag-like sea-squirt, the lancet-like fish and the fish-like lamprey. The case along the southern half of the western wall contains the skeletal parts of some fishes, while the corresponding part on the northern half contains examples of various living fossil fishes. These living fossils are of particular interest, as they are the only living representatives of certain types which were the dominant forms in the earlier eras. The remaining wall-cases along the northern wall contain special exhibits of air-breathing fishes, breeding habits and development of certain fishes, larvicidal fishes, flight of fishes, etc. In the cases along the northern half of the eastern wall are exhibited the common edible fishes of the Calcutta markets, while on the walls are hung up specially large specimens of different

species of fishes. Along one side of the entrance to the Art Gallery has been installed an illuminated habitat case of a mud-skipper from Port Canning, showing how this fish is capable of breathing air direct from the atmosphere and prefers to live on muddy ground rather than in water.

Art Gallery

The visitor next enters the Art Gallery which lies to the south of the Fish Gallery over the Prehistoric Archaeological Gallery. The exhibits in this gallery are arranged primarily under three main heads: (i) textiles, (ii) metal, wood, ceramics, wares, etc., and (iii) pictures. In the northern half of the gallery the exhibits consist mainly of textiles arranged as (a) fabrics decorated in the loom, and (b) those ornamented after they leave the loom. The latter consist of examples of wax cloth, wax-printing, tie-dyeing, cotton printing and various types of embroidered stuffs from all parts of India. The collection of Indian embroideries is particularly rich, and various fine examples of kinkhobs, shawls and brocades are exhibited. In the southern half of the gallery are displayed metal, stone, glass, earthen, lacquer, leather and ivory wares, Papier-mache objects, painted woods, inlaid woods, wood-carvings and glass mosaics. Amongst metal wares there are very good examples of indigenous statuary, brass and copper wares from Tibet, Bhutan, Nepal and various parts of India, damascened and encrusted wares, enamelled, niello and *bidri*, silver and gold wares and imitation gold ornaments. It would require several discourses to describe in any detail the rich variety of the material exhibited in the gallery, but a few of the outstanding exhibits may be noted. The exquisite Tibetan banner of applique work from Burma, the Bhavnagar House which is a faithful representation in wood of a Rajput Chief's palace in Kathiawar and is a very good specimen of a purely Hindu style of wood carving, lamp stands from Madura and the necklace and girdle made of human thigh bones from Tibet, the ivory model of the Taj and the screen carved out of stone, together with the enamelled 'hooka' with 'chillim' belonging to the Nawab of Oudh, etc., are some of the objects to which attention may be invited. The Nahar and Carmichael collection of Indian and Tibetan art among which are prayer wheels, ornaments, scabbards and writing tables, and *tankas* and pictures from the same area are exhibited in a separate room at the extreme end of this gallery.

This finishes the survey of all the galleries on the first floor of the Museum and the visitor has now to

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retrace his steps and walk along through the Fish, Amphibian, Reptile and Bird Galleries along the corridor to the main staircase where the marble statue of Queen Victoria presented by the late Maharaja of Burdwan is placed. Passing down the staircase to the south of the statue the visitor comes back into the main Entrance Hall of the Museum on the ground floor and turning northwards along the west corridor to the north corridor. In this corridor are exhibited specimens of various types of Indian building stones as also a part of the large fossil tree, some 70 feet long, which was found in the rocks of the Raneegunj series.

Geological Galleries

From this corridor the visitor enters the large Rock and Mineral Gallery which occupies the major part of the northern wing of the Museum on this floor, and in which is exhibited a very rich collection of different types of rocks found in India and adjacent countries. This collection is more comprehensive than spectacular, but is of especial value for study purposes.

Passing along towards the east the visitor comes to a small squarish gallery known as the Meteorite Gallery in which is exhibited the largest collection of meteorites in Asia and also one of the most important in the whole world. Several rare iron meteorites also are on view and there are in addition several specimens of structural geology and some economic exhibits, such as those relating to coal and manganese. Maps illustrating phases of Indian geology are displayed on the walls.

To the south of this gallery is the comparatively large Vertebrate Fossil Gallery also known as the Siwalik Gallery. In this are exhibited representatives from that very rich storehouse of Tertiary vertebrates, the Siwalik beds situated along the foot-hills of the Himalayas. A few foreign fossil specimens are also exhibited, and a chart illustrating the ancestry of man was recently put up in this gallery.

This completes the survey of the various public galleries of the Indian Museum. In this account I have not included the Picture Gallery which lies on the top floor of the Museum and which contains a very rich collection of pictures representing various schools of Indian paintings. Visitors have to obtain special permission from the Curator of the Art Section for visiting this gallery.

This is rather a disjointed account of the very varied and extensive exhibits in the various galleries of the Indian Museum, but nothing better is possible in the course of a single article. It should be remembered that behind the scenes there are the very intricate and elaborate tasks of preparing the exhibits, of arranging them in a form suitable for exhibition, preparation of descriptive labels, and hundred-and-one other details connected therewith.

The Indian Museum, with its very rich and ever-growing collections and the important research work carried out in its different sections, has played a very influential part in the cultural advance of the country. Started originally as the private museum of a society, it has grown into an Imperial institution of vast proportions, and is at present the headquarters of several scientific surveys of the country. Like similar institutions in other countries, it is at the present moment congested and is in urgent need of more staff, space and funds for its expansion. Unfortunately the exhibition space in the Museum is over-crowded. In most of the galleries the show-cases are of an antiquated and unsuitable type, and the lighting also in most of them is very poor. As the late Dr. Flower, a great authority in museums, rightly remarked, "A museum is like a living organism—it requires continual and tender care. It must grow or it will perish; and the cost and labour required to maintain it in a state of vitality is not yet by any means fully realised or provided for." Every specimen in a museum is exhibited with a definite purpose, and the main lesson to be derived from the exhibited specimen must be distinctly indicated by the label affixed to it. Further, every specimen exhibited must be the best of its kind, and all available skill and care must be spent upon its preservation and exhibition. All these questions require a very large technical and highly trained staff and funds both for the maintenance and the further development of the museum. Unfortunately the growth of the Indian Museum, which is the only national institution of its kind in the country, is, for want of funds, space and staff, greatly hampered, and Dr. Brown Goode's maxim regarding museums seems to be entirely lost sight of in reference to the maintenance of this institution. He remarked—"One thing should be kept prominently in mind by any organisation which intends to found and maintain a museum, that the work will never be finished, that when the collections cease to grow they begin to decay. A finished museum is a dead museum, and a dead museum is a useless museum."

Spawning Grounds and Hatcheries in the District of Chittagong, Bengal

Chinta Haran Majumdar

Spawning Ground

THERE is perhaps no place in Bengal where carps liberate their eggs so liberally and regularly as in the river Halda in Chittagong. It is a tributary of the Karnafuly and joins the latter near the bridge of the Assam Bengal Railway over it. The portion of the river about 4 miles in length from Ramdas's *Tek* (A *tek* is the winding of a river) up to the mouth of the Kumarkhali river forms the chief spawning ground. The river takes a peculiar sort of zig-zag course in this particular place and is under tidal influence. Every year a large number of carps, especially the *Catla* (*Catla catla*), *Rohu* (*Labeo rohita*), and *Mrigala* (*Cirrhina mrigala*), congregate there and spawn thrice at intervals of about 30 days beginning from the month of *Baisakh* (April-May) and ending in *Ashar* (June-July).

Some fifty years ago the people residing on either sides of the river were not so expert in collecting eggs or hatching them. A few of the Buddhist community used to gather them with pieces of ordinary cloth. The collected eggs were then thinly spread in circular earthen vessels of nearly 2 ft. in diameter and 3 to 4 inches in depth and exposed to the sun for hatching. With such crude technique the people could get only a very limited number of fry. Hence the price of fry was as high as Rs. 50/- per thousand, but nowadays it has come down to a nominal figure. The methods of collecting eggs and hatching them are now more practical. Every man intending to collect eggs has to incur an expenditure of Rs. 50/- to Rs. 60/- for making nets, hiring boats and purchase of anchors etc. The nets, made of net-cloth of a very small mesh, are of different lengths and always with the same breadth of 5 cubits having a rope lacing all round.

Spawning Time

Though there are certain variations, the common factors which influence the spawning are similar. If there are rains in the latter part of the month of March, the brood-fishes, especially of the types stated

above, come down from the deep places, locally called "*Kum*" (where they generally remain) in the upper reaches of the rivers Karnafuly and the Halda. From this time the people of the neighbouring villages keep a very strict eye so that not a single fish from that portion of the river is killed. They place test-nets at suitable places and at suitable times to see if eggs are obtainable. By observing the test catches they forecast the date of the big spawning which lasts for 12 hours only at each of the three breeding periods. The process of collection is very simple. Two pieces of bamboo, each 5 cubits in length, are tied breadthwise at the extremities of the net and they are held from or tied to boats at anchor. Those who cannot engage boats go shoulder-deep in water and collect eggs standing all the while.

The spawning day generally falls within 3 days prior to or after the full-moon or the new-moon day during the months of April to July, but the time for spawning is not fixed. It is greatly influenced by thunder storms, rains and cloudy weather. Spawning generally begins at the time when the tide changes from ebb to flood or *vice versa*, and the water is calm for a time, but the fishes seem to prefer the commencement of the ebb tide in the new-moon period for their spawning.

If there is a big spawning on a certain day, say in the months of *Baisakh*, the subsequent spawning will correspond approximately with the 30th day from that date and so on. The third spawning falls in the month of *Ashar* when generally there are heavy floods. And though it is said that the greatest quantity of eggs is shed at the last spawning, the quantity of the catch is not satisfactory nor the circumstances favour the hatching, because heavy showers damage the eggs in their hatching pits.

Hatching Operations

As soon as the eggs are collected in the net the experienced hatcher will examine their condition. If

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they are fully developed and caught after a lapse of 4 to 5 hours from spawning, he will make early arrangements to transfer them to the hatching pits, otherwise they are hatched on the way and mostly destroyed. These hatching pits are dug all along the banks of the main river and its feeders. The pits are connected with the waters of the rivers by bamboo pipes or by hollowed betel nut trunks. These help to clear, empty or regulate the water supply in the pits as necessary. The eggs when put in the pits are treated in a very crude way for hatching. They are hatched within 6 to 7 hours and the larval fish enter the water through the meshes of the nets on which the eggs are treated. The shells are then thrown away and the larval fish are skimmed off and transferred to another pit having a normal temperature and a depth of 1 to 2 ft. Care is however taken that they are not transferred to a hotter or a deeper pit, because a hot pit will kill them and in a deeper pit they may get drowned at that infant stage. The larval fish try to move upwards slantingly like the tadpoles and take some time to learn the art of swimming with their bodies straight. One is to wait at least for 20 days before one can try to distinguish the various species.

If the eggs are caught soon after the spawning, the experienced persons would keep them in a natural condition as far as practicable in the current of the main river by placing them on nets fixed on a bamboo frame so that the eggs may not escape and at the same time the water of the river may help in their embryonic development. They keep them in this position for 4 to 5 hours and then transfer them to the pits where they are hatched in their usual period of 6 to 7 hours. Those who transfer such eggs at once to the hatching pits, have to wait for 24 to 36 hours before they are mature. And the percentage of hatching in this case is also very low.

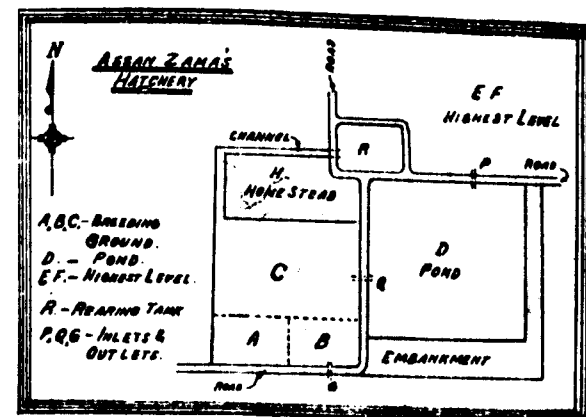
The local hatchers are under the impression that they get 75 per cent and even 100 per cent of the eggs hatched but as they get generally something like 1 oz. of larval fish to 75 oz. of eggs, their contention seems to be very doubtful. The price of larval fish which they begin to sell from the 3rd day is variable, ranging from -12/6 per thousand on the third day, but the price increases with the growth of the fry, and as purchasers from Tippera, Noakhali, Sandwip pour in or requisitions are booked from Assam.

What the local people are doing in the way of hatching etc., is purely a result of their practical experience, and they are quite ignorant of the scientific side of the business, their mode of handling results in a heavy wastage of eggs per season. Excessive collection of eggs without sufficient accommodation for hatching and the want of purchasers in time also results in a heavy loss. It is desirable that scientific methods should be introduced for the improvement of the affairs.

Carp Hatcheries

The village of Kalaujan situated in the jurisdiction of Satkania Police Station is noted for its own way of producing carp fry specially of *Goni* and *Saral punti*. The geographical situation of the village has some speciality. It is situated just on the eastern border of the Chittagong district with gradual undulating slopes running westward. So the rain water can be made to pass any way down the slopes simply by placing embankments and openings wherever desired. The soil is clayey having a great resistant power to percolation.

Some 10 to 12 families have been engaged in this profession with some or partial success for the last 40 to 50 years. The most successful hatchery, as per sketch, is one belonging to Md. Assan Zama. The area of his tank is 1 bigha (nearly $\frac{1}{3}$ of an acre). It



maintains 3 cubits of water in depth during the summer and it contains various kinds of fish e.g., *Catla*, *Rohu*, *Mrigala*, *Calbasu*, *Goni*, *Saral punti* and others, just like any other pond of the locality. The land on the north-east is on a higher level, and water accumulates in it during the rains.

The portion "H" as shown in the diagram is the homestead of the owner and "R" is the rearing tank

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for the young fry where they are taken by a canal round the homestead wherefrom again they are sold later on. The area of the former is $\frac{1}{2}$ bigha and the latter $\frac{1}{4}$ bigha. The total area including the homestead all in a compact block comes to something like 3 bighas in all.

Working of the Hatchery: No water is allowed to stand in the breeding ground till the brood-fishes are allowed into that area. Grass is allowed to grow during the dry season but not for too long.

On an evening after continuous rains when there is sufficient accumulation of water in the area "EF" a passage is made in the bank at "P" to let in water into the pond, which again makes its way to the breeding ground through another opening at "Q." And when the required level is attained in the breeding ground the surplus water is allowed to pass out of it through "G." In order that fishes may not go out of the breeding ground through "G" or from the pond through "P" those openings are protected by bamboo fencing, whereas the breeding ground itself is enclosed by an embankment about 1 yd. high all around.

When the current is on, all the fishes of the types mentioned above pass into the breeding ground through the opening at "Q" and after playing in the deeper portions gradually ascend to the shallower parts. There they begin liberating eggs and milt, which is finished within 6 hours of the night and then return to the pond of their own accord before dawn. The owner keeps a strict watch during this period so that no disturbance is caused to them. The place is naturally very solitary and thinly populated.

Very huge quantities of eggs are seen on the breeding ground but only a very small fraction of them is hatched. In the opinion of the owner the hatching percentage is far less than 1. The owner does nothing except maintaining a current of water through it, but this does not pass all over the area. The way of inflow and outflow lies practically in a line on the eastern side of the breeding ground. Unlike in the Halda river, the eggs are hatched here within 24 to 36 hours, the reason being perhaps that the current of water in which they are caught in the

Halda is highly aerated and it greatly helps the embryonic development while in this case it is not so.

Kind of fry obtained: The greatest number of fry obtained in this area is of *Goni* and *Saral punti*. A few of *Calbasu*, *Rohu* and *Mrigala* are also obtained but the fry of *Catla* have never been found there though *Catlas* also go into the breeding area. It may be true that owing to overcrowding the eggs of the other types of carps do not hatch here to such an extent as those of *Goni*.

Hatching jars with eggs within such an easy reach will greatly increase the hatching percentage and enable one to study the conditions of the eggs of *Rohu*, *Mrigala* and other fishes which are shed in this breeding ground.

Drawback: The drawback regarding the tank is that it contains many types of fishes in a comparatively small space. Experiments with different kinds of fish in separate tanks with suitable breeding grounds attached to them may give better results, and is worth trying in the locality which is naturally so well suited for the purpose. Similar experiments in similar hilly and undulating tracts in other places may prove fruitful.

The people who try to imitate Assan Zama do not realise the scientific side of it. There are some breeding grounds where the fishes go but do not liberate eggs, the probable reason being that the owner accumulates water in that area beforehand which makes the ground damp, soft and clayey and unfit for breeding. There are other breeding grounds also where the eggs are shed and fry come out, but after 3 or 4 days all die out. The reason being that there is no way of maintaining a current of water through them or there is no separate place where the fry can be transferred. Consequently they die out in the stagnant water which becomes poisonous by the decomposition of the unfertilised eggs and the egg shells.

Some people of this village tried the method in another way. During the rainy season when there is an accumulation, say about 1 to $1\frac{1}{2}$ ft., of water in their neighbouring fields enclosed by embankments they introduce some fish from their ponds. There they liberate eggs which are hatched as usual. The fry and the spent fishes are then transferred to ponds and other places afterwards. People have come to believe that when a person wants to breed fishes in any

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area he should procure for his success some fish, which have previously liberated eggs in some breeding grounds. These fish would take the lead to bring out fishes of the new tank to the breeding area after the essential conditions are fulfilled.

It is needless to state that no scientific advice or direction has yet reached this part of the country to standardise or improve these indigenous hatcheries. The people need be instructed in the matter and also in the precautionary measures they should take for the safety of the young fry from contagious diseases which break out in their breeding grounds.

Spawning Ground of the Barbels

The Gorol is the first river that joins the river Sangu on its left bank after the latter has made its way through the plains. It has its origin in the biggest lake area of the district called the "Mahalyar dheba." With the rains in the hills heavy floods set in in the river Sangu and with its current carps, specially the *Calbasu* and the *Mahseer* (which is locally called *Mirka*) come down from the deep beds in the upper reaches. They then try to ascend the river Gorol for the purpose of spawning. It is something like 55 to 60 cubits in breadth and 8 to 10 cubits in depth at its lower courses.

The fact that a large number of brood-fish come up this river annually is well known to the people living in the villages lying by. Hence before the advent of the rains they make all necessary arrangements to put strong obstacles at certain places in the river, locally called "*Nadas*." Thus the fishes are stopped in their course of upward migration, and at such places they are caught in hundreds with the help of various implements. Sometimes, in the middle portion of the obstruction 3 to 4 cubits of the fencing is removed at a height 1 to 1½ cubits above the water level. On the other side of this a bamboo platform is erected with enclosures so that the fish which generally jump over such barrier may not escape. And there some people lie in ambush to catch hold of the fish jumping on the platform. This arrangement is called a "*Fala*." The practice of putting *Nadas* and *Falas* is also in vogue in another river called Hadar Khal near about the Gorol. By these *Nadas* the people kill many brood-fishes annually from these two

streams. This is a ruinous practice committed by the ignorant people. They do not realise that by allowing the fish to spawn, they can earn more by selling their fry, instead of killing them only for better meals for a day or two. If however, there is a sudden flood so that water can submerge those fencings or if a few fish can make their way up, they liberate eggs up the rivers and the local people get a chance to earn a handsome amount by selling the fry collected therefrom.

The obstructions in the river divert the fishes. The turning back of the *Mirkas* (*Mahseer*) thus obstructed can be followed by the bystanders during this part of the rainy season. Big fishes of the type weighing from 35 seers to one maund, move four to five in a shoal just a few inches below the water surface, swelling the water and speeding their way up the strong current of the river Sangu. At this stage they become careless of the surroundings so much so that sometimes the people, passing by in country boats can easily bag them. The diverted fishes in general go to shed eggs in other rivers wherefrom they cannot be collected owing to the irregular nature of the spawning. Some of the carps also make their way in the stream Harwalcheri near about the Gorol.

This uneconomical and harmful practice of killing brood-fishes in the Gorol and the Hadar Khal need be stopped and the area should be utilised as the spawning ground of a type of rare fish as *Mirka* (*Mahseer*) in the plains of Bengal.

Artificial Culture of Carps

The carp family which have now spread all over the world is said to be of Asiatic origin. Though physical and climatic conditions have brought in some changes in their habits and qualities, those of this country are generally similar to those of the Continental ones. The statement that the European carps breed in confined waters, while the bigger types of Bengal do not is not exactly correct. It has been observed that they also breed well in confined or semi-confined waters during the monsoon in this country.

In Bengal, good many carps full of spawn and milt can be had in confined waters like those of a tank during the months from March to August. It is true that owing to unfavourable circumstances they re-absorb all these in their system, but it may also be possible that some of them shed eggs and milt in such confined waters as spent fishes are also found in certain tanks. The point of difference therefore lies

SPAWNING GROUNDS AND HATCHERIES IN THE DISTRICT OF CHITTAGONG, BENGAL

in the fact that the eggs are hatched in confined waters in a cold climate while this is not so in the stale confined waters of a tropical place like Bengal.

Artificial breeding of carps has long been in vogue in this country though in a very limited and crude way. It is only necessary now to put it on a

standard footing by the introduction of scientific apparatus and expert knowledge in the matter. It is an established fact that the supply of carps is steadily decreasing year after year and it is high time that artificial aids be sought to increase it. The question of expenditure is not likely to be large and considering the potentialities any expenditure on such a project is sure to be well repaid. What, however, is of primary importance is that no time should be lost in initiating the work, so that the present rate of reduction is arrested and the inland waters replenished.

Geological Prospecting and Mineral Survey Work of the Soviet Russia in 1939 *

S. Deb

THOSE of us who have studied with interest the account of the progress of the Soviet mineralogical and geological development given by Dr C. S. Fox, Director, Geological Survey of India, after his visit to the U.S.S.R. in 1937 are aware of the remarkable achievements of the U.S.S.R. in this line based on a planned economy. Dr Fox remarks that the Central Institute of Geology and Prospecting, which is under the All-Union People's Commissariat of Heavy Industries, had a permanent staff of 500 geologists, and a budget grant of £450,000 for the year 1936. It is estimated that there are now altogether 6,000 qualified geologists at work in different universities, research institutes and in museums, exclusive of engineers, drillers, and technicians. One can well imagine the progress of the exploration of a country's mineral wealth with a permanent staff of this strength. Recently Prof. Grigoriev, the Vice-Chairman of the Geological Committee under the People's Commissariat of the Heavy Industries, gave a detailed account of the progress achieved by the geological prospecting and exploration committee of the U.S.S.R. during the year 1939. This involves a definite planned programme for the development of newly occupied territory of Eastern Poland.

*Read before the Sanskriti Parishad, a cultural association.

†A short account was published in this journal Vol. 5, pp. 218-20, 1938.

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Diamond deposits were unknown in Russia during the Tsarist regime. The Soviet geologists have found a rich diamondiferous area on the western slope of the Ural mountain. This deposit has proved to be of great economic value.

The U.S.S.R. possesses a very important reserve of copper-ore which may be about 10 per cent of the total world reserve. Some more new copper deposits have been discovered in the Bashkiria region on the south-western extremity of the Urals. On the Kola peninsula, situated on the East of Lapland, important kyanite and sillimanite deposits have been found in the vicinity of Lovozero. Both these minerals are very rich in alumina and thus would be used as a raw-material for the manufacture of alumina as well as for the production of refractories. Important nickel deposits have been known to occur in the Neulinsk district of the Kola peninsula. The *Pravda* announces that rich deposits of nickel and cobalt have been found in Aktyubinsk Province in Kazakhstan. The construction of a big nickel works is projected early this year, in a district adjoining the Kaudagach Orsk Railway.

Very near Leningrad, a bituminous shale deposit has been prospected. Up till now, the Leningrad industries had to depend on a supply of Gdov shales, which had to be transported over a distance of 200 miles. This deposit is very important, because of its close proximity to Leningrad and for its high tar

GEOLOGICAL PROSPECTING AND MINERAL SURVEY WORK OF THE SOVIET RUSSIA IN 1939

content (25 per cent) which can be distilled into liquid fuel.

Sixteen tungsten deposits have been found in the north of the Caucasus mountains, in the vicinity of the Lab and Blyb rivers. Deposits of non-ferrous and precious metals have been found to occur in the heart of Donetz basin, the upper carboniferous coal-field of the Ukranian S. S. R. Among the other discoveries in this district is a very rich deposit of zircon, which would be used as a refractory material in the manufacture of iron and steel.

A very rich iron-ore deposit has been found in West Siberia, which is associated with a rich deposit of manganese carbonate. The People's Commissariat for the Heavy Industries is contemplating the establishment of a local iron industry in West Siberia.

Geophysical prospecting, specially Schlumberger's electrical method of prospecting, has produced many surprising results in regard to the oil resources of the Soviet Union. Oil indications have been noticed in Turkmenistan, along the Amga river. Mention should be made of numerous findings of rare metal ores, —columbite, tantalite, monazite, etc. in Buryat Mongolia, in Kazakhstan (Altai Mountain), Kirghizia and in Tadjikistan situated on the northern border of Kashmir.

The People's Commissariat for the Coal Industry of the U.S.S.R. has decided to create a powerful and well-organised coal industry in Western Ukraine and in the recently occupied regions of Poland. Regular supply of coal from this industry will take place from 1940 to all the towns, workshops, factories and railways situated in Eastern Poland. The Districts of Lvov, Tarnopol, Stanislaw and other coal-producing districts would get coal from the local mines. The Commissariat is founding a new trust, known as 'Lvovuglerazuedka' or Lvov coal prospecting trust. This new trust will have the power to control the four geological and prospecting bureaux and research stations, established in the towns of Rawa-Ruska, Zloczow, Kremenets and Kolomea; the trust will control also the central mechanical workshop and its attached laboratory. The Commissariat is also forming a mine-sinking trust at Lvov, whose function will be to sink new coal mines according to the instructions put forward by the geological and prospecting

bureaux. Seventeen new coal mines with an estimated aggregate approximate output of 850,000,000 tons of coal per year will be sunk in the regions of Rawa-Ruska, Zloczow, Kremenets and Kolomea. About a dozen of these mines will be ready for operation in the middle of 1940, and the rest five at the end of the year. Just after the occupation of these territories, the Soviet development programme of Eastern Poland was put forward and accepted by the authorities on industrial matters. A sum of 8 million roubles was expended on coal prospecting in these districts in 1939, and an allocation of 40 million roubles was made for further prospecting and development work for the year 1940.

A special expedition organised by the People's Commissariat for the Coal Industry is making a detailed examination of the Kzyl-Kaspaksi coal field situated on the Mangyshlack peninsula, in Kazakhstan, near the north eastern shore of the Caspian Sea. The coal production in this coal-field has been estimated to be approximately 25,000,000 tons. Six shafts are being sunk, two of which were finished a few months back. Everybody is expecting that the Mangyshlack coal will supply parts of the Volga and Kazakhstan area.

Want of good supply of water was long felt and considered to be a very serious obstacle for the development of any industry in the peninsula, but scientific geological water prospecting has proved the existence of several artesian wells and good potable water bearing zones.

Geophysical prospecting work fully corroborated the hypothesis put forward by the geologists that petroleum might exist in the region of Mangyshlack. Geologists have found sand saturated with oil and several oil seepages in the area. The Commissariat is seriously considering the prospects of making deep borings in search of oil. Geologists are under the impression that the deep soil of the peninsula must contain useful minerals and metals. Extensive copper deposits and phosphorite have already been located in this area. These discoveries have helped the development of a new industrial centre in the peninsula and a working class settlement of about 30,000 people has already been established in this area. Good healthy dwelling houses and flats with all modern comforts are being built for the workers. A well-equipped hospital and schools and a college are being built to enable the workers to educate their children. Club houses and swimming pools are also being established for the recreation of the workers.

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OBITUARY

P. N. Mathur

THE untimely and unexpected demise on March 27, 1940, at Nagpur of Mr P. N. Mathur has removed one of the best known personalities from Jamshedpur and has created a gap in the industrial field of the country. He was the superintendent of the Duplex Plant of the Tata Iron & Steel Co., Ltd.

The late Mr Prem Narayan Mathur was born at Lahore on November 30, 1892. He entered the local Medical College to study medicine. But after a year and a half he left Lahore all of a sudden in the year 1913 practically penniless and by working all through his way reached the United States of America.

In America, his first venture was at the Ford Motor Car Company, where he joined the foundry department as a moulder and by perseverance and merit gradually rose to higher positions. He took up meanwhile correspondence course in metallography from Cambridge, Mass. During this period he showed special aptitude for theoretical metallurgy and he was made a senior research assistant in which capacity he did much useful work on alloy steels. His work gained him high appreciation of the officials of the Ford Motor Company and Mr Henry Ford himself. But he did not stay there as he wanted to utilise his knowledge for the service of his country.

His desire to serve his mother country found an outlet due to the good offices of late Mr Tutwiler, the then General Manager of the Tata Iron and Steel Co., Ltd., who appointed him as an assistant superintendent of the Duplex Plant in the year 1927 and by sheer ability and merit he rose to the position of superintendent, Open Hearth, and later superintendent of the Duplex Plant. Mr Mathur was the first Indian to hold such high responsible technical positions in the Steel Company.

Apart from his work in the Steel Plant, Mr Mathur took several other responsibilities at Jamshedpur. He was a member of the Technical Education Advisory Committee where he made many valuable suggestions to improve the system of technical education in order to make the students more useful both to the country and

the Company. To the same end he worked in the capacity of chairman of the Technical Night School Committee. He was also a very enthusiastic member of the Jamshedpur Schools Committee and president of the Jamshedpur Harijan Seva Sangha. He threw himself heart and soul into the work of uplift of the Harijans and supervised the schools for the Harijan children with his characteristic devotion and energy. His zealous leadership will long be a source of inspiration to the Sangha.

For some years past Mr Mathur had been much interested in establishing an Indian automobile industry and collected valuable data for the purpose. He had high hopes in the future of an industrialised India and his experience in the industrial field made him confident of establishing successful industries for which he had strong faith in the efficiency and capacity of his countrymen.

Mr Mathur's interest in the industrial development of the country brought him into close association with the National Planning Committee. As chairman of its engineering industries and transports sub-committee, he was reported to have produced a very thorough and painstaking report which would serve as a monument to his zeal and practical bent of mind. He was also a member of the mining and metallurgical sub-committee of the National Planning Committee.

Mr Mathur was a man who had plenty of dash and energy. To him work was a pleasure. In him India has lost a man whose vast experience was now needed to build an industrialised India.

Preservation of Wall Paintings from Central Asia

THE famous wall paintings from Central Asia, on exhibition in the Central Asian Antiquities Museum, New Delhi, which were in danger of decay, owing to the operation of salts existing in the material used, are now assured of a long lease of life, by a process of preservation evolved by the Archaeological Chemist, Government of India. This process is now being carried out in the Central Asian Antiquities Museum in a specially devised "Humidity Chamber." A number of panels bearing the paintings are secured on the sides of

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the humidity chamber with the painted surface inwards, while a relative humidity above 85° is maintained inside. Wet paper pulp is applied to the outer (plaster) surface of the panels. The layer of pulp is removed when dry and the salts absorbed estimated by colorimeter. These applications are repeated till the concentration of salts in the plaster is reduced to small fraction. When this stage is reached, the paintings are taken off the chamber and coated with a vinyl acetate solution to strengthen the decayed surface and fix the colours. Finally, the surface is pressed down carefully with hot iron.

These wall paintings are more than 1,000 years old, and were discovered by Sir Aurel Stein in the ruins of the ancient Buddhist shrines in Central Asia in course of his explorations during 1906-08 and 1913-16. The walls of the shrines which bore the paintings were plastered with mud finished to a smooth surface and finally coated with a wash of burnt gypsum to serve as the painting ground. Natural minerals only were employed for the pigments and the painting was done in tempera style. This plaster was removed in slabs of convenient size for safe transit, which were re-assembled in Delhi by an elaborate mounting process, after the bulky mud backing had been carefully removed and replaced by about half an inch thick layer of plaster of Paris with aluminium netting embedded for reinforcement.

Parasites for Controlling Pests

FOR research workers in India and abroad information collected over 30 years from all parts of India on a group of parasites known as *chalcidoid* is published in the *Miscellaneous Bulletin* No. 30 of the Imperial Council of Agricultural Research, just issued. A knowledge of the natural habitat of parasites of an insect pest and the variety of hosts attacked by them is essential for using parasites for controlling pests. Practically every insect species in India is attacked by one or more parasites, particularly the *chalcidoid* group and a great mass of information on them has been accumulated in the laboratory of the Imperial Entomologist at the Imperial Agricultural Research Institute at Delhi. The bulletin summarises all this information together with scattered notes published in a variety of periodicals. Nearly 200 parasites are dealt with and all information available about their distribution, life-histories and different hosts attacked by them is included. A host-parasite index is also given.

The Bulletin does not deal with all the parasites which actually occur in the country, as a large number of them have not yet been identified. A supplement to the bulletin will be issued as the mass of unnamed parasites in the Imperial Pusa Collection is worked out.

India's Survey Organisation

BECAUSE of the tension in the international situation, intensive military training was given to the personnel of the Survey of India during the cold weather, says the latest Annual Report of the Survey. The training in survey methods suitable for active service of the personnel in times like the present is an extremely important function of the Survey of India. Air Survey is now of paramount importance in military operations. The developments, during the last few years, in the technique of this branch of survey work have made it possible to provide the army with maps of country not yet occupied by advancing troops, which are comparable in accuracy with those produced by careful methods of ground survey. A party of the Survey of India, which has specialised in Air Survey, has, in close co-operation with the R.A.F., evolved many of the improvements in technique which have rendered these results possible.

For some time past the programme of modern style surveys, begun in 1905, had been carried on at the rate of about 36,000 square miles per year. Owing to the need of retrenchment, however, this had to be reduced to about 20,000 square miles. In the higher Himalayas, surveys have been carried out during the year in the vicinity of the Nanda Devi basin, an area of great interest to the mountaineer, and it is hoped that the work will be completed in one more field season.

Map Publication continues to be one of the major activities of the department and the problem of keeping maps up to date has been receiving a great deal of attention. Difficulties arise from the fact that while the Survey is responsible for the upkeep of many thousands of maps, the public demand for many of these is small. Experiments with a view to the discovery of a suitable non-distorting material on which map originals may be drawn, and in lettering by means of photography for use with map originals drawn on metal are being continued. A large variety of scientific instruments have been manufactured in the Mathematical Instruments Office. This office has now expanded into the foremost factory in India for the manufacture and repair of scientific, and, especially, of optical instruments.

The increase in "outside work" has been a feature of the activities of the Survey of India for some years. In 1938-39 the most important of these operations was the work of the Lahore Survey Detachment which is carrying out an urban survey of Lahore City and its environs on scales of 40 feet and 100 feet to the inch respectively. The work which is paid for entirely by the Punjab Government was begun in September 1938 and is expected to take over two years more. Framework for a similar survey of the Murree Municipal area has also been laid out during the summer. Other work

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done for the Punjab Government included rectangulation, levelling and large scale survey in Hissar District in connection with the Bakra Dam Project.

Indian Forest College at Dehra Dun

SIXTEEN students, of whom eleven are from British India and five from the Indian States, are now being trained in the Indian Forest College, Dehra Dun, according to the latest Annual Report of the College. Four of the students are from the United Provinces, two each from Bengal, Bihar, Bombay, Hyderabad (Deccan), Jammu and Kashmir and one each from Orissa and Kotah. Only students with the prescribed qualifications, who have a guarantee of employment on the successful completion of the course, are admitted, and their training expenses are mostly borne by the Provincial Government or the State concerned. The course of studies which extends over two years, comprises both theoretical and practical training. In the forests of the United Provinces the students were last year given practice in laying out plots, charcoal making, cleanings and thinnings and various other works connected with forestry, besides a general acquaintance with forest conditions and natural regeneration experiments. In the Punjab a study was made of active erosion and its causes and also both passive and active counter erosion works. The irrigated plantations were also visited and the students assisted in the burning of a clear felled area. In Bengal the various types of forest and the taungya and other plantations were the chief points of interest. After the All-India Forestry Conference held in December 1937, the Government of India decided to start again a course for the training of students for the Superior Forest Services of the various provinces and States of India, and the Indian Forest College was opened next year. The staff of the College comprises the Principal, who is also the professor of forestry, and the lecturer in surveying and engineering. Besides, the research officers of the Forest Research Institute act as lecturers in their respective subjects.

The Oldest Vertebrate Egg

FOSSIL reptilian eggs have been only rarely found in Cretaceous and Jurassic deposits. The most striking discovery up till now was the nest of dinosaur eggs found in the Gobi desert by Dr Roy Chapman Andrews and fellow-explorers. The recent discovery of an egg nearly 60 mm. long at Rattlesnake Canyon, Texas, in rocks which lie close to the boundary between Carboniferous and Permian has much antedated all previous finds. Prof. Alfred S. Romer and Llewellyn L. Prince have given a description of the find in a recent issue of the *American Journal of Science* (Vol. 237, p. 826, 1939).

The shell is about 1 mm. thick and ornamented with small round tubercles and the interior as examined by X-rays, showed no indication of embryonic development. Although it is not possible to identify the egg definitely, the fact that the *Pelycosaur ophiacodon* is the most abundant of the common reptiles of the red beds of Texas, "the chances are somewhat in its favour as the possible progenitor."

Relics of the Buddha

SOME Buddha relics, discovered in Central India nearly a century ago and since held in private possession in England is returning to the East. The relics have been given to a Buddhist temple in Ceylon by Mrs. Leslie Smith and Mrs. Winifred Burrows, grand daughters of the late General F. C. Maisey, by whom they were discovered. General Maisey assisted Sir Alexander Cunningham in investigating numerous Buddhist monuments around Bhilsa in Central India. The finds which were dated at about 350 B. C. consisted of a relic casket—a small crystal tope with terrace, plinth, hemispherical dome, square pedestal and a double pinnacle, this last forming the stopper of a small perpendicular shaft. The relic chamber at the bottom of the shaft contained minute pieces of bone, the whole being enclosed in an earthenware box which contained a series of the seven precious things usually accompanying the relics of an eminent person, namely, thin round pieces of gold, a bead of garnet, a crystal bead, two beads of pale greenish crystal and some minute fragments of pearl.

Controversy about Radium Treatment

CONFLICTING opinions regarding the beneficial effects of a radium treatment in cancer cases have been expressed recently through the columns of *Nature*. With reference to radium treatment Sir Leonard Hill has expressed the belief that "we would be little the worse off if all the radium now buried in deep holes for security from bombarding remained there." He seeks to make good this assertion by mentioning some casualties due to misuse of radium which have come to his personal notice.

It is well known how Dr Lawrence and others in America are energetically pursuing the possibilities of artificial radioactivity and neutron rays in cancer therapy. Similar opportunities are at present lacking in Great Britain, and the necessity has been keenly felt of a radiological institute where the various possibilities of radiation can be developed and extended. The statement of Sir Leonard Hill in the present circumstances is considered by many to be unduly pessimistic and ill-timed. In earlier stages of cancer cases, cure or palliation has been possible by three means, surgery, radium, and X-rays. All three methods have been abused in certain cases, but generally beneficial results have been obtained. Surgery has never been condemned wholesale

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because of occasional failures due to incapacity, ignorance or carelessness. It has also to be remembered that while surgery has been in the hands of skilled men for centuries, both radium and X-rays are comparatively recent discoveries and their therapeutic applications are still in their infancy. A system of properly controlled and measured dosage takes time to be fully evolved. Even now in consequence of the research work already done on the proper direction of the radiation and on the determination of the magnitude of the dosage delivered to the growth and to the surrounding tissues, deplorable results or failures have been avoided to a large extent.

Relics of an Egyptian Pharaoh

THE granite sarcophagus of Pharaoh Psusennes discovered last year by Prof. Montet of the University of Strasbourg at the site of ancient Tanis (see p. 699, vol. 4, in the last June, '39 issue of this journal) was recently opened in the presence of King Farouk of Egypt. The *London Times* of February 29, published photographs of the site, sarcophagi and some of the finds and gave a detailed report of the contents of the sarcophagus. Inside the granite sarcophagus was a silver sarcophagus 7 ft. long in the likeness of Pharaoh Psusennes wearing a royal insignia on the head and carrying a sceptre and a flail in the hands. Owing to the excellent state of preservation and the exquisite carvings found on it, the sarcophagus has been considered to be one of the most beautiful objects discovered from Egyptian tombs in recent years. Inside this was another sarcophagus of which the top was a silvergilt body covering and a gold mask, also a likeness of the king. On the chest are found inscriptions presumably from religious texts. The lower half of the coffin which was of some other metal had completely disappeared owing to damp seeping in between cracks. For the same reason the mummy had also disappeared leaving only a mass of mud and a few bones. A mass of fine jewellery was found in the granite case. Twentyone gold bracelets bearing inscriptions were found which trace the king's genealogical tree and give details which will be of importance for the history of a period obscure in its dynastic relationships. Inscriptions have already been deciphered which give the names of the Pharaoh's mother and uncles and point to a possible relationship with Thebes. Among the other articles of jewellery found were gold necklaces adorned with rubies and scarabs as well as finger and toe cases of gold.

Tuberculosis and War

DR E. Rist of Paris has recently published an important paper on Tuberculosis and War in *Paris Med.* (1, 52, 1940) in which he has discussed how war favours the extension and aggravation of tuberculosis not only

in belligerent countries but also in neutral ones owing to economic disturbance caused by blockade and scarcity of many indispensable articles due to destruction of merchant shipping and dislocation of transport of goods by land or sea. The mortality curve from tuberculosis in Europe which had steadily fallen from 1900 to 1914, rose sharply from 1915 to 1918 during the years of the last Great War and did not show a decline till after the conclusion of peace. Among other numerous causes of increase is the rapid and wholesale evacuation of urban population to districts which are not sufficiently prepared to receive them with the result that numerous healthy persons become infected with tuberculosis by those suffering from an active form of the disease. Another important factor leading to the increase is the interruption of successful methods of treatment of pulmonary tuberculosis like artificial pneumothorax, due to evacuation of patients to areas where qualified practitioners and necessary technical facilities for carrying out such courses of treatment are not available. Numerous other factors are also responsible for the increase of the disease, such as overwork, mental worry and underfeeding. While not questioning the necessity of an ample supply of tuberculosis experts in the armed forces, which is always maintained, Dr Rist draws timely attention to the possibility of spread of this menace among the civil population and emphasises that proper care should be taken to combat the spread of the same.

Life in Hotter Regions

MAJORITY of animals display their characteristic vital activities within a temperature range of 0° to 38°C. A survey of thermal springs at Hammam Meskoutine in Algeria has yielded some information with regard to some species which are tolerating higher temperatures. In an encysted condition some animals can resist very extreme temperatures. But life in these springs suggests an enquiry how animals adapt to abnormal temperatures. The water here is neither saline nor sulphurous, and the effects of high temperature are therefore uncomplicated by other factors. The first group of inhabitants which includes frogs consists of animals living very close to their thermal death point. Frogs were abundant below 38° and if immersed in water at 39° they died within 10 minutes. It is presumed that these animals pay a hasty visit to this hotter region. The second group is composed of species which have formed adaptive physiological races. A small fish (*Barbus*), living ordinarily in the stream at a maximum temperature of 20°C, has been found to die after it reaches a region at 33° and others generally living at 30° survives till the temperature is 38°. Of the species of hotter regions, a beetle and a small crustacean have not been found below 33°C and 39°C respectively. The crustacean has been found even at 51.5°C. This is the highest temperature recorded for metazoan life and is 10° higher than our normal hot bath. It has been

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suggested that these forms retreat to the hot regions for security from competitors in the regions of normal temperature.

New Kind of 'Blood Bank'

IT has already been reported that nowadays blood is being stocked in hospitals for immediate transfusion into the patient's body. These 'blood banks' which preserve for a few months bloods of different varieties properly labelled eliminates the delay experienced in getting the donor at hand as also the difficulty of getting a large supply from individuals. The blood for this purpose is collected from voluntary donors and from fatal accident cases who were otherwise healthy. Recently the *Science Service* of the U.S.A. has announced that mothers as they bring new life into the world, are also contributing blood that has life saving properties in Massachusetts Memorial Hospital, Boston. The blood is secured from the placenta during normal, healthy childbirth through the cord, which supplied to baby its nourishment before birth. The collected blood is 'typed' to tell whether the blood will mix safely with the blood of a prospective patient. Some other tests are performed and with the addition of a special preservative the mother's blood has been found to remain good for three weeks. It is reported that this blood has a stimulating effect and is successfully used on desperately ill patients suffering from malnutrition, and from certain types of cancer, ulcer, gall bladder and stomach and bladder disorders.

Source of Energy in Bees

AT a speed of 10 miles an hour, a bee, when flies 2½ miles in 15 minutes, makes 18000 wing movements with an equivalent number of breast muscle contractions. In such a flight besides the normal weight of the body, which is about 75 mg., a burden from 10 to 80 mg. may be carried. The energy for this work depends on the sugar content of the blood. The variation of sugar content depends again on the physiological condition of the bee, on age and nourishment, and upon atmosphere and temperature.

Professor Bentler performed tests as reported in the *Discovery*. A bee was captured on its way to seek honey and tested. It showed 2% sugar but after half an hour's flight in the "aquarium" the sugar content was reduced to nil. This is an extreme case. The bees generally fly for a shorter period halting on the way to take nourishment. It has become clear that high blood sugar content of the bee is related to its exceptional activities and muscular performance. The centre from which the sugar supply comes is the honey stomach. A bee can fly as long as it has sugar. The function of the

'queen' is however different from that of the 'worker.' In case of vertebrates the sugar content of the blood must also be at a certain degree to avoid cramp and weakness. The sugar is manufactured within the body from the carbohydrates we eat as also by the liver.

Announcements

PROFESSOR P. N. Ghosh, Sir Rashbehary Ghose professor of applied physics has been appointed chairman of the Bengal Industrial Survey Committee set up by the Government of Bengal last year for formulating a plan of industrial development for the province. He succeeds Dr John Matthai, who has resigned. After being appointed to the Ghose chair of applied physics in the University of Calcutta in 1920 he was sent on deputation to Europe where he was associated with the works of Siemens Schukert and Siemens Halske at Berlin, and got opportunities to study the different systems of electrification in several countries of Europe and in England. Prof. Ghose had training at the National Physical Laboratory in England in the design and standardisation of electrical and other types of measuring instruments and he also worked for some time in the Bureau International Poids et Mesures at Versailles, France.

He has organised the department of applied physics comprising electro-technology in all its aspects. He is in touch with a large number of industries round about Calcutta and he is a member of the Bengal Government Industrial Research Board. He is a fellow of the Institute of Physics, of the London Physical Society and of the National Institute of Sciences of India. In the line of academic research work he with his students has carried out investigations in molecular spectra and is engaged in the study of dielectric constants and other behaviour of liquids as affected by electric fields.

THE Society of Chemical Industry has awarded the Messel Medal to Lord Samuel. This medal is given in alternate years for "meritorious distinction in science, literature, industry or public affairs, and to persons who are prominently concerned with the welfare of society."

THE British Association is arranging a conference on "Science in National and International Aspects" to be held at Reading during July 24-26. This will take the place of the ordinary annual meeting which would in normal circumstances have been held at Newcastle.

THE Royal Society of Edinburgh has awarded the Keith prize for the period 1937-39 to Prof. F. A. E. Crew for his papers in the *Proceedings* of the Society and in recognition of his valuable contributions to animal genetics, and the Neil prize to Mr. James Wright for his important paper on "The Scottish Carboniferous Crinoidea" published in the *Transactions* of the Society.

SCIENCE IN INDUSTRY

Fostering Village Industries

THE Bombay Government proposes to start at Poona a Cottage Industries Workshop, for the testing and improvement of appliances connected with cottage industries—particularly in adapting improved processes and machinery so that these can be employed, manufactured, and repaired by the village artisan. It is not much use telling the villager that he can obtain improved results by the use of an approved appliance, if the appliance is either beyond his means or is so constructed that, if it breaks down, it cannot be repaired locally. It is hoped, too, to afford in the workshop opportunity for experiments by persons interested in cottage industries who have no facilities to try out their ideas, but whose ideas appear to be practicable. It is also hoped to make this workshop a demonstration centre of improved appliances such as the improved village glass furnace designed by the Department of Industries.

The Government of India had been maintaining a hide grading station at Bandra to demonstrate the proper method of flaying carcasses and of grading their skins, since very great loss is caused to the cultivator in India by improper skinning methods and the absence of any system of grading. But the Government of India, for reasons of economy, decided to close down this station and the Government of Bombay has taken it over from December last. It has so far done very good work in connection with animals killed at the Bandra slaughter house.

Development in Refractory Materials

HIGH and fluctuating temperature, load, actions of slag, cutting action of the flame, and the abrading action of a solid or liquid are some of the important service factors that a refractory has to reckon with during service. Dr H. K. Mitra, Assistant Ceramic Engineer, of the Tatas at Jamshedpur, narrating these developments in the course of his address before the Bihar Branch of the Institution of Chemists (India) mentioned the use of counter-current mixers which mixed different ingredients of a refractory body without further grinding, and described how such an equipment was useful in reducing the porosity of a refractory brick without sacrificing its spalling resistance. The use of humidity dryer, another

comparatively new equipment, makes it possible to dry bricks from centre outwards instead of from outside to centre as is the case in ordinary drying in atmosphere or in tunnel dryer. This equipment enables manufacturers to reduce their drying losses specially when large shapes are concerned. De-airing is another process which by means of a vacuum pump removes air lying between the particles of a ceramic body. Such removal of air gives many beneficial properties to the finished refractory brick, such as low porosity, high spalling resistance, increased crushing strength, etc. The manufacturer further gains by reducing his drying and kiln losses as also by reduced fuel consumption. A de-aired column of clay coming out of an Auger-machine could bear its own weight for a length of fifteen feet without any support while a column not de-aired would break immediately if it was unsupported.

Discussing the new technique for old material and the development of new refractory material, Dr Mitra pointed out that these developments might be said to have one end in view, viz., the possibility of constructing a basic open hearth furnace using basic materials only. In this construction the Austrian magnesite containing high amount of impurities was preferred by the steel industry of the whole world to the purer varieties, such as that of India, Greece or America. Purer varieties of magnesite such as the Indian magnesite has been now developed so that they can easily substitute magnesite from Austria. Further it is now realised that they are capable of such a flexibility that magnesite brick with many desirable properties are capable of being manufactured from natural raw magnesites such as are found in India and Greece. This development of purer varieties of magnesite opened the possibility of recovering magnesite as a by-product in the manufacture of common salt from sea water. Purer varieties of magnesite have been processed under the electric arc. Electrically fired pure magnesite is a very promising material.

The development of dolomite has been along similar lines. As a result of research, dolomite brick has been put in the market which are fairly resistant to attack by water and can therefore be stored to a certain extent for a period without disintegration. The next important development in the production of basic refractories is the chrome-magnesite bricks. These are produced from a mixture of chrome and magnesite

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together with addition of other ingredients and a chemical bond. Suitable grinding of the material and high moulding pressure are some of the important steps in the manufacture of these bricks. Perhaps the most fascinating history of the development of basic brick is that linked with the production of Forsterite refractory. Its development was possible due to the fundamental research on the study of equilibrium of such systems as MgO (magnesia) and SiO_2 (silica) and their practical application in the attempt to make Forsterite refractories. Forsterite is a silicate of magnesia and chemically has the formula $2MgO, SiO_2$. There are other magnesium silicates known to occur in nature, but their fusion point is lower than that of Forsterite and they are comparatively poorer in magnesia. Basically, therefore the problem is to enrich these poorer silicates with magnesia in order to produce Forsterite which has a melting point of $1910^\circ C$.

Power and Metal Industry in Finland

JOURNAL de Four Electrique writes about the development of the hydroelectric and electro-metallurgical industry of Finland. Finland has got no coal deposit but she possesses vast resources of water power. The production of electricity has developed in the last ten years from 1,000,000,000 kWh. to 2,500,000,000 kWh, of which more than 75 per cent is hydroelectric. This French journal gives a detailed account of the remarkable Finnish electro-metallurgical industry, worked by the Outokumpu undertaking. This company is working on a deposit of chalcopyrites which is being melted at Imatra. An electric furnace of 9,000 kW has been built by a Norwegian electrical engineering company and is believed to be the biggest of its kind installed in the industry of copper smelting in Europe. The copper production amounted to 15,000 tons in 1938. The purple material resulting from the roasting of the pyrites is taken over by another company and is briquetted and smelted in electric blast furnaces and Tysland-Hole type furnace to manufacture pig iron.

S.D.

Paper and Fibre from Clay

COLLOIDAL suspension of clay, such as bentonite, when worked in an ultra-centrifuge or dehydrated, gives shall flakes which adhere strongly to each other. This can be made into sheets or threads which are transparent and resistant to water, acids, alkalies and oils. This observation is due to Professor Ernest Hauser of the Massachusetts Institute of Technology. In a vessel of colloidal clay thousands of small particles are observed under an ultramicroscope to move slowly at random motion. The velocity of the motion of these particles gradually become nil and in technical terms the

sol becomes gel, or the suspension appears gelatinous. When electrolytes, (substances like salt) which give to the water in solution the property of conducting electric currents, are added to the clay suspension. On spreading out the gel and squeezing out the water carefully it has been found that the particles adhere into filaments which later interweave. Thin sheets of these materials can now be used as an electrical insulating agent like mica from which it is chemically indistinguishable. To produce a water resistant film on coarse paper, colloidal clays are now being used. Like ordinary paper of good quality it can also be used for printing and can be dyed. The threads of this clay, on the other hand, are valuable in filter cloths as they are unattacked by chemical reagents.

New Power Station in Russia

THE Mining Journal writes about the construction of a hydro-electric power station of 240,000 kW capacity on the Irtysh river, six miles from the town of Ust-Kamenogorsk. This new power supply station will be situated in the heart of the Altai mountains which are very rich in mineral resources. The power will be supplied to all the existing industrial enterprises on the upper reaches of the Irtysh river, and will help the building of new factories and workshops.

This new power station will stimulate the development of the Soviet non-ferrous mineral industries of this region. The Altai mountains contain very rich resources of lead, and zinc ore of the U.S.S.R. as well as big deposits of copper, sulphur, barytes, gold and other useful minerals. It will also facilitate the development of the chemical industry and other important industries which require a constant supply of big electrical energy. The Ust-Kamenogorsk scheme will entail the excavation of 95,350,000 cubic feet of earth, the pouring of 21,194,000 cubic feet of concrete and the assembling of 9,300 tons of structural steel.

S.D.

Cement to Prevent Corrosion

CORROSION is the nightmare of the engineers. To fight it many new alloys, new compounds and processes are being developed. The latest attempt is an improved process for the manufacture of cement-lined steel pipe. The composition of the cement varies according to the specific properties of the fluids to be handled. The cement is made in a new type of high speed mill especially designed for the purpose. A measured quantity of the special mixture is placed in the pipe to be lined and forced on the walls by a process which extracts a high percentage of water. The process results in an extremely even distribution of the mixture. The lining has lower co-efficient of friction than the original pipe. It does not become friable so that no special care in handling is necessary.

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The pipe can be shipped, cut to length, and fitted just like unlined pipe, but cannot be bent or deformed. Different industries are already using these types of pipes for conveying many kinds of corrosive liquids and gases.

—N. K. S. G.

Novel Baits for Fish

LIKE moths fishes can be attracted by spot of bright light. An American gentleman, as reported in the *Discovery*, putting a small electric flash lamp and bulb inside a celluloid toothbrush case has amazed the fishermen by pulling fish after fish out of the sea. He has commercialised the process and the illuminated baits range from small shrimp like baits to things simulating sand eels. At a depth of 400-600 metres under the sea there is a strange angler-fish that attracts prey by a luminous tip to a spike above the mouth. The luminous baits were tried in Florida as 'teasers' to lift the fish to the surface where a fresh live bait waited to finally catch them but the fish showed preference to the plastic material. Beside these, unlighted baits with spirals having differently loaded heads so as to move inside the shell in various alluring ways imitating life have been tried, and the fishes have shown the greater attraction for blue colour than red and white. Another cunning device imprisons a live minnow inside a transparent shell with air holes, the advantage being that the bait can be used a number of times.

Gas Driven Automobile

IN England due to the strict rationing of petrol, continuous efforts are being made to replace it by other alternative fuels for use in motor vehicles. In the last January issue of this journal (pp. 421-2) it was mentioned that Brush Engineering Company of England are manufacturing gas producers named Brush-Koela Producer plant, which can be used to drive all types of internal combustion engines, and can be fitted to all class of vehicles. Since then the machine has been somewhat modified and the new design has been named Brush-Koela Duo-Draught Model. It is run on a cross draught principle and can take sudden loads or sudden increased demand for the gas very quickly. At the moment, the Company is producing only one size of producers. This size is mainly suitable for 50 cwt. unladen class of vehicles. The gas generator is 4 ft. 5 in. high with 14 in. diameter. The fuel charging door is at the top and ash discharge door at the bottom. The gas generated is purified by passing it through two scrubbers each 2 ft. 6 in. long and 14 in. in diameter. The complete plant weighs 2.5 cwt to 3 cwt. The capacity is from 40 to 70 lb. of fuel according to the type used, and the consumption is approximately 1 lb. per mile.

The plant requires a constant draught of air for producing the gas, so the engines fitted with this type of producer are normally started up on petrol, the change over to gas operation then being made in 1 min. to 1.5 min. If required a hand fan can be fitted which enables the draught air for starting without the use of petrol.

—N. K. S. G.

Coating Lenses for More Light

LENSES are used in photographic camera, cinema film projectors, and other optical instruments, for concentrating light rays, thus increasing its intensity. But for a polished transparent lens, the full incident light is not transmitted. From 4 to 6 per cent of the incident light is reflected at each glass-air surface of a lens, the precise amount depending upon the type of glass used, and the wave length or the colour of the light. A Crown-glass-air surface reflects about 4 per cent of the light, whereas flint reflects 6 per cent.

It has recently been found that screen illumination in a cinema can be increased 15 to 30 per cent depending upon the type of projection lens and its focal length, simply by coating the surfaces of the lens with a very thin film of metallic fluorides or barium stearate. Such lenses have found immediate commercial application; many cinema houses in America have fitted their projection apparatus with such lenses.

Although this is the first commercial application of the new coating process, its history goes far back. In the year 1892, few tarnished lenses were given for repolishing to a British lens designer, H. Dennis Taylor, who, while working with these lenses, noticed that 95 per cent of the incident light reaches photographic plates through these tarnished lenses, whereas freshly polished lenses transmit 89 per cent only, the rest being reflected back. Taylor therefore attempted to tarnish lenses artificially by immersing them in various solutions and found that hydrogen sulphide and alkaline sulphides reduced reflection appreciably. In the year 1917 several other experiments were conducted in U.S.A. in this connection, and two or three hypotheses were also advanced to account for this phenomenon. It has been suggested that during the process of etching by the attacking solution the surface becomes covered with minute pits, which are small compared with the wave length of light.

In the year 1936, a physical method of coating films to produce the same effect as that of the chemical was developed. The process involves the evaporation of metallic fluorides in a high vacuum, so that the evaporated molecules travel without intermolecular collisions from a hot metal source and deposit on the cold surfaces of the lens. It was noticed that with such a lens 54 to 85 per cent of the reflection is decreased depending upon the wave length and the angle of incidence of the light.

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Subsequent works, which were carried on projects originally instituted by Langmuir, show that thin molecular films of barium stearate on glass surfaces also decrease reflection. The lens is dipped in a tank of liquid on the surface of which one molecule thick layer of barium stearate is spread. As the lens is dipped down one layer of the film is attached and on withdrawal another layer is applied, each full immersion adding two layers, each one molecule thick.

Both the film and the lens surface may reflect light. For decreasing reflection or entirely eliminating it, it is necessary that the crests of the waves of one beam shall fall into the troughs of the others, thus being out of phase, the waves will neutralise each other. So in both the processes, whether chemical or physical, the most effective thickness is one quarter of the wave length of light, or about four millionths of an inch, and the refractive index of the film must be intermediate between air

and the glass. It has been shown by experiment that the missing radiation reappears with the transmitted beam, which contains as much as 99.6 per cent of the original radiation. By the above process of coating with barium stearate it requires 22 complete immersions i.e., 44 successive layers to build up the required thickness.

In a long series of investigations conducted by the research staff of the Bausch & Lomb Optical Co., it was evident that a combination of the above two processes could be used to greater advantage. On lenses having an exposed outer surface a corrosive chemical process is used, in which oxides of high refractive index are removed from the surface, leaving an invisible structure of silica, while the inner glass surface is coated by the deposition of metallic fluorides in high vacuum.

The new coating process is confined to a limited number of products, but the progress so far attained promises a wider field for investigation.

—N. K. S. G.

Photo Electric Relay for Control of Smoke from Boiler Flues

B. B. Ray

The use of photo electric cells for sound reproduction is now universal. Photo electric cells are also used for other industrial purposes such as: automatic control of street lighting, door-opening, as a safety guard for machine and machine tools, counting of cartons on a conveyer belt, etc. The use of photo electric cell for control of smoke from boiler flues has not been used before and in this article, working of such an apparatus is described. This equipment is installed in the Works of Messrs. Bengal Chemical and Pharmaceutical Works Ltd., the photo electric relay being supplied by Messrs. The British Thomson Houston Co., Ltd., and other engineering works being done by Messrs. W. Billinton & Co. The photo cell used is type 'PE7B,' with the cathode having a caesium-oxygen-silver surface.

A photo electric cell consists fundamentally of a sensitized surface, the cathode, which emits electrons when light shines on it, sealed into an evacuated container with a second electrode the anode, to which a positive potential is applied to attract these electrons. The special manufacturing methods employed in manufacturing these cells eliminates excess caesium, thus an insulation resistance of many thousands of megohms is secured.

It is usual to express the sensitivity of a photo cell in micro-amperes per lumen of light falling on the cell,

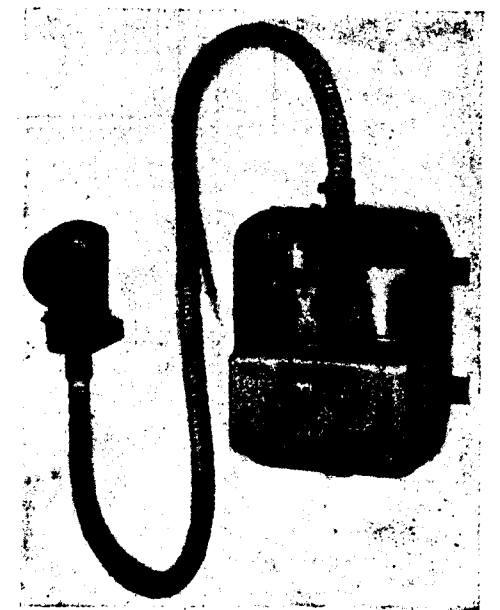


Fig. 1.—Photo electric relay with external photo cell holder.

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the lumen being the unit of measurement of light flux. One lumen of light is radiated by a light source of one candle power on an area of one square-foot at one foot distance from the lamp filament.

The principle of operation of photo relay depends upon the change in the light intensity on the photo cell causing a corresponding change in the photo cell current, which is amplified by a high vacuum valve sufficiently to energize a telephone type relay. The contacts of this relay control a small contactor which is used to control the desired external circuit. The contactor may be made to open or close with the decrease in light intensity and by suitably adjusting a variable resistance, the operation of the equipment may be effected at various values of light intensity. The photograph of a photo electric relay with external photo cell holder is shown in Fig. 1.

The apparatus for control of smoke from boiler flues consists of photo electric relay described above with external photo cell holder and projection lamp assembly. Electrical arrangement of the apparatus is shown in Fig. 2. The photo electric cell is housed at

little smoke settles on the glass window, thus a column of smoke approximately 5 ft. long and 4" diameter is observed by the photo cell resulting in marked sensitivity and selectivity. The column of smoke is, of course, trapped from the flue. Trouble due to soot settling on the glass was anticipated but in practice, no difficulty was experienced and it is only necessary to clean the glass window once a week for normal operation. The boiler is of Lancashire type and is used for supplying process steam varying in pressure and quantity from day to day.

When steam is drawn for processing, a fresh charge of coal is fed into the furnace resulting in heavy smoke due to evolution of a large quantity of carburetted hydrogen gas which requires air to bring about complete combustion. The smoke column thus intercepts the beam of light from the photo electric cell and operates a small post office type relay, which in its turn closes a TMC contactor starter. The contactor starter starts a blower motor supplying additional air into the furnace. The correct quantity of secondary air is thus introduced at high pressure during firing periods ensuring smokeless operation. Some trouble was experienced due to chattering of the contactor but this was remedied by inserting a suitable tuning condenser across the post office relay coil.

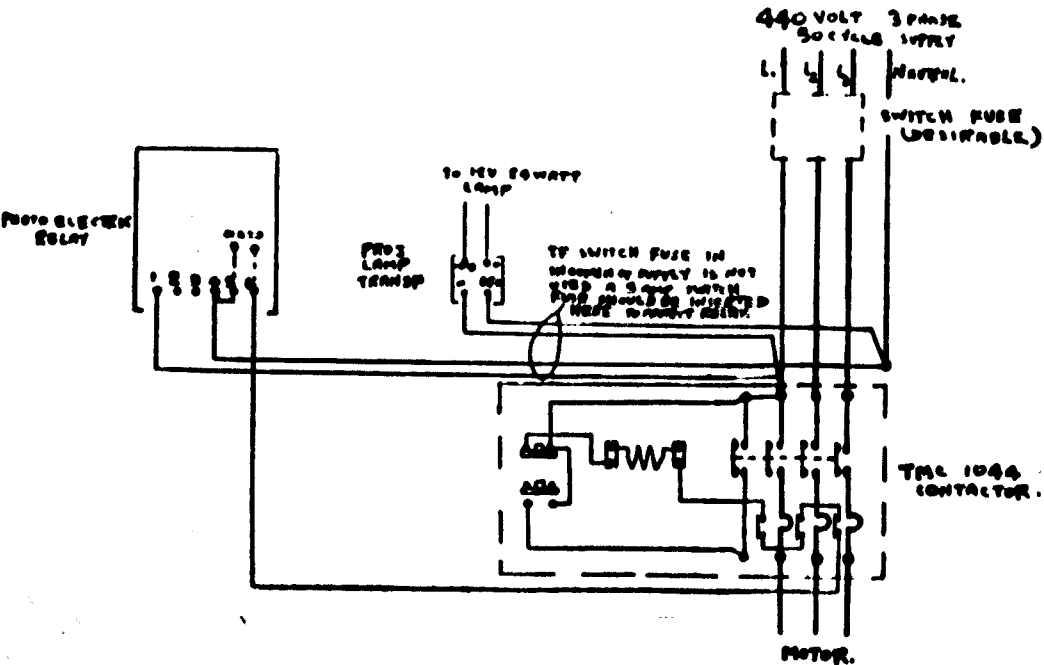


Fig. 2.—Typical electrical connections for photo electric relay for smoke control.

the end of a 4" diameter tubing approximately 5 ft. long, the exciter lamp being situated at the other end. Plate glass windows are provided at both ends for light to pass through the column of smoke on to the photo electric cell. The tubing is so constructed that very

This application of photo electric relay prevents the formation of smoke and consequently any injury or nuisance therefrom. It increases boiler efficiency and effects a saving in fuel quantity.

Chemical Nitrogen Industry and India's Defence problem

K. M. Chakravarty
Department of Chemistry, Dacca University

Position of the Industry

The term, chemical nitrogen, is generally used to mean the combined nitrogen obtained from air or from coal and other mineral sources by manufacturing processes. The total world production of chemical nitrogen which was 843,525 U. S. tons (2,05,02,272 mds.) in 1913 has increased to 1,966,115 U.S. tons (4,77,87,351 mds.) in 1934. But the most significant fact of this increase is that while Chile produced in 1913, 55 per cent of the world's total chemical nitrogen, her proportion fell to 23 per cent in 1929 and to 4 per cent only by the end of 1933. On the other hand, Germany's share in this industry today is the biggest. Her total producing capacity of combined nitrogen in January, 1934, was 1,47,580 U.S. tons (3,57,68,660 mds.). Great Britain produced only 99,525 U.S. tons (24,190,002 mds.) in 1913 and imported 18,745 metric tons (5,02,214 mds.) of Chilean nitrogen. Her present capacity for nitrogen production exceeds 390,500 U.S. tons (94,91,286 mds.). Japan's share was only 3.5 per cent of the total world production as late as in 1929, but it has increased to 10.5 per cent in 1934, and she is the biggest producer in the East.

The phenomenal increase of the indigenous production of chemical nitrogen by all the principal industrial countries, is interpretable as the desire of those countries to be independent of foreign supplies of nitrogen compounds for both military and agricultural purposes. Germany was the first to foresee the danger of depending on Chilean nitrate for meeting the demands of both Mars and Ceres and developed by costly and laborious experiments before the last Great World War, the well-known Haber-Bosch process for the synthesis of ammonia utilising the atmospheric nitrogen. The Allies committed the blunder of relying exclusively on the Chilean supply to a dangerous degree and in 1918 the submarine blockade, instituted by Germany, led to a state of affairs, which was extremely perilous, particularly to Great Britain.

In the World War of 1914-18 explosives were used on an unprecedented scale. The reason for the increased requirements for explosives was the change

over to fire arms of heavier calibre as will be seen from the following table.

TABLE I
Powder-Requirements of Various Guns.

Gun	Propelling Charge in Kg.	Shell Charge in Kg.	Total per shell in Kg.
7.5 cm. Field Gun	0.55	0.66	1.21 = 0.032 md.
15 cm. Howitzer	1.3	5.8	7.1 = 0.180 "
15 cm. Cannon	12.4	6.2	18.6 = 0.496 "
30.5 cm. Mortar	13.7	38.0	51.7 = 1.379 "
35 cm. Cannon	193.0	70.0	263.3 = 7.016 "
42 cm. Howitzer	55.0	98.0	153.0 = 4.081 "

[From Chem. Met. Eng. 1939.]

Subsequent wars will utilise much larger quantities of explosives than were needed during the last World War. The increasing importance of aerial forces seems to indicate that nitrogen will continue to be a primary requirement to a degree greater than ever before, both for offensive and defensive operations, particularly from air. For, aeroplanes are futile in times of war without bombs. Europe is witnessing today another big war before she could forget the horrors of the last Great War. The present conditions of the world do not point to a stage when wars will not be waged. It will be idle to believe that India will not be directly involved in near future in a campaign against any foreign aggression. Against the threat of war preparedness is the most effective weapon and we must make plans to equip adequately our air, land and sea forces with the modern armaments and materials to maintain properly our national responsibilities and to protect our country. In 1917 the nations at war consumed over a million tons of combined nitrogen in the manufacture of explosives. There are in India two Government factories manufacturing ammunitions. But without indigenous production of the different ingredients for explosives, particularly nitric acid and ammonia etc., these factories after proper expansion will prove to be of no use during crisis. As a matter of fact, in view of the modern warfare methods, India is practically defenceless.

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It will be interesting to cite, for example, the huge Blumau powder plant of the small State of Austria. The capacity of this Austrian Government plant is guessed from the fact that in 1918 no less than 25,000 men were on its employment role. Austria is a very small country compared with India, and our cordite factory at Nilgiri Hills employing only 638 workers is therefore a pigmy and quite out of proportion with the vast size of the country. In the whole Ordnance Department of India about 19,000 men are employed.

The present world situation has provided a greater impetus in the direction of autarchy and the measures adopted are proceeding at a pace greater than ever before. But, in India, the lesson of the last War, has been forgotten. No body now hears of the Indian Munitions Board constituted in 1917 under the pressure of War. India produced 2,500 U.S. tons (60,763 mds.) of combined inorganic nitrogen in 1934 and her share was only 0.02 per cent of the total world production—a negligible figure indeed. In all industrial countries, the production capacity is greater than normal home requirement and this ensures a provision for higher consumption and guards against blockade in time of war. The following table, which shows the production capacity, the actual production and apparent consumption of chemical nitrogen of a number of industrial countries, will indicate the extent of self-sufficiency achieved by these countries by the year 1934.

TABLE II

Country	Apparent consumption Capacity	Apparent consumption Production	Production Capacity
Germany	24.3%	77.5%	...
Great Britain	18.3%	50.9%	...
France	55.4%	10.8%	...
Norway	...	...	3rd place amongst exporting countries
Belgium	41.5%	90.4%	...
The Netherlands	39.8%	84.3%	...
Italy	68.9%	106%	...
Japan	81.5%	119%	...
Canada	13%	39.5%	...
Soviet Union	...	...	22%
U. S. A.	65.5%	...	...

State Help

It is to be noted that this is an industry which requires adequate government help. The German Government extended large loans and rendered every possible help for the establishment of chemical nitrogen factories. The Government subsidies to the Norwegian nitrogen industries, amounted to £765,000 (Rs. 1,01,74,500*). £1 = Rs. 13.3.

During the latter part of the world war (1918), the British Government took the initiative and erected the well-known Billingham plant of synthetic ammonia so as to reduce the extent of dependence on the imported Chilean nitrate and granted £5,000,000 (Rs. 6,65,00,000*) for this purpose. This Government has also accorded tariff protection to this industry. The duty on most nitrogen fertilisers after 1935, has been increased 100 per cent *ad valorem*. France was the first allied power to take adequate steps to meet internally the chemical nitrogen requirement of the country and at the time of armistice was well on the way of becoming self-supporting in fixed nitrogen for explosives. America on her entry into the last struggle made preparations on a most imposing scale. The most of the experimental plants in U. S. A. were built by the Government. Italy also made solid contributions to the solution of this problem. Official acts and appropriations of various Governments during and after the War are clear indications of their fostering care. In Great Britain the Nitrogen Products Committee was appointed to consider the relative advantages, both for the United Kingdom and for the Empire, of the various methods of fixation of atmospheric nitrogen from the point of view of both war and peace purposes, and further to ascertain the relative costs and to advise on the proposals relevant thereto. The nitrogen fixation industry has since considerably developed in Great Britain, Canada and South Africa. In India however the only plant, we can boast of, is situated in Mysore. Japan has also by now reached the verge of self-sufficiency.

Manufacturing Processes

The primary sources of chemical nitrogen are the air and certain mineral deposits. As the average composition of air shows the nitrogen content to be as high as 75.5 per cent by weight, it is by far the greatest source known. The mineral sources are limited to coal and the natural deposits of nitrate principally those of sodium nitrate in Chile. A brief outline of the different important processes that have been in use to tap these sources for the manufacture of chemical nitrogen will be interesting.

The processes by which sodium nitrate is recovered from the huge natural deposit in Chile consist essentially of mining and leaching operations. Ammonia is one of the gaseous by-products obtained in the manufacture of coke and town gas by the action of heat on coal, and it is arrested by passing the gas through water (giving ammonia liquor) or through sulphuric acid producing ammonium sulphate. Calcium carbide can be produced at a very high temperature by the action of coke and lime-stone. When treated with nitrogen under slight pressure at 1000°C, calcium carbide yields what is known as calcium cyanamide. Ammonia can be obtained

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from calcium cyanamide by the action of superheated steam under pressure. This process is known as the cyanamide process for the fixation of atmospheric nitrogen. In the arc process nitrogen and oxygen of air are made to combine at the high temperature (2000°–3000°C) of the electric arc giving an oxygen compound of nitrogen which when cooled gives nitric acid by the subsequent action of air and water in sequence. In the pressure-contact synthetic ammonia process, nitrogen obtained directly or indirectly from air and hydrogen obtained directly or indirectly from water or coal are made to combine under pressure at 400°–600°C, in the presence of certain substances called catalysts, which assist the process.

It is clear that of all the processes mentioned above only the last three utilise the atmospheric nitrogen. The following table however will show that the nitrogen of air was not a factor in the manufacture of nitrogen compounds in 1900. But by 1934, the situation has changed totally and we find that above 75 per cent of the total chemical nitrogen were obtained from air as a source of nitrogen. Though political situation gave the lead to the air-nitrogen industry for fertilisers and explosives, its momentous success is attributable mainly to economic grounds.

TABLE III

Source	1900	1913	1934
	%	%	%
Chilean sodium nitrate	66.6	55.4	6.9
Total mineral	100.0	92.7	25.5
Air	00.0	7.3	74.5

[From U. S. T. C. Report, 1934.]

Of the three synthetic processes, the cyanamide process and the arc process have failed to compete with the contact-pressure process. The only large-scale operation of the arc process which survived more than a few years was that of the Norwegian Hydroelectric Nitrogen Company. It ceased to be a factor in the world chemical nitrogen industry by 1930. As a matter of fact, the arc process plant of this company has been converted into a contact-pressure plant of synthetic ammonia in 1927-29. The cyanamide method of producing ammonia has also been superseded by this lower-cost synthetic process. In 1934 only 238,500 short tons (5,796,000 mds.) of chemical nitrogen were produced by this process while the figure for total synthetic nitrogen was as high as 1,331,900 short tons (3,23,724,000 mds). It is clear therefore that the

pressure-contact synthetic ammonia industry has survived all competitions.

Owing to the almost universal adoption of the by-product type of coke and gas ovens, practically all industrial countries producing coke and gas now have a supply of combined nitrogen available from this source. The cost of production of synthetic ammonia has however been so much reduced in recent years that even the by-product ammonium sulphate has frequently been sold at a loss.

Haber-Bosch Process and its Modifications

The unique process of producing ammonia by the chemical combination of nitrogen and hydrogen in the presence of catalyst was first worked out in Germany between 1905 and 1913. It is largely the work of Fritz Haber, a physical chemist, and Carrel Bosch, an engineer of ability, backed by the old German firm, Badische Anilin and Soda Fabrik. The basic patents on the process however expired in 1927.

The great success of this synthetic ammonia process in Germany during the World War stimulated researches in Europe and America. As a result of these researches a number of processes has been evolved which are more or less modifications of the original Haber-Bosch Process. Each of these modifications differs from it in one or more of the following aspects: (a) source of hydrogen, (b) method of separating the nitrogen from air, (c) method of purifying the nitrogen and hydrogen (d) pressures and temperatures (e) method of removing ammonia from the system and (f) catalysts. The principal processes in use throughout the world are, the Haber-Bosch, Casale, Fauser, Claude, Imperial Chemical Industries (I. C. I.), Nitrogen Engineering Corporation (N.E.C.), Mont Cenis, General Chemical Co. (G.C.C.) and American. In the following table will be found the world capacity for the production of synthetic ammonia by countries and the different processes employed there.

The significant facts regarding the operational methods of the different pressure-contact processes mentioned above, will be found in the following brief descriptions:

Haber-Bosch Process:—This is the original synthetic ammonia process. In it hydrogen is obtained from water gas and nitrogen from producer gas. The reaction is carried out at a pressure of 200 atmospheres and at a temperature of 550°C in the presence of promoted iron oxide catalyst. The recovery of ammonia is about 8 per cent per circulation through the converter.

Claude Process:—This is an invention of George Claude. Outstanding features of this process lie in the purification of the gas mixture by liquefaction and the operating pressures of 900 to 1,000 atmospheres. The

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reaction is carried out at 500-650°C with an ammonia recovery of 25 per cent, no circulation of the gases being involved. Installation cost of this type of plant is high.

Casale Process:—This is an Italian process patented by Luigi Casale now utilising hydrogen from coke oven gas. The special catalyst used has a longevity of about

and electrically heated converter permitting accurate temperature control. Ammonia recovery is about 12.5 per cent.

Nitrogen Engineering Corporation Process:—In this process is applied mainly the patents of Dr L. C. Jones and R. J. Richardson. The main features of the installations of this process are difficult to obtain, and is believed to be a modified Haber-Bosch Process working

TABLE IV
Production in tons of 2,000 pounds of nitrogen

COUNTRY	PROCESS											National capacity	National % of world capacity
	Haber-Bosch	Casale	Fausser	Claude	I. C. I.	Mt. Ceniz	N. E. C.	G. C. C.	American	Other			
Germany	880,000	59,400	4,950	38,500	.....	101,200	52,070	.....	.....	.....	1,136,080	35.2	
United States	...	35,000	...	65,000	.....	28,000	4,900	200,000	7,800	7,500	341,350	10.6	
France	18,400	92,700	.....	78,850	.....	22,000	61,600	.....	.....	1,100	274,850	8.5	
Gt. Britain	3,700	.....	.....	.....	266,200	.....	.....	.....	.....	.....	209,500	6.3	
Japan	.....	123,200	27,100	8,360	.....	48,400	15,400	.....	.....	.....	818,480	25.0	
Belgium	.....	82,830	26,400	67,870	.....	.....	28,060	.....	.....	.....	906,180	28.0	
U. S. S. R.	132,000	10,500	33,000	.....	.....	.....	.....	.....	.....	.....	181,500	5.6	
Italy	.....	23,100	86,800	7,150	.....	.....	7,700	.....	.....	.....	123,750	3.8	
Netherlands	.....	.....	102,300	.....	.....	19,800	.....	.....	.....	.....	122,100	3.8	
Norway	105,080	.....	.....	.....	.....	.....	11,000	.....	.....	.....	110,080	3.4	
Poland	.....	.....	41,250	9,360	.....	.....	19,910	.....	.....	.....	70,510	2.2	
Manchuria	.....	.....	.....	.....	.....	39,600	.....	.....	.....	.....	39,600	1.2	
Canada	.....	2,750	33,000	.....	.....	.....	.....	.....	.....	.....	35,750	1.1	
Yugoslavia	.....	29,700	.....	.....	.....	.....	.....	.....	.....	.....	29,700	0.9	
Czechoslovakia	.....	.....	.....	24,200	.....	.....	3,080	.....	.....	.....	27,280	0.8	
Spain	.....	6,000	.....	3,740	.....	.....	.....	.....	.....	.....	10,740	0.3	
Switzerland	.....	9,900	.....	.....	.....	.....	.....	.....	.....	.....	9,900	0.3	
South Africa	.....	.....	.....	.....	8,250	.....	.....	.....	.....	.....	8,250	0.3	
Hungary	.....	.....	.....	.....	.....	.....	6,600	.....	.....	.....	6,600	0.2	
Sweden	.....	.....	5,280	.....	.....	.....	.....	.....	.....	.....	5,280	0.2	
Total (tons)	1,138,750	481,680	355,080	303,020	274,450	259,000	210,170	200,000	7,800	1,950	3,211,800		
Total as % of world capacity	35.2	14.9	11.0	9.4	8.5	8.0	6.5	6.2	0.2	0.1		100	

(a) Process known as Hecker (b) Process known as Jourdan.
[From U. S. T. C. Report, 1934.]

6 to 10 months in its special converter with provisions for efficient temperature control. A pressure of 600 atmospheres and a temperature of 500°C are used with ammonia recovery of 15 per cent per passage.

Fausser Process:—This is also an Italian process patented by Dr Giacomo Fausser, operating at about 200 atmospheres pressure and 500°C temperature and is the property of the Société Ammoniaque Synthétique et Derivés of Brussels, a subsidiary of the famous Montecatini Co. in Italy. The special features of this process are the type of electrolytic cell for producing hydrogen

at 200 to 300 atmospheres pressure and 500°-600°C, special features being the pre-heating of gases and the use of low cost catalyst of high longevity. Ammonia conversion in larger installations is reported to be 20 to 22 per cent.

Mont Ceniz Process:—This process is unique for its method of purifying the gases, hydrogen being obtained from the coke oven gas and for its system of heat exchangers. It was developed by the German engineer, Uhde. The operating pressure and temperature are respectively 100 atmospheres and 400-425°C. A special

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iron cyanide catalyst is used. The ammonia recovery is reported to be 9 to 25 per cent in liquid form.

American Process:—The United States Government developed this process and the complete details have been made public. It uses a preconverter which does the final purification of the reacting gases. Its efficient catalyst is composed of iron oxide granules mixed with potassium and aluminium oxides. A pressure of 300 atmospheres and a temperature of 475°C are used. The ammonia recovery in dry liquid form is at the rate of about 20 per cent.

In all the above processes the converter is made of alloy steels of chromium and nickel, tungsten and vanadium which can simultaneously resist the action of hydrogen and nitrogen at high pressure and temperature. The efficiency of the process depends upon (i) the particular types of catalyst used, (ii) satisfactory heat inter-change to maintain a uniform optimum temperature, (iii) maintenance of pressure depending upon the process varying from 100 to 1,000 atmospheres (1,500 to 15,000 lbs. per square inch), and (iv) the method of arresting ammonia formed.

Costs of the Operations

Under the cost items hydrogen holds the anomalous position being much more important than nitrogen itself. About 75 per cent of the expenditure incurred is due to the preparation of the 3: 1 mixture of hydrogen and nitrogen. Of this 75 per cent of cost is due to the preparation and purification of hydrogen. The susceptibility of the catalysts to traces of foreign materials

TABLE V.

Source	Fertiliser year					
	1926-27	1927-28	1928-29	1929-30	1930-31	1933-34
Water gas	89.0	84.1	77.3	69.7	67.9	57.0
Coke oven gas	3.0	5.8	11.1	14.2	15.8	25.0
Electrolysis of water	6.4	8.8	10.5	15.2	15.4	16.0
Other (Electrolysis of brine, fermentation, natural gas etc.)	1.6	1.3	1.1	0.9	0.9	2.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

[From U. S. T. C. Report, 1934.]

like arsenic, phosphorus etc., necessitates elaborate purification of the reacting gases. The equipment necessary for storing the huge volumes of these gases at ordinary pressure or under pressure is another item of major cost.

Hydrogen is obtained from one or more of the well-known sources but their relative importance has undergone a radical change since 1915. Table V summarises the actual situation.

The following table which shows the comparative costs of synthetic ammonia from the different sources of hydrogen reported (1930-31) by the eminent English authorities will be of considerable interest.

TABLE VI

Source of Hydrogen	Investment* per metric ton year of ammonia.			Manufacturing cost per metric ton of ammonia as 25% liquor.	
	Plant	Building	Total	Rs.	Rs.
Electrolytic(a)	660/-	83/-	743/-	113/-	to 910/- (b)
Water-gas(a)	493/-	73/-	566/-	117/-	
Coke-oven gas(a)	470/-	63/-	533/-	147/-	
Coke-oven gas(c)	...	...	313/-	100/-	

*Calculated on the basis of Rs. 10=3 dollars.
(a) From report of Col. G. P. Pollitt before the second World Power Conference, Berlin, 1930.
(b) Depending upon local cost of electrical energy.
(c) From E. F. Armstrong, Chemical Trade Journal, Nov. 1931.

[From U. S. T. C. Report, 1934.]

The nitrogen for synthetic ammonia is obtained from air. Though one has not got to pay for air, there are the power and processing costs, the interest and depreciation of the equipment. Considering all these, however, air-nitrogen is found to be the cheapest raw material used in the synthesis. There are three methods of general use for obtaining nitrogen:—(a) from air via producer gas (b) fractional distillation of liquid air, (c) burning out oxygen of air by hydrogen where the latter is very cheap. The following table which gives the estimated cost of nitrogen fixation by the different pressure-contact processes per ton of 2,000 lbs. (24,305 mds.) of product or of nitrogen content as specified may prove useful in the selection of a particular process.

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Site of the Manufacturing Plant

The comparative suitability of a particular method of nitrogen fixation depends to a large extent upon the locality in which the plant is to be built. The site should be so chosen as to ensure economy in the items of major production costs of a particular process. In

of power available economically at a point. For water-gas and coke-oven gas ammonia plants, coal and coke must necessarily be very cheap.

The location of the Haber-Bosch plant at Merseburg, (Germany) for synthesising ammonia in which hydrogen derived from water-gas and nitrogen obtained from producer gas are used has been rightly dictated by the presence of rich lignite fields in the near vicinity.

TABLE VII

Estimated cost* of nitrogen fixation by various catalytic processes per ton of 2000 pounds of product or of nitrogen content as specified

Cost Item	Direct synthetic ammonia process					
	With electrolytic hydrogen (based on 26,000 short tons of ammonia capacity)		With water-gas hydrogen (based on 200,000 short tons ammonia capacity)		Coke-oven gas hydrogen (based on 20,000 short tons ammonia capacity)	
	Ammonia	Nitrogen content of ammonia	Ammonia	Nitrogen content of ammonia	Ammonia	Nitrogen content of ammonia
Capital cost per ton year	Rs. 67/-	Rs. 600/-	Rs. 517 (a)	Rs. 627 (a)	Rs. 463/-	Rs. 500/-
Operating Expenses :— Amortization of Capital cost, interest, taxes charged at 15%	Rs. 100/-	Rs. 120/-	Rs. 78/-	Rs. 94/-	Rs. 73/-	Rs. 80/-
Power consumption per ton	12,055 kilowatt- hours at Rs. 0.0067 Rs. 80/-	14,640 kilowatt- hours at Rs. 0.0067 Rs. 98/-	1,230 kilowatt- hours at Rs. 0.0133 Rs. 17/-	1,500 kilowatt- hours at Rs. 0.0133 Rs. 20/-	2,000 kilowatt- hours at Rs. 0.0133 Rs. 27/-	2,430 kilowatt- hours at Rs. 0.0133 Rs. 33/-
Other operating and maintenance costs in- cluding royalties ...	Rs. 63/-	Rs. 76/-	Rs. 89/-	Rs. 107/-	Rs. 106/-	Rs. 128/-
Total estimated costs ...	Rs. 243/- (b)	Rs. 294/- (b)	Rs. 184/-	Rs. 221/-	Rs. 206/- (c)	Rs. 260/- (c)

*Rs. 10 = 3 dollars. (a) The high plant capacity is partly responsible for low capital cost. (b) Does not include any allowance for by-product oxygen produced. (c) Borchardt estimates German cost to be Rs. 173 and Rs. 208 respectively. This difference is due to smaller capital charge against the product.

[From U. S. T. C. Report, 1934.]

the above table the cost of production is calculated on the assumption that all the conditions favourable for cheap production were available. The plant capacity is also a factor in production cost. For this reason plant capacity upon which costs are calculated vary. The water-gas-ammonia process is economic in large-scale operations. But the coke-oven-hydrogen plant can be operated economically in comparatively smaller units. Power is the most important cost factor in the electrolytic-hydrogen-ammonia process and the plant capacity is limited to the size of the electrolytic cell and the amount

The Billingham Plant of England is only 9 miles from the Durham coal field and the river Tees ensures ample supply of water. The volume of water necessary can be gauged from the fact that the Oppau plant and Merseburg plant of Germany consumed together in 1928 a volume exceeding 1,500,000 cubic yards of water.

The growth of two new industries, the methanol industry and the synthetic gasoline industry, first consuming the excess carbon monoxide of the synthetic ammonia process and both of them requiring huge volumes of hydrogen and thereby lowering the cost of production, have been positive economic gain to the

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synthetic ammonia industry. This feature is noticeable in the Merseburg plant of Germany and the Billingham plant of England. The displacement of expensive coke by the cheaper lignite for the production of hydrogen has added further economy to the running costs at Merseburg.

But the Mont Cenis process utilising the hydrogen in coke oven gas and requiring smaller units than the old Haber-Bosch process, appears to possess great economic potentialities. The by-product ammonia of coke ovens was failing to compete with the cheaper synthetic ammonia, but nowadays completely amortized Haber-Bosch plants even cannot compete in costs with the Mont Cenis process of coke oven plants. The Interessen Gemeinchaft Farben-industrie A. G. therefore for strengthening its position entered into a financial union with Norsk Hydroelektrisk Kvaestof A. S. of Norway. To be more secure I. G. leased out two German Mont Cenis plants in 1930 for a sum of 5,000,000 dollars (Rs. 1,66,66,666*). The cost of synthetic ammonia is however the cheapest in Norway owing to its water power resources.

Conditions in India

A consideration of the facts given above primarily suggests that the pressure-contact synthetic ammonia plant must be situated in a coal district having sufficient supply of water or in a place where electricity is very cheap. The erection of one plant in Mysore has been quite natural in view of its cheap electric power. The coal fields of Bengal, Bihar, Central Provinces and Assam for example are the places where more plants should be built. It has been shown above that the by-product coke industry as a whole can be run on more economic lines by installing Mont Cenis plants of synthetic ammonia. This process appears to be feasible in India owing to the smaller size of its economic units with consequent lower capital expenditure in comparison with the Haber-Bosch process. Unfortunately, however, the production of coke in by-product ovens is not yet a legal compulsion in India.

Ammonia as such however has limited number of uses. The secondary products like ammonium sulphate, ammonium chloride, nitric acid etc., are commodities of greater importance. Ammonia, as a matter of fact, is the raw material from which about 75 per cent of the world's chemical nitrogen compounds are obtained. The erection of the secondary product plant in the vicinity of the mother plant in most cases may prove to be of

*Rs. 10 = 3 dollars.

considerable economic gain. But such centralisation may, on the other hand, prove to be extremely disastrous in view of the modern warfare method. Highly concentrated capacities such as at Billingham in Great Britain and Merseburg in Germany are liable to be the targets for military offensive. Owing to the ease with which anhydrous ammonia is now transported in tankers and cylinders, the fertiliser and the explosive plants preferably of moderate size should be widely distributed.

The factories in India manufacturing sulphuric acid get their supply of sulphur from foreign countries. The value of total import of sulphur was 21.74 lakhs during 1938-39. This is again an unsatisfactory state of affairs. We must depend on the sulphur present in combination in gypsum, pyrites and coal. For these are the sulphur containing minerals available internally in considerable quantities. Gypsum is directly utilised for manufacturing ammonium sulphate from ammonia at Merseburg. At Billingham anhydrite is used. It is also utilised at Billingham for manufacturing sulphuric acid. In Germany sulphur present in coal is utilised for the manufacture of sulphur and sulphuric acid. India consumes a huge quantity of washing soda (value of import was Rs. 61.44 lakhs during 1938-39). The simultaneous production of ammonium chloride and sodium bicarbonate by the action of ammonia liquor, common salt and a waste product of ammonia synthesis, namely carbon dioxide, appears to be feasible in India to the extent of her ammonium chloride requirement (import value was 3.52 lakhs during 1938-39). For the bicarbonate can very easily be converted into washing soda simply by heating or to sodium nitrate by the action of nitric acid. Nitric acid, on the other hand, can very economically be prepared by the catalytic oxidation of ammonia. Incidentally it can be mentioned that during 1938-39 the value of imported dry ammonia was 2 lakhs, that of ammonium carbonate and bi-carbonate was Rs. 2.02 lakhs and that of other ammonium salts 13.49 lakhs. The value of ammonium sulphate imported during 1938-39 was Rs. 83 lakhs and that of sodium nitrate Rs. 2.2 lakhs.

Incidentally, it might be mentioned that in India, 4,300 tons (1,17,046 mds.) of carbide are consumed annually. This should encourage the establishment of carbide factory. One advantage of having these factories lies in their easy adaptability to produce ammonia when abnormal situation calls forth for an increased supply of chemical nitrogen.

The economic aspect is however not of the greatest import when self-sufficiency is the aim, particularly for defence purposes. But the survival of the pressure-contact process of synthetic ammonia in spite of all other competitive methods throughout the world is a sure guarantee of its success. The cheap Indian coal and labour are

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factors of great economic significance. The industry however will have to be protected from unfair competition from outside. The shape and extent of assistance rendered should provide for price fluctuations of products, steady supply of labour and raw materials. It is to be noted that nitrogen cartels dividing the world chemical nitrogen market are in existence amongst the manufacturing countries. Britain's market for chemical nitrogen is limited to her Empire mainly.

Nitrogen for Manure

At the present moment the demand for chemical nitrogen by Indian industries is very little. But with the growth of industries, the consumption of nitrogen will gradually increase, and for the production of explosives for defence purposes the consumption will rise to higher figure. In peace time about 90 per cent of the total chemical nitrogen is consumed as fertilisers in agriculture. But in India this artificial manuring is restricted mainly to the tea gardens and sugar cane plantations. The vastness of Indian agriculture is undoubtedly a market of huge potentiality. The artificial manure has not been generally used in Indian agriculture because of the poverty of the farmers. The cultivators are compelled by circumstances to sell off their produce at a low price and the main profit goes to the middleman. Artificial manures should be made available at a low price commensurate with the level of income by subsidising the nitrogen industry in its initial stages. The increase of crop yield will lead to higher earning power of the agriculturists. This improvement in the condition will ultimately help the economic regeneration of the country. India, as a matter of fact, is unable to meet even her own present demand for ammonium sulphate. In 1937 only 18,000 tons (4,89,960 mds.) of the sulphate were produced in the country, while 48,136 tons (13,10,262 mds.) were imported. Much larger quantities are imported nowadays, the figure for 1938-39 being 76,748 tons. The total value of chemical nitrogen fertilisers imported during 1937 was about Rs. 55.3 lakhs.

There are a number of factors governing the consumption of nitrogen in fertilisers, while these factors apply universally, they are of some greater significance in Europe and Asia than in the countries of the Western Hemisphere, because of the more intensive cultivation and greater exhaustion of the soil of the older continents. The consumption of nitrogen, including organic nitrogen in guano, cottonseed meal, tankage, fish scraps etc., per acre of crop and pasture land for European countries and the United States in 1934 has been estimated as follows:

TABLE VIII

Country	Pounds of nitrogen per acre of crop and pasture land.
Belgium	26.3
Netherlands	23.9
Germany	13.6
Denmark	9.6
Norway	6.6
Spain	6.0 ^(a)
France	4.4
Italy	4.2
Sweden	3.5
Great Britain	2.9
Czechoslovakia	2.4
Austria	1.4
Greece	1.2 ^(a)
United States	1.1
Switzerland	0.8
Poland	0.6
Hungary	0.1
Yugoslavia	0.04
Rumania	0.01

(a) Related to crop land only.
[From U. S. T. C. Report, 1934.]

The average figure for nitrogen manure per acre in India is not available. But it can be confidently said that the figure when calculated will be too low in comparison with the European countries. The partial failure of crop of the American varieties of cotton in the Punjab has been found to be closely connected with a nitrogen deficiency.

According to Dr Litmann, Director of the New Jersey Agricultural Experimental Station, there is a net loss of 3,000,000 to 4,000,000 U.S. tons (7,29,15,000 to 9,72,20,000 mds.) of nitrogen annually from the 300,000,000 acres of arable land in the United States as will be clear from the following Table.

TABLE IX.

Nitrogen Balance Sheet for the United States
(based on a total acreage of harvested crops in 1933) of 306,505,000 acres.

Losses from :		Gain by :	
	Short tons.		Short tons.
Harvested crop	5,500,000	Bacterial fixation	3,000,000
Pastureage	1,500,000	Rainfall	1,300,000
Drainage	800,000	Fertilisers	400,000
Erosion	500,000		
Total loss	8,400,000	Total gain	4,700,000

Annual deficit 3,700,000 short tons (8,99,30,242 Mds.)

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This loss of nitrogen must be replenished every year to maintain the fertility of the soil.

India is unable even to produce her annual requirement of rice and has imported during 1937-38 more than 1,198,000 tons (3,26,09,560 mds.). This is sure to be looked upon with great apprehension. For, if we are cut off from the Burma supply of rice, the consequence will be extremely disastrous for us in India. It may be argued that the loss of fertility is not the only cause for this state of things, but it is certainly one of the

predisposing factors. It is far from truth that the soil is kept at a state of fertility comparable with that of Europe or America. The growth of population and the limited availability of virgin lands are sure to lead to food scarcity if the present methods of farming are allowed to continue. The only method to postpone the danger which is of immediate application lies in the direction of increasing the output per unit of agricultural land by growing the food crops in well-nourished soils. This will evidently lead to a large increase in the use of inorganic fertilisers of which the most important are the nitrogen fertilisers.

Commercial Utilization of Industrial Wastes

H. E. Howe and F. J. Van Antwerpen, *Industrial and Engineering Chemistry*, Washington, D.C., at the recent meeting of the American Chemical Society in Boston, Mass., conducted a survey type discussion, the principal purpose of which was to recall the more important of the large number of instances where industrial or trade wastes have been converted through research into raw materials for the manufacture of commercial products. In this, differentiation must be made between by-products in the usual sense and materials which are true wastes—not only useless but often involving expense for their satisfactory disposition. Under such classification may be included the manufacture of sulfuric acid and recovery of elemental sulfur from smelter gases, the production of sulfuric acid from the hydrogen sulfide in petroleum still gases, and the recovery of by-product sulfur from the hydro-

gen sulfide in illuminating gas. Sulfite waste liquor has become the source of vanillin and a number of other products. Waste casein finds its way into resins and adhesives; the fermentation residues in the alcohol industry have been converted into cattle foods and the carbon dioxide into dry ice. Potash is recovered from the dusts of the cement industry and building blocks have been made from fly ash. In a sense the long list of solvents now recovered from gases derived from petroleum represent success in the use of otherwise waste materials. The same may be said of cements made from blast furnace slag, and synthetic methanol utilizes carbon monoxide present as an interfering substance in gases used in the fixation of nitrogen. Furfural from oat hulls, celotex from bagasse, are other examples of this type of material.

—Journal of the Franklin Institute.

MEDICINE AND PUBLIC HEALTH

Thiamin Excretion in Health and Disease

IN determining the urinary excretion of thiamin in normal and diseased conditions Robinson *et al* (*J. Clin. Invest.*, 19, 399, 1940) have observed that male individuals receiving adequate thiamin (vitamin B₁) in their diets excreted 90 micrograms or more in twenty four hours' urine, whereas normal females excreted about 60 micrograms. When the dietary intake for this vitamin was definitely inadequate the thiamin excretion was within 66 micrograms in males and 43 micrograms in females. Subjects receiving adequate thiamin in their diets excreted 7.5 per cent of an oral test dose of 5 mgm. of thiamin given per mouth while with those receiving inadequate vitamin in their diets excreted less than 7 per cent of the test dose. Three patients suffering from alcoholic beriberi and seven patients with cardiac decompensation due to organic heart disease excreted small amounts of thiamin in the urine. Six patients with regulated diabetes mellitus and six patients with hyperthyroidism excreted thiamin as normal individuals. Patients suffering from peptic ulcer and from achlorhydria excreted smaller amounts of thiamin but when they were subjected to the oral test dose of 5 mgm. thiamin, a normal fraction of the oral test dose was excreted in the urine.

S. B.

Is Myopia a Deficiency Disease?

MILLER (*Amer. Journ. Ophthal.*, 23, 296, 1940) has studied the dietary intake of a large number of patients suffering from myopia. He has observed that a large percentage of myopic people discard fats from their diet. He therefore suggests that myopia is largely due to a dietary deficiency.

S. B.

Hyperaemia as a Test of Male Sex Hormone

STEINACH (*Lancet*, 2, 688, 1940) has observed that testosterone-propionate (the male sex hormone) induces hyperaemia of the scrotal region and a descent of the testes in infantile male rats. Hyperaemia is also obtained in castrated immature rats. Androsterone benzoate, oestradiol benzoate and progesterone do not produce cutaneous hyperaemia. He has therefore suggested that hormonal substances whose effects resem-

ble most closely those of the natural sex hormone are to be preferred.

S. B.

The Drugs Bill, 1940

On the 3rd February 1940, a bill to regulate the import, manufacture, distribution and sale of drugs was published in the Gazette and was introduced in the Central Assembly on the 5th February, 1940.

In 1927 a resolution was passed in the Council of State for the appointment of a Drugs Enquiry Committee to enquire into the question of control of import, manufacture and sale of adulterated and useless or ineffective drugs. In 1930 an expert committee (Drugs Enquiry Committee) headed by Col. R. N. Chopra was appointed to go into the problems and make recommendations. This committee submitted its report in 1931 recommending adequate legislation and establishment of a laboratory for collection and testing of drugs. No attempt, however, was made to give effect to these recommendations till 1937, when a laboratory (The Biochemical Standardisation Laboratory) was established for the testing of drugs as to their quality and potency. In 1938 a bill was also introduced in the Assembly called the "The Import of Drugs Bill" for control of importation of Drugs. The bill, however, excluded the locally manufactured drugs. The select committee of the Central Assembly, to which the bill was referred, recommended the redrafting of the bill and asked the Government to bring a more comprehensive bill. The present bill followed these recommendations.

The Drugs Bill, 1940 was referred to a Select Committee of the Central Assembly which has submitted its recommendations with certain amendments. Amongst other amendments, the Select Committee have suggested an increase in the number of members of the Drugs Technical Advisory Board by including a member who shall be a registered medical practitioner and a non-official, to be elected by the Medical Council of India, a representative of the pharmaceutical profession to be nominated at present by the Central Government and two representatives of chemists to be elected by the Indian Chemical Society. Changes in the electorate

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have also been suggested in that the members from the Indian Research Fund Association shall be elected by the Scientific Advisory Board instead of the Governing Body and that the Medical Council of India shall elect the members from amongst teachers of pharmacy and therapeutics instead of the Inter-University Board.

Three members of the Select Committee have submitted a minute of dissent. Amongst other things

they suggest that the bill should be more comprehensive on an all-India basis and should come into operation simultaneously all over the country and that the composition of the Drugs Technical Advisory Board should be so amended as to include representatives from independent medical profession and of pharmacists as well as those from manufacturers of drugs and therapeutics. There should also be a non-official elected majority.

—P. K. C.

The Use of Hemp Drugs in India for Euphoric Purposes*

Col. R. N. Chopra

Director, School of Tropical Medicine, Calcutta

Historical and General

The hemp drugs commonly used in India are derived from the flowers, fruits, leaves (and the resinous matter derived from the leaves), young twigs, and bark of the stem of the plant known as *Cannabis Sativa* Linn. The plant belongs to the family *Cannabinaceae* and has been found growing in a state of nature to the south of the Caspian Sea, in Siberia, in the desert of Kirghiz in Russian Turkestan, in Central and Southern Russia and along the southern lower slopes of the Caucasus mountains. In China, where probably it is indigenous on the lower mountain tracts, it has been known since the 6th century B. C. It grows in almost a wild state in Iran and in the Western Himalayas and Kashmir, and it extends to the east of Assam. The plant is referred to in the ancient Sanskrit literature under three names: the ancient 'bhanga', 'indracana' and 'vijaya' or 'jaya'. The earliest mention of the word 'bhanga' occurs in the *Atharva Veda* which, according to western scholars, dates from 2000 to 1400 B. C.

The hemp drugs are used in India in three principal forms, *ganja*, *charas*, and *bhanga*. *Ganja* is the female flowering tops and twigs covered with resinous exudation, *charas* is the resinous exudation found on the leaves young twigs, bark of the stem, and even on the young fruits; *bhanga* is composed of the mature leaves and in some parts of India of the fruits also.

*Adapted from a public lecture delivered before the Royal Asiatic Society of Bengal.

Cultivation of Hemp Drugs

Indian hemp grows wild over extensive tracts in northern India and along the slopes of the Himalayas from Peshawar to Assam. With the change of climate, and the consequent alteration in the conditions of growth, some of the important characters of the plant are changed or modified. Thus, in Europe, hemp produces a valuable fibre, while showing little or no tendency to produce the narcotic principle, which in Asia constitutes the chief value of the plant. On the mountain tracts of upper India hemp yields a fairly good fibre, but in Kashmir and Ladakh, its narcotic principles become much more predominant. When hemp is cultivated in the plains of India, the resin (*charas*) is not generally secreted but the young female flowers and shoots show a tendency to develop the narcotic principle (*ganja*) instead. In other parts of India again, the narcotic property is often not developed until the fruits are mature. The plant appears to be very hardy once it is well established. The soil need not be rich, but it should be well drained and permeable.

Though hemp grows wild in many parts of India, it has to be properly cultivated in order to obtain for commercial purposes its fibre or its narcotic principle as the case may be. For a good growth of hemp a rich soil as well as elaborate methods of cultivation are required. At present, cultivation of hemp drugs for the production of *bhanga* and *ganja* by the wholesale vendors is only permitted under licence, and covers about 1500 acres in the whole of India.

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Manufacture of the Drugs

Hemp drugs that are obtained by cultivation or from spontaneous growth require further treatment at the hands of experts before they are fit for consumption as narcotics.

Manufacture of Bhang (synonyms 'siddhi', 'subzi', 'putti', 'sawi'): *Bhang* consists of specially dried leaves and flowering shoots of both female and male plants, wild or cultivated. The inclusion of male plants and male flower heads in the manufacture of bhang is not considered of special advantage as the male flowers are believed to contain very little of the active principle. Recent work has thrown doubt on this belief. The narcotic principle in hemp develops only when the plant matures, reaching its maximum about the time of flowering and then it gradually begins to disappear when the leaves and the flowers turn yellow. The usual time for gathering leaves varies in different localities but generally it is done during the months of May and June in the plains and during July and early August in the hills.

Manufacture of Ganja: *Ganja* consists of dried flowering tops of the cultivated hemp plant which becomes coated with a resinous exudation, chiefly from the glandular hairs, in consequence of being deprived of the opportunity of setting seeds. To secure these results, the male plants are removed from the field at an early date. As the female plants begin to form *ganja*, all the large leaves on the stem and branches are also removed. The smaller leaves and the brackets of inflorescence become agglutinated into a mass called *ganja*. Fresh excise *ganja* has a rusty green colour with a characteristic odour. The colour and the smell are considered to be features of merit but as a rule *ganja* which has least mixture of leaf is regarded as the best. The plants thus collected require further treatment to form the *ganja* of commerce sold by the excise vendors. In Bengal the entire plant is cut, while in Bombay the flowering tops are generally pulled off by hand.

Manufacture of Charas: *Charas* is the name given to the resinous matter collected from the leaves and flowering tops of the plant and constitutes the active principle of hemp. *Charas*, as sold in this country, is a greenish mass, with a peculiar and characteristic odour. When kept for some time, it becomes hard and friable and acquires a brownish-grey colour, thereby losing most of its narcotic properties.

Although the hemp plant when cultivated in tropical countries such as India, Africa and Malaya, becomes rich in narcotic principles, it seldom yields enough resin to be collected as *charas*. On the plate as of Central Asia and southern Himalayas (Nepal) *charas* is some-

times collected, but it is poor both in quality and yield. The best quality and the maximum amount of resin is obtained from plants grown in Yarkand in Chinese Turkestan in Central Asia. In Chinese Turkestan at an altitude of 3,000 to 5,000 feet above sea-level, *Cannabis sativa* grows extensively in a state of nature. It formed one of the most important articles of trade between Central Asia and India. During recent years the Government of Chinese Turkestan have stopped the production of *charas* and the import into India is now practically stopped. Contraband *charas*, however, comes into India nowadays mostly through Chitral and to a certain extent through independent tribal territories, mainly smuggled by travellers.

Narcotic Principles of Hemp Drugs

An interesting feature about the formation and development of the narcotic principle is that this process is generally found to be associated, and sometimes runs parallel with, some distinct morphological modification of the plant anatomy. In some plants the leaves are the chief organs where the narcotic resin is found; in others, the flowering tops assume the important role of storing and secreting the resin; while in a third group, the fruits and surfaces of stems take upon themselves the secretory function. The first group of plants where the narcotic is primarily stored in the leaves yields the *bhang* of commerce, the second group affords *ganja*, and third group is considered particularly suitable for the production of *charas*. The factor or factors which are responsible for such modifications in the physiology of the hemp plant are not known.

The resinous substance contained in hemp is considered the most important principle responsible for the physiological activity of the drug. The resin as obtained from the plant, apparently contains a number of compounds, one of which is *cannabinol* (Cahn) and which is probably the active principle. There is no satisfactory evidence to show that the other constituents are physiologically active. The narcotic principle of the hemp drugs deteriorates with age. The retention of physiological activity of the three different types of hemp drugs largely depends on the climate and also on the care exercised during its storage. *Bhang* is not as susceptible to deterioration as *ganja*.

Modes of Consumption

Ganja and *charas* are mostly smoked, while *bhang* is taken by the mouth in the form of beverage or a confection.

Hemp drinking and eating: The simplest and probably the oldest form of consumption consists of a drink made from *bhang* leaves by pounding them together with a little black pepper and sugar and adding enough water to reach the desired strength. Various kinds of

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special beverages are prepared by the middle and well-to-do classes by the addition of almond kernels, sugar, iced milk, curds, etc. A number of other ingredients are at times added to improve the taste and possibly with the idea of enhancing the euphoric effects produced by these drugs. Amongst these, aniseed, ajowan, cucumber, melon and poppy seeds, rose petals, saffron, cloves, cardamoms, musk and essence of rose are the most common. Besides their common use as a beverage, *bhang* leaves are sometimes chewed for their sedative effects for example during travelling, and also during the winter season when the system does not require large quantities of fluid. A number of preparations containing *bhang* are made in different parts of India. Sweetmeats containing *bhang* are sold and even ice cream containing powdered leaves is available in some towns.

Hemp smoking: *Ganja* and *charas* are usually consumed by smoking. Different kinds of apparatus have been improvised in various parts of the country for smoking hemp drugs, the one commonly used being an earthenware 'chillum' (used for smoking tobacco) with an elongated neck. The smoke is inhaled into the lungs by powerful inspiratory efforts, and the narcotic principles are at once taken into the blood. The smoke is retained in the lungs as long as possible and is then allowed to escape slowly through the nostrils, the mouth being kept shut. The longer the smoke is retained inside the lungs the better the effects obtained.

Charas is smoked more or less in the same way as *ganja* but there is some difference in the initial preparation of the drug. *Charas* is usually warmed a little in the early stages and is mixed with approximately double its quantity of tobacco before being put in the 'chillum'. *Charas* is generally considered to be a stronger preparation and, therefore a smaller quantity of the drug is used.

Uses of Hemp Drugs

Hemp drugs have been used in India from very early times in order to overcome fatigue and worry, for production of euphoric, and to give courage to warriors during times of stress. The present use of these drugs may be conveniently considered under two main headings: (i) use in connection with religious and social customs, (ii) employment for narcotic and euphoric purposes. The use of hemp drugs in connection with religious and social practices is still met with in almost all the provinces of India, though to a much smaller extent than in the past. The habitual use of hemp drugs for the production of euphoria and intoxication is widespread not only in India but throughout Asia and Africa. The rapid development of its use since 1935-36 and widespread traffic in it has been the source of many great concern to the Bureau of Narcotics. Particularly

disturbing is the fact that the victims comprise for the most part members of the younger generations, and even the school boys and girls are not excepted. These drugs are said to alleviate fatigue and also to increase the staying power in severe physical stress. *Ganja* smoking or *bhang* drinking among the labouring classes produces a sense of well-being, relieves fatigue, stimulates the appetite, and induces a feeling of mild stimulation which enables the worker to bear the strain and perhaps the monotony of his daily routine of life more cheerfully. Hemp drugs are perhaps the only narcotic drugs which fall comfortably within their means and they make use of them as occasion arises. A dose worth two to four pice is often sufficient for producing the desired effect in a few individuals.

Indulgence in hemp drugs, unlike alcohol, rarely brings the habitue into a state of extreme intoxication where he loses entire control over himself. As a rule, the intoxication produced is of a mild nature and those who indulge habitually can carry on their ordinary vocations for long periods and do not become a burden to society or even a social nuisance. The use of hemp drugs for euphoric and intoxicant purposes, although quite common 20 to 30 years ago, has gradually declined in India and at the present time it is almost entirely confined to the lower strata of society.

Abuses of Hemp Drugs

Although their habitual use is common, these drugs are not often indulged in to such an extent so as to constitute a definite abuse. It is commonly believed that *bhang* drinking is comparatively less harmful than the practice of smoking *ganja* and *charas*. Impairment of digestion is a common occurrence with *bhang* drinkers of long standing who resort to taking excessive quantities. There is definite and demonstrable stimulation of the higher cerebral and medullary centres but this is seldom intense and, therefore, the harm done is comparatively small. The smoking of *ganja* and *charas* on the other hand, although it affects the digestion to a lesser extent, brings about a state of intense intoxication as a result of action on the higher centres in the brain and, if the abuse is continued for a considerable time, it may lead to mental derangement, behaviour problems, crime and insanity. These habits therefore constitute an important social problem.

Present Extent of Hemp Drugs Addiction

The total consumption of hemp drugs, according to excise returns of 1934-35, amounted to 1,031,496 lb. in British India and this works out approximately at 4.24 lb. per 1,000 of population per annum (census of 1931). The consumption of these drugs in British India in 1912-13 worked out at 15 lb. per 1,000 of population per annum. The United Provinces consume the largest amount of hemp drugs, the total consumption in that

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province being 287,926 lb. during 1934-35; next in order come the Punjab, Bengal, Bombay, and Central Provinces, respectively. As regards the incidence of the hemp drug habit, Sindh shows the highest incidence with a consumption of 35.12 lb. per 1,000 of population per annum, then comes Delhi with 23.84 lb., Ajmere-Merwara 14.6 lb., Baluchistan 8.22 lb., the Punjab 7.6 lb., North-West Frontier Province 5.94 lb., United Provinces 5.94 lb., Bombay 4.4 lb., Assam 2.18 lb., Bihar and Orissa 2.2 lb., Bengal 1.6 lb., and Central Provinces and Berar 1.6 lb., respectively.

It is very difficult to form an accurate idea of the number of persons addicted to the three forms of hemp drugs as there are many occasional consumers, and there is no system of registration of addicts. It is only possible therefore to form a very rough estimate of the number of addicts from the total amount of the three preparations consumed and the average dose taken (15 to 20 grs. daily). Assuming that the whole amount was used for euphoric purposes and for habitual consumption (the amount used for medicinal purposes being negligible), the number of hemp drug addicts in the whole of British India at the present time works out to be 855,844, provided only the amount issued by the excise authorities is considered. We are inclined to believe that the actual number is a good deal higher, as fair amounts of the drugs are obtained from illicit sources, for example by smuggling or from the spontaneous growth, which can be easily utilized. From our investigations in the field it appears that nearly 0.5 to 1 per cent of the population of this vast country take hemp drugs habitually at the present time, that the habit is on the whole declining and it certainly is not on the increase anywhere. The localities in each province where the incidence of hemp drug addiction is high are urban and not rural areas. Large industrial towns or large agricultural centres as a rule, have large labour populations in low economic circumstances. They have to work very hard and they usually indulge in these drugs as cheap euphorics.

Thus, in towns such as Calcutta, Bombay, Madras, Ahmedabad, Cawnpore, etc., the consumption is high on account of this large industrial population. The mining areas also show a high incidence due to the preponderance of labour forces. Burdwan district in Bengal with large mining industries shows a comparatively higher incidence than other parts of Bengal, with the exception of Calcutta. Religious centres and important places of pilgrimage also show a high incidence of the use of hemp drugs. This is due to the presence of hordes of mendicants who collect at such places.

Effects of Hemp Drugs Addiction

The general health may not suffer when hemp drugs are consumed in small doses (below 20 grains daily); further increase in the dosage is attended with deleterious effects. It is also evident that the evil effects were admitted more frequently in the case of *ganja* and *charas* addicts than in the case of *bhanga* addicts. Moderate habitual use of *ganja* or *charas* however, may or may not be attended with harmful effects, and in the case of *bhanga* there is evidence that no apparent harm may result if it is taken in moderate quantities. Of all the preparation of Indian hemp, *bhanga* is popularly believed to be the least harmful. According to the Indian Hemp Drug Commission (1893-1894) it is the refreshing beverage of the people corresponding to beer in England and moderate indulgence in it is attended with less injurious consequences than similar consumption of alcohol in Europe. This view has been corroborated by our own experience in the field.

Bhang drinkers, unlike other drug addicts, are robust and physically well-built individuals. Its moderate habitual use does not lead to malnutrition, on the other hand appetite is said to be stimulated. The cases in which loss in weight occurs are probably those who are at the same time addicted to some other pernicious drugs such as opium, cocaine, or alcohol. In a certain number of our cases from the well-to-do and priestly classes, an atonic condition of the voluntary muscles of the body was commonly met with. These individuals were flabby and therefore had a tendency to become obese. The appearance of *bhanga* addicts taking excessive doses is generally sleepy and they often have a vacant look. The conjunctivae are congested and have a yellowish red tinge which becomes intense when the dose is repeated.

The confirmed *ganja* and *charas* addicts, especially those taking large doses, often exhibit signs of deterioration of general health. The excessive smokers are thin, emaciated persons with a sallow or muddy complexion, and dull grey eyes. Excessive smoking also produces chronic catarrhal laryngitis and considerable bronchial irritation may result. The daily repeated dosage of these drugs overburdens the alimentary and excretory systems, the appetite declines and food is not properly assimilated. The addicts lose weight rapidly and may suffer from general cachexia; the skin becomes pale and dry and is often covered with scales; the nails, teeth and hair, which are often affected, become dry and lose their lustre. The general bodily nutrition suffers as the money, which should be spent for the purpose of procuring wholesome and nutritious food, is used to buy the drug itself. Impairment of vitality is thus produced which renders the system incapable of resisting an intercurrent disease. Addicts are generally more sensitive to the vicissitudes of weather than ordinary

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individuals. The main effect of hemp drug addiction is on the central nervous system. These effects can be grouped under two headings: (a) *Temporary effects*, i.e., those that are only present when the person is actually under the influence of the drug (b) *Permanent effects*, i.e., the sequelae of the prolonged use of these drugs.

Temporary Effects

Soon after taking moderate dose the pulse increases somewhat in fullness and frequency, the face becomes flushed, and there is a feeling of warmth all over the body; the appetite becomes sharpened and there is a tendency to talk. In rare instances aphrodisiac sensations are experienced. The sensation of pain is definitely dulled and there is a feeling of partial anaesthesia all over the body. The pupils are slightly dilated. With larger doses, the above symptoms become more pronounced; the pulse becomes rapid and sometimes irregular at first and slows afterwards. The temperature varied according to whether the individual is excited or depressed. This stage is usually followed by drowsiness and deep sleep.

The immediate effects of moderate doses in a habitual consumer whether taken by mouth or in form of smoke is the initial feeling of anxiety and restlessness which is followed by a refreshing and stimulating feeling of well being and internal content. The sense of fatigue is alleviated, pleasurable sensations are produced so that the consumer is happy and congenial to everybody and may behave in a childish and stupid manner. He may start laughing or crying. Restlessness is removed and there is a quieting effect on the nervous system which induces a sense of forgetfulness of all mental worries.

In some consumers the mental life takes form of a wonderful dream. Extraordinary ideas flash through the mind and every movement of his is a source of joy. At the same time a certain state of confusion may be present in which all kinds of far away thoughts attack him. Confused schemes which hitherto seemed unrealisable become practicable before his eyes. The limits of time and space are broken. The effect may last several hours. Disturbances of sensations of taste and smell may also occur during the later stages. Deep sleep generally follows in the majority of cases after an hour or two or more after indulgence. There are individuals amongst *ganja* and *charas* smokers on whom the effect of intoxication is quite different to that ordinarily obtained. They lose all sense of proportion and become irresponsible.

Smoking produces its effects more rapidly than consumption by the mouth because by the latter method the absorption of the resin, which is combined with large

quantities of colloidal matter, is considerably delayed from the gastro-intestinal tract. With pure resin absorption is of course much quicker. In the case of *ganja* smoking the mental effects appear within three to five minutes while in the case of *charas* they may appear with the first pull from the pipe ('*chillum*'). In the case of *ganja*, the effects from half to one hour or even longer, in the case of *charas* from 15 to 20 minutes. With *bhanga* the symptoms may set in from 20 to 30 minutes or may be delayed and may last from two to twelve hours.

Permanent Effects

Mental injury is more likely to occur in the case of those individuals who take large doses and for prolonged periods. The effects of different preparations are interesting. Emotional character and judgement are affected more in the case of *bhanga*, while memory and sleep are more disturbed in the case of *ganja* and *charas*. *Bhang* habitues were also more peevish and hypochondriacal than those indulging in *ganja* and *charas*. The incidence of gross injuries to the central nervous system such as insanity and moral depravity appears to be more frequent amongst the *ganja* and *charas* habitues than the *bhanga* drinkers. Epileptic fits are on the other hand more frequent amongst the *bhanga* habitues. Sleep is disturbed more in the case of *ganja* and *charas* addicts and little or not at all in the case of those addicted to *bhanga*. This may be due to the fact that *bhanga* as a sedative has a mild and prolonged action, while *ganja* and *charas* have rapid and intense effects in which euphoria and stimulation are more pronounced.

We have come across a few instances of insanity resulting from the abuse of *bhanga* or *charas* or *ganja*. The testimony of many of the competent medical authorities in this country also sponsors this belief. The abuse of hemp drugs injures the constitution in the same manner as an excessive indulgence in any other narcotic drug. It does not necessarily produce insanity except in perhaps those who have predisposition to it. It may however lead to rough manners and apathy and extraordinary behaviour on the part of the individual. Those who smoke *ganja* and *charas* excessively are often quarrelsome and do not heed the consequences of their deeds. We have examined records of murder and crime cases in jails and mental hospitals and found that only in a very few instances (1 to 2 per cent) the temporary or the permanent mental derangement induced by hemp drugs was directly responsible for a crime.

As regards the relationship between hemp drug addiction and crime, there are instances where the addicts committed criminal acts under the effect of these drugs, especially after smoking *ganja* or *charas*, under grave provocation or in cold blood and with premeditation.

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Such instances do not necessarily prove any definite relationship between hemp drug and crime. Indulgence in alcohol undoubtedly gives rise to a feeling of bravado and courage by depressing the higher controlling cerebral centres, and there are many instances in which it has led to crime of a very grave nature. With regard to hemp drugs, however, the situation may be viewed from a different angle. Hemp drugs are cheap and are generally used by the poorer classes who belong to the lower strata of society, to which most of the criminals in this country belong. This may be an explanation of the fact that proportionately more consumers of hemp drugs, especially of ganja and charas smokers, are found among bad characters than among the population in general.

Moreover the associated poverty of the addicts may lead them to commit thefts and other petty offences but this does not throw the entire responsibility on the hemp drugs.

So far as premeditated crime is concerned, especially that of a violent nature, hemp drugs in some cases may not only lead to it, but they may actually act as deterrents. The result of continued and excessive use of these drugs in our opinion is to make the individual timid rather than to lead him to commit a crime of violent nature. Our opinion in this respect, based on the study of a large series of addicts, is that the tendency of the drug appears to be to develop or bring into play the natural disposition of the consumer and to emphasize his true character and peculiarities.

Future of Scientific Workers

"There is now a considerable movement on the part of scientific workers, to consider their responsibilities to society at large. It is quite a new urgency. The British, the American, the Australian and other Associations for the Advancement of Science, all in the last year or so, have created special divisions for the study and improvement of the relations of the world of research to political and social life; they have set on foot an inquiry into the modernization of education

and the wider diffusion of knowledge and I believe it would be of very great mutual advantage if we could bring our assertion of intellectual freedom into a co-operative *liaison* with this awakening of the scientific world republic to the dangers of official interference and misdirection that threaten it. Their cause is our cause."

H. G. Wells.

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PROCEEDINGS AND PUBLICATIONS

Royal Asiatic Society of Bengal

(Calcutta 1st April, 1940)

EILEEN W. E. MACFARLANE: Mother and Child Combinations of Blood Groups and Blood Types and their Development in Bengalis. JATINDRA MOHAN DATTA: Bagh-Chal at Kamakhya. Challis-Ghuttia and its degenerate variants. DAYA SHANKAR SARBAHI: The Alimentary Canal of *Labeo rohita* (Hamilton). B. S. GUHA: Three Tibetan Manuscripts. CHINTAHARAN CHAKRAVARTI: Study of Manuscripts.

(Calcutta 6th May, 1940)

D. C. SIRCAR: Digvijaya of King Chandra of the Meharauli Pillar Inscription. CHINTAHARAN CHAKRAVARTI: Manuscripts in the Society's Collections of Sanskrit Works of Maharaj Visvanath Sinha of Rewa. M. HIDAYAT HOSAIN: European Physicians and Surgeons in the Moghul Court.

Indian Chemical Society

(Calcutta, January 1940, J. I. C. S., 17, 1-71, 1940).

RAWA KARTAR SINGH AND TARA PROSAD BARAT: Studies on the dependence of optical rotatory power on chemical constitution. Part XVII. Nitro- and carboxy-aryl derivatives of stereoisomeric methyl-enecamphors. MUHAMMAD QUDRAT-I-KHUDA AND SUBASH KUMAR GHOSH: Stereochemistry of monocyclic rings. Part I. Interconversion of methylcyclohexane into methylcycloheptane ring and synthesis of 4-methylcycloheptanone. H. A. SHAH AND R. C. SHAH: C-Alkylresorcinols. Part IV. Nuclear methylation of 4-acylresorcinols. S. M. SETHNA AND R. C. SHAH: Pechmann condensation of methyl β -resorcyate with some β -ketonic esters. H. A. SHAH AND R. C. SHAH: Furano compounds. Part I. Synthesis of furo-3'-methyl-5:6 (4':5')-coumarin and furo-3'-ethyl-5:6 (4':5')-coumarin. PRAFULLA KUMAR BOSE AND PHANIRHUSAN DUTT: Natural flavones.

Part IV. On the constitution of Erianthin, the yellow colouring matter of *Blumea ciliaris* DC. PRAFULLA KUMAR BOSE AND SACHINDRA NATH DUTT: Investigation of the oil from the fruits of *Ferula alliacca*, Boiss. W. V. BHAGWAT: Application of Beer's law of absorption to solutions. S. S. DESHPANDE, W. V. BHAGWAT AND C. W. SUBNIS: Velocity of transformation of 1:3:5-triketones into 2:6-disubstituted γ -pyrones. Part I. Velocity of transformation of acetone dioxalic ester into chelidonic ester. DUKKHAHARAN CHAKRAVARTI AND NARENDRALAL DUTTA: Synthesis of coumarins from δ -hydroxy-aryl alkyl ketones. Part III.

(Calcutta, February, 1940, J. I. C. S., 17, 73-143, 1940)

H. K. SEN: Economics of coal carbonisation. N. L. VIDYARTHI AND M. VENKATESH MALLA: Component glycerides of vegetable fatty oils. Part I. Niger seed oil. S. V. PUNTAMBEKAR AND S. KRISHNA: The fatty oil from the seeds of *Bauhinia variegata*, Linn. SURESH CHANDRA SEN-GUPTA: Studies in dehydrogenation. Part V. P. C. GUHA AND G. D. HAZRA: Synthetical investigations in the camphane series. Part V. Synthesis of ethyl bicyclo-(2:2:2)-heptanedione dicarboxylate from ethyl cyclopentanone-2:5-dicarboxylate. N. M. BASU AND M. C. MITRA: On the osmotic relationships between egg-white and egg-yolk and the effects of injection of potassium cyanide and sodium fluoride thereon. H. CHAUDHURI, N. N. CHOPRA, MANSA RAM AND J. N. RAY: Biochemistry of *Aerobacter aerogenes* and *Bacillus cereus*. S. S. BHATNAGAR, BRAHM PRAKASH AND JARNAIL SINGH: Magnetism and catalysis. Part I. Catalytic Decomposition of potassium chlorate by manganese dioxide and ferric oxide. S. S. BHATNAGAR, BRAHM PRAKASH AND JARNAIL SINGH: Magnetism and catalysis. Part II. Catalysis of persulphate and iodide reaction by ferrous ions. R. KAUSHAL: Pyrones and related compounds. Part I. Formation and structure of 2:6-dihydroxy-1:4-pyrone.

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Calcutta Mathematical Society

(Calcutta, September, 1939, Bulletin 31, 87-124, 1939).

N. G. SHARDE: On some integrals involving associated Legendre functions. B. N. DASGUPTA: On linear complexes related to a group of six points in 3-space. A. C. CHOUDHURY: On affine motions.

Entomological Society of India

(Bengal Branch, Calcutta, 10th April, 1940)

C. C. GHOSH: Study of and work on entomology in Bengal.

RESEARCH WORK IN INDIA

University of Calcutta

During 1938-39, the different sections of the department of applied physics, besides conducting a number of useful researches in various branches of applied physics and electrical engineering, have carried out successfully many developments and manufacturing works.

In the *Measurement and Instrument Engineering* sections, investigations on the suitability of Indian vegetable oils as lubricants and also as insulants for electrical purposes as well as researches on the magnetic properties of cast and steel irons available in India with a view to ascertain their utility in measuring instruments and appliances are being continued. Several papers embodying the results of these investigations so far obtained have been published. A Schering Bridge has just been set up for the measurement of dielectric losses in insulants at power and high frequencies.

The development work comprising the design and construction of measuring instruments and appliances has been a special feature of this section for the last several years. During the session under review it has supplied the requirements of many public institutions and commercial firms in and around Bengal on a more or less semi-commercial scale.

In the *Radio and Line Communication Engineering* sections, investigations on the nature of negative resistance and impedances and on the nature of "band-pass effect" obtained in high-pass and low pass filters associated with negative impedances have been very successfully carried out. Several papers have been published. Patents have been taken on two inventions (i) Band-pass ampli-filter, and (ii) Ultra wide-band band-pass filter for multiplex radio-phone and television systems. A two-channel multiplex short-wave radio-phone system suitable for large river-crossings in India is under design and construction.

Researches have also been carried out on the wave form and the direction of arrival of atmospherics, the number min., and the field strength of atmospherics on wave-lengths from 10 to 500 metres. Investigations are in progress on the nature and the field-strength of man-made statics from fans, pumps, ignition systems and refrigerators, etc.

The successful design of radio components, such as, variable and fixed condensers, chokes, intervalve and output transformers has been evolved and suitable arrangements are being made for their construction on a manufacturing scale. Preliminary constructional studies on the products of well-known manufacturers have been made with the object of manufacturing thermionic vacuum tubes.

In the *Machine and Power Engineering* Sections, power transformers, rotary converters and fan-motors have been successfully designed and constructed on a semi-commercial scale.

In the *Applied Spectroscopy and Applied X-ray* Sections, a number of papers have been published on the spectroscopic study of heavy diatomic molecules elucidating their electronic structure. Good progress has also been made in developing methods for the rapid spectrographic analysis of iron and steel. A special X-ray equipment has been designed and constructed in the laboratory for the systematic investigation of the constitution of oils and fibres.

BOOK REVIEW

THE FUNDAMENTALS OF ELECTROMAGNETISM—by E. G. Cullwick. (Cambridge University Press, 1939). Pp. xxvi+352 with index. Price 18 sh.

The book has been written primarily for students of electrical engineering. The fundamental theory of electromagnetism has been developed along a new line starting with electrostatics and logically extending the treatment to electromagnetism. The book is divided into five chapters each containing at its end numerous well-selected examples, many of which are worked out.

In chapter I, the author has discussed the principles of electrostatics and then of electric current as a steady drift of a large number of free electrons. In chapter II it is first pointed out that magnetism has no physical existence apart from electricity and that it is a direct consequence of electric currents. In discussing electromagnetic induction, the magnetic flux has been introduced and has been defined as a vector quantity whose change through a closed path produces an e.m.f. round the same. Chapter III starts with the magnetic field of a current element and various types of steady and moving fields are discussed. Some difficulties in treating steady and changing currents in the same manner are pointed out and the discussion is continued in chapter V. In chapter IV the properties of electromagnets and permanent magnets are discussed in terms of magnetic flux only. Chapter V deals with e.m. waves on the basis of both the magnetic field concept and the vector potential of the electric current. It is pointed out that the electric field at a point in space can be arrived at without recourse to any displacement current and that all electromagnetic phenomena can be explained in terms of mutual forces experienced by electric charges.

As mentioned in the introduction, "the book has no pretension to completeness. Its primary function is a simplification and unification of fundamental ideas and a logical presentation of electromagnetic theory in a manner consistent with the physical view point." The physical reality of electric and magnetic fields has not been assumed and the unit magnetic pole has been

completely eliminated from the treatment. The book can strongly be recommended to students of electrical engineering who will certainly find fresh ideas in the new treatment.

H. R.

AN INTRODUCTION TO CRYSTAL CHEMISTRY—by R. C. Evans. (Cambridge University Press, 1939). Pp. xi+388. Price 18 sh.

Within the last two years the Cambridge University Press has brought out two books on the properties of crystals, the first one by W. A. Wooster entitled 'A Text book on Crystal Physics', and the second one is the book under review.

The systematic study of the properties of crystals from the physical standpoint was made possible for the general physicists by the publication by Teubner & Co. in 1906 of Pockel's 'Lehrbuch der Kristall Optik' and in 1910 Voigt's classical work 'Lehrbuch der Kristall Physik'. At present, when the importance of the study of crystals as a means of getting a deeper insight into the properties of, and the interaction between atomic and ionic constituents of matter, is being realised, it is interesting to read what Voigt wrote in the introduction to his book on the aesthetic side of crystal physics. He compares the behaviour of gases, liquids and isotropic solids to the effect produced by the playing together of the same piece of music by a couple of hundred of excellent violinists, independently of one another with no conductor to control them. The effect of such playing is to produce a monotonous mixture of tones, out of which even the finest ear cannot pick out the piece which is being played. A crystal on the other hand corresponds to the same orchestra under the control of a competent conductor, under whose guidance the melody and the rhythm of the piece is fully brought out, which the multiplicity of the performers does not disturb but rather enhances. Voigt maintained that it is only in crystals that the properties of the molecules are expressed in their purest and most complete form.

BOOK REVIEW

It required the discovery of X-ray diffraction in crystals two years later and the subsequent development of X-ray crystallography to bring out the full significance of Voigt's prophecy. Voigt himself however in his text-book described the physical properties of a crystal as dependent only on the symmetry properties of the corresponding crystal structure. These properties, he classified under scalar, vector and tensor quantities. Wooster's book chiefly deals with the popularisation in English of the essential principles of Voigt's analysis; it also contains a short account of the recent attempts to correlate the physical properties with the crystal structure and the properties of atoms and ions.

The book under review has been made possible by the advances which took place after the fundamental discovery of crystal diffraction by Laue and his co-workers, the development of a quantitative theory of ionic crystal lattice by Born and others, and finally on the investigations on the different type of chemical bonds which we owe to quantum mechanics.

The book is divided into two parts, the first of which deals with the crystal lattice and the second with systematic crystal chemistry. In chapter II of the first part, the author gives a classification of the different types of chemical bonds *viz.*, the ionic, the homopolar, the metallic and the van der waal type of bonds and with each type he discusses the structural properties of the crystals exhibiting such bonds and the physical properties characteristic of the type of bond. The four fundamental sections come out to be of metals, homopolar compounds, ionic compounds, and residual or molecular compounds. The next chapter deals with the theory of the solid state and the nature of the attractive and repulsive forces which hold a crystal together and account for its stability. The different types of such binding forces based upon Born Mayer theory of ionic lattices, the theories of homopolar binding associated with the names of Heitler and London, Hund, Pauling and Slater, Bloch's theory of the metallic state, and the London theory of the nature of Van der Waal's force are discussed. Without entering into any mathematical details, the essential points of all the theories are clearly put.

The second part of the book contains a detailed description of the properties of the different types of crystals which are either found in nature or can be synthesised. They are classified according to the

scheme proposed in the first part. The book gives a very balanced account of the investigations which during the last quarter of a century have revolutionised our knowledge of the structure and properties of crystals. It can be strongly recommended as a good introduction to the subject to all serious students of crystal chemistry and of the solid state.

D. B.

PARSIS AND EUGENICS—by *Sapur Faredun Desai*
(Published by the author from *Relc Chambers*,
Raghooji Road, Cumballa Hill, Bombay). pp. 140.
Price Rs 2/8.

The monograph is divided into seven main chapters. In the first chapter the author has generally dealt with the definition and scope of the science of eugenics in social upbringing. The second chapter deals in a nutshell with the history of the Parsis and their migration and immigration into India. The history has been appropriate for a discourse of the eugenic problems. Ethnology of the Parsis, dealt with in chapter III, forms an interesting and important feature of a monograph like that under review. His argument of differential inheritance for different gradations of skin colour of the Parsis does not however seem very convincing, though the question raised by him deserves enquiry. Mendel's principles of heredity have been discussed in chapter IV.

In chapter V he comes to the eugenic problems facing the Parsis. Equipped with very scanty data, he has ably analysed the results of endogamous marriages; but his proposition for avoiding cousin marriage may not find a strong eugenic grounding. In any case when endogamous and exogamous lines of descents are to be considered the question of elimination of undesirable traits in some particular circumstances of marriage-crossings should not be lost sight of. Mr. Desai has in this put forth a problem not for the Parsis alone but for all classes and groups of people in India, especially as all sections of the Indian population more or less encourage inbreeding, which means breeding within the racial stock, and as such cross-cousin marriages may, as we have seen in some cases, prove to have enormous eugenic possibility. The pedigrees supplied by the author should have been more exhaustive; yet the question raised by him is not unwelcome, but his solution would become valuable if it were reasoned by an analysis of more detailed data.

In chapter VI the author discusses the various demographic problems of the Parsi population in India, *viz.*, birth-rate, sex-ratio, fertility and mortality

BOOK REVIEW

and some other social and economic problems like emancipation of women, professions and avocations, housing etc. He gives us in this chapter a clear exposition of the disappointing trend of the Parsi population with the like of which the whole of the Indian population is dismally confronted today. While the correlation of age at marriage and fertility would give a useful analysis of the facts, the discussion of the sex-ratio also has not been very clear. His conclusion that the higher masculinity in the advanced age-groups of population is due to differential mortality of the women at nubile ages is a thesis for special attention. He has outlined with credit in the second portion of the sixth chapter a number of peculiar social problems

of the Parsis—*e.g.*, endowment of funds for marriages, types of persons asking for marriage help; the ideal of equality of men etc., which are really eating into the very foundation of the social structure in the whole of India. The author winds up his discourse in chapter VII with a number of suggestions. We may not agree with all his suggestions, yet he has been successful in giving a clue for solution of so many eugenic problems existing in India.

When the different countries of the world have been earnestly engaged in solving the social and population problems by researches in eugenics and popularizing eugenic methods, we in India have done very little in this direction. Mr. Desai's monograph is therefore a welcome attempt.

—J. N. S.

Archaeological Discoveries in Jaipur

The importance of Jaipur State as a great tract in antiquity, with important and prosperous towns and trade centres, is brought out by the series of excavations inaugurated under the auspices of the Archaeological Department, which has been recently started by the Jaipur State, and the results of which are of great importance to historical research in India.

During excavations started by the ancient capital of Bairat, a novel type of Buddhist stupa and monasteries was found on the hill top, in the neighbourhood of which a version of Asoka's rock edicts was engraved.

Subsequently, excavations were carried on at Nulleasar, an ancient site near the well-known Sambhar Lake, where extensive remains of a mediaeval town with well-preserved structures and important antiquities were discovered.

The latest discoveries come from a third site named Rairh in the south-east of Jaipur in Thikana Bhartala. Here, in a crescent shaped bend of a rivulet, lie the ruins of an important metallurgical and industrial centre over 2,200 years old, extending about 2,500 feet in length from the north to the south, with a width of 1,500 feet.

The attention of the Department was drawn three years ago to the site by the chance discovery of a hoard of 326 ancient silver punch marked coins. Preliminary excavations were started under the sanction of the Jaipur Government by the late Rai Bahadur Daya Ram Sahni during the cold weather of 1938-39 and continued by Dr K. N. Puri, the present Superintendent of Archaeology.—*United Press*.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the Letters.]

Atmospherics of Distant Origin

Three classes of atmospherics are now known to us, viz., (i) atmospherics of near origin during local electrical storms, (ii) atmospherics of distant origin and (iii) atmospherics of extra-terrestrial or cosmic origin. In the present note we shall confine our attention to the atmospherics of distant origins only and shall describe some experimental results on the field-strengths of these atmospherics expressed as a function of frequency in the medium broadcast range and also on the diurnal characteristics of such atmospherics with special reference to the sunrise and sunset times.

We know that a large number of atmospherics in normal times are of comparatively low amplitude and that only a small number stand out prominently above the background level. Our field-strength data were based on measurements of this smaller percentage of peak noise values. Employing this peak method, measurements were made at Dacca over a range of frequencies from 375 kc. to 2000 kc. (from 150 metres to 800 metres) in the month of June 1939. A receiving set consisting of a H. F. amplifier and a detecting valve was constructed for the purpose and this was worked with a triangular loop-aerial, the plane of the aerial being inclined at an angle of about 35° to the E-W direction. The receiving set was carefully calibrated and the field-strengths of the atmospherics were estimated from the observed deflections in the balanced galvanometer placed in the anode circuit of the detecting valve in the receiver. The experimental results and their interpretations are given below.

1. *Frequency distribution of the atmospherics:* The time for the study of the frequency distribution of the atmospherics was so chosen that the number of the atmospherics was fairly uniform and persistent during the time of taking observations. It was found that for the distant atmospherics received in the day time, the field-strength varied nearly inversely as the square of the frequency. The inverse-square variation was not found to hold for the night observations. Fig. 1 illustrates these results.

The inverse-square relation, as observed during the day, between the field-strengths of the atmospherics of distant origin and the frequency-channel is what is theoretically expected. The recorded waveforms of the

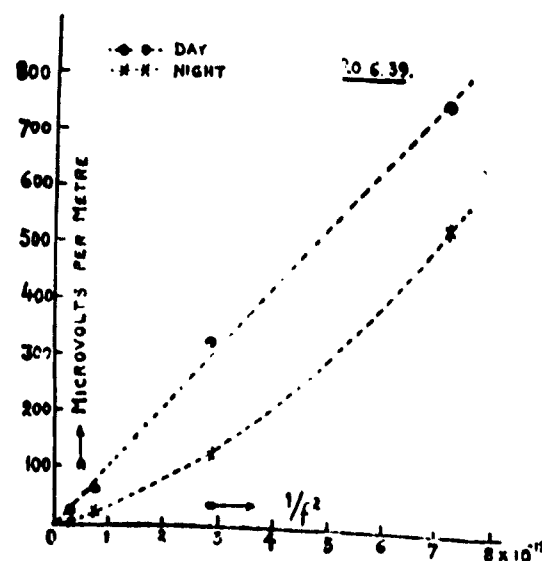


Fig. 1.

distant atmospherics are somewhat similar to damped sinuous waves. Following Burch and Bloemasma¹ in the Fourier analysis of such waves, it is evident that for frequencies much higher than the frequency of the received atmospherics, the amplitude of the particular term involving the frequency to which the receiver is tuned, is inversely proportional to the square of that frequency. This will hold for the distant atmospherics, provided there are no disturbing agents. Usually however there are disturbing effects, (i) due to the ionospheric reflections, and (ii) due to different attenuation for different frequencies. During the day, ionospheric reflection is negligible but attenuation must be different for the different frequencies within the range employed in this investigation so that an exact inverse-square relation is not to be expected. The results of the day

LETTERS TO THE EDITOR

experiments indicated that the attenuation varied only to a small extent over the experimental range of frequencies. During the night however the reflection from the ionosphere would cause a variation of the inverse-square relation.

Similar results were obtained in this Laboratory by M. K. Rao² following the 'warbler' method of atmospheric noise measurements. S. P. Chakravarty, P. B. Ghosh and H. Ghosh³ recently reported such an inverse-square relation between the atmospheric strength and the frequency-channel during the rainy season.

II. *Diurnal characteristics of the atmospherics:* The following are the typical characteristics of the diurnal variations for the month of June:

- a rise in the value of the atmospheric field-strength in the afternoon,
- a maximum in the strength of the atmospherics about the local sunset time, and
- a sharp decrease of the atmospheric strength immediately after the local sun-rise and a subsequent gradual rise to a maximum sometime after the local sun-rise time.

One typical set of morning observations on 600 kc. showing the peculiarity mentioned in (c) is graphically shown in fig 2.

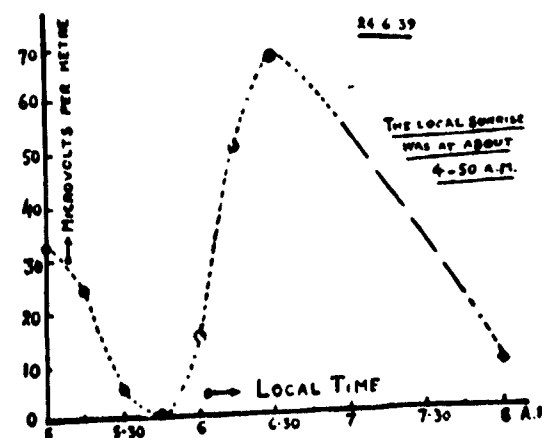


Fig 2

The sun-rise and the sun-set effects had been previously recorded by Espenschied, Anderson and Bailey⁴ and also by Potter.⁵ The latter had also observed in some cases a sharp decrease of the atmospheric field-strength immediately after sun-rise followed by a maximum. According to Potter, these effects depend largely on the relative situation of the source of the

atmospherics and the reception point and on the frequency at which measurements are made. It is evident that Potter's explanation would hold only when the sources of the atmospherics are both east and west of the point of measurement. In our experiment the plane of the loop-aerial was inclined at an angle of about 35° to the E-W direction. It is possible therefore that the observed sun-rise and sun-set effects could be interpreted in the same way.

It should be mentioned that the experiments described in this note were performed at a time when the weather was clear with only few light clouds in the sky and no visible lightning flashes. The received atmospherics could therefore be regarded as having quite a distant origin.

Further experiments on the subject are in progress.

Physics Department,

Dacca University

Dacca, 15-5-1940.

S. R. Khastgir

A. K. Ray.

¹ Burch and Bloemasma, *Phil. Mag.*, XLIX p. 484, 1929.

² M. K. Rao, *M.Sc.—Thesis* (1939), Dacca University.

³ S. P. Chakravarty, P. B. Ghosh and H. Ghosh, *Proc. Inst. Rad. Engr.* 27th Dec., 1939.

⁴ Espenschied, Anderson and Bailey, *Proc. Inst. Rad. Engr.* 7th Feb., 1926.

⁵ Potter, *Proc. Inst. Rad. Engr.* 19th Oct. 1931.

On the Reduction Formulae for the Incomplete Probability Integral of the Studentised "D2" Statistic

The distribution of the Studentised $D^{(1,2)}$ statistic in its earlier form was obtained by one of the authors, jointly with Mr. R. C. Bose as

$$\text{Const.} \frac{(D^2)^{p-2}}{(N + C^2 D^2)^{\frac{N-1}{2}}} {}_1F_1 \left(\frac{N-1}{2}; \frac{p}{2}; \frac{C^2 \Delta^2}{N + C^2 D^2} \right) d(D^2) \quad (1)$$

where ${}_1F_1$ is a certain type of hypergeometric function in Pochhammer's notation.

p = number of characters,

N = sum of sample sizes,

Δ^2 is the population parameter corresponding to D^2

and $C^2 = \frac{np}{2}$, n being the harmonic mean of the sample sizes.

LETTERS TO THE EDITOR

In its later generalised form where the mean differences are based on two samples and the pooled variances and co-variances are based on k samples, the distribution of Studentised D' was obtained by one of the authors jointly with Mr R. C. Bose' as

$$\text{Const.} \frac{(D^2)^{\frac{p-2}{2}}}{(N-k+1)^{\frac{p-2}{2}}} \cdot {}_1F_1\left(\frac{N-k+1}{2}, \frac{p}{2}, \frac{C^2 \Delta^2}{2} \frac{D^2}{N+C^2 D^2}\right) d(D^2) \quad (2)$$

where k = number of samples,

p and C' have the same meaning as before, and N = sum of sizes of all the samples.

In both (1) and (2) the pooled variances and co-variances which enter into the construction of D' were obtained from the pooled (corrected) sum of squares by dividing by N , but if we adopt the modern convention of obtaining the variances from sum of squares by dividing by the appropriate number of degrees of freedom, which is $N-2$ for (1) and $N-k$ for (2) then the distribution (2) which is really a generalisation of (1) takes on the form:

$$\text{Const.} \frac{(D^2)^{\frac{p-2}{2}}}{(N-k+C^2 D^2)^{\frac{p-2}{2}}} \cdot {}_1F_1\left(\frac{N-k+1}{2}, \frac{p}{2}, \frac{C^2 \Delta^2}{2} \frac{D^2}{N-k+C^2 D^2}\right) d(D^2) \quad (3)$$

To render this distribution useful for statistical purposes we have of course to find out the incomplete probability integral of D' which means the integral of (3) from 0 to D' , since D' varies from 0 to ∞ .

To facilitate this we put $N-k = n$, $\frac{C^2 \Delta^2}{2} = \beta$ and transform to a new variate x defined by

$$x = \frac{C^2 D^2}{n+C^2 D^2}$$

Then x is distributed as

$$\text{Const.} (1-x)^{\frac{n-p-1}{2}} x^{\frac{p-2}{2}} {}_1F_1\left(\frac{n+1}{2}, \frac{p}{2}, \beta x\right) dx \dots (4)$$

where the constant is easily found out to be

$$\text{Const.} = \frac{\Gamma(n+1)}{2 \Gamma(p) \Gamma(n-p+1)} e^{-\beta} \quad (4.5)$$

The distribution (4) involves three parameters, n , p and Δ for different values of which we would have

different tables of incomplete integral. There is a simple correspondence between the incomplete probability integral of D' and that of x , so that any one would serve the purpose of the other.

Putting now

$$I(n, p) = \frac{\Gamma(n+1)}{2 \Gamma(p) \Gamma(n-p+1)} e^{-\beta} \int_0^x (1-x)^{\frac{n-p-1}{2}} x^{\frac{p-2}{2}} {}_1F_1\left(\frac{n+1}{2}, \frac{p}{2}, \beta x\right) dx \quad (5)$$

we have found that

$$I(n, p) = - \frac{\Gamma(n+1)}{2 \Gamma(p) \Gamma(n-p+3)} e^{-\beta} (1-x)^{\frac{n-p+1}{2}} x^{\frac{p-2}{2}} {}_1F_1\left(\frac{n+1}{2}, \frac{p}{2}, \beta x\right) + I(n, p-2) \quad (6)$$

Thus $I(n, p)$ is seen to depend upon $I(n, p-2)$

We come down therefore to two basic incomplete integrals $I(n, 1)$, $I(n, 2)$ according as p is odd or even. Now $I(n, 2)$ has been found to be connected with $I(n-2, 2)$ and $I(n, 1)$ with $I(n-2, 1)$ by the respective relations:

$$I(n, 2) = e^{-\beta} x (1-x)^{\frac{n-3}{2}} {}_1F_1\left(\frac{n-1}{2}, 1, \beta x\right) + I(n-2, 2) \quad (7)$$

$$I(n, 1) = - \frac{\Gamma(n+1)}{\sqrt{\pi} \Gamma(n/2)} e^{-\beta} (1-x)^{\frac{n-2}{2}} x^{\frac{1}{2}} {}_1F_1\left(\frac{n-1}{2}, \frac{1}{2}, \beta x\right) + I(n-2, 1) \quad (8)$$

The evaluation of $I(n, p)$ for any particular value of x depends therefore in the first place upon the use of tables for confluent hypergeometric function with which ${}_1F_1$ is simply connected and in the second place upon the evaluation by numerical quadrature of

$$I(2, 2); I(3, 2); I(1, 1); I(2, 1);$$

but luckily

$$I(3, 2) = x e^{\beta(x-1)}$$

$$\text{and } I(2, 1) = x^{\frac{1}{2}} e^{\beta(x-1)}$$

We are therefore left with the evaluation by numerical quadrature of the two basic incomplete integrals $I(1, 1)$ and $I(2, 2)$, whose forms were evident from the relation (5).

LETTERS TO THE EDITOR

The actual construction of numerical tables for (5) for different values of the variate x and the parameters n , p and β is now in progress at the Statistical Laboratory on the general mathematical plan indicated in this note. It should be noticed that by putting $R' = x$ in (4) we immediately get the well known distribution of the multiple correlation under a particular kind of hypothesis. Hence the proposed set of tables will also serve for the incomplete probability integral of this type of multiple correlation.

Statistical Laboratory,

Calcutta, 6-5-1940.

S. N. Roy

Purnendu Bose

Bose, R. C. and Roy, S. N. The distribution of the Studentised D' Statistic. *Proceedings of the Indian Statistical Conference*. Calcutta 1938.

Roy, S. N. A Note on the distribution of the Studentised D' -statistic. *Sankhya*. Vol. 4 Part 3.

Roy, S. N. and Bose, R. C. The use and distribution of the Studentised D' -statistic when variances and co-variances are based on K samples.—*Proceedings of the Second Indian Statistical Conference*, 1939.

A New Analytical Reagent

Quinoline 8-carboxylic acid, $C_{10}H_7O_2N$, gives white precipitates with neutral solutions of mercuric and thallous salts. With cupric salts it gives a blue precipitate of the composition $Cu(C_{10}H_6O_2N)_2$. The compound is stable up to $288^\circ C$, and is soluble in strong acids and strong alkalis. The precipitation is observed to be quantitative and estimations of copper have been effected in presence of very dilute mineral acids and dilute acetic acid up to an acidity of $pH = 2.7$. The copper compound is very characteristic and the reagent promises to be useful for estimating copper in presence of various other metals. The details of such separations will be shortly published elsewhere.

Chemical Laboratory,

University College of Science,

Calcutta, 6-5-1940.

Anil Kumar Majumdar

Sun-spots and Magnetic Storms during the last week of March, 1940

The period between March 24th and April 2nd, 1940, was marked with severe magnetic disturbances attended with widespread interference with both radio and cable communications. The Alibag Observatory

magnetograms show that a severe magnetic storm commenced at $19^h 20^m$ I.S.T. on March 24, 1940 with a sudden increase of 62 gammas in H and 1.3 westerly D . There was a fall of 10 gammas in Z . This storm lasted till about $16^h 30^m$ on March 25. Seven hours later, a moderate disturbance began and continued till $12^h 34^m$ on the 26th. On the 29th March at $21^h 32^m$ another storm of great intensity began with sudden commencements in all elements and ended at 8^h on March 31st. After a short interval of slight activity, a fresh disturbance of great intensity commenced at $15^h 12^m$ on the same date and continued till 4^h on April 2nd.

Simultaneously with these magnetic storms, reports have been received of great dislocation in the radio and cable communications all over the world. It is reported that the United States suffered most severely and communications to Europe and South America were crippled for hours together. Britain's overseas radio and cable communications also suffered and in India too radio reception, especially on short waves, was very much affected.

The magnetic storms and the radio disturbances have long been attributed to the presence of large and active sun-spots near the central meridian of the sun. During the last few years, a number of papers have also been published correlating the bright chromospheric eruptions in the sun with terrestrial magnetic disturbances and radio fade-outs. A study of these solar flares and the nature of the relation that exists between these and the associated terrestrial effects leads to a better understanding of the physical state of the upper atmosphere. In the present paper, an account is given of the sun-spot group associated with the magnetic storms and the radio disturbances, during the period under consideration.

This is a large bipolar group of spots at latitude $12^\circ N$ which crossed the central meridian of the sun on the 26th March, 1940. It is a long lived spot group which had already passed the sun's visible disc thrice before making its present appearance. In the first rotation, this appeared as two distinct spot groups viz., Kodaikanal numbers 7252 and 7253 which were about 10° apart. Each group consisted of a number of smaller spots and they were first seen near the east limb on 30-12-39 and 1-1-40 respectively. No special activity was noticed in these groups till 3-1-40 when the spectrohelioscope observations showed a brightening up of the flocculus in the surrounding region. The flocculus was very bright the next day also and showed a Doppler displacement of $1.0 \text{ \AA}$ to the red indicating a velocity of approach of 45 km/sec . towards the sun. When seen on the 5th March, the spot groups had already developed into a large bipolar group which was very active. An eruption was photographed in the region on the 6th January between $8^h 20^m$ and $9^h 15^m$ I.S.T. and a

LETTERS TO THE EDITOR

dark marking in the neighbourhood showed a displacement of 2.4 A to the red. The spot group continued to be active till the 12th January when it passed the west limb. No information is available about the radio fade-outs during the period, but the Alibag Observatory reported a great magnetic disturbance on 3-1-40, namely when the group was about 26° east of the central meridian.

The spot group exhibited no special activity in the next two rotations across the sun's disc. In its fourth rotation, it was first seen near the east limb on 21-3-40. It was still a bipolar group and was active. H α dark markings in the neighbourhood showed displacements of 1 to 2 A to the red. Eruptions were photographed in the region on the 23rd, 24th and 25th. On the 24th March i.e., on the day of the commencement of the severe magnetic storm and radio disturbances, the spot group was about 20° east of the central meridian. It was a fairly large group covering an area of about 1450 millionths of the sun's visible hemisphere. The leading spot which was the most active of the two was large and irregular in shape, with the umbra broken up into a number of smaller portions. The following spot was a smaller one with a regular outline.

Great activity was observed in the region of the spot group from the 29th March, when an eruption was photographed between 9^h 53^m and 10^h 1^m. On the 30th March two eruptions were recorded between 8^h 4^m and 11^h 35^m. The first of these was observed at 8^h 4^m at two points adjoining the leading spot. Its intensity was 3 times that of the undisturbed disc as viewed in the spectrohelioscope by inserting a step-wedge between the eye-piece and the rotating prisms. The eruptive portion showed a Doppler displacement of 0.6 A to the red and 1.0 A to the violet at 8^h 10^m. At 8^h 23^m a small dark marking near the spot was showing a displacement of 0.6 A to the violet at its end away from the spot and a displacement of 1.6 A to the red at the end nearer the spot, indicating that the whole marking was being pulled into the spot. The eruption subsided at about 9^h 40^m. Another eruption commenced just before 11^h. This was a much larger eruption which started from the leading spot and extended in two streaks towards the following spot. The eruptive portion nearer the following spot was showing a displacement of 2.0 A to the red indicating that the eruptive matter had been flowing into the following spot at a velocity of about 90 km per second. From these observations, it is not possible to conclude that either the spot group or the eruptions that give rise to are entirely responsible for the magnetic storms and the radio disturbances experienced during the period

under consideration. It is well known that a magnetic storm often happens when a large and active sun-spot passes the central meridian of the sun. But in this particular case, the two great magnetic storms commenced about 2 days before and 3 days after the spot group had crossed the central meridian. Further, no magnetic storms were recorded during the previous three passages of the spot group excepting the feeble one of 3-1-40

It has been found that terrestrial magnetic disturbances and the radio fade-outs that have their origin in these eruptions last only for short intervals of about 10 minutes to 1 hour and they manifest themselves only on the illuminated side of the earth. The present magnetic storms and associated radio disturbances lasted for days together and manifested themselves with equal intensity both on the illuminated and dark sides of the globe. The cause of these therefore is some other than the sudden ionisation caused by the chromospheric eruptions. Investigation of a large number of eruptions and the associated terrestrial effects indicates that a number of large and active spots are not accompanied by magnetic storms and a number of magnetic storms occur without any large spot on the sun. While no definite conclusions as to the genesis of magnetic storms and radio effects can be derived, one is forced to the belief that the active agent linking the effects on the sun with the terrestrial disturbances originates in an affected region lying beneath the spot.

Solar Physics Observatory M. Salaruddin
Kodaikanal, 7-5-1940. C. K. Ananthasubrahmanyam.

Insoluble Phosphatic Manures in Acid Soils of Assam.

The province of Assam contains extensive areas of acid soils in which insoluble phosphatic manures, as a rule, not only improve the immediate crop, but also produce beneficial residual effects on succeeding crops. Soils of the old alluvium and of hills of the province are generally acid and low in P₂O₅ (phosphoric acid), whereas riparian tracts contain high percentages of P₂O₅ and are less acid, and are often neutral or slightly alkaline. The latter are very suitable for rabi crops (winter crops), such as pulses, mustard, potato, etc. It may be noted that the percentage of available phosphoric acid (soluble in 1 per cent citric acid solution) ranges as low as .004 per cent P₂O₅ in old alluvial soils, whereas in riparian tracts the soils may contain as high as .06 per cent P₂O₅.

This note deals mainly with responses of different crops to treatments of different insoluble phosphatic manures (such as alphas, flour-phosphate, bone-meal)

LETTERS TO THE EDITOR

in acid soils of Assam, and is based exclusively on experimental results obtained at different Government farms and demonstration centres under the direct supervision of the Department of Agriculture, Assam and the Sugarcane Research Scheme of the Imperial Council of Agricultural Research, to which the second author belongs.

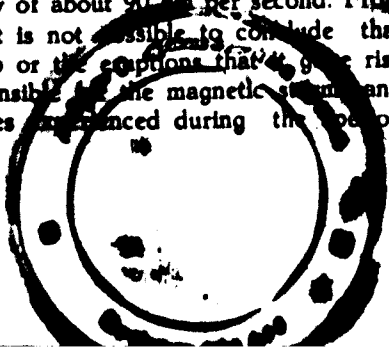
All results given in the statement below were obtained from demonstrations in cultivators' fields which were carried out in single plots, but the same demonstration was repeated in several centres in the district under uniform conditions as far as possible. Although the results do not admit of statistical analysis, they are convincing, being the average of several centres and numbers of years. Manures were applied in the first year and their residual effects were observed in the second and third years. The mean percentage increase over control, as shown in the statement, is the combined result of three years including residual effects. The residual effects of these manures appear to be very satisfactory.

(i) **Alphas** (Algerian phosphate with 30 per cent P₂O₅, a cheap mineral phosphate). Satisfactory results have been obtained in the acid soils of Jorhat Farm with alphas on sugarcane. From the results of the manurial experiments conducted at the farm during the years 1936-37 and 1937-38, it appears that in two years, under the conditions of these experiments, 200 lbs. alphas per acre produced a total increase of 2.66 tons of stripped canes per acre over "no alphas," while the corresponding total increase due to 300 lbs. alphas per acre over "no alphas" was 2.72 tons per acre.

In the green manure and rotation experiment at the same farm, distinct difference was obtained in cowpeas grown on phosphated and non-phosphated plots. The phosphatic dressing of 6 mds. of alphas per acre gave on an average about 30 per cent increase of cowpeas both in the third year (1936-37) and fourth year (residual effect) of the experiment over non-phosphated plots. The growth of pea was also much better on phosphated plots. There was a difference in the flora between the two sets of plots in the same experiment, one set of which received an application of 6 mds. of alphas per acre in the third year of the experiment (1936-37) and

Statement showing the results of manurial demonstrations on paddy.

District in which demonstrations were carried.	No. of demonstrations averaged.	Period.	Treatment.	Duration of each demonstration.	Yield of grain	Average net profit per acre for 3 years.
					Mean % increase over control.	
1. Sibsagar	11	1914-16	3 mds. bone-meal per acre	3 Years. 1st Year for immediate effect of treatment and 2nd and 3rd years for residual effects of each demonstration.	19.81	Rs. 18 0 0
2. "	12	1915-17	"		25.34	18 0 0
3. "	8	1916-18	"		20.60	26 0 0
4. "	3	1917-19	"		16.11	13 8 0
5. "	3	1918-20	"		15.18	18 0 0
6. "	4	1918-20	"		39.42	51 0 0
7. "	2	1919-21	"		26.13	18 0 0
8. "	8	1920-22	"		11.89	3 0 0
9. Kamrup	7	1915-17	"		18.39	20 0 0
10. "	4	1916-18	"		28.27	20 0 0
11. K & J Hills	10	1914-16	"		58.83	
12. "	10	1915-17	"		57.48	
13. "	20	1916-18	"		32.63	
14. "	5	1917-19	"		30.57	
15. "	7	1919-21	"		33.31	
16. "	6	1920-22	"		25.15	
17. "	14	1917-19	"		39.86	
18. Sibsagar	11	1914-16	3 mds. flour-phosphate per acre		28.00	Rs. 30 0 0
19. "	3	1917-19	"		28.19	24 12 0
20. "	2	1918-20	"		19.73	21 12 0
21. "	4	1918-20	"		35.43	46 8 0
22. "	1	1919-21	"		40.67	36 12 0
23. K & J Hills	10	1914-16	"		33.35	



LETTERS TO THE EDITOR

followed both in the third year and fourth year (1937-38), while the other set remained fallowed both in the third year and fourth year but without any phosphatic applications. Good grasses grew naturally on the former set of plots due to phosphatic manuring, while *phutuka* (*Melastoma Mala-bathricum*), a plant characteristic of the acid soils containing low amounts of P_2O_5 , grew on the latter. There is thus a distinct indication that grazing areas, which are mostly covered by *phutuka* under acid condition, can be improved by a light phosphatic dressing.

(ii) *Flour-phosphate* (Belgian mineral phosphate containing about 27 per cent P_2O_5): This mineral phosphate has been found satisfactory, particularly for paddy. This is borne out by the results of some of the manurial demonstrations noted in the above statement.

(iii) *Bone-meal* (containing 24 per cent P_2O_5 approx.): A series of manurial demonstration, the results of which are recorded in the above statement prove the efficiency of bone-meal as a manure for paddy in acid soils of Assam. It is used in other crops, such as fruit trees, with excellent results.

It is evident from the foregoing details that good responses are obtained from insoluble phosphatic manures in the acid soils of Assam.

There seems to be no possibility of obtaining the mineral phosphates within the province, but the price of the imported brands are not at all prohibitive compared to other artificials and should be within the easy reach of cultivators. In fact the price of alphas is cheaper than bone-meal produced within the province.

The position with regard to bone-meal however is entirely different. This is most widely used among phosphatic manures in the province and its demand has been gradually increasing. At the same time there are evidences that large stocks of raw bones go out of the province every year, which can with profit be manufactured into bone-meal within the province. Already some cultivators in Khasi and Jaintia Hills have taken up grinding their own bone-meal, and at some centre attempts are being made to manufacture it on a big scale. It will be meet and proper to collect all raw bones within the province and manufacture them into bone-meal for use within the province.

Chemical Laboratory.

Department of Agriculture

and

Sugarcane Research Scheme, I.C.A.R.

Jorhat, 3-5-194.

L. N. Phukan

H. N. Pal

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