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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

JULY 1942—JUNE 1943

Nos. 1-12

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PUBLISHED UNDER THE AUSPICES OF

INDIAN SCIENCE NEWS ASSOCIATION

92, UPPER CIRCULAR ROAD, CALCUTTA



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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

JULY, 1942

No. 1

A Message

I SEND my greetings to "SCIENCE AND CULTURE" on the eighth anniversary of its birth. The very name of this periodical signifies the two things which, more than anything else India, like all progressive and civilized nations, must possess. For science and culture in their widest meaning comprise almost everything. Science is the very basis and texture of life today and without it we perish, or, what is even worse, slide back to barbarism. Science does not just mean the thousand and one applications of it that we see to-day, but even more so the scientific and rational approach to all problems of life. Science has made great progress in the west and raised the standard of living in some countries to unprecedented heights. And yet that very science has failed to solve the major problems of the age and we see war with all its horrors ravaging the world. Thus science destroys itself if it is not extended to the political, economic and other fields of human life and endeavour. It would appear that science today is in a position to solve all these problems, or most of them, and to create conditions of well-being and progress for all humanity. Yet though we swear by science and accept it advantageously for many purposes, still the habit of unscientific approach remains. Vested interests, superstitions and out-of-date customs prevent the full application of the scientific and the rational method.

Science thus becomes a narrow field unless it is accompanied by a wider and more far-seeing view of human society. This is where a real culture comes in. Not the narrow culture of the upper social groups that we see, but the real culture which enthuses the great majority of human beings and gives to all their undertakings a moral and human basis.

So science and culture are of the essence of life today, in war and in peace, and any periodical which serves the cause of science and culture performs a service to India and humanity. I wish that "SCIENCE AND CULTURE" will continue its useful career and will widen its sphere of influence, so that its message may reach even the laymen in India and might not be confined to the experts and the scientists. It is comforting to know that in spite of the war and the difficulties that inevitably result from the war, this journal has continued to come out. Indeed it is in these times of war and crisis that the rational message of science is all the more necessary. So more power to "SCIENCE AND CULTURE".

Jawahar Lal Nehru

Civilisations in Transition

A VERY thoughtful contribution to the comparative study of the growth, maturity and decline of civilisations was made by Prof. Rostovtzeff in a symposium on "Civilisations in Transition" held on September 25, 1941, as part of the celebration of the fiftieth anniversary of the University of Chicago. The subject was on the "Destinies of Hellenism in the Near East" and Professor Rostovtzeff dealt with the impact of Hellenism on the civilisations of the Near East. The scene begins when Alexander the Great led his hordes of Macedonian soldiers to Asia in 334 B.C., and quickly overran the extensive but decaying empire of the Achæmenids—which then comprised Anatolia, Syria, Egypt, Babylon, Persia, Bactria and north-west India. It is well known that Alexander's army completely destroyed the political systems in these countries, and they turned back from their schemes of world conquest only after reaching the banks of the Sutlej in the Punjab, probably in fear of the Great Eastern Empire of the Nandas (The Prasii). Alexander, however, effected not merely the destruction of an empire which was after all a corrupt and decaying one and had outgrown its usefulness, but also attempted a real synthesis between Hellenism and the great eastern civilisations. He adopted a policy of broad toleration towards the conquered people, admitted their nobles to a share of the government and, as a token of goodwill, himself married a daughter of the last Achæmenian emperor, and made his generals take Persian wives; but in order to safeguard the interests of Hellenism, he also founded a number of Greek Polis all over his wide empire in which large numbers of Greeks were permanently settled and Greek literature, arts and sciences, Greek manners and customs were cultivated.

After Alexander's death in 323 B.C., the central authority collapsed, and there was a period of internecine war amongst his Generals. Out of this confusion, arose a number of kingdoms and an empire: Egypt under the Ptolemies, the whole of the Near East except Anatolia under Seleucids, a number of smaller kingdoms in Cyrenaica, Anatolia and in

Macedon proper. The Greek Principalities in India and Afganistan were rolled up by Chandragupta Maurya, but a hundred and thirty years later, after the collapse of the Mauryan empire, the Bactrian Greeks were able to make successful and enduring conquests in Afganistan and the Punjab.

All these various States carried on Alexander's policy of synthesis between Hellenism and the indigenous cultures, many of which were far older in age than and in some respects as rich as the Greek civilisation. In Egypt, the Ptolemy was not only a Basileus Basilikon, but also a Pharaoh; he dressed like a Pharaoh on ceremonial occasions, and even a new god Serapis, a sort of synthesis between Jove of the Greeks and Osiris of the Egyptians was introduced, and had a high prestige amongst all classes. Greek arts and sciences were extensively cultivated along with the old Egyptian culture, and the fame of the Savants of the Alexandrian Museum far surpassed that of Athens even. In the Seleucid empire, the same spirit was at work; Greeks became willing students of the Babylonian systems of Astronomy, Medicine and Engineering which they enriched by their own investigations and bequeathed to posterity. In India, the Greeks felt the spell of the Indian civilisation. King Menander became a Buddhist, Heliodorus, a devotee of Vishnu, and Greek art revived India's artistic conceptions.

But Hellenism in foreign lands had only a brief existence of barely 200 years. In Egypt, the Ptolemies, after a brief resistance, had to become unwilling subject allies of Roman Imperialism, and passed away with the masterful Cleopatra. It does not appear that in their long-continued struggle against Rome, the Ptolemies had any sympathy or active help from the native Egyptians. Nay, they were probably glad to exchange the Roman yoke for the Greek. In Syria, the Seleucids had a ceaseless struggle with the Persians, Jews, Parthians and other conquered races, and when Rome assailed Antiochus the Great in Syria, and reduced him practically to vassalage, he could depend only on his fellow Macedonians settled in the Greek Polis.

The Macabees, leaders of the Jews, sought the aid of the Romans, in spite of the fact that they were greatly influenced by Hellenic civilisation, adopted Hellenic names and manners and some of them were learned Greek scholars. The Parthians who put an end to Seleucid domination in Eastern Persia were so much influenced by Greek civilisation that on their coins they called themselves Philhellenes; but even they combined with the Romans from the west to accelerate the death spasms of the last Seleucids in the Tigris-Euphrates valley.

What was at the root of the bitter hostility of all the different conquered populations—Egyptians, Jews, and Persians—to the dominant Greek population, in spite of their admiration and partial assimilation of the Hellenic culture? Prof. Rostovtzeff remarks:—

"At first the Greeks, bearers of a high culture, were an *élite*, organising a complex bureaucracy, which virtually undermined the royal power, and which milked the native population of its wealth. The tendencies towards cultural acclimatization began to take effect, and by the time of the rise of Roman power, the Greek creative force in Egypt had been exhausted.

"Since the status of the Greeks was that of a privileged class, the higher strata of the native population naturally tried to acquire for themselves this status. The prerequisite for it was Greek education and participation in Greek life. Thus a certain part of the native population became gradually 'Hellenized' and some of them received from the king the status of Hellenes.

"While 'Hellenization' was effected among the well-to-do natives, it did not touch the masses of the population of the two monarchies, the peasants of the country and the artisans of the cities, towns, and villages.

"In time, the Greeks became privileged servants of the king and soon a powerful bureaucracy grew up dominated by the Greek administrators. From the point of view of the masses the Greeks were their oppressors. They extracted from them ever heavier taxes, they supervised their compulsory labour, they acted as agents of the Government in exercising an ever stricter control over their economic life. The native working classes complained to their protector, the king, but they soon found out that the kings

were helpless to relieve their sufferings. The powerfully organized bureaucracy was stronger than the royal will. No wonder then from time to time the natives rose in revolt.

"The buoyant energy of the pioneers of the third century B.C., their creative force, gradually subsided. Creation was replaced by routine, the Greek tempo of work was followed by oriental passivity.

"By the time of the rise of Roman power, the Greek creative force in Egypt had been exhausted and Egypt and the entire Greek world became incorporated into the Roman Empire".

The state of affairs described by Prof. Rostovtzeff finds a close parallel in recent times in the impact of modern Western civilisations on the ancient civilisation of Greater India. West European civilisation has come to the East through the agencies of the British, the French and the Dutch. The domain of influence of the Dutch has been the East Indian Islands, where like their Greek predecessors in Egypt, they were successful in europeanising a certain part of the native population, and some of them received the status of *Gazetted Europeans*. But the Dutch had kept the strings of economic control in their tight grasp, and the general poverty of the masses was unrelieved by the fruits of scientific exploitation. The creative force was exhausted, and the heart of the native in spite of his admiration of the conqueror's culture and civilisation, has not been with the conqueror who discovered this unpleasant truth only when he was assailed by a deadly foe.

If the Dutch East Indies can be compared with Egypt under the Ptolemies, India can be compared with the Near East under the Seleucids. Their vast empire like that of the British was a heterogeneous collection of ancient races with proud memories of past greatness *viz.*, the Jew, the Babylonian, the Syrian, the Persian, the last being the dominant race before the advent of the Greeks. These races were bitterly divided amongst themselves. The Seleucids used to play one race against another, and keep their hold with the aid of descendants of Greek settlers in the Greek Polis. They admitted the natives to the advantages of their own system of education and a few who attained a certain standard were allowed to participate in Greek life. But there was no real synthesis, no real love as was proved by the open hostility and indifference of all the native races, when

the Seleucids were assailed by Roman Imperialism, and destroyed (65 B.C.).

Here perhaps is to be read the answer to a query put some time ago by a puzzled Anglo-Indian contemporary of ours—why then men like Mahatma Gandhi, Pandit Nehru, Subhas Bose, who had received the blessing of the British system of education and professed to be genuine admirers of British culture are amongst the bitterest opponents of British Imperialism. Here also is to be found the reason of the great difference in attitude towards the present Axis aggression between the people of U. S. S. R. and those of Burma, Malaya and the East Indies.

We may contrast the behaviour during the present struggle of the Malayas and the Burmans with that of the various races of Russia whose magnificent resistance to Fascist aggression has evoked the admiration of the whole world. While various races of Russia—the Ukrainian, the White Russian, the Georgian, the various races of the Caucasus, the Tartars, the Uzbeks, the Kazaks, the Kalmucks, the Tajiks, and the Siberians are fighting shoulder to shoulder with the dominant race—the Great Russians

evoking the admiration of the whole world, the races living in Burma, Malaya and the Dutch East Indies are at best indifferent if not actually hostile to the Allies. The reason is simple. The last World War swept away the corrupt aristocracy of Old Russia who followed towards their subject races the traditional path of imperialism, but the Russia that emerged out of its ashes, the Russia of Lenin and Stalin, has been wedded to a new philosophy of life, has given up all ideas of economic and cultural exploitation of subject races and has admitted them to the full status of citizenship and advantages of the new system. The same is also partly true of the magnificent resistance of the Filipinos under American leadership to Japanese aggression.

What then is wanted in India for a willing co-operation with the United Nations against the forces of Fascism? "*A change of heart*", as the Mahatma has so often reminded the British politicians. Let us hope that the United Nations would take a lesson from history and also from their Russian allies, and admit the subject races to equal rights and privileges and thus ensure the victory on which the future of civilisation depends.

A PARABLE

A wolf had a goat and he had him tied up to a tree by the side of a forest. The wolf used to come every day and eat a slice of the goat's flesh. One day, the roar of a lion was heard in the distance. The wolf said "Brother goat, we are both in danger, for I am eating only a slice of flesh every day from your body, but the lion will devour both of us. Will you kindly help in my fight against the lion?" The goat said "Mr Wolf, I am quite willing to help, but how can I use my horns and my hoofs with effect unless you untether me?" The wolf said, "But what is the necessity for that? You can fight as well with your ether on". The goat, however, could not take the wolf's advice, and while the two were wrangling, the lion did arrive.

Science and Culture

[We were looking into the old files of SCIENCE AND CULTURE and the first editorial struck in us a concordant note in the midst of the present conditions. We have, therefore, been tempted to reproduce relevant portions of that. In context with the editorial of this issue, the feelings which surged in our minds seven years ago will be found intensified now and we offer no other apology for reiterating our faith and, for the matter of that, showing our countrymen a right way of approach to our national problems.]

[Ed.—SCIENCE AND CULTURE]

THE CALL that brings "Science and Culture" into existence is truly the call of the times. For it is obvious to every thinking man that India is now passing through a critical stage in her history, when over the cultural foundations of her ancient and variegated civilisation, structures of a modern design are being built. It is necessary that at such a juncture the possible effects of the increasing application of discoveries in science to our national and social life, should receive very careful attention; for if the present is the child of the past, it may with equal emphasis be asserted that the future will be the child of the present. The present generation by its policy and action will shape the course of the future.

There are many views of civilisation amongst thinkers. Some of them regard civilisation as a steady and continuous advance in material power, in social organisation, in political and economic life. According to this view civilisation has been so far a phase in the evolutionary process of man's existence on this globe. Others regard civilisation as a cyclic process, passing through long periods of preparation for birth followed by periods of growth, development, and decay. Amongst the protagonists of the second view are to be found such men as the Egyptologist Sir Flinders Petrie and the German philosopher Otto Spengler who expounded his ideas in the learned volumes of the *Untergang des Abendlandes*. He talks of these periods picturesquely as the spring, the summer, the autumn, and the winter, and defends his thesis by a careful survey and analysis of the civilisations that prevailed on our globe, viz., the Egyptian, the Babylonian, the Graeco-Roman, the Hindu, the Chinese, the Arabic and the West-European. The first three ran through their full cycle (which is estimated to vary between 1500 to 3000 years) and are now dead, the next three are passing through their long winter. The West-

European civilisation which is at the present time dominating the world, has passed through its summer and according to Spengler has now entered its depressing autumn. What will be its ultimate destiny?

We may not try to answer this question, but we may ask ourselves whether Spengler's analysis is correct. Are the courses of civilisations to be thought of in terms of the phases of power, prosperity and activity of the dominant races which pass before us on the screen, or in terms of their total contributions in thought, in science and material prosperity which are left as heritage to the succeeding generations? When we talk of the old and the new stone age, the chalcolithic and the iron age, the age of steam and electricity, we are thinking of civilisation as a continuous growth, marked by steady additions in moral and material power as well as in thought. It is refreshing to find that in his new book *Man and Technics*, Spengler seems to have reverted to the first view and probably there is no essential difference between the two. The dominant races which are the principal actors in the drama of any particular civilisation may pass off the stage due to some cankerous growth in their body politic, but their traditions and achievements remain and act as a lesson stimulating cultural growth among the groups which take their place on the stage. Many examples may be given from history but one will suffice. The Graeco-Roman creators of the Mediterranean civilisation disappeared from Italy about 500 A.D., but the barbarians who stepped in their place on the stage picked up the threads of progress where they had been left, and created an entirely new culture, viz., the modern West-European civilisation marked by its science, its technic and conquest of Nature. When probably the creators of this civilisation will pass off the stage, their heritage will fall on the Russians, the Japanese, the Africans;

and, may we not expect, also on the representatives of the Ancient East, now just emerging out of their long winter into a fresh cycle of activity? Has not such a stage begun already? It is in this hope that we may examine the cultural foundations of Indian civilisation.

In regard to the historical development of Indian civilisation one may say that it has begun receiving attention only recently. No European savant can now contend, as some used to do two decades ago, that India emerged from a barbarous stage two thousand three hundred years ago as a result of contact with the invading Greeks from the West. The discovery of the Indus valley civilisation in 1923 by the late Mr R. D. Banerjee has once for all shattered that view. But this discovery also proved that the commonly accepted view held by Indian savants of pre-British days that the Indian civilisation started with the Vedic Aryans is equally erroneous. It now appears that the Indian civilisation is pre-Aryan and probably autochthonous and had a long period of development prior to the Aryan conquest of India; this may be at least as old as, if not older than the Egyptian. About 3000 B. C. the Indians lived in well-planned and well-built cities, knew the use of copper, practised spinning and weaving, undertook trading expeditions to distant Ur of the Chaldees, and probably as Von Hevesy has shown also to the far Eastern Polynesian Islands. Probably the religious beliefs like Saivism* in which the dead were supposed to take the form of beasts and attend on a meditating deity Siva (or the lord of the departed spirits or beasts) and Jainism (negation of belief in a personal God and belief in right conduct and great men) are, as Mr R. Chanda contends, as old as the days of Mohenjodaro and Harappa. The Aryans who, like the latter-day Turks flowed from the steppes of central Asia into India on the east and into civilized Babylonia and pre-Greek Hellas on the west, had probably not much civilisation of their own to boast of, but adopted like the pre-Turks and the Turks between 500 B.C. to 1500 A.D., the superior civilisation of the countries into which they poured. In India, they created the civilisation reflected in the Vedas, the great epics, and in Buddhism. They brought a sense of political and cultural unity in the regions constituting the Indian continent and among its vast medley of people com-

* Figures of cult images on seals indicate that the people of Indus worshipped humans and superhumans resembling Siva and the Jain Tirthankaras seated and standing in the postures of yoga.

posed of different ethnic stocks. We do not know the precise story of these movements as we do in the case of Egypt or Babylonia where, thanks to the spade of the archaeologists the past up to 3300 B.C. has been very satisfactorily unearthed. But as Messrs Masson-Oursel, Willman-Grabowski and Stern remark in their *Ancient India and Indian Civilisation*, the vast Sanskrit literature of India in its mystical legends is full of echoes of mighty happenings of the past. We can think of a day when the spade of the archaeologist will disinter the bases of these legendary stories, and some of the mystic figures of the past may again be conjured to life in flesh and blood. Coming to more historical times, we find how the great Mauryan empire which extended over a larger area than even the present British, anticipated many of the modern movements for unity. The great Asoka tried to knit the vast people into a homogeneous community by adopting Buddhism, which may be regarded as the first religion of the world that appealed to the whole mankind instead of a particular tribe, as the State religion and imposing the script* (*viz.*, the Brahmi) and one language (that of the chancellory of the central court at Pataliputra) over the far-flung regions of his empire. We also know in subsequent ages the disintegrating forces of provincialism, communal and foreign interests, and foreign invasions laid in the dust the edifice sought to be built by many successive dynasties, how the struggle between imperialism and provincialism continued for about one thousand years, till Hindu civilisation was overwhelmed by the conquering invaders from Central and Western Asia.

The Muslim conquerors brought with them the elements of Islamic culture then passing through its glorious summer and tried to impose this on an alien population imbued with totally different ideas of life and civilisation. These attempts met with some success, but failed to create a common civilisation, partly because the protagonists of the two cultures held steadfastly to their dogmas, but mainly on account of the fact that they were unable to impart a dynamic impulse to the ancient social system, whose rigidity remained unaffected.

During the last one hundred and eighty years, India has again come into contact with another culture *viz.*, that of Western Europe which dominates the world to-day. This civilisation differs from the earlier ones in the enormous increase of scientific knowledge, in the increase of power of man

* Or rather two, the Brahmi and the Kharosthi in the north-west.

over the forces of nature and in the intensive application of scientific discoveries to all branches of human activity. This has revolutionised man's way of living, having brought different groups of men formerly living in complete isolation into almost daily contact, and tending to make the whole human society into one economic and cultural unit. India has not escaped the effects of the contact, but it has always taken a long time for a country with a distinct tradition of its own to assimilate an alien culture, particularly when forced upon it by its conquerors.

In the case of India, the period of contact has not been long enough and the clash is not yet over. It is true that the West-European culture has gained very considerable ground and has succeeded in shaking our ancient social structure and our belief in time-honoured religious dogmas and practices, in disturbing the economic life of the country, and in *modifying the very ways of our thought*. But though the two cultures stand face to face as thesis and antithesis, the synthesis is not yet in sight.

There still remains a large section of the population not much touched by the changes, and even the literate and urban classes cannot wholly reconcile themselves to the idea of the subjugation of their old system by the new conditions which are being created by modern science. We find, therefore, amongst our leaders a considerable number, who are incapable of seeing the great and inevitable part which the new age of technic will play in India's destiny and the lasting contribution that it is likely to make to the future of Indian civilisation. In the vernacular literature particularly, one very frequently comes across overdrawn pictures of imaginary good old days when nobody is supposed to have had anything to complain of, and a tendency to attribute all present troubles to the evil effects of science. One of the solutions usually offered is the total rejection of all modern technic for manufacture of the necessities of life, based upon the applications of scientific knowledge. It is a fact that large sections of the masses have suffered terribly from the effect of industrialism as practised in India to-day, which amounts to an exploitation of the masses for the benefit of a few. The great success of Gandhism is due to the fact that it expresses genuine sympathy with the victims of an aggressive and selfish industrialism, but we do not for a moment subscribe that better and happier conditions of life can be created by discarding modern scientific technic and reverting back to the spinning wheel, the loin cloth and the bullock cart. On the contrary we hold that if the

discoveries of science are properly and intensively applied, they will offer far better solutions to our bewildering economic, social and even political problems.

It is true that large scale application of science to industry has given rise to a series of acute problems all over the world, but it should be recognised that these troubles are of two types *viz.*, national and international. The national problem consists in the adjustment of the dislocation created by policies of industrialisation adopted by different countries, the remedies which have been suggested being the development of natural resources, State regulation of economic life and rationalisation of industry. The international problem consists in protecting home industries by artificial regulation of foreign trade and betterment of the methods of production at home. With respect to our country, we would hold with Mahatma Gandhi that the spinning wheel and the bullock cart should be protected so long as the State cannot provide for the victims of unemployment; on the other hand, there should be unremitting effort to adopt the modern technic to all the needs of industrial and economic life, and old antiquated methods should be discarded without a sigh or tear when the proper insurance against unemployment has been made.

It is to preach this middle path that "Science and Culture" makes its debut before the public. Its object is dissemination of scientific knowledge amongst the public and advocacy of its application to all walks of life as far as practicable. The need of such a journal has long been felt, for, though India can now boast of a large number of workers in different branches of science some of whom have by their contributions won international positions, their labours are mostly confined to their technical subjects. It is true that they are neither wanting in capacity, nor are lacking in will to instruct the people by means of well-written articles about the progress of science and the advantages of their application to the economic and cultural life of the country. But the absence of a medium of publication solely devoted to this purpose has long been felt. "Science and Culture" has been assured of the co-operation of a large number of eminent scientists in its efforts. It will publish articles written in popular language by experts about the recent contributions to knowledge in various branches of science. It will publish articles discussing Government policy in technical matters like rural reconstruction, transport, power development, industrial policy and such others as have their bases on science.

Zodiacal Light—A Cosmic Mystery

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INTRODUCTION

ON CLEAR moonless evenings a tongue or cone of faint light is often seen to rise above the horizon in the west after the disappearance of the twilight. (Fig. 1). The phenomenon appears distinctly in middle and lower latitudes. The colour of the light



FIG. 1. ZODIACAL LIGHT.
(Photograph by Rudaux, taken on April 26, 1913.)

cone is reddish yellow to white; its intensity is comparable to that of the milky way, being brighter near the base and growing fainter at higher altitudes. The main portion of the light pyramid lies in the zodiacal belt; hence the name zodiacal light. The base of the cone extends on the horizon 15° to 20° on either side of the point of intersection of the

ecliptic with the horizon. Upwards, it rises 50° to 60° from the base. A similar cone of light is also seen in the east before the incidence of the first morning rays. The former is called the west zodiacal light and the latter, the east zodiacal light.

In middle latitudes the west zodiacal light is best seen in spring and the east in autumn, when the pyramid tends to stand erect on the horizon.

As the sun sinks below the horizon the pyramid sinks with it but the light is usually discernible on the horizon till the angular distance of the sun reaches 90° . In low latitudes and in very clear weather, the zodiacal light may be seen to extend up to 180° from the sun. The west and the east zodiacal lights then join together forming a continuous bridge of light close to the zodiacal belt. This is called the *zodiacal band*. Its width and brightness decrease with angular distance from the sun. At 90° it may be about 20° wide and at 150° about 10° . At 180° from the sun the band widens into a patch, brighter than the adjoining portions, and a knot of delicate glow is observed; on account of its being just opposite the sun the glow is called *gegenschein* or *counter glow*. Because of its faintness, it is difficult to assign to *gegenschein* any accurate dimension. Generally it covers a region of a few degrees. It is evident that the *gegenschein* is seen only when the anthelion is in the dark region on the sky.

According to some authors the zodiacal light, in reality, extends over the whole sky though, of course, it is strongest along the light bridge. Such

extension of zodiacal light can be observed only from fairly high altitudes when the atmosphere is quite free from pollution.

The following description of the changes of zodiacal light in course of a year in moderately high latitudes is taken from Schmid who has made a careful study of the phenomenon¹: "The west zodiacal light begins to appear by the end of September and in November fully develops the character of zodiacal light. The cone of light rises out of the south-west horizon as the ecliptic rises and it reaches the highest point in the month of January. It then sinks gradually and is lost in the summer night glow in the month of May. The sky is free from zodiacal light in the month of June. By the end of July we see the first appearance of morning zodiacal light shortly after midnight. At the beginning the cone of light is strongly inclined to the horizon like the ecliptic. With the approach of autumn the inclination gradually changes and in the month of November the cone of light becomes almost vertical. It then begins to incline more and more towards the south with increasing inclination of the ecliptic and disappears in the south-eastern sky towards the middle of March." (For general descriptions of zodiacal light see references^{1, 2, 3}).

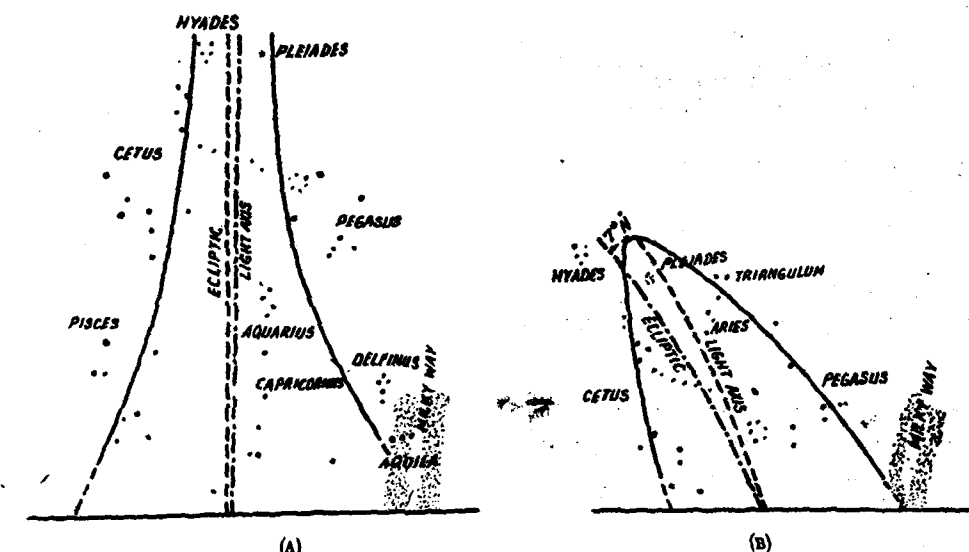


FIG. 2. ILLUSTRATING HOW THE ZODIACAL PYRAMID TENDS TO STAND ERECT ON THE HORIZON AS THE ECLIPTIC DOES SO. The light axis does not in general coincide with the ecliptic. It does so only when the ecliptic stands perpendicular to the horizon. Fig. 2(A) depicts the light pyramid as observed from Lat. $0^\circ 14' N.$, Long. $5^\circ 4' W.$ (Atlantic Ocean) on December, 1931, at 20 hrs. Fig. 2(B) is as observed from Lat. $47^\circ 21' N.$, $9^\circ 6' E.$ (Oberhelfenswil, Germany) on December, 1922, 23 hrs., 30 mins. (Both the drawings are after Schmid. See Ref. 4.)

¹ F. Schmid, *Das Zodiacallicht*, Vol. II, Probleme der Kosmischen Physik.

² Russel, Dugan, Stewart, "Astronomy", 1, 359, 1926.

³ Ruedy, *Die Naturwissenschaften*, 18, 401, 1930.

SOME CHARACTERISTICS OF ZODIACAL LIGHT

As already mentioned and, as the name implies, the main portion of the zodiacal pyramid lies in the zodiacal belt. The pyramid stands erect on the horizon when the zodiacal belt cuts the horizon perpendicularly. This occurs during the equinoxes in the tropics—in the evening for the spring equinox and in the morning for the autumnal equinox. In the equatorial regions the ecliptic always stands more or less erect, being more specially so at sunrise and sunset hours during the equinoxes. Observed from higher latitudes the zodiacal pyramid is inclined to the horizon as is the zodiacal belt, and the inclination varies according to the season and the hour of observation. (Figs. 2(A) and 2(B)).

Though the main portion of the light pyramid lies in the zodiacal belt, the axis of the pyramid does not in general coincide with the ecliptic. It does so only when the ecliptic stands erect on the horizon, that is, when the observer is situated in the plane of the ecliptic. For inclined position of the ecliptic, the light axis is deviated from it; the greater the inclination the greater is the deviation. Observed from northern latitudes the deviation is to the north and from southern latitudes to the south. For large

distances from the tropics, the deviation may be quite large. Thus, from $42^\circ N$ Lat. the north deviation

of the apex of the pyramid from the ecliptic was found to be 28° in the month of February, while from 39° S Lat. the top of the western pyramid was found to lie 26° south of the same⁴.

The change in the position of the light axis with reference to the ecliptic may also be observed in course of a single night, because, in general, the motion of the observer due to the diurnal motion of the earth on its axis, transports him towards or away from the plane of the ecliptic. Under favourable conditions, as for instance, when the west zodiacal light is observed from high northern latitudes in winter months, the change of position of the light pyramid (against the starry background) might be considerable in course of a few hours. (Fig. 3).

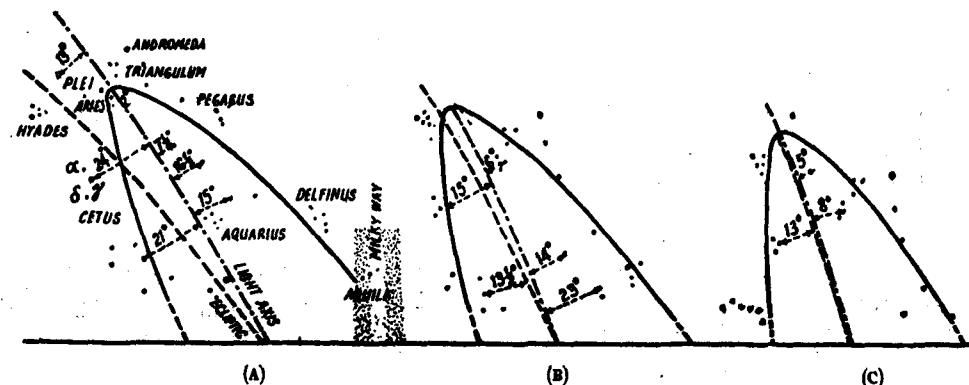


FIG. 3. ILLUSTRATING HOW THE POSITION OF THE LIGHT AXIS CHANGES IN COURSE OF A SINGLE NIGHT. OBSERVATIONS MADE AT OBERHELFENSWIL ($47^\circ 21' \text{ N.}$, $9^\circ 6' \text{ E.}$)—ON 9 JAN., 1934—FIG. (A) FOR 19 HRS., (B) FOR 22 HRS., AND (C) FOR 24 HRS. (After Schmid).

The whole light cone not only tends to stand erect with the progress of night (as the zodiacal belt does so) but also appears to move sideways, so that the light axis which was originally to the right of the ecliptic crosses over slightly to the left⁴. These movements of the zodiacal light are called its nightly motion.

It has already been mentioned that the intensity of the zodiacal light is comparable to that of the milky way. Measurements at Montpellier, France, show that the intensity is about 2.4 times that of the night sky luminescence near the region of the pole star. The intensity varies considerably from night to night and also from hour to hour in a particular night. At times the light may be almost completely extinct. It appears that some at least of such large

variations are coincident with the incidence of magnetic storms⁵. Some authors believe that the rapid variations in the intensity of zodiacal light might also be coincident with solar outbursts associated with bright eruptions on the sun's surface⁶.

Fig. 4 depicts the seasonal as well as the latitudinal variations of the evening and morning zodiacal light. This is from quantitative measurements by Elvey and Roach, made with a photoelectric recording photometer⁷. The ordinates give the intensities in units of the tenth photographic magnitude per square degree of the sky. It will be seen that in November-December, the evening zodiacal light is rather inconspicuous; for the morning zodiacal light, the gradient of intensity is steeper.

be remembered, however, that in any spectrum of the zodiacal light, the spectrum of the night sky must also be superposed on it. But it appears that even making due allowance for this there is strong

sky is so. The plane of polarisation of either is found to pass constantly through the sun. The results obtained by Dufay are shown in Fig. 5. The ordinate represents the depolarisation factor

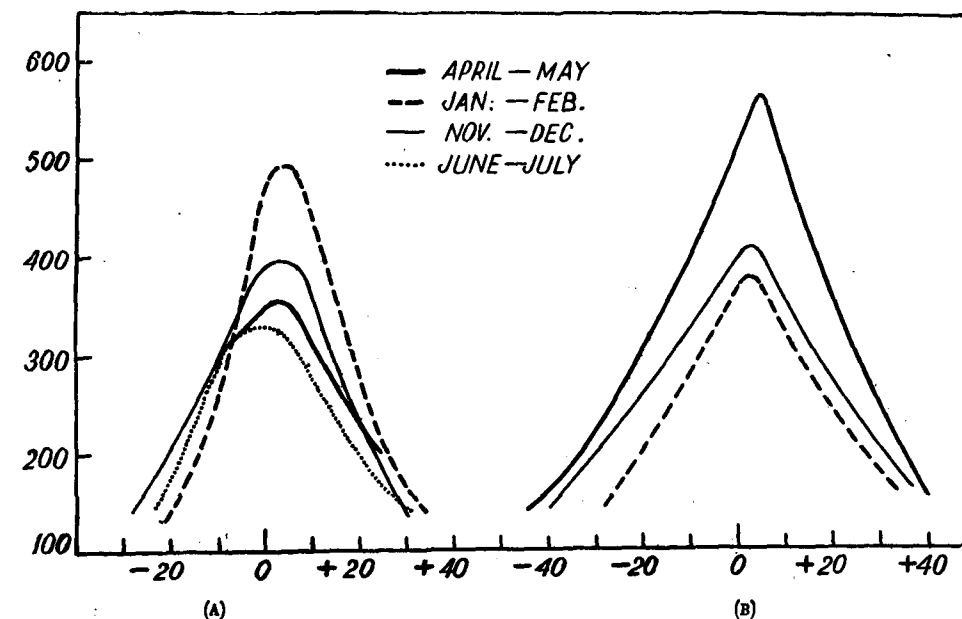


FIG. 4. SECTIONS ACROSS (A) THE MORNING AND (B) EVENING ZODIACAL LIGHT AT LONGITUDES 300° AND 60° RESPECTIVELY FROM THE SUN, FOR DIFFERENT SEASONS OF THE YEAR. It will be noticed that the evening zodiacal light has the greatest intensity in April-May and least intensity in Jan.-Feb. The reverse is the case for the morning zodiacal light. The ordinate gives the intensity in units of tenth photographic magnitude per square degree of the sky, the abscissa marks the latitudes.

evidence of the zodiacal matter itself emitting the lines and the bands of the night sky. This raises an interesting point. It is well known that the night sky light has irregular as also regular nocturnal and seasonal variations of intensity. In view of the fact that the zodiacal light in reality extends over the whole sky it is possible that the observed irregular variations of the night sky are due to the irregular variations of zodiacal light intensity already referred to. Similarly the nightly and the seasonal variations of the night sky intensity may be related to the nightly and seasonal variations of the zodiacal light pyramid and its associated extension.

Comparative study of the polarisation of light from regions of the sky in the zodiacal cone and from regions outside it has been made by Dufay¹². It is found that while 15 per cent. of the light from the zodiacal cone is polarised, only 2 to 4 per cent. of the light from the night

which is the ratio of the minimum to the maximum of light transmitted through the analysing nicol when it is rotated in the line of sight. (The region of the night sky observed was in the meridian towards the north, while that for the zodiacal cone was necessarily in the region of the ecliptic). The upper curve is for night sky and the lower curve for the zodiacal light. The stronger polarisation of the zodiacal light is evident from the figure. It will be noticed that the general trend of its variation is similar to that of the night sky light. It has, therefore, been suggested that the polarised component of the night sky light is only an extension of the zodiacal light.

Attempts have been made to find out the distance at which the zodiacal light originates by measuring its parallax¹³. This has not been successful as no parallax could be detected. The same remark applies to the gegenschein. According to some authors this

⁴ F. Schmid, *Gerlands Beiträge z. Geophysik*, Vol. 45, 1935.

⁵ Hulburt, E. O., *Phys. Rev.*, 35, 1098, 1930.

⁶ Hulburt, E. O., *Phys. Rev.*, 34, 344, 1929.

⁷ Elvey and Roach, *Astrophys. Jour.*, 85, 233, 1937.

⁸ E. A. Fath, *Lick. Obs. Bull.*, 5, 141, 1909.

⁹ K. R. Ramnathan, *Nature*, 280, Feb. 20, 1932.

¹⁰ D. Evopkin and N. Kozivew, *Poulkovo Obs. Cir.*, No. 13, 21, 1935.

¹¹ V. M. Slipher, *Lowell Observatory Circular*, Feb. 20, 1931.

¹² J. Dufay, *Jour. de Physic et le Rad. Sere*, VI, tx, 209, 1929.

¹³ Scarle, *Astrophys. Jour.*, 8, 244, 1898.

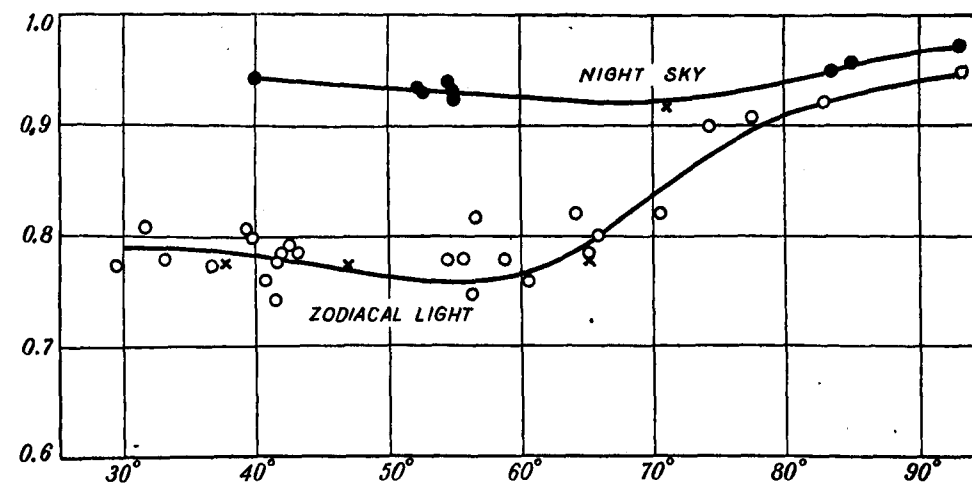


FIG. 5. COMPARISON OF THE POLARISATION OF THE ZODIACAL LIGHT WITH THAT OF THE NIGHT SKY.

[Note that the zodiacal light is much more strongly polarised than the night sky. Proportion of polarised light is equal to $\frac{P-1}{P+1}$ where P is the depolarisation factor. See text. (After Dufay).]

absence of parallax shows that the origin of zodiacal light and gegenschein must be at great distances from the earth beyond the orbit of the moon or even further away. We will presently see, however, that the absence of parallax may be only apparent, being masked by other effects.

(To be continued)

A MESSAGE FROM EINSTEIN

In his message on the Common Language of Science, sent to the Conference in London on Science and World Order, Professor Einstein concludes:

'The supra-national character of scientific concepts and scientific language is due to the fact that they have been set up by the best brains of all countries and all time. In solitude, and yet in co-operative effort as regards the final effect, they created the spiritual tools for the technical revolutions which have transformed the life of mankind in the last centuries. Their system of concepts served as guide in the bewildering chaos of perceptions so that we learn to grasp general truth from particular observations.

'What hopes and fears does the scientific method imply for mankind? I do not think this is the right way to put the question.

'Whatever this tool in the hand of man will produce depends entirely on the nature of the aims alive in mankind. Once these aims exist, the scientific method furnishes means to realize them. But it cannot furnish the aims themselves. The scientific method itself would not have led to anything, it would not even have been born at all without a passionate striving for clear understanding. Perfection of means and confusion of aims seem, in my opinion, to characterize our age. If we desire sincerely and passionately the safety, the welfare, and the free development of the talents of all men, we should not lack the means to approach such a state.

'Even if only a small part of mankind strives for such an aim, their superiority will prove itself in the long run.'

—With acknowledgment to M. S. N.

Mineral Policy in India

A SYMPOSIUM was organised by the sections of Geology and Geography of the Indian Science Congress, Baroda session, 1942 and both official and non-official experts took part in it. It is hoped that the India Government would give this discussion a careful consideration and would chalk out a suitable mineral policy of a far-reaching character for the proper development of industries based on mineral wealth of this country.

In opening the discussion Dr J. A. Dunn of the Geological Survey of India outlined the following points regarding the future mineral policy for India:

- (1) India's mineral industry is not backward and has not lagged far behind the capacity of the market to absorb production.
- (2) Mineral rights should preferably be vested in Government.
- (3) Rents and royalties should be at such rates as will provide Government with the maximum return for the depletion of the country's wasting assets, but yet will not bear unduly heavily on the miner.
- (4) Mining leases should be governed by certain conditions. Leases should be preferentially allotted:
 - (a) To those who will treat the minerals in India.
 - (b) To those with considerable capital who can work the deposits efficiently.
 - (c) Certain deposits should never be mined, such as float iron-ores, which on working, occasion greater damage to forests than the value of the deposits is worth.
 - (d) Certain rather rare deposits should be withheld from mining for a while until related industries, when developed, make them usable in India.
- (5) The domestic treatment of mineral raw materials should be encouraged as far as possible.

- (6) Prospecting might be stimulated by offering a small bonus to villagers for new finds.
- (7) Research on the industrial development of a long series of minerals should be encouraged.
- (8) Statistics of mineral production should be more complete.
- (9) A bureau of mineral information should be established.
- (10) There should be a closer co-operation between Government, industrial and university geologists.

Dr Dunn pointed out that during the last year the outlook of people throughout the free world changed considerably and that there was a tendency to think internationally rather than nationally. He concluded by saying that it would be almost futile to discuss the details of possible post-war policy regarding India's mineral raw materials and that the time for detailed discussion of India's future international mineral policy should await the emergence of the post-war international political framework.

Mr E. R. Gee of the Geological Survey of India recommended the following points regarding the mineral policy:

- (i) The acquisition of the mineral resources by the state, exploitation being left in most instances to firms and individuals.
- (ii) Limited state control over exploitation to ensure efficient working, a high standard of labour conditions and prevention of waste.
- (iii) Advice and assistance by the State, by the financing and encouragement of mineral and industrial research.
- (iv) Cheap internal freight charges in the case of ores and fuels.

According to Mr Gee, the above measures would not entail nationalisation, they would merely anti-

cipate a greater measure of Government control, guidance and assistance. He also tried to impress upon the members that it would be a short-sighted policy to limit the export of many of India's minerals except perhaps in extremely rare cases of proved immediate national necessity. Finally he strongly advocated for the introduction of cheap internal freight charges in case of ores and fuels. Such a measure would in all probability render unnecessary the imposition of tariff, bounties etc. and would incidentally tend towards greater conservation.

Mr N. N. Chatterjee of the Calcutta University in his speech suggested that in order to initiate and encourage proper and healthy development of mineral resources of this country India should have a *National Mineral Policy* and that there should be a central organisation like the National Research Council of other countries. The Board of Scientific and Industrial Research may be empowered to function in that way. With regard to the proper functions of the National Mineral Policy the following points need careful consideration:

(1) Reserves of mineral wealth together with their qualities to be more accurately determined. To procure all possible data on the subject. The present staff of the Geological Survey of India would rather seem to be inadequate and the Government may be moved to expand the department to cope with the work. The Provincial Governments should also take adequate measures to carry out mineral survey work.

(2) Conservation of mineral wealth. The process of conservation includes two important aspects:— (i) maximum extraction and (ii) proper and efficient utilisation. In order to effect proper and efficient utilisation the various physical and chemical characters of coal and other economic minerals should be definitely known. To initiate series of investigations on coal and other minerals, the Board of Scientific and Industrial Research, recently started by the India Government, should organise two separate research stations to be directly under respective expert bodies, namely, Fuel Research Board and Mineral Research Board.

It was suggested that the Fuel Research Station should be immediately started and located at the Alipur Test House where necessary equipment and staff were already existing and further expansion

might be made at moderate cost. The Mineral Research Station should be allowed to develop in the Geological Survey of India laboratory and the important properties together with the methods of concentration, improvement etc. of the ore and gangua minerals should be studied in each and individual case. State control and intervention would sometimes be necessary to discourage malpractices of utilisation and the export of many important mineral raw materials to other countries. The wasteful process of mining should be checked and more efficient and improved methods should be introduced in coal and other metal mines so that maximum extraction of mineral wealth might be effected.

(3) Government should give impetus to the enterprisers to start suitable industries in India based on mineral wealth. The domestic industries should receive help and protection, if required, to stand against unfair competition from abroad.

(4) There should be one well-planned and permanent "Central Marketing Board" for ensuring systematic mineral development and greater expansion of mineral trade.

(5) The rules and regulations governing grant of prospecting licenses and mining leases to the companies or individuals in different parts of British India and the Indian Native States should be carefully reviewed and scrutinised and they should be revised and placed on more rational and uniform basis than what are prevalent today. The question of fixing royalty rates of the different mineral properties should also be discussed and the rate and scale of fees should be placed on equitable and fair basis. It was suggested that like the Mines Act, the regulations regarding grant of prospecting licenses and mining leases of mineral properties should be in charge of the Central Government so that the rules could be applicable equally to all the places in British India. The properties lying in the Indian States should also be guided by almost similar regulations and the state authorities should, therefore, be persuaded to adopt similar measures to avoid confusion and irregularity in mineral business. This scheme, if successfully functioned, would surely lead to a healthy and fair competition amongst the enterprisers engaged in the line of mineral industry in different parts of this country.

Dr V. S. Dubey of the Benares Hindu University in his written communication mentioned that in

framing the mineral policy the following points should be considered:

(1) Organisation of State Agencies for mineral development. All provinces and States should start mineral departments.

(2) Industries for national defence.

(3) The question of Mineral Tariff. There should be stoppage of the export of key minerals out of India.

(4) The question of labour and transport.

(5) Mineral conservation. The question of waste during process of mining in oilfields, metalliferous mines and non-metalliferous mines should be carefully tackled.

(6) Mineral taxation in different provinces needs to be critically reviewed and revised.

(7) Rules and regulations about mining and prospecting should be revised.

(8) Ownership and control of mineral industries. The key minerals like coal, petroleum, iron and steel, aluminium and copper should be under the control of the Federal Government, while other smaller deposits should be controlled by Provincial Governments.

Messrs C. Mahadevan and Syed Kazim of the Hyderabad Geological Survey suggested in their written statements that for the industrialisation of the country the fundamental requirements would be to obtain correct knowledge of her mineral potentialities, the regional distribution and the location of her industries with a view to taking the best advantage of the available raw materials. It would be necessary to nationalise at least the key industries. India can ill afford to export certain raw materials to other countries if she has to find her due place amongst progressive nations.

N. N. Chatterjee

NO TRUE "DRY ROT"

There is no real "dry rot" that attacks wood and causes it to decay. Wood must contain more than 20 per cent of moisture before fungi can grow on it. What is ordinarily called "dry rot" is caused by one of a few species of fungi that grow rootlike strands that serve as pipelines through which they draw into dry wood the water they must have to live and to destroy the wood. These rootlike strands must reach moist soil or some other source of moisture if the "dry rot" is to cause decay of the wood, say U. S. Department of Agriculture scientists who have studied the various forms of wood destruction. Wood kept dry, they emphasize, is a permanent building material. One way to prevent decay of wood is to inject into it preservative chemicals that prevent fungus growth. The other way is to keep it dry so that fungi cannot live. Even the "dry rot" fungi cannot develop if water can be kept beyond their reach.

—Journal of the Franklin Institute

Indian Opium : Its Principal Groups of Chemical Constituents

JITENDRA NATH RAKSHIT

H. B. DUNNICLIFF¹ in his paper on "Chemistry of Indian Opium" has insufficiently treated important chemical aspects of the valuable drug, for example, total alkaloids. In this article some of these aspects will be dealt with.

The natural synthesis of various constituents of opium has been found to be influenced by many factors. H. E. Annett² classified environmental and non-environmental factors which influence the constituents and yield of latex. Environmental factors are: (i) the number of capsules on the plant, (ii) the age of the capsules, (iii) manures, (iv) starvation and (v) climate, season, and weather conditions.

Non-environmental factors are: (i) the method of extraction of latex, (ii) successive lancements, (iii) the latex at different periods of time after incision and (iv) the method and time of lancing.

The various constituents of opium may be broadly grouped as follows: (a) microbes, (b) enzyme, (c) gums and resins, (d) carbon compounds, whose chemistry has been ascertained and (e) inorganic radicals.

The microbes, enzymes, gums and resins present in opium have not been much investigated. The constituents which have been somewhat investigated are: (1) *gases*—Carbon dioxide, nitrogen and oxygen; (2) *non-basic carbon compounds*—ethyl alcohol, sugar, lactic acid, meconic acid, and wax; (3) *bases*—ammonia, and substituted ammonium bases; (4) *inorganic radicals*—SiO₂, P₂O₅, SO₃, CaO, K₂O and Fe₂O₃, Al₂O₃.

H. B. Dunicliff¹ did not notice gaseous constituents of opium, and these should not be overlooked in alkaloid synthesis in plant products. The complex mixture of final chemical compounds in opium is a result firstly of purely chemical reaction—(i) oxida-

tion, (ii) reduction, and (iii) polymerization; and secondly of biochemical reactions—(i) bacteriological, (ii) fungal, and (iii) enzymatic. Experimental facts seem to be in favour of a suggestion of fixation of atmospheric nitrogen in the milky exudation from poppy capsules.

The following gases were found in opium.

Sample	Carbon dioxide % w/w	Oxygen % w/w	Nitrogen % w/w
Standard Indian opium or Government Excise opium, 1940 ...	0.0350	0.0284	0.0502
Government Excise opium, 1941 ...	0.0368	0.0290	0.0514
Government Medical opium powder, 1941 ...	0.0160	0.0114	0.0380

Medical opium powder, when heated to render it powder, is expected to have lost all or most of its occluded gases and probably absorbs air again when cooled down, therefore the proportion of nitrogen and oxygen was closer to that of ordinary air. Indian standard opium is a natural drug which contains the two gases in altered ratio.

Combustible gas.—A search for combustible gases like hydrogen, methane etc., was made in the nitrogen left after absorption of oxygen, by passing through red hot furnace duly charged for the purpose of organic combustion analysis. This portion of gaseous constituents did not suffer any loss in volume, indicating total absence of any combustible gas.

Hydrocarbon complex.—In examining opium wax³ some proportion of unsaponifiable matter was found. J. N. Ray also confirmed presence of

hydrocarbon fraction but no paper has yet been published by him on the subject.

Ethyl Alcohol.—When medical opium cake or standard Indian opium was distilled with 10 times of its own weight of water, the first few drops of the distillate sometimes indicated probable presence of ethyl alcohol by iodoform test. In most cases formation of iodoform was very minute. Presence of acetone was not detected in any case, because no distillate was found to give iodoform test using lime water⁴ in the place of sodium hydroxide.

Acetic Acid.—Ten grns. of opium sample were distilled with 200 ml. of water to collect about 170 ml. of distillate. This distillate was successively re-distilled twice each time rejecting about 10 ml. in the distilling flask. Presence of acetic acid was confirmed by qualitative tests as well as by conversion into silver salt and determination of silver in it. Exact percentage of acetic acid in opium was not determined because lactic acid contained in the drug was also partly distilled with water.

Lactic Acid.—Occurrence of lactic acid in opium was known and it was found in all samples examined for the same. It is noteworthy in connection with researches on natural products containing lactic acid that it was found to distil slowly with steam. A separate paper on the subject will be published afterwards.

Meconic Acid.—Meconic acid may be estimated by the method outlined by H. E. Annett and M. N. Bose.⁵

Sugars.—Natural opium contains a certain quantity of organic matter which reduces Fehling's solution,⁶ but its isolation by precipitation, by extraction or by conversion into its derivatives of ozazone, semicarbazone, or phenylhydrazone was found unsuitable. For the determination of sugar in opium titration with Fehling's solution after removal of the bulk of the alkaloids seemed to be the only practicable method. Average Indian opium contains 2.9 per cent. before inversion, and 3.1 per cent. after inversion reducing substances expressed as sucrose.

Opium Wax.—This constituent of opium was isolated and analytical constants were determined in 1918³. Its percentage was conveniently determined.⁶ An average Indian opium contains about 12 per cent. wax.

AMMONIA AND SUBSTITUTED AMMONIUM BASES

Occurrence of ammonia and probably of substituted ammonium bases was noticed in 1917⁷. It contains 0.3 to 0.2 per cent. ammonia in opium. The products, however, were found to be contaminated with some carbonaceous matter which was suspected to be substituted ammonium bases.

IMPORTANT ALKALOIDS

(A) MORPHINE

Among the alkaloids present in opium, morphine is the most valuable in medicine. Consequently its estimation in the drug was considered important and various methods were adopted by various investigators. The following are prominent:—

(1) *Precipitation or lime process.*—This method was adopted in old and new pharmacopoeias. It does not deposit pure morphine⁸ and correction suggested to compensate the alkaloid left undeposited in the mother liquor is actually too high.⁹ It was proposed that 0.66 gm. per 100 gm. of dried opium be added for the correction of results obtained by the calcium hydroxide method for the determination of morphine.

(2) *Polarimetric method*¹⁰.—It was based on specific rotatory power of morphine in acid solution when separated from other bases. It gave quite reliable results, when the drug is not mixed up appreciably with interfering substances.

(3) *Iodic acid method*¹¹.—Liberation of iodine from iodic acid by morphine was tried for the estimation of morphine. A colorimetric method by extraction of the liberated iodine by means of chloroform or carbon disulphide originally proposed by Proctor and Stein¹² was found unsatisfactory in Indian laboratories probably due to atmospheric heat and light. Another colorimetric method of estimation of morphine by means of iodic acid and ammonia¹³ was also found to be not as reliable as the titration method. When a solution of morphine was treated with an excess of iodic acid in the presence of dilute sulphuric acid, the oxidation of morphine was found to be quantitative, two molecules of morphine absorbing three atoms of oxygen, —2. C₁₇H₁₉NO₃ + 3O = (C₁₇H₁₆NO₃)₂O₃. The method is specially suitable for determination of morphine in ampoules, which are so widely used now.

(4) *Colorimetric method*.—Colorimetric methods of estimation of morphine are not expected to give dependable results in India. A method was recommended in B. P. 1932, p. 128, for estimating the presence of morphine in codeine. Although this method was found to be the best of all colorimetric methods, it did not give sufficiently reliable results for purposes other than limit testing.

Basing on unreliable data obtained by faulty B. P. method^{8, 9} of analysis of morphine in opium, H. B. Dunncliff and his co-workers¹⁴ recorded a conclusion "opium dried at 60°C stored in contact with air suffers a rapid loss of morphine", which cannot be supported because standard Indian opium or Excise opium containing 10 per cent. moisture is, as a rule, in considerable part, dried at about 60°C, distributed all over the country, and even so it keeps its morphine strength 9.5–10.5 per cent. in dry matter fairly uniform for many years. The stability and unstability of morphine in natural opium are expected to be discussed in a subsequent paper.

(B) CODEINE

Among the opium alkaloids codeine is next to morphine in importance. It is very valuable therapeutically, and Indian opium containing higher percentage of it should make the natural product more useful. Several methods of estimation of this base in opium have been worked out but the method described in the *Analyst*¹⁵ gave uniform results in the author's laboratory.

(C) NARCOTINE

Indian opium is also rich in narcotine. The method described in the *Analyst*¹⁶ gave satisfactory results for many years.

(D) PAPAVERINE

Indian opium was always found to contain some papaverine. No satisfactory method of its direct estimation was worked out. Results of comparative value can be obtained by a method outlined by Annett and Bose.¹⁶

(E) TOTAL ALKALOIDS

In India opium is widely used as a household remedy. Its therapeutic effects are entirely due to joint reactions of all alkaloids present in the drug. Consequently determination of total alkaloids seems quite advisable. The determination of total alkaloids⁸ consists essentially of three processes: (1) the preparation of a solution containing all the alkaloids present in the sample; (2) precipitation of some of them by a suitable precipitant; and (3) recovery of the bases left unprecipitated in the mother liquor. Average Indian opium contains about 24.6 per cent. alkaloids precipitated by sodium carbonate, and 15.0 per cent. extracted by chloroform-alcohol mixture, making a total of 39.6 per cent. of the dried drug.

INORGANIC CONSTITUENTS

Annett and his co-workers¹⁷ found that simultaneously with the fall of morphine contents of the latex calculated on the dry matter in each successive lancings of the same capsule, there is a rapid rise in ash constituents. Such ash consists of SiO_2 , P_2O_5 , SO_3 , CaO , K_2O , Fe_2O_3 and Al_2O_3 . It is possible that there is a physiological connection between the rise in ash constituents and the fall in organic bases.

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The Late Rai Bahadur Sarat Chandra Roy

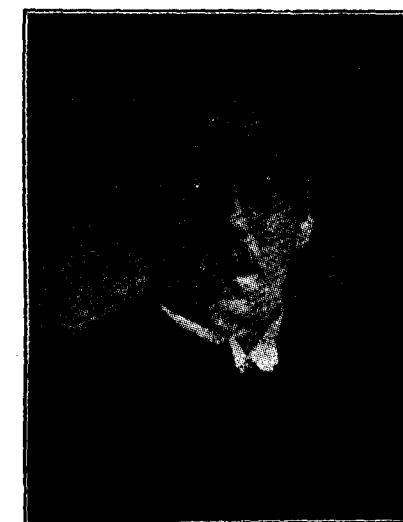
MANY forms of learning are the poorer in India today for the death of Rai Bahadur Sarat Chandra Roy, best known as an anthropologist and the founder-editor of *Man in India*, a quarterly journal of anthropology and archaeology. The students of Indian anthropology are deeply indebted to Rai Bahadur Sarat Chandra Roy for the light that he has thrown on the past and present culture of the Chotanagpur plateau where most of his researches were confined to. Roy was a pioneer in the cause of anthropological teaching and research in India. Dewan Bahadur L. K. A. Iyer and Roy were the two outstanding personalities in the anthropological field whose contributions have raised the status of Indian anthropology.

Sarat Chandra Roy was born in an orthodox Kayastha family of 24 Pergannahs, Bengal. He received his early education at the City School, Calcutta and in 1892 he graduated with Honours in English literature from the General Assembly's Institution (now Scottish Church College), Calcutta. A year after, he obtained his M.A. degree and in 1895 he passed his final law examinations. Two years later Roy joined the Alipore Bar as a pleader. When the Chotanagpur Judicial Commissioner's Court was opened, the colourful stories he heard about the life and customs of the aboriginal people attracted him to that country and soon he transferred himself to Ranchi and started practice there.

During his early career as a pleader at Ranchi Roy was struck by the hardships and oppressions of the aboriginal people. Tribal customs and usages were often at variance with the complicated system of law and legal procedure obtained in the British system of justice and the tribal people had to encounter much difficulty due to the fact that although the judges and magistrates might be inspired to do justice, they could not do so, as they were not conversant with the dialects, customs and mentality of the people. The exploitation of the tribal people by alien officers, money lenders, itinerant vendors of foreign merchandise, the excise vendors and last but not the least, by the landlords and their agents excited Roy's keen and sympathetic interest and soon directed him to the study of the Munda language. Through its medium he recorded the various details of their social organisation, economic life, laws of succession and inheritance and their religious ex-

perience. The scientific presentation of data on the tribal life of the Mundas soon established him as an authority on the Mundas and this was a landmark in his career.

The Provincial Government recognised the talents of this lawyer-scientist and encouraged him to pursue his investigations. With the financial help given by the Government from time to time he published several monographs on the tribes of the Chotanagpur plateau, each monograph being more perfect than its predecessor. His book on the Oraons, a primitive tribe of the Dravidian linguistic family revealed the similarity with primitive cultural



life, while bringing out also the minute differences that exist between the Oraons and the Munda speaking tribes of the area. While the Mundas were early immigrants into the Ranchi district, the Oraons formed a wedge between them and the tolerance of the Mundas and the subservience of the Oraons to the former, did not encourage any hostility to their settlements. It is among the Oraons that Roy found a well-organised and efficient system of dormitory life and discipline which he recorded with wealth of details.

Roy's monograph on the Oraons (1916) was followed by one on the Birhors (1925) and another on the Hill Bhuiyas of Orissa (1935). The last two tribes, though partaking of the same culture pattern, afforded some contrast to the Mundas and the Oraons both of whom had come into contact with

alien and highly developed cultures, missionary influence and caste hierarchy. In 1928 Roy published his monograph on *the Oraon Religion and Customs* in which the materials of tribal religion were admirably set forth. It must be noted here that Roy was never a theoriser or a partisan. His is a faithful presentation of every phase of life and thought of the people he described and his inspiration came straight from the hearts of the simple folk with whom he made friends. How far this was true was seen by us in 1923, when some of us, then students of anthropology at Calcutta visited the Munda country with Dewan Bahadur L. K. Anantakrishna Iyer, Reader in Anthropology, Calcutta University. We visited hamlet after hamlet, we went into the interior villages of the Munda country, we enquired about the intimate social life of the people and everywhere we visited we felt the invisible presence of Roy. Every village we passed through we were greeted with shouts of 'Sarat Babu Ki Jay'. It is no wonder that Roy represented the tribal people of his district in the Bihar Legislature for successive terms.

In 1937 in collaboration with his son Mr R. C. Roy, he published two volumes on the Kharias, another little known jungle tribe of the same cultural area. Dr R. R. Marett who wrote a brilliant introduction to this work described it as 'a model of how such research should be conducted'. The achievement of Roy in the field of anthropological research was not based only on the scientific character of his investigations, the meticulous care with which he selected his data and the interest these have for the specialist, but on the simple and non-technical language in which he described every phase of life and thought of the people, their folklore, myths, dances, music, amusements, games and other recreations of daily life and all these appeal to the general reader, laymen and specialists alike.

As a prehistoric archaeologist, Roy has done much to be remembered. He had opened up new grounds on the prehistoric antiquities of the Province, the detailed accounts of which are to be seen in the pages of the Bihar and Orissa Research Society's Journal. He has explored many prehistoric sites in Chotanagpur known as 'Asura' sites and the rich collection of antiquities he has dug up will always remain a monument to his scholarship and resourcefulness. His admirable description of the savage and prehistoric crafts, the wonderful examples of primitive handiwork, has amplified the geographical and ethnographical distribution of each type or specimen and the future student of prehistoric archaeology will

realise how his masterly pen has pictured the great contributions of savage culture to the store of our common knowledge.

Like the Dewan Bahadur L. K. A. Iyer, Roy never missed an opportunity to talk on the value of anthropology to those interested in social matters. He deeply regretted the indifference to anthropological studies in India. It is true that in all countries, anthropologists had struggled hard to secure practical recognition of the claims of anthropological studies but though the apathy on the part of the public and lack of active help from the Government have been conquered in Great Britain and America, India has not shown much concern for anthropology. While not less than 15 Universities in Great Britain provide instruction in one or more principal departments of anthropology, of the 19 Universities in India, only the Calcutta University provides full course instruction in anthropology. Since the inauguration of the Anthropology Department at the Calcutta University for which he had worked pretty hard, Roy was in touch with the academic work at the University and was an examiner in all the examinations of the subject. This brought him into fresh contact with undergraduates and graduates and also with those who chose a career in anthropology and his personal interest in the students was repaid by enduring friendship and occasional visits by them to his house which is a museum of rare specimens.

Only a week before his death, Roy was presented with a Volume of Essays in anthropology by his colleagues in India and abroad, a richly deserved tribute to his faithful devotion to the cause of Indian anthropology. The publication of the *Mundas and their Country* (1912) was followed by a shower of honours. In 1913 he was awarded the Kaiser-I-Hind Medal for his literary and public services. In 1919 he received the title of Rai Bahadur. In 1920 he was elected an Honorary Member of the Folklore Society of London. In the same year, he was elected President of the Anthropology Section of the Indian Science Congress and in 1933, of the All-India Oriental Conference. He was long connected with the Patna University as a member of the Senate and was a Foundation Fellow of the National Institute of Sciences, India. For over two decades he edited *Man in India*, the quarterly journal of Anthropology which has a recognised status among the scientific organs of the world.

D. N. M.

Notes and News

OBITUARY

SIR JOSEPH LARMOR

SIR JOSEPH LARMOR, F.R.S. was born in 1857 in Northern Ireland, and took his mathematical tripos at Cambridge in 1880. Larmor was senior wrangler of his year, while Sir J. J. Thomson was second. After serving some years as a lecturer in Mathematics at Cambridge, Larmor became Lucasian Professor in 1903. His researches are on mathematical physics and extend over thermodynamics, electrodynamics and electrical properties of ether and matter. Larmor will be best remembered for his theory of the influence of magnetic field on spectral emission, a thesis which he published almost simultaneously with Lorentz's alternative treatment of the same subject. The idea of magnetic atoms precessing about the axis of the external field (Larmor-precession) has survived the wreckage or oblivion of his highly speculative theories of ether and matter and has found an honoured place in quantum theory. In 1924, Larmor was attracted to the problem of the ionosphere, and made fundamental contributions. Larmor also collected and edited the works of Cavendish, Fitzgerald, Kelvin, Stokes and J. J. Thomson, and represented the Cambridge University in the Parliament as a Unionist member from 1911-'22. He was elected to the Royal Society in 1892 and was Secretary from 1901-'12.

DEATH ROLL OF ROYAL SOCIETY

THE obituary notices of the Fellows of the Royal Society (1941) show a heavy loss of not less than 29 Fellows in course of the year. Amongst these, occur names of very distinguished leaders in science and technology—Sir J. J. Thomson (84) and Sir Oliver Lodge (89), physicists, whose obituary notices appeared in *SCIENCE AND CULTURE*; Lord Cadman (64), who was professor of oil technology in the University of Birmingham, chairman for a time of the Department of Scientific and Industrial Research, and rose to be

the chairman of the board of directors of one of the biggest companies in the world, viz., the Anglo-Iranian Oil Co., and of the Iraq Petroleum Co. It is said of him that he found the oil industry empirical, and left it scientific; Sir Robert Hadfield (82), the famous metallurgist, who discovered ferro-manganese alloy steels, and made a special study of the famous iron-pillar of Delhi; Sir A. Evans (90), famous archaeologist who brought a new world of culture to view by his excavation of Knossos in Crete and discovery of the Palace of King Minos, famous in Greek mythology; Sir J. G. Frazer (87), a lifelong student of ancient religious beliefs and superstitions who showed us that man had hardly been rational in his beliefs and outlooks; Sir A. C. Seward (78), palaeobotanist; Prof. MacBride (74), zoologist; Prof. Thorpe (67), organic chemist, all of them teachers of a number of eminent Indian scientists.

BICENTENARY OF THE DEATH OF EDMOND HALLEY

EDMOND HALLEY, the second Astronomer-Royal, died two hundred years ago at the age of 86 on January 14, 1742. Fourteen years junior to Newton, he enjoyed the latter's lifelong friendship, and was in fact responsible for the discovery of Newton's 'Principia'. The story is thus told in the *Sky and Telescope* of March, 1942.

It is often said that Halley's greatest discovery was the 'Principia'. For about half a century there had been much discussion in scientific circles as to what force held the planets in their orbits and how it varied with distance from the sun. Kepler seems to have had a glimpse of the inverse square law in 1620. By 1684, confidence in its validity was growing, but no rigorous demonstration was forthcoming. Halley, Hooke and Wren became interested in the problem, and Wren finally offered a prize of a book worth 40 shillings to either of the other two, who could furnish him with a satisfactory demonstration within two months. Hooke claimed he could

give the solution, but never gave any proof. Halley was frankly unable to solve the problem, and after seven months decided to visit Cambridge and put the question straight to Newton.

"What will be the curve described by the planets on the supposition that gravity diminishes as the square of the distance?"

Newton replied without hesitation, "An ellipse."

"But how do you know?" asked Halley.

"I have calculated it", said Newton, and he began searching for his calculations. These he could not find at the time but he sent them to Halley in London in November, and the latter communicated them to the Royal Society early in 1685.

Halley pressed Newton to a fuller account of his discoveries, and as soon as they were forthcoming the question arose as to whether the Royal Society should finance their publication or not. However, that distinguished body was financially embarrassed at that time, and the work was ultimately published with the approval of the Royal Society at Halley's own expense.

Halley is equally distinguished for his work on meteorology, geology and oceanography, but his fame mainly rests for his work on astronomy. He is best known for the comet known after his name, which returns periodically every 75-76 years (last appearance 1910). The comet appeared in 1682 and engaged Halley's attention. Before his time, comets had from time immemorial been considered as evil omens or portending some calamitous event affecting the whole or large sections of mankind. Nobody knew where they came from, and whither they went. Halley thought that they must be regular members of the solar system, and was able to prove from previous records that the same comet had appeared in 1305, 1380, 1456, 1531 and 1607. The comet, therefore, moves round the sun in a period of 75 or 76 years. He predicted that the comet would return in 1758, 1835, and 1910. The prediction was fully verified when the comet appeared on the Christmas day in 1758, again in 1835 and 1910. It will again appear in 1985, but, we are afraid, few of the readers of SCIENCE AND CULTURE will live to witness that event.

Halley thus disproved completely the catching theologo-astrological view that comets portend divine displeasure, and established that they are law-abiding members of the solar system, illustrating the truth of the law of Universal Gravitation.

FRONTIERS OF GEOLOGICAL RESEARCH

DURING the celebration of the fiftieth anniversary of the University of Chicago a number of symposia dealing with the frontiers of geological research were held with the co-operation of the Geological Society of America and the American Association for the Advancement of Science. The first symposium dealt with the structures, properties and occurrence of clay materials and their practical applications. Dr Grim of the Illinois Geological Survey reviewed the old ideas of the composition of clay materials and the researches of the last fifteen years that have led to the present generally accepted concept that clays are composed essentially of minute crystalline particles of one or more members of a few groups known as clay minerals. Prof. W. P. Kelley of the University of California reviewed the importance of clay researches to modern agriculture and emphasised the close relationship between soil, science and geology. Dr Hans F. Witerkom of the University of Missouri pointed out the importance of clay research in engineering construction, particularly of highways and dams, and the use of base-exchange and other methods for stabilizing such constructions. The second symposium dealt with the physical constitution of coals and their practical significance. Dr G. H. Cady of the Illinois Geological Survey pointed out that a satisfactory classification of coals into types must rest upon an understanding of the physical and chemical properties of the primary components of coal—vitrain, clarain, durain and fusain. Increased knowledge of these components has led to the important practical result that it is now possible to synthesise coals or modify them to conform to petrographical specifications. Recent progress in Britain in the study of coals was reviewed by Prof. C. E. Marshall of the University of Birmingham who emphasised the increasing importance of microscopic study of both the plant and the mineral components of coal to its efficient utilisation. George C. Sprunk of the U. S. Bureau of Mines emphasised that in the coking of coals and in hydrogenization, knowledge of the coal components are also of great import. As for example, the portions of coal that are translucent under the microscope are readily hydrogenized and give high yields of liquid fuels whereas components that are opaque are difficult to liquefy. In another symposium related to the search for oil, the rôle of modern surface methods in the search for oil was described by E. W. Owen and the rôle of micro-palaeontology by Prof. Carey Croneis. In speaking of the rôle of ground water in petroleum accumulation Prof. F. B. Plummer of the University of Texas concluded that recent extensive investigations of pore-sizes, of the forces required to move liquid and gas hydrocarbons through them,

of the variation in sub-surface pressures, and of the forces due to interfacial tension, indicate that crude oil droplets cannot move through a porous sand from synclinal position to anticlinal positions by gravity alone. They point to the conclusion that hydrocarbons migrate largely as gas particles and partly as liquid films enveloping gas bubbles, along with the slow downward movement of the ground water towards the lower part of the region and as the tiny gas bubbles come within the influence of decidedly low pressures they accumulate in the trap.

SCIENCE AND WAR EFFORTS

A CONFERENCE was organised by the Association of Scientific Workers of Great Britain on January 10 and 11 for discussing in a practical way the immediate scientific and technical problems associated with the war itself. Men of science fresh from their work in laboratories, factories and research institutions gathered together, put forward grievances and plenty of criticism, and discussed proposals for better co-ordination of research and more effective utilization of technical personnel. The topics ranged from the training of technical personnel and the university education of scientific workers to the organization of maximum productive effort. There were important discussions on the subjects of food, agriculture, housing and A.R.P. Sir Daniel Hall, vice-president of the Association in opening the conference stated that the real problem for scientific workers and the Government was to find the machinery which would ensure a proper method of using the expert. Prof. J. B. S. Haldane pointed out that had many of the recommendations of the A. R. P. Co-ordinating Committees been adopted, not only would there have been an immense saving of life but a saving of materials and money also. Sir John Orr treated nutrition from the point of view of its effect upon the efficiency of the worker, soldier and civilian. He pointed out that considerable increases in food production are necessary to provide a decent standard of health. Dr H. M. Sinclair of the department of bio-chemistry, Oxford emphasised that the primary cause of malnutrition is poverty and the decreased availability of familiar foodstuffs. Sir Daniel Hall outlined a post-war policy for agriculture and called for national ownership of the limited land area of Britain. The session on January 11 was devoted to the place of the industrial and governmental scientific worker in the war effort. Mr E. D. Swann outlined the case for a select committee to investigate the whole question of the utilization of scientific personnel and for the produc-

tion executive to appoint a technical personnel Committee. Prof. H. Levy asked for a place for scientific men in the commands of the fighting forces. The unanimous opinion of scientific workers from a variety of undertakings who took part in the discussions seemed to be that production is being handicapped by lack of scientific training, mismanagement and insufficiency in high places and the spirit of competition between firms. Prof. J. D. Bernal who dealt with the proceedings as a whole stated that attempts by men of science to better the situation would even now meet with opposition from the Government and from industry. In his view the opposition met with by scientific workers during the last few months was equivalent to sabotage. The conference decided to send representations to the ministries of labour and of supply and it is hoped that the serious facts which came to light during discussion would be considered by these ministries.

INTER-UNIVERSITY BOARD, INDIA

THE Annual Report for 1941-'42 gives a brief review of the action taken on the resolutions passed at the annual meeting of the Board held at Trivandrum in January, 1941. Of the more important resolutions on which some action was taken, mention may be made of a few outstanding ones. A sub-committee was set up for devising ways and means of securing as much uniformity as possible in the subject of study for the Matriculation or the Entrance examination of the Indian Universities and the sub-committee's recommendations were circulated. Another sub-committee was appointed to consider the replies received and there was also a joint meeting of this sub-committee with one formed by the Central Advisory Board of Education in the last week of March, 1942. The opinion of the universities on the desirability of founding an Inter-University Publication Trust Fund to be raised from the contributions of the Indian Universities for the purposes of publishing selected original theses submitted for M.A., M.Sc. and Ph.D. Examinations, was considered by the Board. Various opinions were expressed by the universities upon this matter. Though it was not unreasonable to expect that the universities should be interested in the dissemination of knowledge and that they should welcome the publication of their research work by a central organization such as the Inter-University Board, the publication need not, however, be restricted to these submitted for higher degrees but may extend to all useful knowledge which it is the object of all universities to disseminate.

APPLIED PSYCHOLOGY IN CALCUTTA UNIVERSITY

THE first report on the working of the applied section of the department of psychology, Calcutta University gives a short history of how by the pleadings of some of our leading psychologists for the need of applying knowledge of psychology to actual problems of life and the encouraging support given by Dr Shyamaprasad Mookerjee, the then Vice-chancellor of the Calcutta University, the section came into existence in 1938. The section began to function under the supervision of Mr M. N. Banerji, and of the possible fields where psychological knowledge might be fruitfully applied, only vocational guidance to school children of Bengal was chosen. For this purpose the section was engaged in selecting after scrutiny and trial, tests from amongst those employed by psychologists in different parts of the world. The report will enable the guardians of students and the members of the teaching profession to follow the line of work that is being carried on by the psychology department of the University of Calcutta to put vocational guidance on a firm footing. Suggestions have been made in the report for providing facilities for the training of a sufficient number of suitable persons in order to enable them to carry on the work on a more extended and properly standardized basis. Brief reference to some psychological problems indirectly associated with vocational guidance which have also been tackled by the applied section will be found in the report.

ANNUAL REPORT OF THE INDIAN ECOLOGICAL SOCIETY

THE Indian Ecological Society was inaugurated at Benares in 1941 under the chairmanship of Prof. S. P. Agharkar. For the past few years professional and other scientists in India have felt the need for a common meeting ground where all lovers of nature irrespective of their specializations might come together for synthetic discussion of problem, arising in and affecting all branches of scientific endeavour. The Society's aim of bringing together persons

belonging to all branches of natural science seems to have been fulfilled, as out of its present roll of 72 members, coming from all parts of India, there are 36 botanists, 14 zoologists, 8 foresters, 2 pedologists, 2 meteorologists, 2 geologists, 3 chemists, 3 geographers, 1 horticulturist and 1 naturalist. During the first year of its existence the activities of the Society have been mainly concentrated to (1) organization and enrolment of members, (2) creation of regional centres, (3) efforts for the preservation and protection of nature. The Society has already issued during the year 5 bulletins and expects to issue some more shortly. The first regional centre was inaugurated in Bombay soon after the foundation of the Society. It is proposed to open more new centres in Calcutta, Benares and Ahmedabad in the near future.

G. N. RANGASWAMI AYYANGAR

AFTER a very successful career in the Indian Agricultural Service as the geneticist and millets specialist, Rao Bahadur G. N. Rangaswami Ayyangar, has recently retired as the principal of Coimbatore Agricultural College and Research Institute. After a short term of lecturership Mr Ayyangar joined the Madras Agricultural Department in December, 1912. He was associated with Mr Parnell in his work on rice and cotton. In 1921 he was promoted to the Indian Agricultural Service and appointed to a special post of geneticist and millets specialist which he held till his retirement. The researches of Mr Ayyangar and his co-workers have increased our knowledge on millets. In course of his work at the college he reorganized the department of botany. Mr Ayyangar presided over the agriculture section of the Indian Science Congress in 1932. Mr Ayyangar is an editorial collaborator of SCIENCE AND CULTURE and his methodical work in this connection has been an example to us. On his retirement, we wish Mr Ayyangar many more years of healthy and happy life and let us expect that in his leisure the country in general will be benefited by valuable contributions from his pen.

SCIENCE IN INDUSTRY

ARTIFICIAL TROPOSPHERE

AT the Douglas Aircraft Factory in semi-tropical southern California experiments for bombers operating in the frigid troposphere are carried out in a "Cold room" so that conditions and effects of extreme low temperatures on the various components of high-flying aircraft may be reproduced. At 35,000 feet above sea-level, the troposphere has a practical constant temperature of 67 degrees below zero so that the motors, metals, alloys, plastics and other materials to be used for troposphere flights must be thoroughly pretested at such low temperature conditions. A combination of solid CO₂ and methyl-alcohol circulated by pump through a heat-exchange unit reduces the temperature of a room 14' x 16' x 8' insulated with 12 inches of fire and corrosion-proof spun glass. Engineers study here under polar conditions the behaviour of fuel, oil, hydraulic systems, controls, structural parts, insulation, heating, windshield de-icing devices, bearings, lubrication, tolerances, metal fatigue etc. In the extremely low temperature of the room men work without discomfort wearing sheep-skin garments and wrapping themselves into wool-lined leathered suits surmounted by helmets equipped with ear-phones and a telephone mouthpiece. The suits are valved so that the wearers may breathe air warmed by their own bodies, the large helmets providing ample storage space. The intake is near the floor; the exhaust is located in the helmet dome.

ALUMINIUM FROM CLAY

ALUMINIUM which has attained great importance in national defence construction, forms one of the most common constituents of the earth's crust. The alumina from which it is obtained is found almost everywhere, but the extraction of the ore is so difficult that very large portions of the nearly limitless supply have not been tapped. Alumina exists in the greatest concentration in Corundum which is a comparatively scarce substance. Bauxite which contains as much as 65 per cent. of alumina occurs

in fairly large quantities in various parts of the world. At present most of the world's aluminium is extracted from these ores. Common clay of which the world has practically unlimited supplies, contains 4—5 per cent. of alumina. In abnormal times like these, when importation of bauxite from other parts of the world are beset with difficulties, metallurgists have turned attention to studying methods of getting alumina from common materials like clay. Alumina has a tendency to take on impurities and to extract the same from clay becomes specially difficult because of the necessity of separating the same from impurities like silica or iron. A new process recently announced in U. S. A. offers a comparatively inexpensive way of getting rid of iron and silica from aluminium oxide and of obtaining the pure metal by electrolyzing it afterwards. In this process the ores are roasted to destroy organic matter and reduce contained iron to the ferric state. Boiling with hydrochloric acid produces a high concentration of aluminium chloride with small amounts of ferric, sodium and calcium chlorides. The ferric chloride can be separated with iso-propyl ether and the aluminium chloride freed from its impurities is then heated until it decomposes into aluminium oxide. The metal is recovered from the oxide by the well-known Hall process of electrolysis. This new method involving recovering and regenerating the acid and of separating the iron from the aluminium by the acid became feasible because of the availability of corrosion-resistant synthetic plastic containers.

HIGH FREQUENCY DISCHARGE IN OIL REFINING

THE use of high-frequency discharge in the treatment of hydrocarbons is covered by a patent issued recently in U. S. A. In an old process known as 'voltolisation', electrodes that carry the current into and out of the material were placed close together and frequencies below 10,000 were used. It is now found that when frequencies above 600 megacycles are used, even with one electrode, or with no electrodes but a ring coil, 'startling and unexpected

advantages result', and that dehydrogenation, polymerisation and other chemical reaction can be produced. An advantage of the method is that lower voltages can be used, thus diminishing the insulation and lowering initial and operating costs, and also reducing the danger of spark over.

SILVER FOR CHEMICAL PLANTS

THE advantages of silver as a material for the fabrication of chemical plant are discussed by A. Butt and J. Giacobbe in *Chem. and Met. Eng.* (1941, 4, 8, 12). It has been pointed out that silver has important uses in the manufacture of certain highly corrosive chemicals, where equipment made of other metals would have a short life. With silver at its comparatively low price in America silver-made chemical equipment has become an economic possibility, especially when it is remembered that 60—70 per cent. of the metal can be recovered as scrap. The main objection to the use of silver as a structural material being the high cost, it is necessary to consider whether this can be offset by longer life thus eliminating replacements and repairs and by scrap value. Cost can, however, be greatly reduced in cases where it is possible to use a coating instead of solid construction. Specific corrosion tests have shown that for silver there is little or no corrosion in acetic acid (50 per cent.), aluminium chloride at room temperature, amino-azobenzene, aluminium fluoride, aluminium sulphate, barium chloride at room temperature, cadmium sulphate, calcium fluoride, citric acid, cresol, cupric nitrate, lactic acid, potassium chloride at room temperature, potassium bichromate, potassium chlorate, sodium fluoride and zinc sulphate.

RAPID SOAP-MAKING

DISCOVERY of a way to make soap in fifteen minutes is claimed by Joseph J. Jacobs, of Brooklyn

Polytechnic Institute. Fat is dissolved in kerosene in this process, and solid lye is added to the same. The mixture is then heated to a temperature higher than is now feasible. The lye reacts with the fat in less than fifteen minutes to make soap, and this hot mass of soap and kerosene is then sprayed into a vacuum chamber. Here the kerosene and pure glycerine vaporise off, leaving behind a dry, granular, porous, quick dissolving soap. The kerosene and glycerine are condensed and separated, and the kerosene can then be re-used. The heating costs are about one-twentieth of those of the present methods. It has been claimed that industrial soap and high-grade toilet soaps can be made by this process.

LOW HEIGHT LOCOMOTIVE

IN mining operations a few extra inches of height for the passage of trucks mean the removal of many tons of material. A low height electric locomotive capable of operating with a high tractive effort in the confined spaces of a mine has been constructed by International General Electric Co. of U. S. A. The overall height of this locomotive exclusive of the trolley pulley is only 26 inches and the overall length is 20 ft. 8 inches and overall width is 6 ft. 2 ins. The trolley pole can be adapted to the un-uniform heights of trolley wire by means of compressed air. Air is supplied by an automatically working compressor. The power system of the locomotive has also certain pneumatic controls. Power is generated by motors of 250 volts d.c. which are connected in parallel. Compressed air from electro-pneumatic valves operate the air-powered contactors which directly control the motor circuits. The main controller, of the tramway type, which acts indirectly, completes circuits to energise the electro-pneumatic valves. The speed of this locomotive is 7 miles per hour and the engine is capable of a draw-bar pull of 7500 lb.

Use of Alcohol as Motor Fuel in India

J. L. SARIN

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WITH the rationing of petrol, the use of alcohol as a motor fuel has become a realisable possibility in our country. Alcohol was the premier fuel with which it was tried to operate internal combustion engines when they were first invented. It was in great favour for some time because of its well-nigh universal availability, and its favourable physical and chemical properties. The potential supply and low cost of petrol in Western countries, then a worthless by-product from refinery of petroleum, soon turned attention from alcohol to petrol, and a number of years elapsed before there was again a consideration of alcohol as motor fuel. This was the result of universal trend towards national self-sufficiency. Countries without adequate domestic supplies of petroleum are looking to alcohol, made from the products of agriculture or other indigenous sources. Roughly, the present world consumption of this material is in excess of 200 million gallons per year, and each year important expansions are announced. As usual we lagged behind, and although indigenous supplies of petrol in the country were very limited and raw materials for production of alcohol were super-abundant, we did little in this direction and continued to remain dependent, mostly on foreign supplies of petrol. There were some notable exceptions, e.g., in the province of U. P. and the Indian States of Mysore, Travancore and Hyderabad, but the production of power alcohol in these areas was hardly sufficient even for local requirements of these areas. Our total consumption of petrol in India in pre-war days was about 110 million gallons, and on the average an increase of 9 million gallons was registered every year, while the aggregate annual output of absolute alcohol in the country is about 2 million gallons,¹ and the estimated maximum production capacity of the principal distilleries in India is about 6¼ million gallons of absolute alcohol or rectified spirit (of about 97 per cent strength by volume) annually. Thus there is great room for

expansion, and most of existing distilleries can instal dehydrating plants, once the use of absolute alcohol as fuel for motor cars is enforced by law.

SOURCES OF SUPPLY

The world supply of bulk of the alcohol is manufactured from molasses and from cracked gases from petrol refineries. Other sources are from grain (maize) and potatoes. In Germany where alcohol is used to the largest extent as motor fuel, it is known to be produced from wood waste at a much lower cost. Besides, the price in that country is also less because of State subsidy. In our country, molasses is the most important source. Next in importance is *mohwa* flowers. Grain and potatoes we need hardly use as long as our sugar industry flourishes and supplies of *mohwa* flowers are abundant.

TECHNICAL ASPECTS

Scientific literature is replete with reports of characteristics of alcohol as fuel, and the observations that are given below are based on experimental work done on the subject in different parts of the world. A symposium on motor fuels held under the joint auspices of the Division of Gas and Fuel Chemistry and of Petroleum Chemistry at the 91st meeting of the American Society, and reported in the *Journal of Industrial and Engineering Chemistry* (Sept. 1936, p. 1081) gives very useful information on the subject, and most of the references given in this article are taken from that publication.

TYPES OF ALCOHOL USED

In general, two types of 100 per cent absolute alcohol-containing fuel have been employed. In one, alcohol is the principal constituent, and ordinarily

¹ Chatterji, N. G., *Jour. & Proc. Inst. Chem.*, Vol. XIV, 37, 1942.

alcohol or wood spirit is used. These fuels are especially designed for racing engines of very high compression pressure, and many speed records have been established with such blends. The second type is of greater general interest, since it is designed for use in present-day commercial spark-ignition engines. This type ordinarily contains 5 to 25 per cent of alcohol by volume, and the rest is either petrol alone or in combination with benzene or ether. Alcohol-benzene-petrol blends are reported to be popular in Germany and in England.²

Due to practical non-availability of benzene or its other substitutes *e.g.*, ether etc., the fuel that is of greatest interest to us, is alcohol alone or in blends with petrol, and the remarks that follow would be limited to the fuel of this type.

Absolute alcohol has properties of miscibility which industrial alcohol (denatured rectified spirit) does not possess. It is true that in making motor fuel from petrol and alcohol, 95 per cent alcohol may be used, but only by introducing a third blending component such as benzene, ether or tetraline. Without this third component industrial alcohol does not mix with petrol, while on the other hand absolute alcohol does not require a blending agent, since it is miscible with gasoline in all proportions.³

Alcohol has to be denatured before it is blended and the common denaturants used are kerosene wood alcohol, pyridine, etc.

Absolute alcohol-petrol mixtures are liable to separate out due to light introduction of moisture which is unavoidable both in storage tanks and in the tanks of motor cars. It has been found that the addition of 0.2 per cent of water to blends containing 10 per cent of anhydrous ethyl alcohol would cause separation. This corresponds to the presence of two gallons of water in 1,000 gallons storage tanks, which is not unusual.⁴ In general the addition of water to the extent of more than 1 per cent of the alcohol produces a dangerous situation in winter, while not more than 3 per cent can be tolerated during the summer. These limits apply reasonably well to blends containing 5 to 25 per cent of absolute alcohol. Blends of fuel containing larger percentages of alcohol can hold more water. To overcome this difficulty various blending agents are used which increase the

percentage of water *e.g.*, acetone, cresole, fatty acids, etc.

It will be observed that alcohol used for blending should be essentially anhydrous in order to prevent the separation of alcohol in service. By employing a suitable blending agent the water tolerance of the blend can be markedly increased although alcohol used must still be particularly anhydrous unless very large percentages of blending agents are employed.

In India in areas where alcohol-petrol fuels are used at present the strength of alcohol is 99.8 per cent in Mysore and Hyderabad and 99.5 per cent in U. P.⁵ It is essential that before any legislation is passed to compel the petrol companies to blend alcohol with petrol, the Indian distilleries (in areas where not already done) should put up absolute alcohol plants, since only blends prepared from alcohol of this strength could be used interchangeably with petrol straightway in cars without making any alterations in the engines.

Until such time as alcohol of this strength does not become available, the system in vogue in Travancore may be enforced. In Travancore they are using 95 to 96 per cent alcohol blended with petrol. The transport services running on this blended fuel have all had the engines of their vehicles properly adjusted and altered for this type of fuel.*

FUEL CONSUMPTION

Fuel consumption is influenced by the type of engine used. If the mixture is used in the engine without any adjustment, then the fuel consumption is more. The National Bureau of Standards (U. S. A.) together with the American Automobile Association and others, made a series of official comparative road tests⁶ to determine the fuel consumption in representative American automobiles using a mixture of 10 per cent alcohol and 90 per cent petrol and also petrol alone. An increase in the consumption of the alcohol-petrol of 4.94 per cent by volume was shown

* Note on the use of alcohol as fuel in Mysore and Hyderabad and U. P. by Dr. N. G. Chatterji.

* Dr S. B. Dutt's article on 'Rectified Spirit as Motor Fuel' in SCIENCE AND CULTURE, 5, 698, 1939-40 will be found interesting in this connection.

* Official Tests of Regular and Alcohol-Blended Motor Fuels, Joint Comm. Rept. on Performance Characteristics of Regular and Alcohol-Blended Motor Fuels, pp. 5, 6 etc. (June, 1933).

² Leo M. Christensen, *Ind. & Eng. Chem.*, 28, 1089, 1936.

³ Riegel, *Industrial Chemistry*, 339, 1937.

⁴ Egloff, G. and Morrell, J. G., *Ind. & Eng. Chem.*, 28, 1080.

over that of the petrol alone. The results are given in the table below.

OFFICIAL CONSTANT SPEED TESTS

OVER A 10 MILE COURSE

Percentage increase in fuel consumption with 10% Alcohol-Petrol Blends over Petrol.

Make of Car	By weight	By volume
1933 Chrysler "6" sedan ...	4.87	4.13
1933 Oldsmobile "6" sedan ...	3.81	3.07
1932 Ford "V-8" coupe ...	10.20	9.51
1932 Rockne "8" convertible sedan	3.75	3.06
Average ...	5.66	4.94

As a check on the road tests, a block test showed an increased consumption of 4.5 per cent when using the alcohol-petrol blend. Reports from Germany show 3 to 4 per cent higher fuel consumption for alcohol-petrol, containing 10 per cent by weight of alcohol than for petrol alone. The Experimental Station for Motor Vehicles in Vienna carried out tests which showed an increase in consumption of 3 to 3.5 per cent using petrol containing 20 per cent alcohol.

In an extensive series of tests Brown⁷ shows an increase of fuel consumption of 5 per cent for each 10 per cent of alcohol added to gasoline. For the best operation with alcohol-petrol, it was necessary to make individual adjustments according to the type of engine.

Approximately 50 to 65 per cent more alcohol by weight is required to produce the same power as petrol in a given engine. This represents about 50 per cent more fuel on a gallon basis for the same power output.⁸ It follows that larger fuel orifices are required on carburetors for alcohol. Higher compression ratios are also necessary. The use of high compression ratio, however, does not lower the specific fuel consumption. The specific fuel consumption with maximum power-air-fuel ratio is 43 per cent higher for alcohol used with compression ratio of 8 to 1 than with standard petrol used with compression ratio of 5 to 1.⁹

⁷ Brown, "Agricultural Alcohol in American Motor Fuels", pp. 1-7 (May 18, 1933). *Trans. Am. Inst. Chem. Engrs.*, 20, 15, 1927. *Univ. Mich. Eng. Research Bull.*, 7, 1927.

⁸ Brown and Zach, *Oil Gas J.*, 28, No. 34, 44, 1933.

⁹ Lichty, L. C. and Ziurys, E. J., *Ind. & Eng. Chem.*, 28, 1095.

It follows from the above that the larger the percentage of alcohol in the blend, the greater would be the fuel consumption, and the extent of extra ration during war-days that may be given to vehicles that will be put on this fuel will depend on the composition of the mixture that will be finally decided for use.

CORROSION

It is reported that alcohol-petrol increased corrosion of containers and fuel systems, especially in the presence of water and other contaminants¹⁰. Pure alcohol, as well as the water-free petrol-alcohol mixture showed no action on various metals.

Addition of water caused corrosion. The loss of weight of the metals in 60 days from immersion in a petrol fuel containing 20 per cent ethyl alcohol, and 0.5 per cent water was 0.30 to 0.37 gram per square meter¹¹. The effects are noticeable in cylinders, exhaust manifolds and mufflers. An example of corrosion at low operating temperatures is as follows.

WEAR—INCH/1000 MILES

Fuel composition	Cylinder	Top piston ring
Gasoline	0.00044	0.0027
83% gasoline+17% ethyl alcohol ...	0.00080	0.0052

At high operating temperatures, the top piston ring wear was 0.00032 inch per 1000 miles for both types of fuel¹². It was also observed that engine valves are attacked more rapidly by alcohol-petrol than by petrol alone¹³. The few reports of abnormal corrosion of engine and fuel system due to alcohol fuels have been traced to the use of corrosive denaturants. As stated above, addition of denaturants to alcohol fuels is necessary in order to make them unfit for human consumption.

¹⁰ Austrian Petroleum Inst. "Alcohol Blend Fuels", pp. 7-16; Bauer and Schikorr, *Automobiltech. Z.*, 35, 583, 1933; Bridgeman, *Ind. Eng. Chem. News*, Ed. 11, 139-40, 1933; Egloff, *Nat. Petroleum News*, 25, No. 17, 30-2 (April 26, 1932); Memorandum on Alcohol-Gasoline Blends as Fuel for Automotive Vehicles, pp. 1-4, Paris, 1933; Rept. Inst. Automobile Engrs. Research Comm., *Petroleum Times*, Aug. 18, 1934, p. 187.

¹¹ Bauer and Schikorr, *Automobiltech. Z.*, 35, 583, 1933.

¹² Rept. Inst. Automobile Engrs. Research Comm., *Petroleum Times*, Aug. 18, 1934, p. 187.

¹³ Braun, *L'Officiel de l'automobile, due cycle et de la motocyclette*, 38, No. 41, 17-33 (Oct. 8, 1933).

The corrosion is greater with a high percentage of alcohol in the blend. In case of blends containing not more than 25 per cent of ethyl alcohol, the products of combustion are the same as that of petrol¹⁴. If higher alcohol contents are used corrosion on metals particularly magnesium, aluminium, tin and copper etc. occurs within the combustion chamber, exhaust manifold and mufflers etc. Rubber parts and pump diaphragms are also likely to be affected.

It may be concluded from the above that in case it is decided to introduce in the Punjab a fuel with more than 25 per cent alcohol content, the danger of corrosion would be certain and considerable, unless certain rubber and metal parts of the engine and exhaust system are materially changed. At the present time, however, this should not be of any major consideration. In this country, public vehicles are mostly run by individual owners who are not very particular about the upkeep of their engines. Lubricating oil is not changed regularly and oil and air-filters are hardly ever cleaned and renewed with the result that corrosion due to grit getting into the system from the dusty roads of the country, is ever so greater than it would be the case with the use of alcohol.

OPERATING DIFFICULTIES

Starting.—Alcohol-petrol fuel shows harder starting both with cold and warm engines. Difficult starting can also be caused by separation of fuel into alcohol and petrol for one reason or the other¹⁵. As a result of a large number of tests that were made in 1933 on one engine at various temperatures and with various amounts of choking on a series of petrols covering a wide range of volatility and on a number of fuels prepared by blending 10 per cent absolute alcohol with each of these petrols, it was found that the starting of engine would be easier with blend at temperature above 0°F., and would be more difficult with blends at temperature below -10°F. with little difference in the intermediate range. Greater defect in engine starting would be experienced with higher than 10 per cent blends, in particular with 40 per cent blends.

ACCELERATION

The Bureau of Standards made tests on acceleration with the following conclusions. For equal

¹⁴ Hubendick, E., *Trans. Fuel Conference, World Power Conference, London (1928)*, p. 724, and *S. Spiritusind*, 53, 23, 1931.

¹⁵ Egloff, G. and Morrell, J. C., *Ind. Eng. Chem.*, 28, 1085.

acceleration with alcohol-petrol, it was found that a carburettor setting giving about 3 per cent greater fuel flow (i.e., richer mixture) was required¹⁶.

OVERHEATING OF ENGINES AND LUBRICATION DIFFICULTIES

Alcohol-petrol has an overheating influence on motors in spite of a tendency towards lower mixture temperature¹⁷. This objection may be overcome in part by adding lubricating oil to the alcohol-petrol in order to maintain the same properties as when petrol alone is used¹⁸.

VAPOUR LOCK

Vapour lock is defined as the interference with fuel flow in the fuel feed system as the result of formation of vapour or gas, and is manifested by loss in engine power, by poorer acceleration, and in extreme cases by engine stoppage. When used in the same engine, a 10 per cent alcohol blend is more likely to give trouble from vapour lock than the petrol with which the alcohol is blended. Little difference would be expected with a 10 per cent blend and the situation would be reversed with a 40 per cent blend¹⁹.

ANTI-KNOCK

The addition of alcohol to petrol serves the purpose of increasing the antiknock value and otherwise improving the fuel from this point of view. The value of alcohol as an antiknock agent has been of considerable importance in the development of alcohol blends. The antiknock effect of alcohol is the greatest within the limits of 5 to 20 per cent alcohol²⁰.

It would be observed from the above that small percentage of ethyl alcohol in blend is more advan-

¹⁶ Official Tests of Regular and Alcohol-Blended Motor Fuels, *Joint Comm. Rept. on Performance Characteristics of Regular and Alcohol-Blended Motor Fuels*, pp. 5, 6 etc. (June, 1933).

¹⁷ General Review of Alcohol Situation in France, pp. 4-7, Paris.

¹⁸ Braun, *L'Official de l'automobile, des cycl et de la motocyclette*, 38, No. 41, 17-33 (Oct. 8, 1933).

¹⁹ Bridgemann, O. C., *Ind. Eng. Chem.*, 28, p. 1108.

²⁰ Brown, L. T., *Iowa State Coll. Comm. on Use of Alcohol in Motor Fuel*, Progress Rept., 2, 1932. Brown, G. G., paper presented before 3rd mid-year meeting of Am. Petroleum Inst., Tulsa Okla, May 18, 1933; *Oil Paint, Drug Repr.*, 1933, July 24, p. 28D, and July 31, pp. 36-8. Kuhring, M. S. *Canada Jour. Research*, 11, 489, 1934. Gray, R. B., *Agr. Engr.*, 15, 106, 1934.

ECONOMIC ASPECTS

In Western countries where petrol blends are used, it has been estimated that the actual cost of petrol blends to the consumer is greater than for petrol alone, but as stated before due to national reasons, countries deficient in petrol, are taking to this fuel. In India, however, probably due to cheaper sources of raw materials, the distilleries producing absolute alcohol are marketing it at reasonable price. Besides the price of petrol is high especially in inland towns, and this would be a very favourable factor for the use of alcohol as a motor fuel in India. The present emergency also shows that the use of alcohol as motor fuel might have been a great advantage, if organised steps in that direction were taken several years ago.

tageous than larger percentages from the standpoint of power and acceleration, the reverse is true from the standpoint of vapour lock. From the technical point of view, therefore, both factors have to be borne in mind in determining the composition of the blend more suitable for a particular purpose.

It cannot be said whether all these observations would be true under Indian conditions. Considerable experiments on suitable compositions have been done in U. P., Mysore, Travancore and Hyderabad (Deccan), but since climatic conditions vary so widely in the sub-continent of India, it appears essential that most suitable working conditions should be determined separately for each area. Work in this connection is already in hand in the Punjab and some useful results have been obtained.

MEDICINE & PUBLIC HEALTH

TUBERCULOSIS ASSOCIATION OF INDIA

THE importance of combating the scourge of tuberculosis, which claims to rank as public health enemy No. 2 in India, is now realised by the public, thanks to the drive given by Her Excellency the Marchioness of Linlithgow.

The report of the Association for 1941 makes illuminating reading. 14 Provincial and 13 State Associations were affiliated to the central body and a number of clinics, hospitals and sanatoria were opened. The Lady Linlithgow Sanatorium at Kasauli, which is to function as a model centre for the training of doctors, including demonstration of the up-to-date methods of treatment, was opened on the 21st May, 1941. One important fact noticed by the Model Tuberculosis Clinic at Delhi was that 8-10 per cent of the contacts of tuberculosis cases showed evidence of disease when they were examined along with the original case or source in the home. The need for early detection and isolation of cases is thus apparent.

A few of the provincial towns are realising the necessity of building cheap isolation hospitals for segregating dangerously ill patients. Out of 733 cases of pulmonary tuberculosis treated during the year at the New Delhi Model Clinic, as many as 618 were found to need admission into hospitals and sanatoria. A more rapid progress is needed in starting more clinics, more hospitals and more sanatoria. The attention of those who are concerned with the planning of institutions may be drawn to the following remarks of Her Excellency made at the opening of the Kasauli Sanatorium. Her Excellency remarked, "You must have your clinics as near as possible to the centre of the large cities; you want your tuberculosis hospitals in close proximity to the cities; you want your home visiting scheme perfected in every district, but you must have your sanatoria in the hills when money permits". No doubt the uninitiated have seen reference to treatment in the hills not being necessary in these modern days. It is very true that in parts of Europe where summer heat is not excessive, treatment can

be carried out all the year round at lower altitudes with equal success, but this is not the case in India where the heat of summer in the plains is most detrimental to the health of the patients.

The question of disposal of sputum of infective cases is an important item in prevention. Most Indian patients cannot afford to buy costly spittoons and disinfectants. The New Delhi Tuberculosis Clinic has improvised a small outfit in which is incorporated a cigarette tin for boiling the sputum at a cost of only 4 annas. The free examination of sputum for suspected cases in all State and local bodies hospitals was introduced in a few provinces and States. Increasing numbers of hospitals, maternity clinics and private practitioners are taking advantage of the diagnostic and consultation facilities now offered by well-run tuberculosis clinics.

Post-graduate instruction in tuberculosis and the training of tuberculosis health visitors were undertaken in a few of the provincial centres.

It is interesting to note that different Provincial and State Associations are spending the funds raised as a result of the King Emperor's Fund Appeal in a different way. Most branch Associations have invested a part of the corpus for meeting recurring expenditure, while the remainder is being distributed to various organisations for meeting capital expenditure for construction and equipment. A few of them are only prepared to utilise the interest accruing from the collections and are averse to spend the corpus in any form. The extension of work has no doubt been more rapid with the previous method.

The Government of Bengal has received the congratulations of the Central Association for drawing up a plan for the examination, treatment and re-employment of tuberculous Government employees. It is hoped that other Governments will not only follow suit but large employers like the Railways and industrial concerns will also do likewise. The Hassan Masud Suhrawardy Memorial Anti-Tuberculosis Challenge Shield which is given to the organisation which has done the best anti-

tuberculosis work in the year, was won by the Anti-Tuberculosis Association of Budgebudge, 24 Parganas, Bengal.

HEALTH OF LONDON IN 1940

LONDONERS think that the year 1940 was the most dire in London's history, not even excepting the years of plague and fire in 1665 and 1666. During the last four months of the year, the whole of the county of London was subjected almost every night to bombing attacks. Although the wartime conditions differed greatly from peacetime conditions owing to the danger of the hospitals, casualties among hospital staff and exceptional movements of population, the statistics of health conditions showed an extraordinary steadiness.

The infant death rate per 1000 live births was 48, compared with 47 in the previous year, and the maternal death rate was 2.81 per 1000, compared with 2.84 in the previous year. During 1940, the number of children evacuated was 150,000, and by the end of that year only 85,000 children of school age remained. The general health conditions of these children did not differ much from those before the war. Comparing 47,000 children of school age examined in 1940 with 170,000 children of the same age groups examined in 1938, the nutrition was found to be satisfactory in 93.3 per cent, almost exactly the same figure as in 1938. 65.2 per cent showed sound dental conditions as compared with 70.2 per cent in 1938; the percentage with normal vision had increased from 67.8 to 77.3; and the percentage of adenoids and enlarged tonsils had dropped from 9.2 to 3.5; but there was a slightly increased incidence of rickets and of skin diseases. Although the first impression on the effect of bombing on children was rather depressive, later observations showed that nervous disorder or shock arising from air-raid experience was very little; in fact the children were standing up to it as well as, or better than, adults.

As for infectious diseases, there was a large increase in the number of notifications of cerebro-spinal fever and of measles but other diseases showed no increased incidence. In spite of the reduction of hospital beds to 50% of the peacetime accommodation, all cases of "normal" sickness were admitted, even during the most intense phase of the air attacks.

In India, the number of hospital beds available for "normal" sickness has also been drastically

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reduced, especially in those areas where air-raids are apprehended. Abnormal movements of population have also taken place, owing to the loss of territories close to India's borders. It would be worth while to make a comparative study of health conditions among the civil population now and those of pre-war figures. The private medical profession including those in charge of institutions and public health authorities might collaborate in undertaking such an investigation for the ultimate object of reducing sickness and mortality so that positive health does not receive a set-back during the emergent period.

LEPROSY AND ITS CONTROL IN INDIA

THE Central Advisory Board of Health is to be congratulated on drawing up a comprehensive report on the above subject. Leprosy has been common in India from ancient times. While the infection has been practically controlled in the Western countries, in India the estimated number of sufferers is still about a million. In some highly infected areas, the incidence is as high as 5-10 per cent of the total population.

Leprosy is infective. It spreads chiefly by direct contact. It can be controlled by the isolation of infective cases, supplemented by treatment, educative propaganda and welfare work. It is important to realise that all persons attacked by leprosy are not infective. At least two factors appear to influence transmission: (i) the age of the person exposed to infection, (ii) the closeness and duration of contact. Possibly susceptibility—individual, familial or racial, plays a part. A study of leprosy in families shows (i) that a child of a parent with infective leprosy segregated at birth nearly in all cases never develops leprosy; the disease, therefore, is not hereditary, (ii) that children not segregated from infected parents frequently develop leprosy, and (iii) that an adult similarly exposed to infection (e.g., the wife of a person who has leprosy and *vice versa*) develops the disease comparatively rarely. It is the close continued contact which is most dangerous. Casual contact rarely transmits the disease in adults, but more commonly in children.

To a large extent, leprosy in India is a social and economic problem. The widespread poverty, bad housing with overcrowding, bad diet, the presence of debilitating disease, lack of education and knowledge on health matters in general, contribute to the spread of the disease, although they are not essential to transmission. There is no reason, therefore, for indifference on the one hand and exaggerated fear on the other.

The Mission to lepers is the biggest agency for anti-leprosy work in India. Although "the control of leprosy is the inescapable responsibility of the Government concerned", there is a large field for voluntary assistance and organization in this direction. Infective cases in India are roughly estimated at 2,50,000, while institutions for taking care of lepers cannot accommodate more than 14,000. Provincial and local authorities should wake up to their responsibilities in this regard. The urgent problem of beggars with leprosy needs immediate attention of all cities and industrial areas.

The report appeals for the establishment of more clinics, more hospitals and more colonies. About 500 is probably the optimum number in an institution. Rs. 12/- per head per month is the bare minimum to maintain a case.

Chaulmoogra oil is chiefly employed in the treatment of leprosy. Experienced workers consider that treatment produces valuable results, and that it plays a larger part in anti-leprosy work than clinical results alone would indicate.

Leprosy research in India has been chiefly undertaken by the Indian Research Fund Association, the Calcutta School of Tropical Medicine and the British Empire Leprosy Relief Association. Some amount of slow but steady progress has been made. Useful surveys have been carried out and several types of disease have been described. Extensive educative work should be carried out and special provisions should be made for teaching in medical schools and colleges.

The special nature of leprosy makes special laws essential to minimising its spread. Existing legal powers in India for the control of leprosy have not been of much practical value. The possibility of incorporating existing and projected legislation in one comprehensive Act, in order to make the legislation more effective, is being considered.

LADY TATA MEMORIAL SCHOLARS

The Trustees of the Lady Tata Memorial Trust have announced the awards of the following scholarships and grants for the year 1942-'43.

1. *International Awards* for research in diseases of the blood with special reference to Leucæmias.

Dr Jacob Furth of American nationality, Cornell University Medical College, New York.

Dr P. A. Gorer, Guys Hospital, London.

Dr A. H. T. Robb-Smith, Nuffield Reader in Pathology and Morbid Anatomy, Oxford University.

Dr Werner Jacobson, Part-time Sir Halley Stewart Fellowship at the Strangeways Research Laboratory, Cambridge.

Dr Sybil Williams, Cambridge.

Prof. Doljanski, Jerusalem.

2. *Indian scholarships* for scientific investigations having a bearing on the alleviation of human sufferings.

Mr S. Rajagopalan, Madras will continue the work on Synthesis of New Sulphanilamides under the direction of Lt. Col. S. S. Sokhey, Haffkine Institute, Bombay.

Mr Nirmal Chandra Datta will continue the Investigations on Certain Aspects of the Role of Fat in Human Nutrition under the direction of Lt. Col. S. S. Sokhey, Haffkine Institute, Bombay.

Mr K. Ramamurti will work on the Synthesis of Ascorbic Acid under the direction of Prof. M. Damodaran at University Biochemical Laboratory, Madras.

Miss Mary Samuel will carry on research on the Effect of Fat Soluble Vitamins on the Histology and Cytology of the Female Gonad and Associated Organs with Special Reference to Vitamin A and E Deficiency Abortion under the direction of Prof. R. Gopala Aiyar at University Zoological Laboratory, Madras.

Miss Beatrice de Menezes Braganca will work on Dietary Factors in Relation to Haemopoiesis under the direction of Prof. B. C. Guha in the department of applied chemistry, University College of Science, Calcutta.

Mr Sudhir Ranjan Das has been given a grant for the construction of a vacuum tube apparatus for the generation of a copious supply of neutrons and to study therapeutical and biochemical applications of neutron and X-radiations under the direction of Dr D. M. Bose at Bose Research Institute, Calcutta.

Mr M. V. Lakshminarayana Rao will carry on Research on Insulin, Carbohydrate Metabolism and the Cure of Diabetes under Dr V. Subrahmanyam at Indian Institute of Science, Bangalore.

The Nature of Immunity in Virus Diseases*

THE viruses are intracellular obligate parasites and their existence depends entirely on their ability to multiply in the tissues of the host they parasitize.

One interesting feature in this connection is the remarkable affinity which viruses have for certain organs and tissues of the host. For example, some viruses attack epithelial tissues, while others exhibit this for nerve tissues. There are some viruses which are pantropic, while there are others which do not show any well-marked tissue tropism.

After the virus has gained entry into the susceptible cells, subsequent changes in the cells are determined by the specific characters of the virus. These changes are either in the nature of cell proliferation followed by necrosis, or, in the case of viruses whose action is 'explosive and rapid' by necrobiosis and lysis of cells. Another important manifestation, due to virus activity which arises in an affected cell, is the development of an inclusion body. The inclusions are of two types—cytoplasmic and intranuclear. There is, however, no unanimity of opinion concerning their nature. Recent work on other cytoplasmic inclusions has revealed that some of them at any rate were aggregates of small bodies—the elementary bodies which are now regarded as the actual virus agents. It has to be stated in this connection, however, that inoculation of material not containing any virus occasionally produces 'inclusion bodies' or appearances simulating them in experimental animals and in the Chorio-allantoic membrane of the developing chick embryo.

Recovery from an infection is associated with the development of immunity which, in the majority of virus diseases, is usually permanent. Only in some cases, as in influenza, herpes and foot and mouth disease, it is transient. To this extent virus diseases as a class may be said to differ from bacterial diseases in which the immunity is usually of a transient character except, perhaps, in typhoid and in diphtheria. The problem of immunity to any given virus or bacterium is, however, a problem to itself; each has its special features and peculiarities.

In natural or experimental infections antibodies, such as are usually met with in bacterial infections are also present in the serum after recovery from virus diseases. That such is the case has now been definitely proved. By the use of purified suspensions of viruses it has now been demonstrated that agglutinins are present in such virus infections as vaccinia, variola, fowl-pox, varicella, herpes etc.

It has been found that agglutinins make their appearance on the 5th or 6th day after an intradermal injection of the virus, rise to a maximum titre and then slowly decline. Immunological relationships between related viruses have also been determined by the application of the agglutination absorption technique. Common agglutinins for variola and its variant, alastrim have thus been determined. That a common antigen exists between variola and vaccinia viruses has also been demonstrated.

Complement-fixing antibodies in some virus infections such as influenza and flocculation antibodies in others such as vaccinia and variola have also been demonstrated. The antigenic structure of vaccinia virus has been particularly studied by Craigie and his collaborators. Two types of antigens have been shown to exist in suspensions of elementary bodies of vaccinia. One is thermostable—the S type of antigen, and the other thermolabile—the L type of antigen, both of which take part in serological reactions. A specific soluble substance has been isolated by the extraction of elementary bodies of vaccinia. This substance behaves as an antigen, as determined by precipitin and complement-fixation reactions with anti-vaccinal serum. These elementary bodies produce rapidly all the antibodies including the neutralizing antibody, but the specific soluble substance produces them more slowly and with the exception of the neutralizing antibody, which seldom appears to any appreciable extent. The finding is important and brings to our mind the significance of a similar substance isolated from pneumococci. Such an antigenic analysis has been attempted with other viruses also, e.g., in the case of influenza virus. Apart from the antibodies, anti-viral or neutralizing antibodies are also found in viral infections. This antibody seems to play a major rôle in the mechanism of immunity in virus diseases. It has been shown that when the virus

* Abstract of the Presidential Address of Dr C. G. Pundit to the Section of Medical and Veterinary Research, Indian Science Congress, Baroda, 1942.

and its antibody were mixed in suitable proportions, and the mixture inoculated into the skin of a rabbit, no lesions appeared in the animal. In this respect the results correspond to similar reactions noted with the Toxin and antitoxin mixtures. On the other hand, it has been shown that in experimental animals there is no union at all between the virus and the antibodies in the immune serum. The balance of evidence, however, tends to show that the immune serum does combine with the virus and that the union is reversible by dilution.

The question now arises how the anti-viral antibody acts *in vivo*. What part do leucocytes play in the process? These are important questions as they have a bearing on the possible treatment of virus diseases with immune sera. It is not possible to give a direct answer to these questions. Two factors have to be borne in mind in this connection. The antibody, even though it unites with the antigen, does not kill it. The dissociation results recorded above prove this. Secondly, the action of viruses in most cases is explosive. The antibody, if it is to act at all, must do so rapidly. It has been established that an anti-vaccinia serum, suitably prepared and administered in suitable doses to experimental animals either subcutaneously or intravenously, confers some degree of protection against a subsequent inoculation of vaccinia virus.

Experiments done by the author at the King Institute shows that when vaccinia immune serum is obtained from hyper-immunized buffaloes and both vaccinia and variola viruses are used in the experiments and that when the serum is administered along with the virus, a considerable degree of protection is obtained against both viruses. The same phenomenon has been observed in tissue cultures. These experiments also suggest that leucocytes play no part in augmenting the action of the immune body, for leucocytes in such cultures are normally scanty and immobile.

How does the antibody act in exerting its protecting influence? It would appear from the above that once the virus enters the cell, the antibody is powerless to neutralize it. It is likely that the antibody, when it is introduced in advance of the virus, alters the tissue cells in such a way that the virus finds it difficult to gain a foothold.

From the experimental evidence so far recorded, it is reasonable to conclude that the neutralizing antibody plays an important part in the mechanism of immunity. Failure to demonstrate this antibody in some viral infections has led some workers to postulate that there might be another process at work,

whereby tissue cells become resistant without the intervention of the antibody—the so-called *tissue immunity*. There is some evidence, however, that in plant viruses a sort of tissue immunity does exist and humoral antibodies do not play a part.

Persistence of virus after recovery is shown to occur in a number of virus infections. The phenomenon of persistence of infection is not a monopoly of viruses, however. It is particularly noted in protozoal infections. It has been seen to occur in non-pathogenic trypanosomiasis, kala-azar, malaria and also in some bacterial and spirochaetal diseases.

The survey has only revealed the great complexity of the problem. This is not surprising in view of the intimate type of parasitism exhibited by viruses. We have no adequate knowledge of the vital processes involved when a virus invades the susceptible cells. This is, of course, true of other infections also. Indeed, it would appear that the defence mechanism of the infected host is the same whether the infective agent is a bacterium, a virus, or a protozoal parasite. Agglutinins, precipitins and neutralizing antibodies are produced much in the same way as in bacterial disease. If the virus is introduced in the fluids of the host, these antibodies are produced and the virus destroyed. The only difference is in the action of the neutralizing antibody. We may assume that when the virus is in the body fluids, the antibody acts much in the same way as in bacterial infections, *viz.*, it unites with the virus and renders it susceptible to phagocytosis. Once the virus enters the susceptible cell, the antibody has no direct action on the virus. When the cell bursts, the virus will pass into daughter cells and, as long as the process is kept up, it will maintain a latent infection or persistence of infection. If the cell is destroyed, the virus will be brought into contact with the antibody in the surrounding fluid and will then be destroyed. More antibodies are also produced. If such is the course of events, it would be interesting to speculate what would happen in the case of neurotropic viruses. As Goodpasture has stated, if a virus can utilize the living cell for its reproduction, there is nothing to prevent it from making its way from cell to cell along the connected cytoplasmic processes and thus reaching its central termination. During its sojourn it will not come into contact with the antibody at all. The failure of immune sera in such infections as polio-myelitis is thus explained. There seems to be another defence mechanism which is dependent on environmental factors such as heredity, sex locality etc.

How has the knowledge thus gained been applied in the prevention of virus diseases in man?

On the analogy of bacterial diseases, it is not surprising that attempts should have been made to use killed virus vaccines as a prophylactic measure. It does not appear that dead vaccines have so far proved their utility, and the consensus of opinion amongst virus workers seems to be that the use of attenuated live vaccines is the method of choice in the prevention of virus diseases.

The only dead vaccine which has been used extensively in the fields is believed by the author to be rabies vaccine. Shortt and his collaborators have investigated the immunizing value of different strains of rabies virus inactivated by different ways. Formalin or carbolic acid showed no special advantages of one over the other as a preservative. They also investigated other methods of immunization in rabies. They concluded as follows:—

Treatment by one dose of a combination of fresh living fixed virus and antirabic serum has been shown to have a considerable immunizing value; although the main effect appears to have been exerted by the live virus, the serum being used merely to render the use of the live virus more safe. The use of fresh living fixed virus has been shown to be the most effective method yet tried for the immunization of dogs and therefore of other animals also. They suggest that future lines of advance towards the most efficacious means of producing a solid immunity against rabies will be along the path of utilization of antirabic serum and fresh live fixed virus, possibly combined with the use of dead vaccine.

The methods envisaged in the case of rabies have already been utilized in the case of yellow fever, for in this disease only living vaccines are found to be of any value. The yellow fever virus has two predominant affinities, the viscerotropic and the neurotropic. The alteration in pathogenicity which ensues on prolonged cultivation in the presence of embryonic cells is now fairly well established. That procedure has rendered the use of live vaccine safe for human immunization. Attempts at human immunization date back to 1930, when Theiler demonstrated that viscerotropic virus, rendered neurotropic by passage through mice, lost its virulence without altering its immunizing power.

As a rule, no untoward results have been noticed with the use of such vaccines. The antibody titre, however, diminishes gradually and re-vaccination becomes necessary after two years.

Findlay in England advocates the use of the pantropic virus. This is now so attenuated in virulence by tissue culture passages that it can be used without the addition of immune serum. This method is claimed to be as efficient as others used in America.

The author in concluding his brief summary of the present position of immunity in virus diseases, stated that the subject was a complex one and that the evidence accumulated so far did not permit us to postulate any comprehensive working hypothesis. It is probable that all the factors discussed, *viz.*, circulating antibodies, tissue immunity, persistence of virus after infection, etc. play their part in bringing about that solid immunity after infection which is such a marked feature of virus diseases.

BOOK REVIEW

Public Health as a Social Service—By Dr J. B. GRANT, University of Calcutta, 1941, 8vo × 65 pp. Price 8 Annas.

The Calcutta University is to be congratulated on having secured the services of Dr J. B. Grant, a Rockefeller Foundation Worker who has to his credit 20 years' public health work in China, in delivering the Basanta lectures for 1940.

The conception that a failure of the social machinery to ensure to every individual in the community a standard of living and education adequate for the maintenance of health is responsible for much preventable ill-health, has increasingly gained ground in England and America since the last Great World War. The discoveries of science and the impact of the machine age on the agricultural civilisation of mediaeval times created new problems in the organisation of community life. The application of the knowledge, at successive periods, to solve these problems has helped the development of the social services, but there has always been a lag between modern knowledge and its community utilisation.

In his efforts to ascertain the position of public health in the domain of social service, Dr Grant has defined Public Health as "that social service which is responsible for medical protection of the individual through organised community effort". He has drawn attention to the lag between modern knowledge and its community utilisation as an important social problem which is present in many countries of the world at the present time. He has traced out the causes of such lag and has ably discussed its implications, as also the steps which are necessary to remove the lag. He has defined six postulates for developing public health as a social service and thinks that "national public health administration assures medical protection to the people in proportion to its adherence to these postulates".

The arguments brought forward by him in support of his theses have been amply substantiated by factual illustrations from various countries and are

thoroughly convincing. It is to be hoped that the administrators and public health authorities in India will carefully study this book with utmost care and try to mould their machinery in terms of the principles enunciated by the author and thus remove the colossal lag between science and its utilisation for community service.

The author regrets that the "social background and its relation to public health and disease" do not yet constitute any part of medical education, as much as the older fields like surgery or bacteriology occupy. It is imperative that the preventive and public health aspects of medical knowledge should be incorporated in the medical curriculum and that students should be given facilities for participation in practice fields, just as they get the clinical illustrative material with regard to disease in the hospital. I do hope that the Calcutta University will take early measures to reorganise undergraduate (and if possible post-graduate) medical education, so as to assign public health its proper place in the growing concepts of community life. If this is carried out, post-graduate education in public health will be more purposeful and more effective in removing the enormous lag which exists in India to-day between science and its applications to the benefit of community life.

A. C. U.

Introduction to Semi-micro Qualitative Analysis—By M. L. SCHROFF and G. P. SRIVASTAVA; Pp. X + 203. Price Rs. 3/-; foreign 5s.

Prof. Schroff has been doing a good service for some years by writing now a number of handy books, particularly for the benefit of the students of Pharmacy. As, however, a large and integral part of Pharmacy is Chemistry, instruction in the latter subject in all its theoretical and practical bearings is of prime importance. As the authors say in the Introduction to the book under review, the semi-

micro-method has met with great success as a routine class measure in the teaching of chemistry, in the Department of Pharmaceutics of the Benares Hindu University.

The book deals simply and clearly with practical details regarding semi-micro manipulation for qualitative inorganic analysis. Many practical points which beginners are apt to overlook, are emphasised in italics. The book is a lucid and at the same time concentrated digest of authoritative publications on the same subject incorporating the authors' own experiences in Indian laboratories. The book, therefore, has provided an excellent handbook, which should be useful for all chemical laboratories throughout India.

The advantages of the semi-micro-technique do not require to be emphasised. For speed, economy and neatness, it is greatly to be preferred to the usual macro-methods whether for qualitative or quantitative analysis. It should make much greater headway in Indian laboratories than it has done hitherto. For those wishing to develop in this direction, the present small book is a very clear and useful guide.

B. C. G.

Perversities—By G. L. M. Published by G. L. Mehta, 100, Clive Street, Calcutta. Pp. 173. Price Rs. 2/-.

It is not usual to expect of the business men materials to make people laugh. But the present book from the pen of Mr G. L. Mehta makes a very pleasant departure from the rugged business men's routine. A successful and well-known personality in the business circles of the country, Mr Mehta has a peculiar way of seeing at men and things of the world from the window of his office-room.

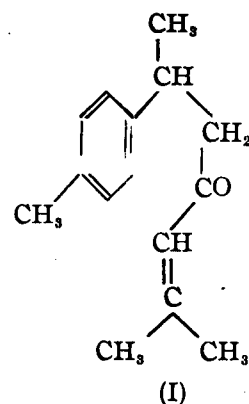
The book under review is a collection of his writings as a columnist in a well-known periodical of Calcutta and of a few other contributions in other papers. The subjects cover political and economic activities of the country and the dates given at the end of the articles will be useful for sustaining the interest of the readers who will read about the topics after the lapse of a period as long as 5 years. The reading of the book will convince one of Mr Mehta's wide interest and penetrating insight into the country's different movements. His humour is so refreshing that at no place the reader will be jarred by repetitions or over-strung descriptions.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

A SYNTHESIS OF α -TURMERONE

The occurrence in natural oils of sesquiterpenes and of sesquiterpene derivatives accompanied by related aromatic derivatives is uncommon. It is, therefore, of particular interest that the elegant investigations of Rupe and his collaborators¹ have shown that the oil from the rhizomes of *curcuma longa* contains the ketones α -Turmerone (I) and Turmerone. As the method of Rupe and Gassman¹ for the synthesis of α -Turmerone is not free from ambiguity, experiments were undertaken in this laboratory to synthesise the ketone by method which leaves no doubt about its constitution.



(-p-tolyl)-propionaldehyde² was reduced with zinc dust and acetic acid to give α -(p-tolyl)-propyl alcohol, b.p. 102/5.5 m.m. in good yield. The alcohol was converted into the corresponding bromide, b.p. 88°/6 m.m. by means of PBr₃ or 48% hydrobromic acid. The Grignard reagent from this bromo-derivative was allowed to react with β -methyl-crotononitrile in benzene. The product obtained after the decomposition of the resulting imino compound with acid and working up by the usual procedure was distilled in vacuo. b.p. 158°/8 m.m. (lit. 159°—160°/10 m.m.) semicarbazone, m.p. 106° (lit. records 108°—109°). The substitution of the piperidide of β -methyl-crotonic

acid in place of β -methyl-crotononitrile¹ (cf. Rupe and Gassman) also gave the desired product (I).

My grateful thanks are due to Prof. P. C. Mitter, M.A., Ph.D. for his kind interest and valuable advice during the progress of this work.

SAILENDRA MOHAN MUKHERJI

Palit Laboratory of Chemistry,
University College of Science,
Calcutta, 15-5-1942.

¹ Rupe, Clar, Pfau and Plattner, *Helv. chim. Acta*, 17, 372, 1934. Rupe and Gassman, *Ibid.*, 19, 569, 1936.
² Dutt, *Jour. Ind. Chem. Soc.*, 18, 233, 1941.

FUNCTION OF RAUWOLSCINE IN *RAUWOLFIA CANESCENS*, LINN.

The alkaloids are one of the most interesting groups of plant products both for their physiological activity and complex chemical structure. Much work has been done to investigate the metabolic role and the mode of formation of alkaloids in plants, and the close connection between protein breakdown and phytochemical synthesis of alkaloids. In the present histochemical researches the alkaloid deposition in the tissues of all the parts, the roots, stems and leaves has been examined and the variations of rauwolscine in the plants with the seasons have been studied with a view to understanding the biological significance of the alkaloid rauwolscine¹ present in *Rauwolfia canescens*, Linn. (N. O. *Apocynaceae*). It is observed that in leaves rauwolscine is most abundant in semi-lunar xylem, pericyclic sheath, palisade tissue and the multicellular hairs. In stems and roots the alkaloid is deposited in corkcells in the bark region, in wood elements and in sclerenchymatous tissues. In all cases, the phloem in the leaves, stems and roots is free from alkaloids.

A critical examination of the distribution of the alkaloid rauwolscine throughout the various tissues reveals the fact that the alkaloid is lodged in cells which are known chiefly to perform mechanical functions, i.e., the sclerenchyma and it is accumulated mainly in dead and other cells which take no part in metabolic activities and so they are not drawn at all in metabolic changes.

The seasonal variation of rauwolscine in *Rauwolfia canescens* shows that the alkaloid content is highest, just after the period of most active growth, i.e., during October and November; following that period in the cold season, December and January when the plants cast off their leaves the base content remains constant. With the advent of the spring during February and March new shoots sprout and rauwolscine content drops to a minimum in young organs. But the accumulation of the alkaloid increases slowly till it reaches a maximum in October next, when the growth cycle becomes just complete. These findings, therefore, show a connection between the utilisation of protein in the growth of the plants and the synthesis and storage of rauwolscine.

The histochemical study of the alkaloid, therefore, leads to the deduction that in *R. canescens*, rauwolscine is merely stored as a waste product, a view put forward by Pictet,² and held up by several authors like Annett,³ Cromwell,⁴ and Chaze.⁵ This waste material rauwolscine is translocated in some special cells where it is locked up and not readily reabsorbed into the active plant tissues, thus being rendered harmless to plant metabolism. Regarding the function of rauwolscine in *Rauwolfia*, it appears from the migration and accumulation of the alkaloid in the peripheral parts, i.e., multicellular hairs and bark etc. that it acts as a protective material against attack of the plant from predatory animals by its extremely bitter taste.

A detailed account of this paper will be published elsewhere.

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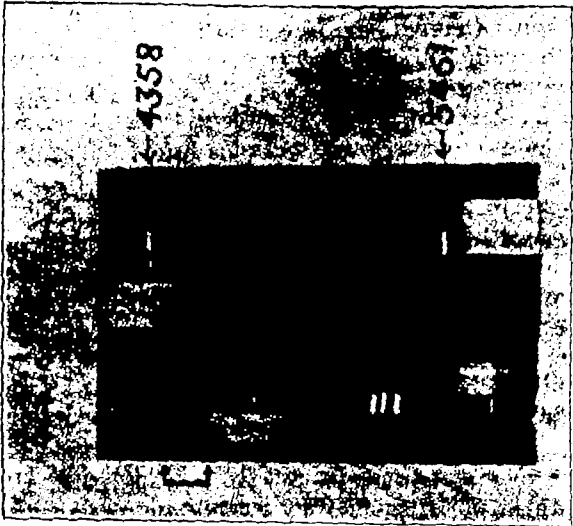
¹ Mookerjee, *Jour. Ind. Chem. Soc.*, 18, 33, 485, 1941; Chakravarty, *SCIENCE AND CULTURE*, 7, 458, 1941-42.
² Pictet, A., *Ber.*, 40, 3771, 1907; *Arch. Sci. Phys. Nat.*, 19, IV, 329, 1905.
³ Annett, H. E., *Biochem. J.*, 14, 618, 1920.
⁴ Cromwell, B. T., *Biochem. J.*, 27, 860, 1933.
⁵ Chaze, J., *Compt. Rend.*, 187, 837, 1928.

SPECTROSCOPIC EVIDENCE OF THE EXISTENCE OF [COCl₄] GROUPS IN THE AQUEOUS SOLUTION OF COBALT-CALCIUM CHLORIDE

The effect of adding alkali or alkaline earth chloride to the aqueous solution of cobalt chloride has been studied in detail by various workers. One direct consequence of such an addition is the change of the colour of the solution from red to blue. Various attempts have, from time to time, been made to explain this colour phenomena. Some people advanced the hydration hypothesis which postulates the existence of hexa or poly-hydrates in the solution of red colour and lower hydrates in the blue solution. The hypothesis is partly supported by the recent observations of Pearce and Dawson¹ on the change in the width of the characteristic absorption band of cobalt chloride solution on the addition of a strongly hydrating alkali or alkaline earth chloride. They are of opinion that on the addition of a strongly hydrating chloride the water dipoles about the CO⁺⁺ ion are removed to a greater or lesser degree by the hydrating cation added, allowing, thereby, the chloride ions to approach the paramagnetic ion to a certain distance. The close proximity of the chloride ions, according to them, deforms the outer electronic system of the paramagnetic ion; and this results in the change of the colour of the solution from red to blue. The explanation is, however, a hypothetical one and is in no way conclusive. Hill and Howell², on the other hand, are of opinion that the colour change of the solution depends on the co-ordination number of the CO⁺⁺ ion. The red colour is due to the six co-ordinated cobalt ion, and the blue colour is attributed to the co-ordination number four of the ion. Thus change of the colour to blue, on the addition of calcium chloride to cobalt chloride solution may be due to the four chlorine atoms coming in the co-ordinative sphere of CO⁺⁺ ion and forming a tetrahedron around the ion. The possibility of such an arrangement in the solid state is definitely established in a recent structure analysis by X-ray method of a blue double halide of cobalt, viz., CS₂ COCl₂, by Powell and Wells³. They find that in this compound each CO⁺⁺ ion is surrounded by four negatively charged Cl atoms forming a tetrahedron around it, the fifth Cl atom standing apart far removed from the CO⁺⁺ ion. The magnetic anisotropy measurement by Krishnan and Mookherji⁴ also points to the same conclusion.

Hence a study of the absorption spectrum of this compound in the solid state and its comparison with the absorption spectra of the aqueous blue solution of cobalt-calcium chloride at various concentrations may give us some information regarding the distribution of the chloride ions around the central para-

magnetic ion in the solution. With this end in view we made a systematic study of the absorption spectra of the blue solution at various concentration of calcium chloride in the cobalt chloride solution ; and some of the interesting observations made are recorded here.



1. COCl_2 solution.
2. Cobalt-Calcium chloride solution.
3. Cobalt-Caesium chloride crystal.
4. Copper arc spectrum.
5. Cobalt-Calcium chloride solution of different concentration.

In Fig. 1, the well-known continuous absorption band, in the bluish-green region, of the cobalt chloride solution, at a particular concentration,

extends from nearly 4358 Å to 5461 Å. There is no trace of any other band in the spectral region studied. Fig. 2, again, is the absorption spectrum of a blue solution of cobalt-calcium chloride, having the same number of absorbing centres (CO^{++} ion) in the path of the incident light as in Fig. 1. It shows that for a particular concentration of calcium chloride in the solution, besides the appearance of an absorption band

on the longer wave-length side of 5700 Å, the continuous band gets some definite structure with its resolution into two component bands of different intensity. With a still further increase in the concentration of the calcium chloride added, it is observed that the new faint band makes its appearance in the region shown by the bracket (Fig. 5) and the other component band decreases very much in width. The whole spectrum, now resembling very nearly the absorption spectrum of cobalt-caesium chloride (Fig. 3) in the

solid state, is shifted slightly, as expected, on the shorter wave-length side.

Thus a comparison of Fig. 5 with Fig. 3, conclusively proves that in the blue solution at a particular concentration of the calcium chloride there is a tendency of a tetrahedral distribution of the chloride ions around the paramagnetic ion ; and the formation of $[\text{COCl}_4]$ groups in such a solution is responsible for its blue colour. The resulting change in the co-ordination number of the paramagnetic ion from six to four may also be responsible for the lowering⁵ in the magnetic moment of the paramagnetic ion in the blue solution. The observations of Hill and Howell⁶ with magnesium chloride also point to the same conclusion. Details of our investigations will shortly be published elsewhere.

In conclusion, the author acknowledges his gratefulness to the authorities of the Indian Association for the Cultivation of Science for having permitted him to do the work in their laboratory.

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Krishnagar, 12-5-1942.

- ¹ *Jour. Chem. Phys.*, March, 1938.
² *Phil. Mag.*, 48, 1024.
³ *Jour. Chem. Soc.*, 359, 1935.
⁴ *Philo. Trans., A*, 237, 135-159, V.
⁵ From some unpublished data of the author.
⁶ *Ibid.*

BLOOD SUBSTITUTE*

THE attention that has been recently drawn by the insertion of a note on "Blood Serum and Plasma" in the Medicine and Public Health Section of SCIENCE AND CULTURE (1942, June issue), is a timely one. The necessity of a blood substitute for the treatment against shock and hæmorrhage at the present juncture demands more detailed notes on the production of a blood substitute and its subsequent use in therapy in the pages of this highly esteemed and popular journal. In the above note certain interesting points have been raised, but for clarification of this new therapy a more detailed knowledge on the preference of one to the other substitute is wanted.

It has been said that serum is preferable to plasma and that the former keeps well on storage. In practice, however, it seems that plasma is easier to obtain and when stored properly (particularly

with an anticoagulant) remains clear for ready use. Next, it is a question whether in transfusion of any large volume of liquid the medium should be stored with a preservative. Further any filtration that might be necessary during the process of production, would be better finished through a Seitz filter rather than by means of a Berkefeld filter.

The investigations that have been so far carried out on this blood substitute therapy, point to the superiority of plasma to serum in all respects. It is believed that during the formation of clot some toxic substances are produced in serum ; whereas plasma is a safer medium, may be easily stored, is more stable, less toxic and possesses proteins that are concerned with innumerable functions of the body economy such as blood volume maintenance, diuresis, kidney function etc., etc. The problem, however, is to find out an easier and suitable method for preparing and storing something that may be safely and readily used in emergency at any centre. Be that the whole blood, or, even the simple glucose saline?

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Calcutta, 11-6-1942.

- Brennan, *Brit. Med. Jour.*, 1, 1047, 1940.
Buttle et al, *Lancet*, 11, 131, 507, 1940.
Jorpes, *Biochem. Jour.*, 26, 1488, 1932.
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Ibid., *Jour. Amer. Med. Assoc.*, 114, 1337, 1940.
Taturni et al, *Mil. Surgeon*, 85, 481, 1939.

[* Strictly speaking, reference to plasma and serum as "blood substitutes" conveys a wrong impression, as the former connotes blood free from cells and the latter blood free from cells, fibrinogen and complement. The question of the superiority of serum over plasma or vice versa is still of a debatable point. If the plasma is kept in liquid state for a long time, the fibrinogen gets precipitated as fibrin and the complement deteriorates. Plasma is difficult to store except in frozen or dried form. As the preparation of plasma needs the use of an anticoagulant (sodium citrate) and as large quantities of it have to be administered in 24 hours (up to 5 litres), it is a source of serious disadvantage in its application. Plasma keeps better on storage only when kept in frozen or dried condition. In the liquid state, serum, in spite of its slight toxic properties, is preferable to plasma. But, with the available knowledge at present, it is still premature to state categorically that serum is superior to plasma. Each has its own advantages and disadvantages in therapy. The question of employing glucose-saline in combating shock is of an entirely different category. We propose to publish a more complete review on the subject in subsequent issues.—Ed., SCIENCE AND CULTURE.]

EFFECT OF SOME HYPNOTICS AND FODDER EXTRACTS ON THE VITAMIN C SECRETION IN GOAT'S MILK

Longenecker et al^{1, 2} found that the vitamin C-synthesising activity of the rat could be increased considerably through administration of various substances like oat oil, grass oil, carvone, paraldehyde etc. The present work was undertaken in order to find out whether the application of similar substances would increase the vitamin C content of milk of cows or goats. As is now well established, these animals can themselves synthesise vitamin C, the vitamin C content of their milk being independent of the amount of this vitamin contained in their ration.³ A preliminary report of the results obtained is given below.

Goats in milk were used as experimental animals. The effect of four substances viz., paraldehyde, barbitone (soluble), dhuh grass fat and the unsaponified portion of oat oil was studied. When given per os, none of these substances had any effect. Given subcutaneously, paraldehyde and barbitone increased the vitamin C concentration of the milk whereas the unsaponified portion of oat oil decreased it. (Table I).

TABLE I.

EFFECT OF ADMINISTRATION OF VARIOUS SUBSTANCES ON THE CONCENTRATION OF ASCORBIC ACID IN MILK

Substance given and amount	Concentration of ascorbic acid in mg/100 c.c. milk			
	Before dosing	During dosing	After dosing	% increase
1.0 c.c. paraldehyde ..	2.62	3.93	3.46	50.0
1.5 gm. barbitone ..	2.42	2.74	3.14	29.8
1.5 gm. grass oil ..	3.90	3.68	3.98	2.0
1.5 c.c. unsaponified portion of oat oil ..	3.87	2.56	2.68	33.8

Each column represents the daily averages, three animals being used for each test substance. The first period consists of seven days during which the animals received the basal ration alone. The middle period usually consisted of 3 to 4 days when the animals received the injections daily in the doses given. During the last period, again consisting of seven days, the animals were given the basal ration alone. The basal ration consisted of ¼ lb. of concentrate mixture of equal amounts of casein and wheat bran and 2 lbs. of Pakar tree leaves (*Ficus*

infectoria). This ration had no stimulating or depressing effect on the vitamin C content of milk.

Paraldehyde had little or no effect on the average daily milk yield so that the total output of vitamin C in the milk was also increased. Barbitone, on the other hand, decreased the yield considerably so that though the concentration in the milk was increased, the total vitamin excretion dropped to a low level. Ultimately, all the animals in this group became dry within a week after starting the injections. Only one animal in the grass oil group showed a decrease in milk yield. The unsaponified portion of oat oil had a very slight favourable effect on the milk yield. The results are embodied in Table II.

TABLE II.

EFFECT OF ADMINISTRATION OF VARIOUS SUBSTANCES ON THE DAILY TOTAL EXCRETION OF VITAMIN C IN MILK

Substance	Average amount of ascorbic acid excreted daily in milk			
	Before dosing	During dosing	After dosing	% increase
1. Paraldehyde	5.10	6.67	6.11	+30.8
2. Barbitone	4.15	2.72	2.49*	-40.08
3. Grass oil	8.65	7.63	7.60	-12.1
4. Unsaponified portion oat oil	7.62	5.73	5.96	-24.8

* Average of 4 days only, after which the animals went dry.

Incidentally, it was found that in two of the animals which accidentally caught cold and developed pneumonia, the vitamin C concentration in the milk was diminished considerably.

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Izatnagar, 6-6-1942.

¹ Longenecker, H. E., Musulin, R. R., Tully, R. H. and King, C. G., *J. Biol. Chem.*, 129, 445, 1939.

² Longenecker, H. E., Fricke, H. H. and King, C. G., *J. Biol. Chem.*, 135, 497, 1940.

³ Whitnah, W. H. and Riddell, C. H., *J. Dairy Sci.*, 20, 8, 1937.

ON THE NATURE OF THE ACTIVE GROUP IN PAPAIN

The original note¹ which gave rise to this discussion, related *specifically* to the gelatinase and peptonase activities of papain. The rejoinder² to my note³ by Giri and Seshagirirao while not meeting with both the points raised by me squarely deals with other topics, which, I must say, are quite beside the point at issue.

Regarding the much discussed nitroprusside test for thiol groups I may state at once that from the works of Anson and his co-workers⁴ and others^{5, 6, 7} it will be clear that while a positive direct nitroprusside test is a sure indication of the presence of sulphhydryl group, a negative nitroprusside test, save in the presence of denaturants or disulphide-thiol reducing substances, is not at all conclusive of the absence of thiol groups.

Balls and Lineweaver to whose work all of us have drawn attention, have definitely corrected their previous statement⁸ about the thiol nature of papain in a later note to Nature.⁹ Because of the fact that HI was detected in the mother liquor, in the reaction between papain and iodo-acetic acid, as is to be expected from the work of Rapkine¹⁰, they state that only one-SH group (in about 10 in the papain molecule) is essential for the papain activity. Ganapathi¹¹ has recorded similar observation.

In their reply, Giri and Seshagirirao refer to the inhibitory effect of Cu⁺⁺ on papain and the restoration of the activity on the addition of HCN and say "even *here* (*italics mine*) the active product obtained did not give any test for thiols". If by *here* they mean the reactivated product, it is a very important and interesting result, which they failed to mention in their previous note. It may be added that in our experience, unless a very large excess of either Cu⁺⁺, iodine or similar oxidants is employed for inactivation the HCN reactivated product invariably gave positive direct nitroprusside test.

It may be stated once again, that the sulphhydryl picture of papain's proteolytic activity is not based on the nitroprusside test *alone* but on its behaviour to many oxidising and reducing agents and specific reagents as mentioned in my previous note.³ It is interesting to note the close parallelism, in the inhibitory effect of selenium on papain¹², urease¹³, succinic dehydrogenase,¹⁴ all of which, are shown to depend on the -SH group for their respective activities and the absence of any effect on arginase, catalase and acetyl-choline esterase¹⁵ all of which so far as is known, do not depend on the -SH group for their functioning.

Caution in the interpretation of results on the sulphhydryl basis seems advisable, if one is mindful of the fascinating complexities of enzyme action. The controversy might be ended if we remember the words of Hellerman.¹⁵ "Workers now seem convinced of the advantages of proceeding in this field on the basis of rational chemical concepts; also, that this approach, where applicable, is much to be preferred to a mere assembly of empirical observations. (Such an assembly may, of course, have served the indispensable function of furnishing suggestions)."

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Indian Institute of Science,
Bangalore,
8-4-1942.

¹ SCIENCE AND CULTURE, 7, 408, 1941-42.

² *Ibid.*, 7, 510, 1941-42.

³ *Ibid.*, 7, 510, 1941-42.

⁴ Anson, J. *Biol. Chem.*, 135, 797, 1941.

⁵ Anson and Mirsky, *J. Gen. Physiol.*, 19, 427, 439, 1936.

⁶ *Ibid.*, 24, 409, 1940-41.

⁷ Hopkins and Morgan, *Biochem. J.*, 32, 611, 1938.

⁸ Balls and Lineweaver, *J. Biol. Chem.*, 130, 669, 1939.

⁹ Balls and Lineweaver, *Nature*, 144, 513, 1939.

¹⁰ Rapkine, C. R. Soc. Bio., Paris, 112, 1294, 1933.

¹¹ Ganapathi, C. V., Thesis, M.Sc., Madras Univ., 1939.

¹² Bersin and Logemann, *Zt. Physiol. Chem.*, 220, 209, 1933.

¹³ Wright, J. *Pharm. and Expt. Ther.*, 68, 220, 1940.

¹⁴ Wright, *Pub. Health Rep.*, 53, 1199, 1938.

¹⁵ Hellerman, *Physiol. Rev.*, 17, 454, 1937.

[No further communication will be published on the subject.—Ed., SCIENCE AND CULTURE.]

THE COLOUR OF SHAMLA JUTE: ITS CAUSE AND REMOVAL

The colour of jute fibre, which varies widely from sample to sample, is an important subject for study both from the industrial and scientific points of view. Fibre from *Corchorus olitorius* tends to have a reddish brown colour while the fibre from *C. capsularis* at its best is a pale creamy-white colour. Analyses made in these Laboratories have shown that the reddish colour commonly found in *olitorius* fibre is due neither to a higher lignin content nor to a higher iron content as compared with *capsularis* fibre. Thus an average figure of 11.3 per cent. lignin content has been found for the former as against 12.3 for the latter. For iron content the former showed an average value of 0.041% (range 0.012 to 0.069) and the latter 0.033 (range 0.017 to 0.045). There

was no relation between depth of red colour and iron content in *olitorius* fibre.

Clitorius fibre often has quite a dark grey colour instead of the more usual reddish brown colour and grey samples of *capsularis* fibre are not uncommon. The cause of the colour of such fibre (popularly known as *shamla* jute) was not definitely known. Matthews (*Textile Fibres*, p. 763, 1923) says "... if steeped in muddy water the fibre takes a dark-grey colour," while Chowdhury (*Jute and Jute Substitutes*, p. 51, 1933) says "... the quantity of iron, although very small, has something to do to discolour the jute." In the first report on *The Marketing and Transport of Jute in India*, published by the Indian Central Jute Committee, we read (p. 51) "It has been noticed that when water is reddish brown the fibre is likely to be blackish. This is due, it is said, to the action of iron salts contained in the water. Water of this sort is quite common in West Bengal and in parts of Bihar. It is quite probable that the dark grey colour of *shamla* jute is the result of retting in such water. This point, however, requires to be verified by chemical experiments."

Estimations of the iron content of various samples of jute have shown that it is distinctly higher in *shamla* fibre than in other samples (about 0.1 per cent. as compared with 0.02 to 0.01 per cent.)—vide Annual Report, I. C. J. C., 1940-41, p. 130.

It had been found at the Jute Agricultural Research Laboratories at Dacca that the tannin content of *olitorius* plants is higher than that of *capsularis* plants (I. C. J. C. Bulletin, Vol. III, p. 236). The idea suggested itself that the dark colour of *shamla* fibre might be due to the production of a kind of ink on the fibre by the combination of the tannin in the plant with iron compounds in the retting water and early in January, 1941, some experiments were made to test this hypothesis. It was soon found that ordinary retted jute fibre contained little or no tannin, no doubt because it was leached out during retting. Consequently, when ordinary pale-coloured jute fibre is steeped in a dilute solution of a ferric salt it does not take on a grey shade. But if the fibre is previously steeped in a dilute solution of tannic acid and then treated with a solution of a ferric salt, a grey colour similar to that of typical *shamla* fibre appears, as expected, the depth of colour depending on both the concentration of the tannic acid and of the ferric salt solution. Further confirmation was obtained by the following experiments—(1) The dark grey colour of *shamla* jute is removed very quickly by treatment with dilute oxalic acid or dilute mineral acids. (2) The colour of jute fibre usually darkens on steeping in a

solution of tannic acid, no doubt on account of the presence of sufficient iron compounds on the fibre to combine with the tannin and produce a certain amount of "ink". (3) Dry bark from mature jute stems which we had stored in the Technological Research Laboratories was chemically retted with 2 per cent. sodium fluoride solution in the presence of a little ferric ammonium sulphate (ferric fluoride is soluble in water). The fibre obtained had a dark grey colour similar to that of *shamla* jute. (4) We also made a number of experiments (beaker-scale) in which jute (dry, mature plants) was allowed to ret biologically with various amounts of iron in the retting water. Under these conditions it was found that the minimum quantity of iron in the retting water that will produce a *shamla* colour was about 0.01 per cent., the colour produced with that quantity being a light grey.

The dark-grey colour of typical *shamla* jute can be removed by very simple treatments. Oxalic acid solutions are far more effective than dilute solutions of hydrochloric or sulphuric acid. Even N/50 oxalic acid solution at a liquor-ratio of 1:10 completely removes the *shamla* colour. A very rapid effect is obtained with N/10 oxalic acid. An acid mixture containing oxalic acid crystals (0.06 p.c.), sulphuric acid (0.25 p.c.) and hydrochloric acid (0.25 p.c.) is very cheap and quite effective (I. C. J. C. Annual Report, 1940-41, p. 130). In all such treatments it is imperative that every trace of acid should be washed out before the fibre is dried. Otherwise tendering is likely to occur. The acid solution may

be used more than once, with the addition of a little fresh acid as required. This will reduce the cost.

Yarn spun from *shamla* jute has been found to suffer no significant loss in strength (as compared with yarn steeped in pure water) by treatment with N/10 oxalic acid for far longer than is required to remove the colour. Thus in one experiment the treated yarn had a mean breaking-load of 8.92 lb. as compared with 9.09 lb. for yarn steeped in water.

It may be noted that it is desirable that the water used in washing the treated fibre should have a very low iron content. The most costly part of the process is likely to be the drying, but during a large part of the year natural drying should be possible. The increase in the value of the fibre may more than balance the cost of treatment. *Shamla* fibre often takes on after treatment the rather deep reddish colour which is preferred for some purposes.

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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

AUGUST, 1942

No. 2

The Economics of Food and Nutrition

WITHIN the limits set by heredity, remarked Sir F. G. Hopkins several years ago, nutrition is the most important among the environmental factors conditioning optimum health and growth. This view has by now been widely accepted. During recent years the Governments in most civilized countries have been increasingly conscious of their duty regarding the supply of adequate food and nutrition to their people, who are also now better educated in this respect than before.

In this country, however, the situation is deplorable in almost every way. As is admitted in the editorial of *Nature* of March 21, 1942, "There are huge blocks of human life, in India and China for example, where the standard of diet is not of the same order as the minimum proposed by the Technical Commission of the League of Nations or as the standard of diet of Western Europe. Europe, excluding the U. S. S. R., with a population little more than one-third of that of Asia consumes more cereals and six times as much meat. A world of such gross inequalities cannot be stable."

It is therefore high time that the production of food in India should be intensively tackled from every angle. The problems of crop rotation, use of natural and artificial manures, genetical production of better seeds, bringing waste land under cultivation, the planning of crop-production in the light of nutritional knowledge, the processing of the numerous food-stuffs in this country in which hardly any beginning has been made—these are all inter-related questions of paramount importance.

A body which represents all the scientific and administrative facets of this all-important problem

should be appointed without delay. There is, unfortunately, no Ministry of Food in this country. One should have thought that this is very necessary in view of its importance. But even without it, much could be accomplished if an expert body with the data at its disposal could formulate concrete steps for implementation by Government. One only hopes that even when such proposals are formulated they may not be pigeon-holed as has been the fate of so many others in this country.

Linked with the question of producing food for India as a whole is the question of regional food production. The present war with its heavy demands on transport has revealed the weakness of one region in India being almost entirely dependent on another for even essential food-stuffs. India is a vast country and it is of the greatest importance that large regions in India should not be dependent on remote areas for essential consumption goods like food and textiles. The National Planning Committee accepted this principle and felt the need of securing a more balanced production in different parts of India. The Committee also felt that particularly in the matter of food and clothing, regional self-sufficiency should be aimed at. This is what the Soviet Union has been aiming to do in different parts of its vast territories. This attitude does not mean autarchy which is definitely a retrograde policy, but the co-existence of the freest movement of goods with a more balanced structure of production.

How to give practical effect to this principle is, however, a difficult question, which can be adequately tackled only if regional investigations are carried out

along right lines. The following article sets forth some broad considerations on the economics of food and nutrition in India. An analysis of the present position of Bengal and Calcutta with regard to food supply which has been presented in the next article will shed more light on the problem.

—Editorial Note.

"THE destiny of nations", it has been rightly said, "depends on the manner in which they nourish themselves."* If this aphorism holds good for all nations, it has a peculiar significance for us. Our diet, mainly because of our poverty, is not properly balanced. Our deficiency in the supply of some of the most important items, particularly what are called protective foods, such as milk and milk products, is almost shocking. The essence of the culinary art consists in imparting taste to the food without sacrificing its nutritive value, but we often sacrifice the latter for the sake of conventional standards of taste. And, lastly, we encounter great difficulty in procuring the food-stuffs in pure form. Adulteration prevails on a scale which would be unthinkable in any civilised country. It has become a national menace and has been steadily undermining our health.

If the science of human nutrition should be a constant guide in the selection and preparation of food, the economics of nutrition is no less important and deserves more careful attention than it has so far received in this country. From the economic angle, it should be the endeavour of every individual to secure a maximum nutritive value for the money spent on food. This is all the more important for a country like India where the average income per head is incredibly low. Yet it cannot be said that this principle is always observed by us. An examination of family budgets will reveal the fact that in most cases there is scope for thrift in the sense that with the same amount of money, a better nutrition can be secured than what is actually the case. For this anomaly habits as well as ignorance must be held responsible.

There is yet another and more general way in which economics is related to the question of national nutrition. Obviously, it is of great importance how the market for food-stuffs is organised and what proportion of the total demand is met from national resources. Other things remaining equal, the greater

* "La destinée des nations dépend de la manière dont elles se nourrissent."—Brilliant-Savarin.

this proportion, the better is it for the country as a whole. From the national angle, there may be two kinds of waste. Firstly, it would be a wasteful policy if a nation were to buy from abroad commodities which could be produced at least as cheaply at home if the internal resources are developed. And secondly, a nation no less than an individual should attempt to secure its money's worth in terms of nutritive value. For example, it is an undoubted waste to import commodities when cheaper substitutes of equal or of greater nutritive value are available at home.

War, as we all know, is a hard economic taskmaster. In the relentless search for economy the twofold waste just referred to, has to be cut down to an irreducible minimum. Sometimes on military grounds a nation at war has to stimulate home production and go over to substitutes even at a sacrifice. As regards the elimination of wastes from national nutrition, the principle of war economy is no less relevant to peace economy. The acceptance of this principle is particularly necessary in India where, as a result of indifference and thoughtlessness of long years, both types of waste prevail on an extensive scale. Large resources lie untapped. Modern science and technique have been harnessed to the production of food-stuffs as to other spheres of our economic life, only to a negligible extent. And as regards substitution, we have for a long time been moving in the opposite direction of replacing cheaper home products by more expensive ones of foreign origin. A readjustment in our system of national nutrition has long been overdue. It is high time to look "home-ward" for our food-stuffs.

Let us examine this question by quoting some figures of the sea-borne imports into India in 1938-39 of a number of articles of everyday consumption. (See p. 52 of this issue). The year 1938-39 has been chosen for a double reason. This was the last pre-war year, after which the normal trend in trade was upset as a result of dislocation in international communications. Besides, soon after the outbreak of war the publication of detailed information on India's foreign trade was suspended so that figures available for the subsequent period are necessarily fragmentary in character.

Strictly speaking, to arrive at the volume of actual consumption for India as a whole, re-exports of the commodities from India ought to be sub-

tracted from the figures and trade across India's land frontiers should be added to them. Re-exports are, however, negligible in quantity while the imports of articles of food by land route are not considerable, except in the case of the import of fresh and dried fruits from Afghanistan. In any case, the volume of actual consumption of imported food-stuffs in India may be somewhat more, but certainly not less than that of sea-borne imports.

The figures show the curious anomaly that a country like India which is so overwhelmingly agricultural, spends several crores of rupees every year on the purchase of essentially agricultural commodities from overseas countries. In 1938-39 we imported 8½ lakhs worth of butter mainly from Australia, New Zealand and England; fruits and vegetables (dried, salted or preserved but not canned or bottled) worth 88 lakhs from Iraq, Portugal, East Africa, Italy, Iran and several other countries; potatoes worth 35 lakhs from Burma, Italy and Kenya Colony, of which the last two accounted for over 12 lakhs and over 4½ lakhs respectively; fish (not canned) worth 7 lakhs mainly from Muscat Territories and England; and fresh fruits worth 45 lakhs from Italy, U.S.A., Australia, Kenya, Straits Settlements, Japan, etc. Yes, even Japan in normal times sells to us fresh fruits worth three lakhs a year.

In the category called 'provisions and oilman's stores' imports into India in normal times amount to something like 2½ to 3 crores a year.

In 1938-39 the purchases were:—

- Fish (tinned or canned) worth 6 lakhs mainly from England, Canada and U.S.A.;
- Fruits (tinned or bottled) worth 10 lakhs mainly from U.S.A., Straits Settlements, England and Australia;
- Cocoa and chocolate worth 3 lakhs mainly from England;
- Farinaceous foods in bulk worth 27 lakhs mainly from Straits Settlements and Java;
- Milk foods for infants and invalids worth 18 lakhs mainly from England and Australia;
- Jams and jellies worth 7 lakhs mainly from England and Australia;
- Condensed milk, cream etc., worth 20 lakhs mainly from Netherlands, Australia, England and Denmark;
- Pickles, chutnies, sauces and condiments worth 8½ lakhs mainly from England;
- Cheese worth 7 lakhs mainly from Netherlands, England, Australia and Denmark;

Biscuits and cakes worth 25 lakhs mainly from England;

Confectionery worth 17 lakhs mainly from England, Belgium and Japan.

In the same year we spent 48 lakhs on "starch, dextrine and farina" mainly supplied by Straits Settlements, Netherlands and U.S.A., 65 lakhs on non-essential vegetable oils (mainly coconut oil) drawn primarily from Ceylon and Straits Settlements; 263 lakhs on various kinds of spices including betelnuts, cloves¹, chillies, cassia, etc., of which Straits Settlements alone accounted for 75 per cent and Zanzibar, Pemba, Madagascar, Ceylon and Burma together for almost the remaining 25 per cent; 105 lakhs on tobacco, of which 51 lakhs went to England and 48 lakhs to the U.S.A. Our salt imports in 1938-39 were worth 38 lakhs, practically the whole of which came to Bengal. Apart from Aden and Egypt, England and Germany sent salt worth 2 lakhs and 5 lakhs respectively.

Lastly, our imports of food grains and pulses, are far from negligible. Imports of wheat alone were valued at 1,17 lakhs in 1938-39, practically the whole of which came from Australia. In the same year India spent 11,39 lakhs on imports of rice and an additional sum of 47 lakhs on imports of paddy. Of the total amount no less than 91 per cent went to Burma.

The above survey, though brief and hurried, reveals the extent to which India now depends on non-Indian sources for various articles of food. The most significant fact about this dependence is that it is in no way enjoined by nature, but is overwhelmingly our own creation. For imposing as is the list of commodities just enumerated, it contains few articles which could not be produced at least as cheaply from our resources. Certainly there should be no imperative need for us to buy from abroad butter, fish, most of the fruits and vegetables, potatoes and most of the items included in 'provisions and oilman's stores'. In fact, it would be legitimate to submit that with the resources available in this country we ought to be in a position not only to meet the internal demand for these commodities, but also to develop a lucrative foreign trade for many of them. All that we would require for this purpose would be to run our agriculture on more scientific lines in order to diversify

¹ As regards the possibilities of cultivating cloves in India, see SCIENCE AND CULTURE, 4, 221, 1938.

production as well as to improve our present yield both qualitatively and quantitatively and at the same time start or develop a number of food industries either on cottage or factory scale, or both. For example, industries for canning or tinning fruits, vegetables and fish have great possibilities, as also the manufacture of various types of fruit syrups and fruit juices, jams and jellies, pickles and chutnies, sauces and condiments, while there is also absolutely no reason why we should not be able to meet our whole demand for milk foods, farinaceous foods, biscuits and cakes, confectionary, cheese and a host of other articles. Similarly, the coconut oil industry could perhaps be further extended so as to meet the entire demand of India. With a little research and enterprise the whole tobacco now consumed in India could be produced within the country and the growing demand for cigarettes met from an indigeneous cigarette manufacturing industry. As regards spices we may have to continue our dependence on outside sources though even here the internal supply, specially of betelnuts and chillies, could be increased.

The present position with regard to the supply of rice calls for a special comment. In the course of the outgoing year we fully experienced the disadvantages resulting from a dependence for our staple food on Burma. The crisis in rice is not yet over. The lessons of this crisis are quite clear; we must make a deliberate bid for self-sufficiency in rice. With vast rice-growing tracts in this country, this should not at all be difficult to attain. The area under rice can easily be extended. The present policy of the Bengal Government to reduce the jute acreage will almost certainly bring about such a result, for rice is at present the only possible alternative crop for the major part of the area released from jute cultivation. It would, however, be more economic in the long run to make good the present deficiency in rice by an improvement in yield figures per unit of land than by an extension of the area under rice. If China can grow twice and Japan three times more paddy per acre than we do in this province, though both our land and climate are better suited for the cultivation of this crop, there is undoubtedly ample scope for improving our yield figures.

During the last two years far-reaching changes have taken place in India's foreign trade. The suspension of trade with enemy countries, the dislocation in communications, lack of shipping facilities, exchange control, have all combined to reduce

the imports of many articles just as the first three factors have hampered the exports of many of our staple products. It is certain, though we have no figures to illustrate the point, that the imports of food-stuffs into India have undergone drastic curtailment. If the present reduction were to serve as a stimulus to home production and carry us a few steps further towards self-sufficiency, good would come out of evil. It is, however, difficult to be optimistic about future development. For, we could derive permanent benefit from the present opportunity only if we could reorganise our agriculture on a more rational basis and start a number of food industries. There are at present no signs that the war-time hardship will serve as a sufficient inducement to bring about the desired changes in agriculture. And as regards the establishment of food industries, transport and other difficulties, as we all know, cut both ways. For if they have cut down the imports of food-stuffs, they have also hampered the import of machinery without which it is difficult to start new industries in many cases.

These are, however, all temporary handicaps. The present war, if seen in the right perspective, is both a challenge and an opportunity. Let it not be used as a mere excuse for continued inaction in a sphere so vital to national welfare. Moreover, the national food front, as has been recognised in all countries, is of overwhelming importance in a modern war. Breaches here can be no less fatal than those in other fronts. In reorganising our agriculture and food production on a more scientific basis, we can, paradoxical as it may sound, profitably take a leaf from the economic history of just that enemy country which has been primarily responsible for our present food difficulties and which now immediately threatens our eastern frontiers. There can be little doubt that if we could imbibe something of the relentless spirit with which the major belligerent countries have been consolidating their food fronts, we could, even while the war was on, go a surprisingly long way in meeting the specific problems now confronting us and thereby solidly lay the foundation for a far-reaching reconstruction in future. And even where action must necessarily be postponed because of the dearth of the requisite capital equipment, we could at least draw up the outline of a comprehensive long-term plan in advance so that when the day of post-war reconstruction should come, we might not be taken unawares.

Sudhir Sen

The Food Problem with Reference to Calcutta and Bengal*

SUDHIR SEN

THE importance of regional economic studies in a vast country like India is admitted on all hands. But the paucity of reliable statistical data on regional production and inter-regional exchange of goods at present renders such investigations extremely difficult. A full appraisal of the present position of Calcutta and Bengal in the matter of food supply would call for much more statistical information than is available at present. Nevertheless, even the limited amount of data published in official reports, when brought together throws some interesting light on this question.

The figures for seaborne imports into Bengal, as shown in Table A on the following page, do not relate to actual consumption within this province. Part of the imports may be and, in fact, is, sent out by rail and river. It is not easy to ascertain the proportion which goes out in this way except for a very few commodities, for which the official publication on the rail and river-borne trade in India gives separate figures to show their inter-provincial movements. Nevertheless, there can be little doubt that by far the greater part of the imports into Bengal is retained within the province and that, of the total consumption of all these commodities, Calcutta alone accounts for a very large part.

The observations made in the previous article with regard to India as a whole, hold, in general, good also for Bengal. There is no doubt that great possibilities exist here for starting many of the processing industries to which reference has been made before, the more so as Calcutta is one of the largest, if not the largest, markets for imported food materials in India. To take a few examples, a fish-canning industry has very good prospects in this province. As we all know from our own experience, there is often a seasonal glut in the fish market in various places of Bengal, which brings about a slump in prices. This is particularly true of the *hilsa* fish. If preservation of fish, either in dried

or salted form, were rendered possible on an extensive scale, seasonal fluctuations in prices would be largely ironed out, to the great advantage of consumers as well as the fishermen's community. If simultaneously scientific cultivation of fish were undertaken in the rivers and tanks of Bengal, coupled perhaps with arrangements to catch sea-fish on a commercial scale, we see no reason why Bengal should not gradually come to rank as one of the important fish-exporting parts of the world. Again if we take the case of salt we find that, in addition to the amount imported by sea which in 1938-39 was worth 37 lakhs, Calcutta imported 1 lakh maunds of salt in 1939-40 by rail and river. What justification can there be for such overwhelming dependence on outside sources? In a moist climate like that of Bengal the process of evaporating salt-water tends to become appreciably more expensive than in Aden and in other places. This is no doubt a severe handicap for the growth of the salt industry in Bengal. Nevertheless, in view of the importance of the problem, it deserves a thorough scientific investigation. 52 lakhs worth of non-essential vegetable oils (mainly coconut) were imported into Bengal in 1938-39. Imports of all vegetable oils into Calcutta in 1939-40 from Indian sources lying outside Bengal amounted to 748 thousand maunds. Yet Bengal has an extensive coconut-growing belt where coconut production is already large and is capable of further extension. An oil industry in the coconut zone will in all probability be an economic proposition and would be able to meet a large part of our demand for coconut oil for food and other purposes. Undoubted possibilities also exist for the manufacture of cigarettes as

* This paper was prepared just before the outbreak of hostilities in the Far East. With war now knocking at our doors, the importance of the question of food supply to Calcutta and to Bengal has greatly increased. The considerations set forth in this paper refer in the main to the longer run, though they are not without relevance to the short-run problems which now confront us.

also of most of the commodities covered by the general label "provisions and oilman's stores".

2

In Table B figures have been provided to show the imports of certain articles, mainly of food, into Calcutta together with the respective shares of Bengal and other parts of India. To arrive at the figures for

actual consumption in Calcutta, we should subtract from the first row of figures the quantities exported to various parts of Bengal and add the imports into Calcutta by coastal steamers, country boats, bullock carts and motor lorries. This naturally involves a good deal of difficulty as separate figures are not available to show the actual volume of imports into Calcutta by different means of transport. Nevertheless

A. SEA-BORNE IMPORTS (1938-39)

Commodities	Imports into India		Imports into Bengal	
	Quantity	Value in 1,000 rupees	Quantity	Value in 1,000 rupees
Butter	8,230 cwts.	8.58	4,567 cwts.	4.88
Sugar	35,679 tons	45.58	3,214 tons	4.65
Fresh fruits		9.21		3.98
Potatoes	876,574 cwts.	35.89	585,979 cwts.	18.33
Fish (excluding canned fish)	94,290 cwts.	6.89	4,183 "	1.15
<i>Provision and Oilman's Stores:</i>				
Bacon and hams	16,910 cwts.	12.87	5,492 cwts.	4.51
Biscuits and Cakes	29,200 "	24.72	7,909 "	6.44
Confectionary	23,772 "	16.71	7,656 "	5.47
Canned or bottled fruits	43,881 "	10.09	10,143 "	2.94
Tinned or canned fish	13,249 "	6.37	3,832 "	2.05
Vegetable products (vegetable ghee, fats, etc.)	3,312 "	1.05	1,655 "	.44
Other vegetable products	73,063 "	34.93	28,149 "	12.58
Cheese	10,373 "	7.37	2,885 "	2.34
Cocoa and chocolate	4,014 "	2.95	1,232 "	.88
Farinaceous foods in bulk	371,240 "	26.69	215,196 "	15.43
Milk foods for infants and invalids (wholly or mainly milk)	9,716 "	18.32	4,401 "	8.68
Jams and Jellies	18,227 "	6.67	5,147 "	2.02
Milk condensed and preserved including milk cream	62,068 "	20.05	24,599 "	6.90
Pickles, chutnies, sauces and condiments	8,507 "	5.91	2,905 "	1.95
<i>Starch, Dextrine and Farina:</i>				
Starch	(1,000 cwts.)		(1,000 cwts.)	
Farina of Potato Flour	323	28.88	123	8.76
Sago flour	83	6.89	6	.52
Dextrine	337	15.04	75	3.37
	22	2.22	3	.29
<i>Grain, Pulse and Flour:</i>				
Beans	15,026 tons	13.10	504 tons	.62
Gram	6,585 "	5.43	1,129 "	.93
Pulse	48,993 "	50.62	3,161 "	3.28
Rice in the husk	83,841 "	47.33	7,628 "	3.88
Rice not in the husk	1,281,697 "	11.39.33	275,395 "	2.26.09
Wheat	159,062 "	1.16.80	76,798 "	55.45
<i>Vegetable Oils, non-essential:</i>				
(Mainly Coconut)	(1,000 gls.)		(1,000 gls.)	
	7,614 "	64.64	6,498 "	52.27
<i>Salt:</i>				
	(1,000 tons)		(1,000 tons)	
	312	37.80	311	37.17
<i>Spices:</i>				
	(1,000 cwts.)		(1,000 cwts.)	
Betel nuts			1,241	1,33.25
Cassia	1,840	1.95.86	26,157 cwts.	4.02
Chillies	55,466 cwts.	8.59	3,642 "	.52
Cloves	62,545 "	10.35	27,116 "	15.02
Nutmegs	69,574 "	36.60	3,605 "	1.36
Pepper	10,454 "	4.00	12,589 "	2.39
	24,050 "	4.57		
<i>Tobacco: (both manufactured and unmanufactured)</i>				
	(1,000 lbs.)		(1,000 lbs.)	
	7,888	1.04.55	5,017	54.08

the figures even as they stand now, are instructive and entitle us to draw substantially valid conclusions.

B. IMPORTS BY RAIL AND RIVER INTO CALCUTTA (1939-40)

Commodities	Imports into Calcutta (In 1000 mds.)	Share of Bengal (In 1000 mds.)	Share of other provinces (In 1000 mds.)
Gram	996	479	517
Wheat	3,463	8	3,455
Wheat flour	62	2	60
Ground nuts	1,000	—	1,000
Linseed	3,083	271	2,812
Rape and mustard	2,618	18	2,600
Til or jinjili	26	12	14
Ghee	240	2	238
Salt	110	10	100
Sugar	1,056	324	732
Gur, molasses, rab, jaggery, etc.	1,145	50	995
Fruits, dried	157	7	150
Tobacco, raw	430	205	225
Coffee	3	—	3
Tea	2,785	1,162	1,623
Vegetable oils	755	7	748
Oil cakes	145	3	142
Cattle (excluding sheep and goats)	(No. in 1000) 97	(No. in 1000) 22	(No. in 1000) 75
Sheep and goats	487	251	236

What strikes one at once is the overwhelming preponderance of outside sources in meeting the demand for Calcutta and the very low share of this province. While climatic reasons and soil conditions make it almost inevitable that Calcutta or even Bengal, should import such commodities as wheat and gram from other provinces, the same argument cannot be put forward to justify the present degree of dependence on those sources for most of the remaining commodities. We may briefly examine the case of some of them:

(a) We have already seen that a salt and a coconut oil industry might be developed in Bengal.

(b) The low lands of East Bengal may not be suitable for growing ground-nuts and linseed on a large scale, but there are possibilities for both crops in West and North Bengal where they can be grown on a commercial scale and meet at least a part of the Calcutta demand.

(c) Imports of rape and mustard seeds into Calcutta in 1939-40 amounted to 2,618,000 maunds. In addition, there were considerable imports into other parts of Bengal. The United Provinces, Bihar and the Punjab were the main sources of supply.

It is strange that while Bengalees, unlike the people in most parts of India, should use mustard oil instead of ghee as the main fat ingredient in cooking, they should be overwhelmingly dependent on others for the supply of mustard seed. Yet this dependence can be considerably reduced provided action is taken along two lines. There are reasons to believe that the cultivation of mustard seeds has gone down in this province in recent years. With proper investigation it should be possible to find out regions where mustard seeds can be grown as a profitable *rabi* crop. It has also been suggested by some that a substitute can be found in coconut oil. Habits, however, die hard and it may be over-optimistic to think that the tastes of our people could be influenced to such an extent by economic considerations. Yet we should do well to bear in mind that in recent years European nations have, on economic grounds, successfully experimented with substitutes and have brought about more profound changes in national taste than would be involved in a replacement of mustard oil by coconut oil. Incidentally, it may be mentioned here that in certain circles there is a prejudice against mustard oil, the extensive use of which in cooking is believed to be harmful for national health. Mustard oil, they say, is meant for external application and not for use as food. It is difficult to judge if there is any truth in this contention. In any case, in view of the obvious importance of this question, the properties of mustard oil ought to be determined by experts and its incidence on the health of Bengalees carefully examined.

(d) The dependence of Calcutta on outside sources for such an essential article of food as ghee is no less startling. 238,000 maunds were imported into Calcutta in 1939-40. We should recall in this context that, in addition to the peace-time supply from overseas countries, butter comes from Aligarh, Allahabad and other places.

Thus on account of ghee and butter, as on account of mustard seeds, Bengal spends a huge sum every year, the greater part of which could be retained within the province. The large import of ghee and butter is no less regrettable as an index to the utter neglect in this province of animal husbandry which, apart from crop-raising, is perhaps the most important source of occupation in agriculture.

(e) Calcutta as well as Bengal is at present largely dependent on other provinces, particularly

Bihar and the U. P., for the supply of sugar and *gur*, molasses, *rab*, jaggery, etc. The question has often been raised whether Bengal should develop a sugar industry. It has been suggested that in view of the over-production which at present afflicts the sugar industry in India, it would be a wrong policy to start new sugar factories which would aggravate the existing difficulties. There is undoubtedly truth in this argument, though it is not enough to decide the issue. The sugar industry is at present mainly concentrated in two provinces. In a vast country like India it is economically wasteful to centralise an industry to such an extent, particularly when it produces an article of mass consumption, for the costs of distribution become relatively heavy. Other things remaining equal, it is wiser to set up factories as near the centres of consumption as possible. Though a decentralisation of the sugar industry in order to secure a more economic distribution of sugar factories all over India may at the outset unfavourably affect some of the existing concerns, it will, in the end, bring about a net gain from the point of view of the country as a whole. Thus there is theoretically, no reason why more sugar factories should not, sooner or later, be developed in other parts of India including say, East Bengal. There are, however, some practical difficulties which have so far been among the factors hindering the growth of this industry in Bengal. For example, a sugar factory must have a continuous supply of canes at reasonable prices and in sufficient quantities during the crushing season. It is not easy to satisfy this condition. It presupposes that, close to the factory, there should be a large area in a block devoted to cane cultivation. But in permanently settled areas with a large number of extremely small holdings there can be no assurance that such an area would be permanently available for cane cultivation. One will have to depend on voluntary co-operation, which may not be effective. Lack of adequate roads in many parts of East Bengal make the transport of canes to the factory extremely difficult and expensive. There is also question of the quality of cane grown and its sugar content, etc. Unless these problems are successfully tackled, it is difficult to see how this industry can be developed in Bengal.

(f) Visits to various markets in Calcutta have brought to our notice certain interesting facts. We may mention in passing that for nine months in a year Calcutta depends on certain districts of Madras for its lemon supply. Onions are drawn in large

quantities from Patna, Nasik, Panipat and certain parts of Madras, while only small quantities are imported from Faridpur district. For potatoes again, in addition to the supply from Burma which has already been considered, Calcutta depends on Mysore, Assam, and partly also on Nainital side, as local or Bengal production falls far short of the total demand. It is interesting to note in this connection that certain wholesale dealers in potatoes complained that Shillong potatoes could meet a greater part of Calcutta demand and compete with Mysore potatoes but for the arbitrary way in which transport charges are put up by the company plying buses between Shillong and Gauhati, whenever heavy orders are placed for Shillong potatoes.

3

We have referred to the possibilities of developing a large number of new industries for the production and processing of various articles of food. In all these cases, the existence of a fairly large demand, actual or potential or both, together with a source of raw material which already exists or may be created, near at hand, makes us feel that, *prima facie*, there is at least a strong presumption in favour of starting such industries. In other words, the possibilities to which we have referred, give rise to a number of hypotheses, each of which deserves to be closely investigated from every relevant angle.

A good deal of misunderstanding often prevails about the nature of investigation which must precede a practical assessment of the prospects of a particular industry. Many a proposal in the past has proved useless and many a venture has come to grief, because all the relevant considerations were not examined in advance with proper care. We have already seen, how in spite of the existence of a substantial market for sugar in Bengal, it may not be possible for a long time to come to develop this industry profitably in this province unless the practical difficulties are removed. Similar considerations, as mentioned before, arise in connection with the salt industry. The market for salt is large and the sea is at hand. But the process of evaporation tends to become far more expensive in a moist climate so that the costs of production are likely to be much heavier here than, for example, in Aden. The future of this industry, therefore, seems to hinge on the question of discovering some cheap method of evaporation suitable for Bengal climate, which would bring down costs.

As regards refrigerated gas storage, a large amount of relevant information will have to be collected before it can be finally ascertained whether this method would be an economic proposition or not in the present stage of our economic progress. For example, if "langra" mangoes are thus to be preserved, we shall have to consider where plants for such storage should be installed, whether in the mango season enough mangoes would flow in at reasonable prices, whether the spot selected would be suitable also as a centre of distribution of mangoes from the gas storage, what would be the overhead charges, that is, how expensive would be a mango served from the gas storage, say, in winter, if the price would be low enough so that the market, including export possibilities, would be sufficiently extensive, and so on and so forth. As a large number of fruits and vegetables may be preserved in this way, every commodity giving rise to a different set of intricate considerations, it is clear that an examination of the purely economic aspect of refrigerated gas storage would be no easy matter.

To take one more example, we have spoken of a coconut oil industry in the coconut belt of Bengal. Again the questions to be considered are—where would the industry be located, what would be the present supply of coconuts, what would be their quality, particularly fat content, whether the existing quality would be good enough, if not, can coconuts of the right quality be introduced and grown on an adequate scale, are there necessary transport facilities for coconuts to flow into the factory smoothly and at reasonable costs, what would be the actual costs of manufacture, how would such costs compare with those of other parts of India and Ceylon, what is the size of the present market and the possibilities of extending it, and so on.

Thus each case would call for a separate investigation covering a wide range of questions. A rational conclusion can be arrived at only if each aspect is considered by an expert. In fact the best way to tackle all these questions would, we believe, be through an organisation like that of P E P in London.¹

4

We need not multiply examples. Enough has been said to show that if the dependence of India

¹ For a description of the aims and objects and the *modus operandi* of P E P, see writer's article on the subject in *SCIENCE AND CULTURE*, 7, 413, 1942.

as a whole on foreign sources for food-stuffs is much higher than is strictly necessary, the same remark holds good with greater emphasis with regard to the position of Calcutta (and Bengal) vis-à-vis other parts of India. And if the share of Bengal in feeding the population of her capital is, for many commodities, much too low, her share in the distribution trade is no higher. This is certainly not a satisfactory state of affairs, particularly at a time when the problem of unemployment in the province has become so acute and the economic outlook appears so gloomy.

There are some who argue that it is all a question of give and take, of a wider division of labour which benefits all. If Bengal buys from others, she also sells to them, for example, her jute. People buy in the cheapest market, and rightly too. To interfere with this natural flow of business would be wrong in principle and would in no way benefit the people. If this thesis were correct, then indeed there would be cause for despair. For it would deprive us of the only kindly light in the midst of the encircling gloom, of the hope that, by our own efforts, we could arrest the progressive impoverishment of the province and ensure for us a better income and a higher standard of living. Fortunately, this doctrine is based on a grievous miscalculation.

When the rain-water drops from the sky, it flows in different directions in obedience to the law of gravitation. But the resultant distribution, as we all know and sometimes to our cost, is not necessarily the ideal from the agriculturist's point of view. A system of canals, if intelligently laid out, can ensure a better distribution with real benefit to agriculture. It is essentially the same with the flow of goods. There is not only scope, but also need for active intervention on the part of the human agent.

Indeed we could go a step further. Sometimes such intervention may be called for to remove artificial hindrances impeding a natural tendency. Thus one might argue that our present position in the Calcutta market is not the outcome of the operation of natural forces, but rather of our own indifference or aversion to certain lines of occupation. The avenues of employment are at present so limited and the volume of unemployment is so large that nothing would be more natural than to expect an increasing number of Bengalees taking to trade and commerce, of which the supply of food-stuff to the Calcutta market is an important branch. But it cannot be denied that thanks to the tradition of the last century Bengalees have acquired a bias for other,

mainly clerical professions. We are largely the victims of our old values. Similarly, with the very low income of the average cultivator, he would naturally have turned to cater to a larger extent for the Calcutta market by supplying commodities which would leave him a wider margin of profit. But, again, his ignorance is largely responsible for the present state of affairs, and even when he is aware of market conditions, he is so innocent of scientific agriculture that he cannot produce the necessary articles on a profitable basis.

Those who invoke the theory of comparative costs in explaining the present position of Bengal (or of India), will do well to remember that the comparative advantages are only too often in our favour, that, if we suffer in competition with others, it is because we have so far not taken the trouble of utilising them. Even under *laissez-faire* our conditions ought to have been very much better, if State *laissez-faire* were not accompanied by individual *laissez-faire* on a large scale. No, it is not any economic law, but the law of inertia which is responsible for the present plight.

The remedy has been implied in the previous analysis and simultaneous action is necessary in several directions.

Firstly, there is a great need for scientific research in agriculture. Moreover, it should be treated as a lever for agricultural improvement. At present such research has become more an end in itself than a means to an end. In most cases it moves in an independent orbit, away from the realities of life. A frankly utilitarian bias must be imparted to agricultural research so that the wealth of the province may be increased.

Secondly, some kind of crop planning has become indispensable so as to secure a better adjustment of demand and supply. In fact, the jute restriction scheme ought to be supplemented, as far as possible, by concrete suggestions for growing alternative crops. And if a plan were drawn up on rational lines, it would be found necessary to keep an eye on the consumer's end and therefore also on the Calcutta market.

Thirdly, there is a very strong case for a readjustment of railway and steamer freights. The present flow of trade is in no small measure influenced by freight charges. Indeed there are reasons to believe that in certain cases lower rates would benefit both the producer and the consumer without involving the

railway or steamer companies in any loss. After the introduction of special rates for the transport of oranges from Darjeeling to Calcutta, the volume of traffic has considerably increased with the result that the railway company, the orange-growers and the consumers all have benefited. The narrow outlook of railway and steamer companies is at present responsible for many anomalies.

Fourthly, we must overcome our aversion to trade and commerce, industry and agriculture. If, educated Bengalees were to pursue animal husbandry as a hobby as well as as an occupation, a great stimulus would be given to a great industry. The same remark applies to horticulture also.

Fifthly, the public has an obvious duty in this connection. Consumers must bear part of the responsibility for the alarming spread of adulteration. They must become more "food-conscious" and must learn to value quality and purity of goods. Besides, their indifference as well as their conventional taste is responsible for the fact that food-stuffs of foreign origin find such a ready market here. Other things remaining equal, we should give preference to what is grown nearer home. Not infrequently we sacrifice cheapness and take to more expensive habits. In certain circles there is a visible tendency towards a Europeanisation of the palate which necessarily involves larger consumption of food ingredients of foreign origin. This is a move in the wrong direction and is not warranted by the economic conditions of the country, and frequently not even by the income of the individuals concerned. In a very real sense the consumers are the ultimate guarantors of the economic interests of the country.

5

All this must not be mistaken to be a plea for economic self-sufficiency of Bengal. If autarchy as an economic ideal is to be deprecated because it entails and imposes sacrifice of wealth for the satisfaction of a mere sentiment, provincial autarchy in a country like India would be still more seriously open to that charge. We must, however, guard ourselves against the danger of falling into the opposite trap and of regarding every move away from the existing system of production as necessarily a move towards autarchy. Exchange of goods there must be on a large scale, but we must not assume that there is any economic sanctity in the interprovincial exchange of goods just

as it exists to-day so that its present volume and composition must at all costs be maintained. To-day most of us feel that the yield of many crops in India is extremely low. Efforts are also being directed in certain cases to improve the yield figure. In fact all are agreed that a better yield would benefit both the producer and the consumer. Nobody takes exception to it on the ground that it might call for readjustments in the exchange of goods. Yet whether the yield is increased or the crops produced are diversified in a particular region, the repercussions on the exchange of goods are, qualitatively, the same. Self-sufficiency is not our aim. Our aim is and should be the best utilisation of the available resources. If such utilisation reduces the dependence of a particular region for certain commodities on other parts of India, certainly no valid objection can be raised just on that score.

The attitude of the National Planning Committee, whose work had to be prematurely suspended, was influenced by similar considerations. It realised that inter-dependence among different parts of India had in certain cases decidedly passed the optimum point. It felt that production was as often as not over-specialised and over-centralised and therefore it stressed the need to secure a more balanced structure of production in every region. The Committee wisely decided to make each region, as far as possible, a self-contained unit particularly in the matter of food and clothing. Our attitude thus fully conforms to the recommendation of the Planning Committee. In fact, what we have done in this paper boils down to an examination of the implications of this recommendation and the formulation of the measures which would be necessary to give practical effect to it in one particular region.

War has revealed the weaknesses which long existed in the food supply system of Bengal. We depend too much on others for the supply of many vital food-stuffs. We turned to outside sources long before the potentialities of the province had been exhausted. The weaknesses of a jute-cum-rice monopoly in Bengal's agriculture have been proved to the hilt. Excessive dependence on sources outside the province goes hand in hand with excessive dependence on two crops. Both producers and consumers have suffered as a result. The cultivator's income depends on the prices of rice and jute, the low level of which hit him hard all through the thirties. The recent rise in the price of rice has told heavily on the poorer classes while transport difficulties are increasingly cutting off the supply of many vital food materials from other parts of India. The cotton textile mills of Bengal have so far been fed with Central Indian or Egyptian cotton, though the incidence of transport charges meant a substantial addition to raw material costs. With the curtailment of transport facilities a situation may soon arise in which Bengal mills will not be able to import sufficient cotton from Central India. Yet cotton can be easily grown in Bengal on an economic basis so that in any rational scheme of crop planning one should expect a certain acreage being set apart for the cultivation of this cash crop.

The present situation is thus definitely untenable. Agricultural production in Bengal can and should be diversified; the production of food grains and other food-stuffs can and should be increased. This will lead to a far more stable income for the cultivator at a higher level than at present while it will place the food supply of the province on better and surer foundations.

Zodiacal Light—A Cosmic Mystery

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(Continued from the last issue)

THEORIES OF ZODIACAL LIGHT

THERE can be little doubt that the zodiacal light is due to light received from an extensive cloud of material particles of some sort, illuminated by solar rays. Two views are held in regard to the location of the cloud in the solar system. In one, the so-called *planetary theory*, the cloud is supposed to belong to the sun and in the other, the *atmospheric theory*, to the earth. In both cases the cloud is assumed to be of lenticular shape; it has the sun at its centre for the former and the earth for the latter. Unfortunately neither of the theories gives any satisfactory explanation of the origin of the cloud, though, as will be seen presently, the form of the atmospheric theory as developed by Schmid explains most of the observed characteristics of zodiacal phenomena.

We give below brief accounts of the two hypotheses as developed by various authors.

ATMOSPHERIC HYPOTHESIS—SCHMID'S THEORY

Of the several formulations of the atmospheric hypotheses, that by Schmid deserves special mention¹. Schmid assumes that the earth is surrounded by a lens-shaped cloud (which may be an extension of the terrestrial atmosphere) with its plane lying in the plane of the ecliptic. The extension of the cloud is uncertain but it must be much beyond the distance at which the centrifugal force due to the earth's rotation equals its gravitational acceleration (about 5.6 earth-radii). The cloud lens participates in the motion of the earth round the sun but its plane always remains in the plane of the ecliptic.

FIG. 6 (A) and (B) explain, after Schmid, how the portion of the atmospheric dust lens illuminated by solar rays will appear to an observer as a pyramid of light⁴. In FIG. 6 (A) the inner circle represents the earth's equator and the outer circle the periphery of the scattering lens. The illuminated portion of the lens is shown as shaded. The observer is situated at B and the trace of his horizon is shown by the tangent through B. The sections of the illuminated portion of the lens visible to the observer are shown by double shading. It is obvious that the observer, looking along the tangent, say along the line BA, will observe a light pyramid such as that shown in FIG. 6 (B).

The phenomenon of *gegenschein* can also be easily explained with the help of the atmospheric lens. The *gegenschein* is due to a portion of the lens receiving scattered light from both the morning and evening zodiacal light⁴. This is shown in FIG. 7 (not drawn to scale). The observer situated at B sees the zodiacal light Z. He also sees the portion of the sky G which is more illuminated than the surrounding regions having received light from both the zodiacal pyramids. The observer at B' (midnight) will see the *gegenschein* overhead. It is clear that the *gegenschein* will always appear in the region of the sky opposite to the sun.

FIG. 8 depicts schematically the position of the earth round the sun in various seasons with the respective illuminated portions of the lens as seen by an observer in middle latitudes in the northern hemisphere¹. Since the intensity of the light pyramid depends upon the amount of matter illu-

minated by the solar rays, it is evident that for the position of the observer as stated above, the morning zodiacal light will be prominent from the autumnal traversed greater thickness of intervening atmosphere. The tilted light pyramid as observed is therefore, not the complete form of the pyramid so far as its symme-

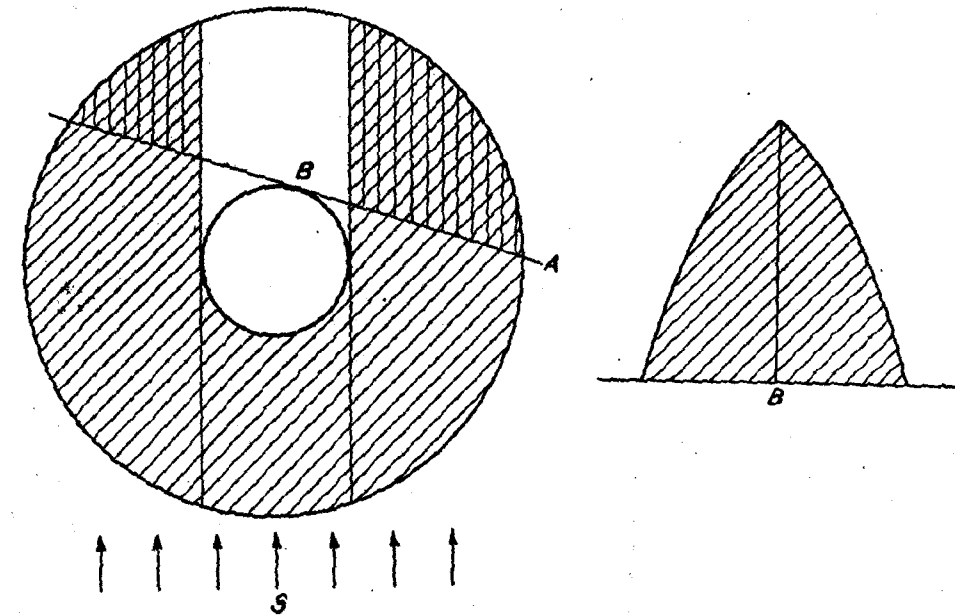


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equinox to the winter solstice and the evening zodiacal light from the winter solstice to the vernal equinox.

The seasonal variation of the tilt of the light pyramid is also understood if it is recalled that the axis of the pyramid always tends to coincide with the ecliptic. Since the ecliptic stands erect in evening and morning hours in the equatorial regions during the solstices and also in the tropics of cancer and capricorn during the equinoxes, the light pyramid will also do so⁴. FIG. 2 (c).

The deviations of the light pyramid from the ecliptic when observed from high latitudes, as already described, are explained by Schmid as due to an extinction effect⁴. Observed from high latitudes one sees the light pyramid from its sides as it were. In such cases the light from the near half of the pyramid is stronger than that from the distant half, because the light from the latter is dimmed due to its having

trical extension to the two sides is concerned. This unsymmetrical form produces the illusion, as if the complete pyramid has shifted away from the ecliptic. It is easily seen that the apparent shift will be northward from the ecliptic for observation from northern latitudes and southward from southern latitudes.

The remarkable nightly motion of the pyramid already referred to (FIG. 3) may be explained in a similar way. As night advances two influences begin to work on the light pyramid⁴. Firstly, due to increasing darkness more and more of zodiacal pyramid becomes visible (this is common to observations from all places) and secondly, due to the diurnal rotation of the earth, the observer on its surface approaches the ecliptic (this is for places beyond the tropics during winter solstice, it being remembered that in this season the northern part of the earth's axis is tilted away from the sun). On account of this motion, not only the zodiacal pyramid tends to stand erect, but more of the zodiacal matter from the

southern limb of the pyramid becomes active. The whole cone of light thus appears to move towards

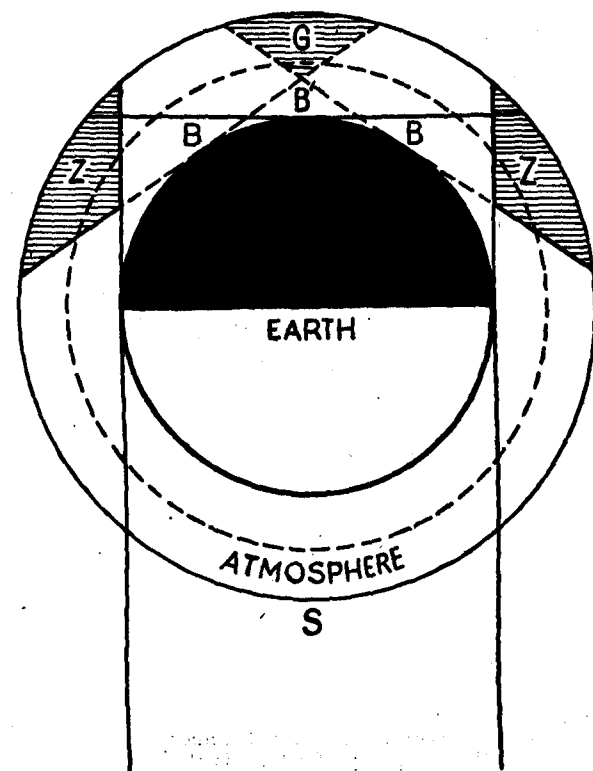


FIG. 7. ILLUSTRATING THE ORIGIN OF GEGENSCHIEIN ACCORDING TO THE ATMOSPHERIC THEORY.

the ecliptic and the light axis nearly coincides with the ecliptic towards midnight. A motion in the opposite sense is noticed when observation is made

on the morning zodiacal light during the same period of the year.

These relative motions of the zodiacal pyramid and the ecliptic raise the important question of parallax of the zodiacal pyramid. The question is important because the existence or otherwise of the parallax would show the proximity or remoteness of the scattering cloud producing the zodiacal light. A little reflection shows that the movements described, namely northward as one moves to the north and southward as one moves to the south, are in senses opposite to those one would expect on the grounds of perspective. The movements are, therefore, likely to mask the effect of parallax, if any. Nevertheless, they indicate one thing, namely that the zodiacal light cannot be conceived of as a phenomenon occurring at a great distance. If this were so, the picture of the zodiacal light against the starry background would have been independent of the position of the observer on the surface of the earth (e.g., like the picture of the milky way on the celestial sphere).

Though no definite evidence of parallax has been obtained, the following interesting fact may be explained after Schmid, as due to perspective effect, i.e., lending weight in favour of existence of parallax. Inspection of FIG. 3 (A), (B) and (C) shows that the light axis of the pyramid does not lie symmetrically with respect to the light pyramid but is rather shifted towards the left. Instead of dividing the base in two equal halves the axis leaves in the case of FIG. 3 (A) only about one third on the left

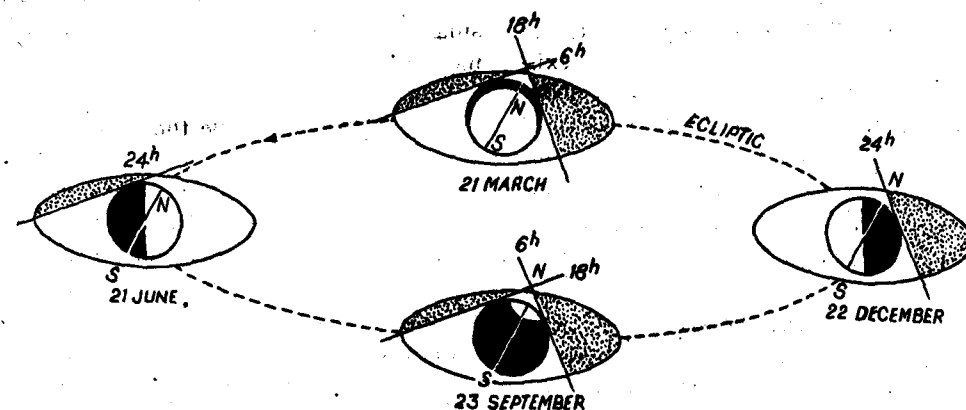


FIG. 8. ILLUSTRATING THE SEASONAL VARIATION OF THE INTENSITY OF ZODIACAL LIGHT ACCORDING TO THE ATMOSPHERIC THEORY. The earth is surrounded by a lens shaped cloud of dust situated in the plane of the ecliptic. Since the intensity of the light depends upon the amount of matter illuminated by solar rays, it is evident that the morning zodiacal light will be prominent from the autumnal equinox to the winter solstice and the evening zodiacal light from the winter solstice to the vernal equinox. (After Schmid).

and two thirds on the right. Such unsymmetrical position of the light axis cannot be explained as due to the "extinction effect" as discussed above. Viewed from northern latitudes the portion of the pyramid lying to the north of the geometrical axis would be brighter than that lying to the south. As a result of this unsymmetrical light distribution—brighter in the north and weaker in the south—the light axis which is the line of the greatest illumination, should appear shifted towards the north. The observed shift is, however, in the opposite direction which is the right direction for perspective effect.

It is evident from above that Schmid's atmospheric "lens" is able to explain fairly satisfactorily many of the details of the zodiacal phenomena. The theory, however, does not say anything about the origin of the lens or, how the lens is held in equilibrium in the plane of the ecliptic. It also does not indicate the nature of the particles constituting the lens—whether they are air molecules or are dust particles of some sort. In a variation of the atmospheric theory proposed by Hulburt, attempt has been made to explain the nature and the origin of the lens. We give below a short account of the theory. For fuller details the original papers should be consulted⁵.

ZODIACAL MATTER AN EXTENSION OF THE TERRESTRIAL ATMOSPHERE?—HULBURT AND VEGARD

Hulburt assumes that the so-called "fringe" or the "spray" regions of the outer atmosphere is the scattering cloud of zodiacal light. According to Hulburt the "spray" region commences from 300–400 km. above the surface of the earth. (Recent calculations, taking into account the probable existence of high temperature—1200°K in regions above 100 km., show that the spray region commences at much higher levels—700 to 800 km.¹⁴). Above this height, the molecular collisions are few and far between and the gas kinetic theory is not applicable. The molecules move freely with the velocity acquired at the last collision in the lower region and, being subject only to the pull of gravity, describe parabolic, elliptic or hyperbolic paths according to the magnitude and direction of their velocities. Normally, the heights to which the particles rise are 2000 to 3000 km. above the surface of the earth. On the side of

the sunlit hemisphere, however, some of the molecules may acquire extra light energy by super-elastic collisions with the molecules (in the region below at 300 to 400 km. levels) which have been raised to excited states by absorption of solar ultra-violet radiation. Such molecules would shoot up to heights of 30 to 40 thousand kilometres from the centre of the earth and, in course of their upward journey which might take a few hours, will be ionised by ultra-violet light of the sun. According to the author of the theory, the ions at levels beyond 30,000 km. will, under the combined solar radiation pressure and the earth's magnetic gravitational fields, form a sort of oblong ring around the earth (FIG. 9). On the daylight side of the earth, the ring lies roughly in the plane of the equator and on the night side it is warped off the equatorial plane approximately in the plane of the ecliptic, and is stretched out into a long oval by light pressure¹⁵. The ions in the ring are assumed to absorb the extreme ultra-violet light of solar radiation and re-emit as visible light a portion of the absorbed energy. This, according to Hulburt, is the zodiacal light.

The theory of the formation of the atmospheric "lens" as described above has a fundamental difficulty. An essential requirement of the theory is the spraying of air molecules to great distances, 30,000 km. or more by super-elastic collisions. No excited states of molecular (or atomic) oxygen or nitrogen are known, however, which could impart sufficient energy to the molecules (or atoms) in the spray region to project them to such enormous heights. Calculations show that the maximum possible height is only 14,000 km.¹⁴ And even at this height the average density of the projected particles is extremely small. The "spray" of the atmosphere, in fact, merges with inter-stellar space, containing on the average one particle per cc. at much lower height—3000 to 4000 km. above the surface of the earth.

Another version of the formation of the atmospheric "lens" is given by Vegard¹⁶. According to Vegard, the terrestrial atmosphere is topped by a "corona", particularly on the daylight side. The process of formation of the corona is as follows: It is assumed that the sun emits radiation in the extreme ultra-violet, of wavelengths corresponding to those of

¹⁴ Physics of the Earth—VIII, Terrestrial Magnetism and Electricity—Edited by J. A. Fleming, McGraw Hill Book Co., Inc. (1939), p. 567.

¹⁵ L. Vegard, *Erg. der Exakt Naturwissenschaften*, Band XVII (1938), p. 263. See also reference 15, p. 654.

¹⁶ S. K. Mitra and A. K. Banerjee, *Ind. Jour. Phys.*, Vol. XIII, Part II (1939), p. 108.

soft X-rays. The atoms and molecules in the topmost layers of the atmosphere are ionised by these radiations and electrons of great energy are liberated. The ejected electrons as they move away—which they do more freely in an upward direction being less hindered by collision—produce an electric field

No quantitative data are given by the authors regarding the shape and size of the bulge, though it appears that its extension is much less than that of the spray being only a few hundreds of kilometres above the auroral layer at 70 to 100 km. height; the average density is also much higher due to the

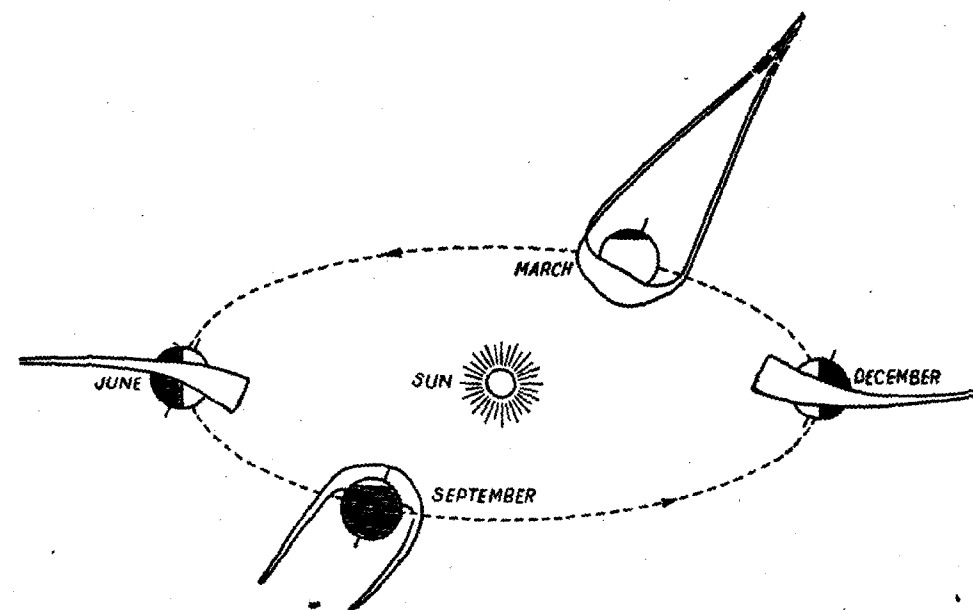


FIG. 9. ILLUSTRATING THE DISTRIBUTION OF ZODIACAL MATTER IN THE ATMOSPHERIC THEORY. The particles are believed to be ions and they are distributed in this curious fashion by the joint effect of solar radiation pressure and the earth's gravitational and magnetic fields. (After Hulburt.)

between themselves and the positive ions left behind. This electric field, not only prevents the photo-electrons from escaping from the terrestrial atmosphere, but also drives upwards to some extent, the positive ions. Some of the neutral molecules are also carried upwards by collision with the ions. This region of electric double layer formed with electrons, ions and neutral particles, crowning the highest layers of the atmosphere, is called by Vegard terrestrial "Corona". Due to the action of the terrestrial magnetic field the corona, consisting as it does of charged particles, bulges out near the equator and assumes a lenticular shape. The axis of the lens coincides with the magnetic equator and the main extension of the bulge is on the daylight side. This bulge on the top of the atmosphere, illuminated by solar rays, appears as the zodiacal cone from the evening zones of the earth; further, since the extension of the bulge is towards the sun, the cone appears to lie in the plane of the ecliptic.

presence of neutral molecules. It is interesting to recall that for the case of Hulburt's "spray", the ejected particles derive their energy by collision with particles in the denser atmosphere below. For the case of the "corona" the sprayed electrons derive their energy from the high-energy photons absorbed by the molecule in the same region. Both the processes probably operate and contribute to the production of the "fringe" region of the atmosphere, extending far beyond the region where gas kinetic laws first begin to break down.

PLANETARY THEORY

As already mentioned the scattering cloud is assumed to belong to the sun in the Planetary Theory¹⁷. It is supposed that the sun is surrounded

¹⁷ Nölke, Band I, Handbuch der Geophysik, published by Gebäder Borntraeger.

by dust particles occupying a flat lens-shaped region extending well beyond the orbit of the earth in the plane of the ecliptic, and that the zodiacal band is the portion of the illuminated lens (by solar rays), as observed from the dark side of the earth. The particles are possibly remnants of the matter sprayed out of the sun when the planets were born of the same due to the close approach of a passing star¹⁸. The particles cannot be of molecular size, they must be much larger, at least several wavelengths of light in diameter, as otherwise they would soon be dispersed by solar radiation pressure. The particles must also have planetary motion round the sun to prevent them from being sucked into it by gravitational attraction. To explain the zodiacal illumination of the sky, the particles need not be numerous. If they are assumed to be 1 mm. in diameter having reflecting power of only 0.073 (the albedo of the moon), it can be shown that the observed intensity is accounted for if the average distance between the particles is 5 miles.

An ingenious explanation of the gegenschein is given in the planet dust theory by the application of a particular solution of the three-body problem in celestial mechanics to the case of the earth, the sun and the dust particle¹⁹. It can be shown that on the side of the earth opposite to the sun and on the line joining the two, there is a point of equilibrium round which a particle, assumed to be of infinitesimal mass (ideally), will move in a closed elliptical path if it entered the region near the point with appropriate initial velocity. If the particle be not of infinitesimal mass, it would move in a nearly closed orbit, and would remain in the region for a considerable time. Now, in the planet dust theory it is supposed that a very large number of small particles are moving round the sun roughly in the plane of the ecliptic. It is therefore, possible that some of the particles would pass near the equilibrium point with the correct initial velocity. Such particles would make one or more circuits around this point before pursuing their courses round the sun. There would, therefore, be a concentration of particles in this region and more light will be scattered from it than from the less populated surrounding region. There will thus be a

glow of light in the dark anthelion region of the sky which is the so-called gegenschein. The effect will be enhanced because, as observed from the earth, the illuminated particles would all appear in full phase. The correctness or otherwise of the theory, of course, depends on whether or not there are sufficient number of particles with the required initial motion to cause them to swarm round the equilibrium point in the manner described above.

CONCLUSION

The facts of the zodiacal light clearly show that it is due to light, scattered (and also perhaps emitted) from an extensive lens-shaped cloud of particles of some sort lying in the plane of the ecliptic and illuminated by the solar rays. Since, with the change of the position of the observer, the zodiacal pyramid appears to change its position (against the starry background)—be that due to extinction effect or to parallax—it is evident that the cloud cannot be very far away from the observer and that it presumably lies in the solar system. Of the two rival hypotheses regarding the actual location of the cloud—the planetary and the atmospheric hypotheses—it is difficult to choose one in preference to the other. Each hypothesis has its special merit. The atmospheric hypothesis, whilst it explains most of the observed characteristics of the zodiacal light, leaves unexplained the origin of the cloud of particles. The planetary hypothesis, on the other hand, gives a plausible explanation of the origin of the particles but is not so satisfactory in explaining the zodiacal light characteristics. We will conclude this article by drawing attention to the difficulty experienced by both the theories in explaining two of the important characteristics of zodiacal light, viz., its polarisation and its irregular fluctuations of intensity.

In regard to polarisation, the planetary theory has this difficulty: Polarisation is a characteristic of the so-called Rayleigh Scattering by particles of molecular dimensions. How then, can the light reflected from such large-sized particles (1 mm. in diameter) as assumed in the planet dust theory be polarised? The difficulty may be got over, if it is recalled that light reflected from minerals such as granite is partially polarised, and if it is assumed that the zodiacal particles are made of such minerals²⁰. The atmospheric theory—so far as it assumes the

¹⁸ J. H. Jeans, Astronomy and Cosmogony, Cambridge University Press (1928).

¹⁹ F. R. Moulton—An introduction to Celestial Mechanics (Second Revised Edition, 1935). Macmillan Company, New York, p. 305. (The explanation was first given by Gyldin, in a memoir entitled Sur un Cas Particulier du Problem des Trois Corps, published in Bull. Astronomique, Vol. I).

²⁰ A. W. Wright, Amer. Jour. Sc. Arts, 7, 451, (1874.)

scattering cloud to be an extension of the terrestrial atmosphere—has also its difficulty regarding polarisation. It is well known that the intensity of light due to Rayleigh Scattering varies inversely as the fourth power of the wavelength. If, therefore, the scattering particles—as assumed by Hulburt—be air molecules, the intensity distribution in the zodiacal light spectrum ought to follow this law. No such distribution of intensity has, however, been observed in the zodiacal spectrum. It should, however, be remembered that the zodiacal light contains a large percentage of unpolarised light the origin of which may not be due to scattering. This unpolarised component may mask the inverse fourth-power distribution.

Neither the atmospheric nor the planetary theory is able to give any satisfactory explanation of the fluctuations of intensity of the zodiacal light. One of its causes might be the fluctuation of intensity of solar radiation falling on the dust particles or air molecules. No strong and rapid fluctuations of the solar constant corresponding to the fluctuations of the zodiacal light have, however, been observed. It is believed that some at least of the large variations of intensity are coincident with the incidence of magnetic

storms. If that be so, such variations might be due to the fluctuations of the fluorescent part of the zodiacal light caused by solar outbursts of ultra-violet radiation, as are known to be associated with magnetic storms. Part of the irregular variations of intensity may, perhaps, be ascribed to variations in the humidity of the upper regions of the atmosphere²¹. That such variations may cause change of visibility is evidenced by the colour, size and general appearance of lunar and planetary corona and visibility and length of meteor trails. Bombardment of the dust particles by meteors is also suggested to be another possible cause of the intensity variations. The dust particles are disintegrated by the impact and an increase in their density results. It will be recalled that in the atmospheric theory the increased intensity of the zodiacal pyramid in late winter months is ascribed to the increased zodiacal matter brought into view of the observer (FIG. 8). On the planet dust theory this may be explained as due to increased meteoric activity in winter.

²¹ Md. A. R. Khan, *SCIENCE & CULTURE*, 5, 812, (1939-40). Summary of a lecture on Zodiacal Light. The original paper may be consulted for a general description of the zodiacal phenomena.

The Late Rai Bahadur Ramaprasad Chanda

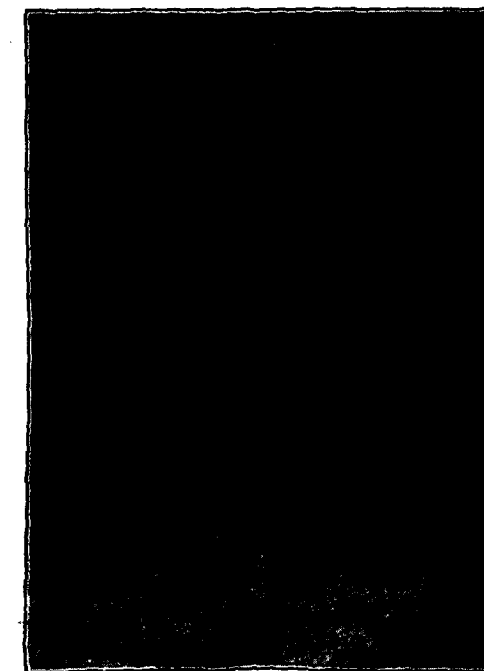
BY the sad death of Rai Bahadur Ramaprasad Chanda, B.A. at Allahabad on May 28 last, India loses a scholar who achieved international recognition in the fields of Anthropology, Indian History, Archaeology and Indian Art. He was a self-made man, in the widest sense of the word. His life is an illustration of the fact that to a man possessed of will and determination, poverty and dearth of opportunities are no bar to gaining distinction amongst the seekers of truth.

Ramaprasad Chanda was born in the village of Sridharkhola in the Munshiganj sub-division of the Dacca District on August 15, 1873, of a middle class family. His father Kaliprasad Chanda was a small landed proprietor, and was *naib* (agent) at Rohitpur to Mr Watt an indigo-planter who had acquired extensive zemindary in the Dacca District. He had income just sufficient to pass as a well-to-do leisured gentleman in the rural area, but not in a city. He was a man of literary habits and though he did not know English, was a voracious reader of Bengali literature and used to subscribe *Bangadarshan* (a Bengali paper in which Bankim Chandra Chatterjee's novels were published) and *Bandhab* (a literary monthly published from Dacca by Rai Bahadur Kali Prasanna Ghosh), and *Prachar*.

Young Ramaprasad, as soon as he came to learn his letters, began eagerly to pore over the pages of these journals, and his father's collection of Bengali books which included even such recent publications as Michael Madhusudan Dutt's *Meghnadbadha*. These studies kindled in him a strong desire for achieving literary distinction. He did not appear to have ever been a brilliant student for he neglected school work and devoted more time to studies outside text-book requirements. At the age of 15, he lost his father, but the family estate was ably managed by a widowed aunt who lived with the family. He passed the Entrance Examination from the Dacca Collegiate School in 1891, his First Arts from the Dacca College in 1893, and graduated from the Duff College in 1896, without any distinction in any examination. This was the highest academic distinction he was ever destined to get, though in later years, many prospective M.A., and D.Litt.'s worked under his guidance. He is said to

have declined the offer of a doctorate degree from a certain University because some conditions were attached to it.

In 1894, he got married, and for a time turned to religion and became disciple of a well-known Sannyasi. Under the influence of his Guru, he practised vegetarianism for some time, and devoted himself to religious practices. He gave up both vegetarianism and his religious practices very soon, and never visited his Guru, when the latter



came round on his peripatetic tours. The cause of this mental revolution appears to have been the great Assam Earthquake of 1897, which destroyed Shillong where he had gone on a visit. Chanda was fortunately unwounded, and rendered as much aid as he could to the wounded and the destitute. The incident was a great shock to his mind, and brought him back from religion to the paths of rationalism, and to his literary and antiquarian studies. For the rest of his life, he followed the motto "Work is worship".

He had been coming to Calcutta off and on even before he joined the Duff College, and in course of

one of his visits, he sought and was lucky in getting an interview with the great Bankim Chandra Chatterjee. He approached the great man with trepidation, told him that he had read his historical essays, and particularly those passages which said that Indian history had been distorted by Western and Eastern writers had caught his imagination and he had an ambition to follow and develop these lines of thought. Bankim Chandra listened patiently and advised the ambitious young man to study intensively before he wrote anything.

Chanda had a passion for buying books and even in his student days oftentimes used to starve himself so that he could save money from the small pittance sent to him from home. His earliest literary venture was a voluminous thesis in Bengali in which he tried to prove that the decay of Hindu Life was due to intermixture of the Varnas. He approached the famous Bengali author Rai Bahadur Kali Prasanna Ghosh with the thesis and sought his advice regarding its publication. Mr Ghosh said "Your subject is beyond me ; none the less I recognise the greatness of your enterprise, but I would advise you not to publish this manuscript just now. You should study the subject more intensively and objectively, weigh carefully every statement you make before you put your views before the public." Chanda returned somewhat disappointed, but the almost identical advice from the two great literary figures of Bengal had the effect of turning his mind from subjectivism to objective studies.

After taking his B.A. degree, Chanda moved from place to place in search of employment. He was for a time private tutor to a rich Bengali family at Ghazipur where he came in contact with Sir Atul Chatterjee, I.C.S., who was then probably the district officer there. Sir Atul Chatterjee was impressed by Chanda's passion for knowledge of history, and told Mr Ramananda Chatterjee of his impressions. From Ghazipur he came to Calcutta, got employment as a private tutor at Shyambazar, and spent whatever time he could spare, reading books on history and anthropology at the Imperial Library, then at Strand Road. He regularly used to cover the whole distance on foot, so that he might save money for purchase of books. In course of these studies, he caught the attention of the then Professor of English literature at the Presidency College who recommended him for a post in the Education Service of the Bengal Government. Through the latter's good offices he received appointment in the Hindu School in the subordinate

branch of the service as teacher of history on Rs. 60/- p.m. The Headmaster, Mr Rasamay Mitra was kind to his somewhat eccentric subordinate, and gave him light work so that he could devote more time to his private studies.

While Chanda was at Calcutta, the great outburst of Indian feeling against official highhandedness burst out in the form of the Swadeshi agitation of 1905, and many of his intimate friends left Government service to join national institutions. But though Chanda was intimate with this circle, he stuck to his post, for he did not want his literary studies to be interrupted. From the Hindu School, he was transferred to the Rajshahi Collegiate School. While a teacher in the Hindu School, he used to contribute articles on social and anthropological subjects to *East and West*, a monthly paper published from Bombay, and to the magazine of the Dawn Society published from Calcutta.

CHANDA AS THE FOUNDER OF ANTHROPOLOGICAL STUDIES IN CALCUTTA

It was through the objective studies which he undertook in connection with his 'theory of intermixture of varnas as the cause of Indian degeneration', that he gradually drifted to anthropology, and we may give an idea of the background of his studies. The Census Report of 1901 (published at Calcutta in 1903) contained some anthropological speculations by Sir Herbert Risley, the then census commissioner which gave great umbrage to the public in Bengal. The controversy was bitter because Bengal was then passing through a very hectic period of political agitation, and motives were ascribed even in matters which should not, under normal conditions, be controversial. It has been proved for over a hundred years by the Western savants that the principal European languages belonged to the same stock as Sanskrit, and ancient Persian, and hence it was concluded (as it appears now quite unscientifically) that the original speakers of Sanskrit and ancient Persian, and of the major European languages formed the same racial stock, the Aryan, to whom some anthropological characteristics (गौरः पिङ्गलः कपिल केश — Patanjali's Mahabhasya on Panini, V, 1. 115), were given. In Europe "the Aryan theory" was utilized by Count Gobineau and Houston Chamberlain for setting up a theory of race-superiority, and thus afforded a moral support for West European imperialism over Eastern nations. Briefly speaking these theories try to prove

that all great events in the world's history, including discoveries, conquests and social movements were the work of the people who were preponderantly Nordic (which were racially identified with the Aryans), and that other groups of people, the Semites, the Hamitic people, the Mongolian races, the Negroes formed inferior groups incapable of any great achievements. The Nordic theories have been partly at the root of 'anti-Asiatic legislations in the U. S. A.', Hitler's Nazi doctrine and persecution of Jews in European countries.

Now Indians have been always holding themselves to be descendants of the Vedic Aryans, and inheritors of the great Aryan culture, and very soon use was made of the Aryan theory for political ends. In several impassioned lectures Surendra Nath Banerjee said, "We, Indians belong to the same Aryan stock as you Europeans, why should we not have the political rights?"

Risley's theory which was based upon a great amount of anthropometrical surveys carried out by the Ethnographic Survey of India seemed to have snapped this theory, as it appeared to have proved on the basis of actual measurements that there was very little Aryan blood in Indians, least amongst the Bengalees, who were the most vociferous amongst them. Wide use was made of this theory in interested circles, and in an address before the Asiatic Society of Bengal, Lord Curzon, the then Viceroy, denied that Indian civilization had any claim to antiquity like the Egyptian or the Babylonian, and stressed the off-repeated slogan that it was a product of Greek civilisation brought on by Alexander's hordes.

These opinions excited great resentment, and gave rise to a good volume of impassioned writings but it was only a few who tried to controvert the views on scientific lines. One of these few was Ramaprasad Chanda. He got a loan of anthropometric instruments from the Ethnographic Survey of India, undertook anthropometric measurements himself, and in order to supplement the measurements tried to hunt out old literature in search of anthropological references. He engaged a number of pandits at his own expense, and began to read Panini, and old Smriti literature. The result of these investigations was his "Indo-Aryan races" (published in 1916),* the first ideas of which were given

* A full account of Chanda's contributions to Anthropology and continuation of his works which have led to complete refutation of Risley's speculations by Dr B. S. Guha and others would appear in a later issue.

out in an article read before the second session of the Bengal Literary Conference held at Rajshahi in 1909. Fortunately this conference was presided over by the Doyen of Indian scientists. Acharyya Prafulla Chandra Roy, who was struck with the profundity of the studies, the substratum of scientifically ascertained facts, and the cold logic, praised the author and his article in unstinted terms. He remarked, "I never knew that a small place like Rajshahi possessed such a great worker". He was also corroborated by Principal Ramendra Sunder Trivedi, the founder secretary of the B. L. C., who was also a science man, and a good writer of science in Bengali.

FOUNDATION OF THE VARENDRA RESEARCH SOCIETY

The unstinted praise from a great man like Sir P. C. Ray had far-reaching effect. The cranky schoolmaster who excited some curiosity amongst the townspeople because he used to carry every day a big load of books comprising lean school texts with big volumes as Mahavastu-Avadan, Grihya Sutra, Memoirs of the Archaeological Survey of India, etc., began to receive due recognition. Rajshahi was then fortunate in possessing two great souls: (1) Akshaya Kumar Maitra, a lawyer who in his spare hours, had made researches in the transitional period of Bengal history covering the period from the extinction of indigenous rule to the advent of British rule in India. He had written a number of books proving that history of this period was awfully distorted, and that Serajoddowla and Mirkasim, the last Indian rulers of Bengal had really fought for the independence of the country against foreign aggression. (2) Kumar Sarat Kumar Roy, the cultured younger son of the richest zeminder of the district, the Raja of Dighapatia on whom these writings had made a great impression.

Next year, Chanda read further papers on his subject at the Bhagalpur session of the B. L. C., and along with Mr Akshaya Kumar Maitra and Kumar Sarat Kumar Roy, went to visit the archaeological remains of classical Anga-desh. The vastness of these ruins made a profound impression on the Kumar. Mr Maitra took advantage of this, and impressed upon the Kumar that his own homeland contained equally rich antiquities, if not richer than those at Gaur, Pandua and other sites, which required the archaeologists' spade to yield their secrets. The Kumar was impressed and was easily induced to finance and organise an archaeological tour in 1910, throughout Northern Bengal. In this first

trip, they collected no less than 32 pieces of sculpture, including the noble life-size statue of Parvati from Mandoil, now exhibited in the Varendra Research Museum and considered as a gem of Pal Art. Mr Chanda persuaded Kumar Sarat Kumar Ray to arrange for the preservation of these sculptures at Rajshahi, in the hope that a centre of archaeological research might eventually be created there. This small collection formed the nucleus of the present Varendra Research Museum of Rajshahi.

Emboldened by the first success, the party ventured to undertake a second tour in 1910 to explore the archaeological remains in the districts of Rajshahi and Bogra, visited about 200 sites and collected antiquities. In this tour, which was financed by the Kumar, they were joined by Mr Rakhaldas Banerjee of the Archaeological Survey of India, the future excavator of Paharpur, and discoverer of the Indus-Valley civilisation. This led to a life-long and ultimate friendship between Mr Chanda, and Mr Banerjee, and between themselves they discussed in later years many knotty problems of ancient Indian history. In course of this tour, the 'illustrious trio', Kumar Sarat Kumar Ray, Mr Akshay Kumar Maitra and Mr Ramaprasad Chanda, conceived the idea of organising a new Research Society. The Kumar was induced to finance it and in 1916 the Varendra Research Society was formally inaugurated with the Kumar as President, Mr Maitra as Director, and Mr Chanda as Secretary. Chanda continued to act as teacher in the Rajshahi Collegiate School. He resigned his post in the school in July, 1917.

While secretary of the Varendra Research Society, Mr Chanda prepared a volume in Bengali called *Gaura Rajmala*. This contained a description of all the inscriptions of the great Pal-dynasty which had its seat in Northern Bengal and of other contemporary dynasties, and held sway over great parts of Eastern India from 750 A.D. to 1160 A.D. The inscriptions had been mostly deciphered before by European and Indian scholars, but they were lying scattered in the pages of learned societies. Chanda brought them together for the first time in a handy form, added his own comments and observations, deciphered some new inscriptions, and thus laid the foundation of the first scientific history of Bengal for this period. Before this book was published, Bengal history started with the advent of Moslems in 1200, but Chanda carried it back to ca. 600 A.D., and for the first time brought before the public unmistakable evidence that even as early at that time

Bengal rulers had worked out a mighty and prosperous empire in Northern India, and Bengal had sent out pioneers to civilise the islands of the East Indies. With his characteristic caution, he did not call it a history, but simply an account of records. As curator, he carefully arranged the antiquities, and created the nucleus of a library for the museum.

SCHOLAR IN THE ARCHAEOLOGICAL SURVEY OF INDIA

The archaeological works of Chanda now began to attract attention from Sir John Marshall, Director of Archaeological Survey of India. In response to the Society's representation, Marshall, who could quickly pick up a genuine worker, first tried to create a government post for Chanda as curator for the Varendra Research Society, for he thought that if Chanda could be permanently kept at Rajshahi, he would be able to carry out far greater amount of archaeological work for the large number of old sites scattered over Northern Bengal. Government regulations did not however, permit of this step, but he very kindly agreed to take Mr Chanda as an archaeological scholar in his department in July, 1917 to give him the necessary scientific training in excavation work. This led to Chanda's permanently leaving Rajshahi, and the work of the V. R. Society's Museum. He was succeeded as secretary by Prof. Radha Govinda Basak. In spite of his leaving the scene of his early labours, Chanda retained a genuine interest in the work of the Museum and never failed to help the Society, or his friend the Kumar, when called upon to do so. The Varendra Research Society of which he was the joint founder, remains thus a monument of his enterprise and initiative.

Speaking of his services and the foundation of the V. R. Society, Kumar S. K. Ray said in his presidential address (27th July, 1927)—"For myself I can say, that but of his assurance of co-operation I would never have agreed to incur the heavy expenditure that the maintenance of this institution in its earlier stage and the erection of this building involved, and would have never personally undertaken the troubles that the explorations of sites and collection of antiquities for over a decade entailed".

FIRST HEAD OF THE DEPARTMENT OF ANTHROPOLOGY, CALCUTTA UNIVERSITY

Chanda spent two years with the archaeological survey exploring and excavating new sites in Northern and Southern India, more particularly at

Taxila, Mathura and Sarnath. During his absence, he had a serious bereavement in the death, under tragic circumstances, of his wife, and he did not like to stay at Rajshahi. In 1919, he joined the Department of Post-Graduate Studies of the Calcutta University as a Lecturer in Ancient Indian History. Soon after this, the late Sir Ashutosh Mukherji started the Department of Anthropology and in spite of the fact that Chanda was a mere B.A. placed him at its head where he remained till 1921. He counted amongst his students the late Mr Nanigopal Majumder, the distinguished archaeologist, who was murdered while excavating sites in Sind, the late Dr Panchanan Mitra, Dr Taraknath Das and others who gained distinction in life.

SUPERINTENDENT, ARCHAEOLOGICAL SECTION, INDIAN MUSEUM, CALCUTTA

But Chanda's connection with anthropology and the Calcutta University was not destined to last long. Sir John Marshall, who had now come to know him more intimately and learnt to appreciate the sterling qualities of his head and heart, appointed him in May, 1921, to the important post of superintendent of the archaeological section of the Indian Museum, to be in exclusive charge of this exclusive and important collections. During his period of superintendence, he reorganised the sculptures of the Indian Museum and of the Sarnath and Mathura Museum. At the request of the Mayurbhanja State, he carried out extensive archaeological explorations and excavations, laid the foundation of a State archaeological department, and started the Khiching Museum in which the important antiquities recovered from different parts of the State were stored. His services to the Mayurbhanja State did not end there, but continued to the last day of his life. For a period of about 16 years he had been collecting materials and documents throwing light on the history of the Mayurbhanj and other Orissa States from the beginning of the British conquest. Of these the official letters and records relating to the History of the Mayurbhanj State have been edited by him during the last four years of his life and he saw them through the press, before his death.

He wrote a large number of monographs for the memoir series of the Archaeological Survey of India. The series in fact started with his monograph 'Date on the votive inscription in the stupas of Sanchi' (1919). All his works were distinguished by a scrupulous marshalling of facts, and profundity of

reasoning. A list of some of his publications which have illumined many dark points is given below.

- (1) The Beginnings of Art in Eastern India with special reference to sculptures in the Indian Museum (No. 30).
- (2) The Indus Valley in the Vedic period (No. 31).
- (3) Survival of the Pre-historic civilisation of the Indus Valley (No. 41).
- (4) Exploration in Orissa (No. 44).
- (5) 'The Visvantara Jataka at Bharhut'—Annual Report of the Archaeological Survey of India, 1921-22, pp. 143-144.
- (6) 'The Mathura school of sculpture'—Annual Report of the Archaeological Survey of India, 1922-23, pp. 164-170.
- (7) 'The Lingaraja or Great temple at Bhuvaneswara'—Annual Report of the Archaeological Survey of India, 1923-24, pp. 119-122.
- (8) 'Notes from the Madala Pāñji—Muhammadan Conquest of Orissa', *Journal of the Bihar & Orissa Research Society*, Vol. XIII, pp. 10-27.
- (9) 'Notes on the Ancient Monuments of Mayurbhanj'—*Journal of the Bihar & Orissa Research Society*, Vol. XIII, pp. 131-136.
- (10) 'The Svetambara and Digambara Images of the Jainas'—Annual Report of the Archaeological Survey of India, 1925-26, pp. 176-182.
- (11) 'Pushyamitra and the Sunga Empire'—*Indian Historical Quarterly*, Vol. V, pp. 393-407 and 587-613.
- (12) 'The Hair and the Ushnisa on the head of Buddhas and Jainas'—*Indian Historical Quarterly*, Vol. VII, pp. 667-673.
- (13) Excavations at Sarnath—Annual Report of the Archaeological Survey of India, 1927-28, pp. 95-97.
- (14) The stigma of Sasānka—The murder of Rajyavardhana—*Prabasi*, Vol. XXXI, 1932.
- (15) Election of two of the early kings of Bengal—*The Modern Review*, Vol. LVII, 1935, pp. 347-351.
- (16) 'Divya Prasanga'—*Mahishya Samaj*, Vol. XXIX.
- (17) Race and Cult in India—*Congrès International des Sciences Anthropologiques et Ethnologiques. Compte rendus de la première session, Londres, 1934*, pp. 195-196.
- (18) Indo Aryan Races—Rajshahi 1916. (Published by the V. R. Society).
- (19) Races of India—*Journal of the Dept. of letters*, Vol. VIII, 1922, pp. 295-312.

A popular account of his contributions is reserved for a separate article. He was elected a Fellow of the Royal Asiatic Society of Bengal, and acted for a number of years as its anthropological secretary.

RETIREMENT AND AFTERWARDS

Chanda retired from service in 1932, built a house near the Rashbehari Avenue, and permanently settled in Calcutta. But he was a man who could not remain idle. He organised his own private library, went on purchasing books whenever necessary, and spent his time in writing articles, finishing his books, occasionally guiding the scholarly work of students. Every historian of note in India particularly, the late Messrs. Rakhaldas Banerjee, and

Kasiprasad Jayaswal, Mr K. N. Dixit, the present director of the Archaeological Survey of India, Mr G. H. Yazdani, director of Archaeological Survey of the Nizam's State, were to be counted amongst his intimate friends. An attempt was made to get him back to the Calcutta University as Egeswari Professor of Art, but it failed. This was particularly to be regretted, for Chanda had a wonderful sense of the problems of Indian History and Sociology, was probably the most extensively read amongst ancient Indian historians, and had a wonderful insight and could easily separate the essential from the non-essential. He had such a plentiful store of ideas that dozens of students would not have been too much for him to guide. But in the frail state of his health in his later years, he was hardly fit to give a finishing touch to these ideas, and many of these unfortunately die with him.

By nature, he was a very cautious man, and would never put anything on print unless he was sure of his ground.

Occasional glimpses of these thoughts are to be found in his later writings and addresses. As superintendent of the archaeological survey, Chanda had come into contact with the products of Indian Art of all ages, and had given deep thought into the question of the origin and evolution of Indian Art. In addition, he was deeply read in Sanskrit classics, and could thus detect in pieces of sculpture the virtual embodiment of the ideas and sentiments described in the rich and rapturous language of the classical authors. He crossed swords on more than equal terms with European savants who started with preconceived notions of Greek influence, and had the satisfaction of seeing his ideas adopted by the International world. We hope that some one of his students would favour readers of SCIENCE AND CULTURE with a popular account of his contributions in this line. Chanda's services were utilized by the authorities of the British Museum when in 1934 he undertook a journey to England to attend the first International Anthropological Congress as a delegate from India. At their request, he rearranged the antiquities of the Indian section of that Museum and wrote a small volume entitled "Mediaeval Indian Sculptures in the collection of the British Museum". In appreciation of this work, Mr R. L. Hobson, C.B., Keeper of the Department of Oriental Antiquities and of Ethnography, British Museum, wrote in the Introduction to the Book:

"The full explanation given of the various motives will be widely welcomed. The subjects depicted in the sculpture

reliefs are so complex that without some instruction in their meaning the spectator is liable to be robbed of part of his pleasure by sheer bewilderment. When he understands the incidents depicted, as he will do after reading the stories told by the Rai Bahadur, he will be able to enjoy whole-heartedly the singular beauty of the Indian sculptor's work and to appreciate the enthusiasm which inspired this monograph."

After the discovery of the Indus Valley civilisation by his friend the late Rakhaldas Banerjee, he became greatly interested in the discovery, and had many animated discussions with Banerjee and others about the importance of these works. Sir John Marshall held an exhibition at Delhi where the antiquities from Harappa and Mahenjodaro, including seals, sculptures and utensils were displayed before the public. Chanda was summoned to assist in the work and while arranging them, was struck by the singular posture of several human figures on the seals. He easily recognised it to be the characteristic posture of the *Yogi*, mentioned in the Sanskrit classics (squatting erect on a seat in the *Dhyana* posture, with eyes fixed on the tip of the nose, and eyes half shut, with the whole mind concentrated inwards). He told Marshall of his impressions, but he was at first a sceptic. But he was persuaded to examine the figure more closely, and ultimately had to accept Chanda's interpretation.

Chanda returned to the implications of this great discovery in his presidential address to the anthropological section of the Indian Science Congress held at Bombay in January 1934. In his address, he brought together a mass of textual and epigraphic evidence to prove that many of the heterodox religious tenets, and practices of India, e.g., Jainism and Buddhism, which were formerly thought to be due to revolts from the Vedic system, had their origin in the pre-Vedic, and pre-Aryan civilisation of India, and therefore far older (ca 3000 B.C.) than the Vedic civilisation. Nay, even such practices as those of Yoga, and such religious systems as Saivism, and asceticism are essentially pre-Vedic. The roots of Indian civilisation are therefore to be traced to the Chalcolithic civilisation of the Indus Valley, on which the Vedic civilisation was an intrusion, just as in Greece, the older Mycaenian civilisation was overthrown by the invasion of the Hellenic races, who first uprooted the older governing class, and then built up a far richer civilisation on the ashes of the old.

After his return from Europe and despite his physical ailments, he collected and investigated the original documents bearing on the life of Raja Ram

Mohan Roy in collaboration with Mr J. N. Mazumder. His researches resulted in a voluminous work on the life of the Raja in which new light was thrown on the early life and activities of the Raja.

He was instrumental in forming an association for Historical Research in Bengal. The immediate programme of this association was to bring out the History of Bengal in three volumes comprising, (1) Hindu, (2) Muhammadan and (3) British periods, in the Bengali language. This work, unfortunately, had to be postponed due to the unusual situation resulting from the present Great War but the late Rai Bahadur published some of the preliminary results of his researches in the form of short well documented articles in Bengali in various journals and magazines which dealt with the history of Raja Kans Narayan of Gaur and the Twelve Barons of Bengal.

In discussions, and in appraising the value of a work Chanda was uncompromising, and unaccommodating, and did not spare friend or foe. He was very often compelled to criticise, in severe terms, hasty theories and generalisations of others, and historians and anthropologists had a wholesome respect for his views. He had unbounded admiration for Sir John Marshall not only because he was his patron and benefactor, but more because Marshall, as he said, was mad for work. "I could never think that a high placed British officer would go to the fields at 2 P.M., when the temperature may be nearly 120°F, and

direct the labours of Indian labourers for hours together." He would be the first man to acknowledge the sterling merits of his opponents. His regard for truth made him critical even of his own works, and he was untiring in his demands for truth and perfection both in his literary criticisms and scientific researches. His career reminds one of that of Grotefend, or Spengler, who rose to greatness in the international scholastic world from the position of teachers in secondary schools.

Mr Chanda took a genuine interest in SCIENCE AND CULTURE and whenever approached would agree to write articles in spite of bad health. He leaves several sons, the elder ones being well placed in life, but the youngers have yet to be provided for. It is impossible to give a full account of his writings, for they are scattered in many journals. It is to be hoped that his sons or pupils do make a full collection of his writings and take steps for publication of his unfinished essays, books, and other writings.*

* We wish to acknowledge our thanks to the sons of Mr Chanda, particularly his eldest son, Prof. Nabani Prasad Chanda of the Rajshahi College, for supplying us with many incidents of his life. Dr. N. K. Bhattachali has kindly supplied us with an account of his work in the field of ancient history; Prof. Radhagovinda Basak and Mr. Nirode Badhu Sanyal, Curator, V. R. S. Museum, with accounts of his part in the foundation of the Varendra Research Society; Drs Achyuta Kumar Mitra, and B. K. Chatterjee with short and valuable accounts of his contributions to anthropology and sociology. To all these friends, we acknowledge our deep sense of gratitude.

Notes and News

MARKETING OF GROUNDNUTS IN INDIA

INDIA ranks first in the acreage and production of groundnuts among the important groundnut producing countries of the world, viz., China, Senegal, the United States of America, Nigeria, Gambia and Burma. Of the world total of 19.4 million acres under ground-nut cultivation during 1933-37 India accounted on an average for 36 per cent of the acreage and 34 per cent of the production. China, the next biggest producer accounted for 19 per cent of the world acreage and 32 per cent of the production. During the above period, India was also by far the largest exporter of groundnuts, mostly in the form of kernels, the principal buyers of Indian groundnuts being France, Netherlands, United Kingdom, Germany, Italy and others. For the last 40 years there has been a steady increase in the production and the acreage under cultivation of groundnuts. India's share in world production has increased phenomenally within recent years, the impetus being supplied by large exports.

Though India has been cultivating this crop on more and more acres, there has been reflected very little effect on the economies of this production to the benefit of the cultivators. At present, the producer gets only about 10 annas of the rupee paid by the wholesale buyers in India and about 7½ annas from every rupee obtained from c.i.f. London sales. It should be noted that though India occupies the foremost position in production and export trade Indian groundnuts lack in quality and standard in consequence of which she has so far failed to command a better price. Economy in internal distribution suffers from many wasteful practices and unnecessary handling. Though India commands greater acreage under cultivation than China her average yield per acre is only 900 lb. compared to China's average yield of 1600 lb. per acre. But the fact that India is capable of a greater yield is amply demonstrated by the yields at government research stations, which have, in some instances, been as high as 1,700 lb. per acre for rain-fed crop and over 3,000 lb. for irrigated crop. The provincial agricultural departments should put in their efforts to increase the yield per acre on the cultivator's fields. There is also a necessity of research work to improve the quality of

the kernel and to produce nuts with a high percentage of kernels. Cultivators should be supplied with better seeds, asked to sow different varieties in suitable areas to the exclusion of other varieties and advised to harvest the crop when fully mature and dry the pods before sale.

Some time ago the Government of India published a report on the marketing of groundnuts in India and the different aspects of production and marketing. The review in the report lay bare enough facts to attempt at organising this growing agricultural industry. The marketing of groundnuts can be greatly improved by undertaking more complete and accurate crop-estimates, reducing the impurities which move along with groundnuts in considerable amount, avoiding the practice of admixture of castor seeds prevalent in many parts of India, particularly in Hyderabad, and adopting a standard contract. With regard to the adoption of a standard contract the central marketing staff with the Government of India has already drawn up terms in consultation with the trade both for groundnuts for crushing and hand-picked selected nuts and kernels for edible requirements, which have been adopted by many trade associations.

The report has further laid stress on the expansion of market for edible nuts in India. It has shown that the 'per capita' consumption of groundnuts in India for edible purposes being very small, there is enough scope for its expansion in our country and that properly graded nuts and kernels from roasted nuts should be very conveniently put on the Indian market. It has also been suggested to develop export trade in groundnut oil in which India's share is negligible though she happens to be the biggest producer. The export trade in groundnut oil has great possibilities in the markets of non-European countries like Canada and the United States of America. Further, favourable prospects await a full-fledged hydrogenated groundnut oil industry in this country.

RESEARCH IN VETERINARY DRUGS AND DISEASES IN INDIA

INDIA imports a large quantity of veterinary drugs from abroad each year. Though the necessity

of preparing these drugs in India has been felt little was done so far in this direction. The Imperial Veterinary Research Institute, Mukteswar, has recently undertaken to prepare these drugs in India both synthetically and from indigenous plant sources. It has been pointed out that medicinal plants can be conveniently cultivated on the plains and in the hills to develop the industry. The Research Institute of Mukteswar has already done much useful work in this direction. Mention may be made of a new vaccine against Ranikhet disease produced at the Institute, which has proved successful. Incidence of this disease has so long hampered large-scale poultry farming in India. Research into a sounder method of preparation and a more complete analysis of its properties are yet to be made. The Institute has also nearly completed its investigation of the warble fly pest of the cattle and goats and obtained data about the ecological conditions favourable for its development. The investigations into the various animal diseases like contagious pleuropneumonia, contagious abortion, acute theileriasis (fatal to calves), diseases of the goat and the influence of climate on veterinary diseases are in progress.

On the nutrition side, work has revealed the importance of vitamin A and its precursor, carotene. Carotene insufficiency leads to serious nutritional disorder in Indian animals. Work has been done on the development of carotene in different species of plants, its distribution at various stages of plant growth and its stability under different storage conditions. The nutrition value of different fodders is also being investigated.

NEW PRESIDENT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PROFESSOR A. H. Compton, Charles H. Swift Distinguished Service professor of Physics in the University of Chicago, has been elected president of the American Association for the Advancement of Science. A great experimental physicist, known particularly in the field of scattering of photons and the cosmic ray research, Professor Compton has great aptitude for organisation work. Like the great Thomson brothers, the Compton brothers have distinguished themselves for original work in the field of science. It may be mentioned that his brother Dr Karl T. Compton, who is now president of the Massachusetts Institute of Technology was the president of the Association in 1935. Dr Wilson Compton, another brother of Professor A. H. Compton, was a member of the finance committee of the same Association for a long period from 1933 to 1941. The mother of the Comptons who is still

living, was awarded a Gold Medal for being the best mother in the U. S. A. in 1937. Arthur H. Compton received his B. S. degree from Worcester College in 1913 and his Ph.D. from the Princeton University in 1915. He was a member of the faculty of the University of Minnesota and a research physicist of the Westinghouse Lamp Company for sometime. He went to Cambridge in 1919 and became a national research fellow of the University for 1919-20. In 1920 he became professor of physics and head of the department at Washington University. In 1923 he became professor of physics at the University of Chicago. He obtained the Rumford Gold Medal of the American Academy of Arts and Sciences, the gold medal of the Radiological Society of North America, the Matteucci Gold Medal of the Italian Academy of Sciences, the Franklin Institute Gold Medal and numerous other medals, honorary degrees and distinctions. The Swedish Academy of Sciences awarded him the Nobel Prize for Physics in 1927 in connection with the new effect, known after his name. Besides, he is a member of the various distinguished scientific societies. Born in Worcestor, Ohio, he is now only forty-nine years of age.

Prof. Compton came to India in 1926 on an invitation from the Punjab University and stayed with his brother-in-law, Dr Herbert Rice, then principal of the Foreman Christian College, Lahore. He delivered a series of lectures in the University, organised a Cosmic Ray Expedition in Kashmir under Professor Benade of the F. C. College, and made numerous friends amongst Indian scientists. The Compton brothers are amongst the best friends of the Indian students in the States, who find their doors always open to them. They are always willing to help the Indian students with the good advice and otherwise. Aided by generous funds from the Rockefeller Foundation and the Carnegie Institution of Washington, Professor A. H. Compton had undertaken a world-wide survey of cosmic rays, has himself been to the Arctic regions, and has deputed Dr P. S. Gill, a young man from the Punjab, trained in America in his laboratory, to carry out the programme in India. His researches have established that the cosmic rays as received on the earth show variation with geomagnetic latitude, and must therefore be mostly charged particles. Recently Schein, and Jesse, belonging to the Compton School, have established that primary cosmic rays are most probably protons (see 'SCIENCE AND CULTURE', 7, 385, 1941-42).

Prof. A. H. Compton is a prominent member of the Society of American Friends for Indian Independence, and had recently issued a circular telegraphic message to Indians internationally known, asking for their active participation in the struggle against

Fascist aggression of the United Nations, on whose victory alone, according to Prof. Compton, the struggle for Indian independence can have a successful issue.

WATERWAYS EXPERIMENT STATION AT VICKSBURG, MISSISSIPPI

IN connection with the needed break-water in San Juan harbour much useful work has recently been done by the Waterways Station at Vicksburg, Mississippi, as reported in one of the recent numbers of the 'Time'. Tide, current and dangerous shoals were for some time great problems before the naval patrol planes. A model San Juan harbour was constructed to reproduce faithfully the actual conditions that obtained in the harbour, and a break-water was also modelled which worked efficiently. It is reported that model experiments for some 34 war time projects are now being successfully conducted at Vicksburg.

The Waterways Experiment Station was called into existence in 1929 after the bitter experience of the Mississippi flood of 1927 which affected an area of 20,000 sq. miles and destroyed human life and property beyond proportion. The titanic task of training the mighty river was entrusted to the U. S. army engineers and a colossal sum of 325,000,000 dollars was sanctioned by the Congress with the result that the models of the Lower Mississippi were built, the tortuous meanderings of the river straightened and the dangers of further incidence of such floods removed in course of last ten years. As a matter of fact, the river course has been shortened by some 120 miles. The Waterways Station at Vicksburg has proved such a useful organisation that hardly any important hydraulic work is now undertaken in the United States without preliminary model experiments carried on in its laboratory. To give some idea of the equipment provided for the Waterways Station, waves are created by motor-driven triangular plungers and tides are generated by valve arrangements operated by motor driven cams. Beaches are constructed with fine sand and a transparent substance known as pyralin is used to make the dams and tunnels. The soil mechanics laboratory, a new feature of the Waterways Station, was introduced in 1931 to investigate river problems mainly connected with the soil, and it is since then doing work of special military importance.

The work in connection with the training of the Mississippi has been modelled on scientific lines; and has been preceded by experiments with models. Planning of engineering works on scientific lines was unknown in U. S. A. even twenty years ago; and

much money was wasted by haphazard engineering devices. It was due to the agitation started by Freemann who had observed the usefulness of River Physics Laboratories in Germany, that U. S. A. rose to the necessity of carrying out model experiments before any huge engineering works were undertaken.

According to the late Sir F. Spring, the Ganges below at Sarah discharges more water than the Mississippi below New Orleans, and the Brahmaputra discharges probably one and half times as much water. The Ganges-Brahmaputra system therefore discharges $2\frac{1}{2}$ times as much water as the Mississippi, and as it spreads over a comparatively far smaller area, the river problems have assumed gigantic proportion. No engineering work likely to affect the water-courses should be undertaken without previous survey and model experiments, otherwise there will be awful dislocation affecting the whole country.

This viewpoint has been urged by SCIENCE AND CULTURE over years, which pleaded for the establishment of a first class River Laboratory in Bengal. The idea has been theoretically accepted by the public and the Bengal Government, and has provided materials for propaganda work by more than one Minister. But the actual progress of the work has still recently been negligible. Like the sceptic courtier in Hamlet, we are tempted to ask the head of the Government Department concerned—"What are you reading, my Lord." Probably our Hamlet would reply, "Words, Words, Words!"

BENGAL INDUSTRIAL SURVEY COMMITTEE

THE Bengal Industrial Survey Committee has recently been reconstituted with Professor P. N. Ghosh, head of the department of applied physics, University College of Science as chairman and Mr D. N. Ghosh as secretary who was lately intelligence officer with the department of industries. The Committee has been requested to submit an interim report as early as possible indicating the possible development of such industries as are deemed vital under the present emergent circumstances. Several impediments to industrial growth due to war conditions are already in sight and the Committee has been requested to refer to such difficulties with possible suggestions to cope with them. It is expected that the salt industry, the manufacture of cotton and yarn, the development of vegetable oil industry will receive adequate attention. The members of the Committee are as follows:—Mr A. L. Ojha, Dr N. N. Law, Mr Syed Badruddoja, M. L. A., Dr J. P. Niyogi, Minto professor of economics, Calcutta University, Prof. Humayun Kabir, M. L. C., Mr A. M. A. Zaman, M. L. A., Mr A. R. Siddiqi, M.L.A., Dr M. Qudrat-i-khuda, professor

of chemistry, Presidency College, Calcutta, Dr B. C. Roy, vice-chancellor, Calcutta University, Mr S. C. Mitter, director of industries, Bengal, Mr K. W. Mealing, representative of the Bengal Chamber of Commerce, Dr P. C. Ghosh, representative of the All-India Village Industries Association, Dr H. L. Dey, professor of economics, representative of Dacca University and Dr J. N. Mukherjee, professor of chemistry, representative of Calcutta University.

We hope the Committee all success, but our experiences of such committees have made us very distrustful of the ultimate result of their labours. The scientific men in the committees are not given any executive power to implement their recommendations, with the result that the civil servants and the Ministers, in whose hands, the execution lies, either sleep over them, and allow the recommendations to be gradually relegated to oblivion or completely mishandle them. We think that scientific men should insist, as a condition of their willingness to serve on such committees that they should have a controlling voice in the direction of policy, as in the execution of the recommendations of such committees usually the tendency is to accord the scientific men the same treatment as rich men do to their poorer relations—keep them in an out house!

NEW BLACKOUT TECHNIQUES

INEFFECTIVENESS of London and Berlin blackouts, to protect the cities from night-raiders, is forcing the attention of U. S. A. Government to new blackout techniques. There appears to be no way of preventing bombers from releasing their death-dealing loads over the heart of blacked-out cities. Lighting engineers in U. S. A. are now studying means of camouflaging the whole part of the cities. From the air, a long line of glowing street lamps along a deserted stretch of road would appear to be a main artery leading into a city. Anti-aircraft and searchlight batteries located several miles from a metropolitan centre would tend to draw raiders away from vulnerable areas. A broad rectangle of flood lights anywhere well out of the way of residential areas would serve as airfield decoys. Dummy airfields with dimly shining lights, wide open spaces illuminated to appear as crowded areas and rows of partially concealed lights along deserted roads, all these are likely to succeed in inducing bombers to aim their bombs to places where direct hits will cause little or no damage.

PACIFIC—THE NEW BATTLE ZONE

DURING the last few months the Battle of the Pacific has provided with a panorama of events

which are fraught with serious consequences and have upset the war strategy of the allied nations in this theatre of war. For its arena,—probably it is imperfectly realized,—the Battle of the Pacific has half the surface of the globe. By far the vastest of the ocean, the Pacific stretches over 10,000 miles between Panama and the island of Mindanao in the Philippines. From the Bering Strait to the ice-packs of the Antarctic, it is again 9,600 miles. Scientifically the Pacific is the least known of the oceans. Charts still show islands in the Pacific marked "Existence doubtful" and shoals whose locations are not known. Throughout the ages the Pacific has appeared very often in the literature and in the dreams of the civilized nations. The name brings up visions of mystery, beauty, danger, death, incredible emptiness and wilderness and the wealth of the Indies. In many respects the Pacific is an ocean of superlatives. By far the deepest and greatest of seas it contains more coral reefs and more islands than any other ocean. It may not be known to many that the mandated islands of Japan alone contained more than 1400 bits of land. In the Malay barrier and the East Indies the Pacific possesses the largest groups of big islands in the world and all the islands are not jungle-covered or with poor soil and sparse population. The island of Java, for example, is one of the most widely populated of agricultural regions, comparable with certain sections of China and with the Ganges valley. On this island were found the remains of *Pithecanthropus erectus*, one of the earliest man, with the smallest brain credited to any manlike creature.

The average depth of the Pacific ocean is 13,300 feet. Far below this level extend the unique and distinguishing features of the Pacific Ocean—its appalling deeps. Off Guam is the Nero Deep, 31,614 feet down; off Japan the Ramapo Deep, 34,626 feet down; and off the Philippines is the Mindanao Deep, 35,400 feet from the surface of the ocean floor and by far the greatest of all. It was measured in 1927 by the German cruiser *Emden*. These deeps are invariably found close to land and the juxtaposition of the great deeps and high, rugged coasts is associated with instabilities in the earth's crust. Indeed the earthquake belt of the Pacific is the most active in the world, and in this region have also occurred all of the very deep shocks hitherto observed and also a large percentage of the intermediate shocks.

THE REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1941

THE report of the Kodaikanal observatory for the year 1941, dealing chiefly with the astronomical

work of the observatory has just been issued. Throughout the year the observatory conditions were to a certain extent less favourable for solar observation than in the previous year. Photoheliographs were taken on 322 days using a 6-in. achromatic object glass and a green colour screen. There were altogether 1951 spectroheliographs taken during the year. The Direct Reading Spectro-photometer built last year has been improved upon by using a balanced circuit in place of the single-tube amplifier. Profiles of some of the strong Fraunhofer lines in the solar spectrum were measured with the instrument. Preliminary observations with the instrument have indicated that the character of the radiation from a sunspot is independent of its position on the disc. The study of the band spectrum of OD in the region of 3000 Å revealed a new ($2 \rightarrow 2$) band. Coincidences between the rotational lines of the OD bands and the Fraunhofer lines were obtained; but there was lack of coincidence between the atomic lines of heavy hydrogen and the solar absorption lines.

On the basis of the results on the dynamical study of the solar envelope the occurrence of highly stripped atoms of Iron, Nickel, Cobalt etc. in the corona was investigated. In connection with the experimental work on Zeeman-effect, an intermittent vacuum arc with rotating electrodes capable of functioning in a space of 3 mm. between the poles of a powerful electromagnet was constructed.

Several solar phenomena such as sun spots, prominences etc. pointed to a further fall in solar activity. With regard to the study of sun spots the number of new groups indicated a decrease of 27 per cent and the mean daily number a decrease of 26 per cent compared with the previous year's numbers. On two days the sun's disc was spotless. Twenty six metallic prominences were observed during the year compared to 33 in the previous year. An eruptive prominence was photographed on the west limb of the sun. The height of the prominence was found to be 10' and the area covered nearly 11 square minutes. Statistical studies on the distribution of the heights of prominences in latitude and on the periodicities in prominence areas, studies of the structure of the H and K lines over sun spots and at various points on the sun's disc are in progress.

DR. J. DE GRAAFF HUNTER IMPRISONED IN GERMANY

News has at last filtered through Sir General Lenox Conyngham of Dr J. de Graaff Hunter,

formerly director of the Geodetic Branch, Survey of India who has been taken prisoner by the Nazis on his way from New York to Cape Town, and is now interned in Germany. The story of this unpleasant incident is that immediately before the outbreak of the present war Dr Hunter went over to California to represent Great Britain at the Pacific Science Congress to be held there in September, 1939. He had with him his wife and daughter. Originally he planned to spend the winter in California whose climate excellently suited his daughter's health when England became involved in war with Germany. The possibility of obtaining money from England being remote under these unforeseen circumstances he had to move to a place in the 'sterling' area, and chose Nassau in the Bahamas. In the meantime he had informed the Surveyor-General of his difficulty and offered to serve in his old department in India in any capacity. His difficulty was, however, realised and he was gladly asked to return to India. Thereupon he went to New York whence he proceeded to Cape Town on board the steamer *Zam Zam* on March 15, 1941. When there were only three days more for the steamer to reach Cape Town it was sunk by a German raider. The passengers were taken on board a supply ship to a port near Bordeaux and thence to Germany for internment. Dr Hunter and Mrs Hunter with her daughter are interned in separate places in Germany. Letters from them indicate that they are so far well. Address of Dr Hunter is: Gefangennummer 102872, British Civilian Internee, Ilag VIII, Deutschland; addresses of Mrs Hunter and her daughter: Interniertentager, Liebenau, Württemberg.

Dr Graaff Hunter presided over the Physico-Mathematical section of the Indian Science Congress held at Calcutta in 1928.

ANNOUNCEMENT

We deeply regret to announce the death of Rai Bahadur Gouripati Chatterjee, Superintending Meteorologist of the Government of India, Delhi, which melancholy event took place at Calcutta on Friday the 10th July. We intend to publish a detailed account of his fruitful career in one of our subsequent issues.

SCIENCE IN INDUSTRY

DRIED FOODS

THE necessity of shipping powdered and dried foods is keenly felt in these days of drastic shipping shortage. It has been pointed out by a group of foodmen who met recently in Chicago that in consequence of the high percentage of water in fruits and vegetables, e.g., 75 to 95 per cent, several thousand tons of water are being shipped every year by U.S.A. to different countries. For instance, last year U.S.A. shipped as much as 150,000 tons of water to Great Britain and a still greater amount to Philippines and Iceland. The dehydrating of eggs and milk is quite well known. The results of scientific dehydration have indicated that the process does not destroy the flavour of the fruits and vegetables and preserves 90 per cent of its vitamin value. In this connection mention may be made of a new technique developed by the Sardik Food Products Corporation of Manhattan, which consists in making a pulp of the fruits and vegetables and then spreading it in a thin film of 3/1000 in. width on revolving drums. In this state the application of heat removes as much as 96 per cent of water in a few seconds. The steaming foodstuffs stand little risk of oxidation, and where it is still apprehended, heating can be performed in vacuum. It is interesting to note that the food-stuffs come out like an endless sheet of paper which easily crumples into fine particles. Tomatoes, peaches, peas, squash, potatoes, apples, bananas etc. can be dehydrated in this way, and keep well for more than three years. The food can be best served after slightly warming it with water.

It has been estimated that apart from the simplification of handling, packing and shipping difficulties, the mass production of dried foods will be 20 per cent cheaper. In Germany the number of dehydrating plants has increased from 6 before 1935 to 114 in the current year. The National Dehydrators Association of U. S. A. has adopted schemes of expansion which will enable them to quick-freeze an estimated \$90,000,000 worth of food in the current year, that is, about 180 times the volume that was handled ten years back.

A NEW TYPE OF HARD GLASS FOR LABORATORY USE

THE *Journal of Scientific Instruments* reported in one of its recent issues a new type of hard glass manufactured in the Laboratory and Pharmaceutical Division of the Corning Glass Works, Corning N. Y., U. S. A. and suitable for laboratory use in many respects. The process involves the removing of all constituents other than silica by leaching of a special glass of normal characteristics in hot chemical solutions. It is a long operation though the time varies with the type of ware for which the glass will be used. The leaching process is then followed by

	"Pyrex Vycor" No. 790	"Pyrex brand" No. 774
Loss in weight, 100 lb. wet steam press for 96 hours.	0.0001 g/sq. cm.	0.0005 g/sq. cm.
Loss in weight, boiling 6 hours in 5 per cent caustic soda.	0.0015 g/sq. cm.	0.002 g/sq. cm.
Loss in weight, boiling hydrochloric acid.	negligible	0.000002 g/sq. cm.
Softening point	1500°C	820°
Linear coefficient of expansion.	0.0000008	0.0000032
Sp. gravity	2.18	2.23
Refractive index	1.458	1.474

washing, slow drying and careful firing under well-controlled high temperature when a transparent vitreous glass is formed. To allow for the shrinkage in the leaching and firing processes special type of mould is required. The chemical composition of the glass is simple and it consists of 96 per cent of silica, the remainder being mainly boric oxide and slight traces of aluminium, sodium, iron and arsenic. The glass is remarkable for its exceptional chemical stability, high softening point and very low thermal

expansion. The maximum temperature it can stand depends on the purposes for which it is used and is generally as high as 900–1000°C. Use of this glass at temperatures above 1000°C is limited by its tendency towards devitrification and softening. The new glass is known as "Pyrex Vycor" No 790. A comparison in properties of this glass with "Pyrex" brand, No. 744, as shown in the table, is informative. The tensile strength is almost the same for both the glasses.

CHEMICAL PROBLEMS SOLVED BY X-RAYS

X-RAY analysis is finding an increasing application in solving problems of industrial chemistry. Mr C. W. Bunn of the I.C.I. Research Department, Northwich, has recently shown how certain problems of industrial chemistry can be very successfully attacked by the X-ray diffraction methods. One of its immediate successes has been noticed in the case of identifying the constituents of bleaching powder. The explanation embodied in the chemical formula $2\text{Ca}(\text{OH})_2 + 2\text{Cl}_2 \rightarrow \text{Ca}(\text{OCl})_2 + \text{CaCl}_2 + 2\text{H}_2\text{O}$ was not satisfactory. Various methods were tried to throw light on the proper constitution, but without success. Analysis of X-ray diffraction patterns indicated that commercial bleaching powder is a mixture of the basic chloride of the types CaCl_2 , $\text{Ca}(\text{OH})_2$ with a variable hypochlorite phase, which explains, on account of the stability of the basic chloride, the difficulty of further chlorination and the fact that the mixture is not markedly deliquescent.

Equally conspicuous has been the success of such X-ray analysis in identifying the constituents of boiler scales. Calcium silicate scales from different sources were found to be essentially the same as certain known minerals. In the case of phosphate scales analysis shows that they are usually apatite. The most interesting investigation has been in the direction of ascertaining correctly the number of water molecules in plaster of Paris. It is more correctly represented as a sub-hydrate of calcium sulphate ($\text{CaSO}_4 \cdot n\text{H}_2\text{O}$) rather than as a semi-hydrate ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$) where n may vary from 0 to $\frac{2}{3}$. When n takes the maximum value, i.e., $\frac{2}{3}$, the crystals dissolve and the plaster of Paris "sets". For details, the *Journal of Scientific Instruments*, 1941, 18, 5 and 7 may be consulted.

INDIAN WOODS FOR BATTERY SEPARATORS

In acid storage batteries separators made of thin sheets of wood, ebonite or glass are used between the positive and negative plates to prevent accidental contacts during handling and use. An American variety of wood, *Chamaecyparis lawsoniana* (Port

Orford), which grows in the United States, has been known to be the most suitable for use as a battery separator, and is now largely used for the purpose. Attempts have been made of late to utilise Indian woods in this direction with varying degree of success. *Adina cordifolia*, an Indian variety has already found commercial use in a manufacturing concern in Calcutta. In a note M. A. Rehman and S. M. Ishaq of the Forest Research Institute, Dehra Dun have pointed out that of the various Indian woods investigated four varieties, including *Adina cordifolia*, have conformed to the requirements demanded by a battery separator, and are suitable for the purpose. The woods are as follows: (1) *Adina cordifolia* (Laldu), (2) *Cupressus torulosa* (Cypress), (3) *Michelia Champaca* (Champak), (4) *Talauma Phellocarpa*.

It is to be noted that the essential requirements of a wood to be used for this purpose are good permeability, mechanical strength, freedom from volatile acids, low percentage of resinous matter and resistance to the action of the electrolyte. A low percentage of tannins and other colouring matter is desirable to shorten the period of chemical treatment. The Indian woods, except cypress, are available in the form of logs to be converted into planks and are then subjected to a seasoning process to reduce moisture content to at least 20%. The air-seasoning, as it is called, is essential as otherwise surface and end-cracks may develop. After seasoning tests are applied to make sure that the percentage of tannins and volatile acids, like acetic acid is reasonably low. Battery separators are then manufactured and treated chemically to remove all the volatile acids, tannins and resinous matter, as far as practicable.

The chemical treatment developed in the Forest Research Institute proved successful. It consists in boiling the separators in 1 per cent aqueous solution of caustic soda for 2 hours and subsequently in distilled water for one hour. In the mean time colouring matter adhering to the separators should be washed away. Finally, a thorough washing is necessary to remove the last traces of alkali when the separators are quite fit for use in cells. In the case of *Talauma Phellocarpa* the separators should be boiled in 1 per cent caustic soda solution for a second time to remove most of the colouring matter which is not ensured in the first boiling.

The cells fitted with battery separators made of Indian woods were subjected to a series of tests for specific gravity of the electrolyte, the voltage of the cells, ampere-hour capacity etc. and compared with those fitted with Port Orford cedar from U. S. A. The results were satisfactory and

indicated the possibility of using Indian woods as battery separators.

ACRYLONITRILE IN SYNTHETIC RUBBER

It is difficult to say when innocent and simple laboratory results assume great practical importance. Such has happened in the case of the determination of inflammability limits of acrylonitrile, one of the constituents of synthetic rubber. The Japanese occupation of the Far Eastern territories, including the principal rubber lands has stimulated research in the field of manufacture of synthetic rubber and as such the various materials used in the synthesis has aroused special interest. Acrylonitrile, largely used in one of the synthetic rubber processes, is a toxic liquid with a limited range of vapour pressure at laboratory temperatures and highly unstable at elevated temperatures. These peculiar characters were responsible for grave experimental difficulties. The necessity of the determination of inflammability limits of this substance was realised and the work was carried on by Jones, Kennedy and Scott of the U. S. Bureau of Mines with important results. Their results indicate that acrylonitrile produces inflammable mixture with air within the temperature range of -6.25 and $+29.4^\circ\text{C}$ and the barometric pressure range of 745 to 750 mm of Hg. But any proportion of acrylonitrile vapour will not produce this mixture. At the laboratory temperature and pressure the lower limit of inflammability is 3.05 per cent by volume. The upper limit is difficult to obtain. It has been determined by noting at what highest temperature the mixture of air with saturated acrylonitrile vapour still propagates the flame. In this way the upper limit has

BAUXITE FOR JAPAN

A good deal has been written about Malayan rubber and tin supplies, which have now fallen into Japanese hands. The *London Times* recently called attention to another aspect of the lost resources of Malaya which may cause more trouble than all the tin and rubber put together. The bauxite mines of Johore will provide Japan with sufficient bauxite to keep her aluminium works in full operation. Before the war the Japanese aluminium industry relied on metal imports chiefly from Canada, Norway and Switzerland and on bauxite supplies mainly from Dutch East Indies and British India. Mines in Johore are capable of producing at least 100,000 metric tons a year and in 1940 exports from the island of Bintan near Singapore reached 275,000 metric tons. Recently the capacity of the mines had been extended well beyond this figure. Bauxite mines cannot be sufficiently scorched to keep them out of production for any length of time and in Malaya alone Japan would very soon have access to something like 400,000 tons of bauxite a year, equivalent to 100,000 tons of metal.

In our country the best and most extensive bauxite deposits are found in the Chhotanagpur Districts, and recently an Indian Company had planned to develop these, and manufacture aluminium in India on a large scale. The work of the Company has been hampered due to outbreak of war, but we understand that difficulties have now been overcome, and the company will soon start production.

Compost and Its Fertilising Value

THE 'Grow More Food' campaign has of late engaged the serious attention of the public. The cessation of import of rice and wheat coupled with the increase in demand of food-stuffs for the army has precipitated a food shortage in our country. The difficulty has been further increased by the fall in production of the food crop and restriction of transport. These difficulties were discussed in a recent Food Drive Conference held at Delhi under the presidency of Hon'ble Mr N. R. Sarker who drew a food crop map of India and stressed the need of making each province self-sufficient in food crops.

The problem of growing more food now is essentially one of increasing the fertility of the soil. Recently in a 'Grow More Food' meeting held at the Calcutta University Institute Dr C. R. Harler* read a paper on Compost and in a similar meeting at Firpo's Restaurant Mr E. F. Watson† spoke on Compost. The following note is adapted from their papers.

MEANING OF THE FERTILE SOIL

At the very outset we should have a clear idea as to what we mean by a fertile soil that will grow a healthy plant to its fullest development. In plant kingdom the word 'healthy' does not simply imply 'free from disease'; it means an inherent power on the part of the plant to resist disease. For a long time we have been taught to value our soils on the amounts of nitrogen, phosphorus and potassium salts present in them. As is generally indicated soil is not a dead inorganic matter, but it is a vast storehouse of living organisms on whose activity our agriculture largely depends. There is one particular group of microscopic fungi, the micorhiza, living in combination with the roots of plants and eventually absorbed into their tissues, that transcends all others in importance since it appears to be the living bridge by which alone powers of resisting diseases enter into the plant. The importance of the chemicals we have mentioned lies in the fact that they are necessary in the food supply

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of all soil organisms—the material known as 'humus', a complex product formed after the decay of organic matter. It is particularly the presence of humus which determines the fertility of the soil and we will subsequently notice that the main purpose of processing the soil, or what is better known as composting, is to increase the humus in the soil.

COMPOSTING AN OLD PROCESS

It is not that our cultivators do not realise the importance of preparing the soil before sowing. The cultivator has a tradition of thousand years and has a knowledge of soil almost by intuition. It is a common practice among the ryots to allow roots of previous crops, weeds and some surface algae growth to rot and decompose in the soil. Even the practice of composting is known to have existed among the cultivators centuries ago. The Chinese cultivators particularly used to feed their soil with compost—which explains why the Chinese can keep their soil constantly under cultivation. But the early method of composting was, however, crude and wasteful. It is only recently that composting has been studied systematically and scientifically with the development of the most useful methods. One of the pioneers in this study is Sir Albert Howard, well-known in India for his work on Pusa wheat and cotton in Indore. At Indore he studied the composting of sugar-cane trash and devised a method known as the Indore process. To-day the great value of compost need hardly be overestimated. Its contribution to the soil productivity is widely recognised though it has not yet attracted popularity among the cultivators. It will be the purpose of the following paragraphs to discuss the process involved in composting in some detail.

ESSENTIALS FOR COMPOSTING

Compost is commonly a decomposed mixture of cowdung and vegetable matter like leaves, twigs, weeds etc. The mixture is generally allowed to rot and decompose before it is buried in the soil as a black mould, resembling soil humus. It is also known that vegetable matters directly buried into the soil also decompose and subsequently turn into soil humus. Naturally the necessity of composting may be called into question. The reason is not far to seek. Vegetable matter is turned to soil humus by

bacteria which exist both in the soil and in cowdung. If we let the soil bacteria do the work the crop which depends for its growth upon the action of soil bacteria suffers. Hence it is preferable to break down the vegetable matter outside the soil and add it after it has been converted to humus.

There are five essentials for composting. They are: (1) Organic matter and soiled stable bedding, (2) Cattle manure, (3) Urine earth, (4) Ashes, and (5) Water. Organic matter forms the bulk of the compost of which there must be plenty of leaves, twigs, stems and rough stuff. It is waste of time to compost leaves and fine weeds alone, for these very soon form humus if buried straight into the soil. The value of composting is that rough stuff can be broken down.

Cattle manure, however, is another essential requirement. In Travancore the cattle graze during the day far from the estates and are brought back to sheds at night. Each night the average cow voids about 10 lb. dung or $1\frac{3}{4}$ tons in a year. This is enough to produce 10 tons compost a year, sufficient to dose half an acre of land.

Urine earth, as the very name implies, is earth soaked in urine. It is made by covering the floor of the cattle shed with tramped down earth to a depth of about 9 inches. When a compost pit is being charged, a patch of this urine soaked earth is dug up and replaced with fresh earth. Compost cannot be made without urine which is very rich in potash.

Wood ashes are important for composting owing to their potash and phosphate contents. Besides being valuable plant foods potash and phosphates, owing to their alkaline properties, are necessary to reduce the acidity which is set up in the compost pit. In place of wood ashes lime may be used. The necessity of water, however, goes without saying.

A PRACTICAL PROCEDURE

The compost pit is generally 30 feet by 14 feet and 2 feet deep. One pit is needed for each five head of cattle if sufficient vegetable matter is available. A rough estimate of the charge with the proportion of the various constituents will be useful. To charge the pit the following should be added in the given quantity:

4 to 5 inches sun dried vegetable matter	
and soiled bedding	... 1,000 lb.
6 baskets urine earth	... 168 lb.
12 baskets wood ashes	... 36 lb.
12 baskets cowdung	... 300 lb.
Water (to be sprinkled)	... 60—100 gallons.

Partially dried green stuff is desirable, for fresh stuff tends to pack tightly and exclude air. The layers described above should be laid down each day for about 6 days and the whole thing is then left to decompose. The changes taking place resemble in some way those going on in the cow's stomach. The pit, in effect, turns green stuff into something resembling cow manure.

[After 15 days from the start the contents of the pit should be turned over to fill half the pit.] This process admits air into the mass. [After about 30 days from the start the stuff is again turned back into the first half of the pit. In this way when about 2 months elapse the stuff is taken from the pit and heaped outside, and after 3 months the mass becomes black and crumbly, resembling well rotted cattle manure.]

[The temperature in the compost pit is important. During the breaking down process the pit heats up. After 21 days the temperature should be 130—140°F.] The ryot will not have a thermometer, but once shown, he will be able to judge the heat for himself. [After 60 days the temperature should be 100—110°F. If the temperature rises very high it indicates that the green stuff used is too fine; on the other hand, a small rise in temperature may be due to various reasons. In the first place it might be due to the ashes being exposed to the rain before use. This may be due to the poverty of urine in the urine soaked earth. It only depends upon the nature of the packing which should not be too tight or too loose and also on the heap which should be neither too wet nor too dry.] Experience alone will beget skill in controlling these factors essential for preparing a successful compost. Further more preliminary experiments are sometimes necessary. If the directions given be faithfully followed there is every chance of success. Later on the cattle manure may be reduced or the green stuff increased, but if decomposition does not take place the experimental steps should be retracted.

IMPORTANCE OF COMPOSTING

The Indore compost costs nothing but the labour. The dose should not be less than 20 tons per acre. The total fertilising value is difficult to assess for its effect is spread over a long period and works in diverse ways. It can be said that a dose of compost has more effect than an equal dose of cattle manure for it is richer in plant food. It is to be noted that after the use of compost there takes place a large increase in the earth worm population. The earth worm is the finest cultivator one can have. It works a 7 day week 24 hours a day bringing soil particles

from below up to the surface and makes channels for air to reach the lower soil. Chemical manures are often a great danger. Not only do they kill the earth worm population but they stimulate the plant to use up humus at an increased rate. They should therefore never be applied to soils that have not got a large reserve of humus. And to a soil that has plenty of humus they are quite unnecessary. Anyone who wishes to use artificials should do so by adding them in small quantity to the compost heap and let them reach the plant that way.

The increase of outturn obtained by using compost is by no means the whole story. Crops grown in fertile soils are found to be so much more satisfying that a smaller quantity suffices both for man and beast. They have moreover the inestimable advantage of handling on to their consumers the disease resisting properties that the crops have themselves attained. One cannot expect to get a healthy people and a healthy live-stock unless their food is obtained from healthy crops grown on fertile soil.

In tropical countries difficulty of a serious nature is often met with when a forest area is cleared up and the tropical sun reaches the soil. The organic matter disappears there at an alarming rate. A few years after opening, a new soil may have lost half its original fertility which decreases to a low level at which it is naturally maintained. Most Indian soils have reached this last stage. The need of tropical soil is, therefore, protection from the sun and the addition of organic matter. The composting of waste vegetable matter if it is available will add greatly to

the fertility of Indian soils and help us to produce more food. We should become 'compost minded', for this will give us respect and feeling for the soil.

CONCLUSION

All over the world to-day the soil is being raped. In America the grass lands were ploughed up and put under wheat year after year so that the organic matter was used up, and the soil lost cohesion and blew away. The 'dust-bowl' is the result. In Australia a similar state has arisen, whilst in both continents the cutting down of forests has released the rain water in spates and washed away many areas of fine soil. Wind and water erosion are forming deserts. In Africa overgrazing has had similar results and the desert is advancing at the alarming rate of half a mile a year in some places. In India we see in all sides the harmful effects of deforestation, soil erosion, overgrazing and general soil mismanagement. If we add up the waste of capital that this state of affairs involves we find that the cost of the war amounts to a mere bagatelle compared to the value of the inheritance we are dissipating daily. The Royal Agricultural Commission to India a few years ago and other many smaller commissions and committees have all put it down in black and white. The ryot himself knows what to do, but he continues to cut down forests, overgraze his land and murder the soil which he is holding in trust for future generation. The problem is not an Indian one but an international one and no doubt post-war planning will take into consideration the methods of preventing fair lands from running into a wilderness.

MEDICINE & PUBLIC HEALTH

ANTI-LEPROSY WORK IN BENGAL IN 1941

THE annual report of the work of the Bengal Branch of the British Empire Leprosy Association for the year 1941 makes interesting reading. The Branch does not propose to usurp or take over the details of the medical and public health departments of the province or local bodies but aims to assist and augment the work of these agencies with their expert knowledge and studies.

Useful work has been done in the districts and leprosy cases have been detected in schools, jails and among the police force. Sample surveys were undertaken in the districts of Tippera, Hooghly, Bankura, Malda, Rangpur and Birbhum, in which 17,827 persons were examined resulting in the detection of the disease in proportion varying from 0.25% to 3.6%.

Special post-graduate courses were given to Local and District Board doctors. Improved propaganda methods have been developed and introduced throughout the province. The work of 139 leprosy clinics was supervised and revitalised.

The leprosy problem in Calcutta received special attention. Nearly 1000 cases attending the leper clinics were carefully examined and a study of the home conditions was initiated. It has been found that while lepers among the beggars in Calcutta and suburbs number about 1000, the number of cases in the general population is probably ten times this figure, a considerable proportion of which are infectious, indicating that the disease has been acquired in Calcutta.

STORAGE OF FOOD IN WARTIME BRITAIN

THE Ministry in Britain are building about 150 single storeyed, pre-fabricated steel buildings with concrete floors, brick walls and steel and asbestos roofs, called "national store cupboards", for conserving tons of the nation's reserve foods and raw supplies. The structural work will protect the food against damp and insects and the danger of bombing. Press reports point out that the Government are pur-

chasing food-stuffs but we are yet to see any efforts towards conserving the food reserves of this country.

POST-WAR DIET PROBLEMS

IN discussing post-war diet problems, Dr H. M. Sinclair, of the department of biochemistry, University of Oxford, predicted a world-wide famine in the period immediately following the war. He suggested that the British Empire, the United States, and the U. S. S. R. should now set up an international committee of scientists to plan adequate feeding of the allies during the war and of the whole world after victory had been secured. Sir John Orr stated that between a third and half of the population of the United Kingdom and the United States did not enjoy a diet adequate for health in pre-war days. He emphasized that the national food supply should be sufficient to provide an adequate diet for the whole population and that the diet should be within the purchasing power of the poorest family. That would result in an improvement of physique and a great increase in the incidence of disease.

Nowhere there is a greater need for the utilisation of scientific knowledge for adjusting the anomalies and insufficiency of food supply than in India. While other countries are taking the help of scientists to solve the difficulties of food problem, it seems to us that administrative officers in India are afraid to approach the subject from a scientific angle, to investigate the nutritional requirements of the different groups of population and to plan the production, storage, marketing and distribution of food in terms of these principles. When is this *laissez-faire* method of approach going to be abandoned?

WAR AND SUPPLY OF CERTAIN MEDICINES

THE entry of Japan into the war has disturbed the supply of certain medicines, like menthol, camphor, agar-agar and quinine, to the allied countries. It has already been pointed out in these columns how the loss of Java, which produced 90% of the world's quinine-containing bark, has caused a

serious dislocation in the supply of quinine. Although the bark with the richest alkaloidal content (*cinchona ledgeriana*) does not take easily to Indian soils, still the areas already found to be suitable for the cultivation of other species of cinchona, if properly planted, can solve the difficulties to a great extent within the next few years. Many eyes are now turned towards India as one of the potential richest sources of medicinal drugs in the world. Podophyllum, belladonna, stramonium, liquorice, squill, colchicum, Karaya gum and valerian are easily obtainable and the lower slopes of the Himalayas offer fertile ground for further crops. A small quantity of ipecacuanha is being produced in Bengal and Madras, the largest bulk coming from Brazil. The war has shown how necessary it is to study the climatic and soil requirements of medicinal drugs in India, as also their active principles and physiological properties.

WARTIME PUBLIC HEALTH PROBLEMS

THE Bengal Public Health Association has made a commendable move in mobilising public health workers all over the province to tackle the problems created by the war and the movements of population from one country to another and from the town into rural areas. A Central Health Defence Committee has been formed, with the Director of Public Health as chairman, to consider the following among other subjects:—(1) Health Services of the National Defence enrolees, (2) Pertinent needs in industrial hygiene, (3) Health aspects of Civil Defence, (4) Con-

trol of certain specified communicable diseases, (5) Health administration problems arising out of mobilisation, (6) Taking a census of public health personnel and of facilities for public health work, (7) Organising community health services, including maternity and child welfare, (8) Safeguarding national nutrition in wartime, (9) Enactment of specific *ad hoc* public health legislation, (10) Co-ordination of health, welfare and related activities, (11) Co-operation between Government agencies and local bodies, (12) Health education, including publicity, and (13) Formation of District and Local Health Defence Committees and the organisation of Health Defence Corps.

The execution of such an ambitious programme requires not only the administrative and financial backing of the Government and local bodies, but also the whole-hearted co-operation of the public, whose health the committee is trying to safeguard. The incidence of epidemics and preventable diseases increases in proportion to the status and efficiency of the public health organisation in a country. In well-organised countries like England and the United States, the health of the population has suffered very little as a result of the war, whereas in the backward countries of Eastern Europe they are more prevalent. In view of the fact that India's public health policy and organisation is still one hundred years backward in comparison with that of the progressive countries above referred to, it is extremely necessary that the State and the people should combine together in taking up the lag between science and its applications and try to prevent the consequences of dislocations caused by the War.

Recent Advances in Blood Transfusion Therapy*

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WITHIN the last decade or less, transfusion therapy has come into great prominence, and has been increasingly resorted to by the clinician for the treatment of various conditions. In the beginning, whole blood was used. But due to the different types of reactions met with and the variability of the results obtained in different hands an enormous amount of work has had to be done to make transfusion therapy readily available and uniformly safe for employment. This has resulted in many advances and improvements in different directions. Being a laboratory research worker interested primarily in the preparation, storage and distribution of material suitable for the clinicians' use, I propose to confine my remarks to the newer developments in our knowledge of transfusion material. Although the laboratory worker has not yet succeeded in developing a technique of blood transfusion by which whole blood can be given completely without untoward reactions, he has made available to the clinician a large number of useful materials each having its own advantages and disadvantages and each being particularly suitable for any one set of conditions more than for another. It will be interesting to give an account of what the laboratory man has achieved and is trying to achieve for the benefit of the clinician and how by a proper choice of the material that he has placed at the clinician's disposal, the clinician can obviate many of the complications of transfusion therapy and obtain the highest therapeutic results for his cases.

Attempts at the practice of blood transfusion may be said to have been made centuries ago in the remotest antiquity. Mythology abounds with references to blood transfusion. Ancient medicine believed that the blood not only carried the vital forces of the body but was the seat of the soul as well. Old age, physical and mental diseases were believed to result from exhaustion, loss or perversion of this vital fluid. Hence the ancient physicians tried to substitute new young blood for old to

cure disease and to revitalize the body. Naam, the King of Syria, is said to have been cured of his illness by the removal of the blood from his veins and by the replacement of it with the blood from a healthy person. Details of the technique used are however not available. Homer's Odyssey describes Ulysses as a blood donor.

The German medical historian Baas reports that the Italian physicians of the 16th century practised transfusion of blood of the young into the veins of the old for rejuvenation. With Harvey's discovery of the physiology of circulation in 1616 transfusion of blood in the modern sense began to be attempted. Francesco Falli, a Florentine physician is said to have performed the first transfusion in 1654. It was soon followed by others like Christopher Wren and Richard Lower in England and Denys in Paris. But unfortunately some of Denys' patients passed "urine black as soot and died". Denys was brought to trial by his enemies and as a result of the publicity given to the trial, transfusion was prohibited by law in England, France and Italy. This was about the close of the 17th century.

In the 18th century transfusion work was restarted due largely to the endeavours of the English obstetrician James Blundell who was interested in saving the lives of his numerous patients developing post partum hæmorrhage. By a crude method of transfusion he was successful in saving the lives of many, while some of his patients developed severe reactions and died. Transfusion, thus, once again fell into disrepute, and this time its revival had to await, among other things, the development of our knowledge in hæmagglutination, asepsis and coagulation of blood. These were accomplished towards the end of the 19th and the beginning of the 20th centuries and modern blood transfusion was revived once again and was attempted cautiously in select cases. In the year 1914 with the outbreak of the first World War a unique opportunity arose and transfusion was attempted on a large scale and proved fairly successful. After the close of the war transfusion with whole blood began to be practised in the major

* Adapted from a lecture delivered at the Calcutta Medical Club on May 13, 1942.

hospitals all over the world. Thus modern transfusion may be said to have been placed on a sound basis hardly 25 years ago.

In the beginning, blood transfusion therapy invariably meant the administration of whole blood. It was thought that the three components of blood namely, the cells, the proteins and other elements, and the liquid, were equally important in all cases requiring transfusion. And in order to make blood readily available for all emergencies arrangements had to be made for collecting and storing blood and a variety of problems arising out of these had to be tackled by the laboratory research worker. The first problem was to obtain a suitable anticoagulant to prevent the blood from clotting. After testing a large number he is at present finding sodium citrate with its short comings the best. The second problem was to evolve a method by which whole blood could be preserved for as long a time as possible. With the invention of refrigerators which can maintain any desired low temperature without much fluctuation it has become possible to preserve whole blood for at least two weeks. The use of various bactericidal substances, especially of the sulphanilamide group, has further helped to prolong the period of preservation. The third problem was to develop a test by which he could determine compatibility of the blood of the donor and the recipient. By the technique of cross matching and the detection of the dangerous universal donor by estimating the agglutinin titre of his serum, the complications due to incompatibility have been minimised though not completely avoided. All these achievements have led to the creation of Blood Banks and to their increasing popularity. But despite these advances, difficulties still exist, chief among which are the poor keeping and transport qualities of whole-blood even under the best conditions, the severe reactions that follow the use specially of the older stocks of stored blood and the errors cropping up during matching and cross matching leading to intravascular haemolysis and death. Even in the best hands a small percentage of serious complications cannot be altogether avoided and the necessity has arisen thus for providing a material that will not have these serious disadvantages. Then came the work of Mann in 1919 who clearly established two fundamental facts—(1) that shock due to haemorrhage is caused mainly by the reduction in blood volume and not by the deficiency in its oxygen carrying capacity and (2) that the shock could be relieved by the administration of serum or plasma freed of corpuscles as effectively as and more safely than whole blood. In shock the indications are, (1) to replace the liquid lost and maintain blood volume and (2) to supply the blood proteins and ensure cell vitality and activity. When these findings were confirmed and accepted,

blood plasma and serum began to be used in place of whole blood particularly in shock. The advantages claimed for plasma and serum are, their simplicity of preparation, freedom from serious untoward complications such as intravascular haemolysis, suppression of urine and death, elimination of typing and cross matching, ease of administration, possibility of long storage under certain conditions, ready transportability, equal effectiveness and therapeutic usefulness in conditions such as shock and hypoproteinaemia. With this claim serum and plasma began to be prepared and stored under refrigeration conditions in the liquid state, and of the two, plasma was found to be a better therapeutic agent than serum in certain conditions because it contained in addition to the proteins of the serum prothrombin, fibrinogen and complement. These elements though not essential for combating shock were found to be helpful in controlling haemorrhage. Another advantage claimed for plasma was that it gave rise practically to no toxic effect or reaction. But the difficulty was to keep plasma in the liquid state without deterioration. It was found that storing of plasma in the liquid state leads gradually to a loss of these elements due to the formation of fibrin which got gradually precipitated as time went on and rendered the plasma unsuitable for administration without further filtration. This rendered the plasma no better than serum and the plasma had the additional disadvantage of containing the anticoagulant. To overcome the first difficulty plasma had to be stored in the frozen state or as a dry powder. But these processes, especially the latter, are very expensive, complicated, delicate and tricky, and have to be conducted without denaturising the proteins. For drying plasma, elaborate machinery is required and has been developed like the Adtevac and the Desivac. But the second difficulty of getting rid of the anticoagulant still remained. This naturally raised the question as to whether serum, which did not require any anticoagulant in its preparation and which was easier to keep in the liquid state, could not be used instead of plasma. And it was soon found that in certain conditions like hypoproteinaemia and shock serum was as efficacious as plasma or even very slightly better in certain respects. So, where facilities for freezing or drying were not available serum was prepared and stored in the cold and made available to the clinician. But serum is a very highly nutrient medium for bacteria and as such required the utmost care in preparation to avoid contamination. More recently therefore attempts are being made to prepare the albumins of the blood chemically in a pure state and to supply concentrated solutions of these for use. The process is simple and elaborate arrangements during collection and preparation for avoiding bacterial contamination need not be taken, even

syphilitic blood, time expired blood and so on which are usually rejected by blood banks may be used for obtaining the albumin by chemical treatment. Although this work is as yet in an experimental state it seems to be full of hope for the future at least for the treatment of a variety of conditions in which

conditions then there is no doubt that the order of preference for the materials will be whole blood, plasma, serum, albumin (human) and other colloids ; and as regards the type of plasma or serum used the order is frozen plasma, dried plasma and liquid serum. But if only one or two of the more important

TRANSFUSION MATERIAL : RELATIVE MERITS AND DEMERITS

	Whole blood	Liquid serum and frozen plasma	Dried serum and plasma	Colloid and crystalloid solutions
1. Preparation.	Simple.	Less simple.	Complex. Special apparatus required.	Quite simple.
2. Preservation.	In cold—4° to 6°C.	In cold : Serum—4° to 6°C. Frozen plasma 10°C.	At ordinary temperature.	At ordinary temperature.
3. Keeping quality.	Poor—2 to 3 weeks.	Good. Several months to few years.	Excellent. Few years.	Good. Few months.
4. Transportation.	Very difficult.	Less difficult.	Easy.	Less difficult.
5. Administration.	Less easy.	Easy.	Easy but has to be dissolved in pyrogen-free distilled water.	Easy.
6. Dose.	Small quantity. Few hundred c.c. only.	Large quantity. 3—4 litres in 24 hrs.	Large quantity.	Large quantity.
7. Typing.	Essential. Cross matching.	Not essential. Due to pooling.	Not essential. Due to pooling and drying.	Not required at all.
8. Reactions.	Often present. Haemolytic, allergic, pyrexial, others.	Often absent. Mild allergic pyrexial.	Often absent. Mild pyrexial.	Often absent. Mild pyrexial.
9. Efficiency.	Very good.	Good.	Good.	Poor.
10. Good effect.	Lasting.	Lasting.	Lasting.	Not lasting.
11. Risk.	Present due to cell rarely serum.	Absent.	Absent.	Absent.
12. Serious complications :				
(a) Haemolysis.	In small per cent.	Nil.	Nil.	Nil.
(b) Suppression of urine.	"	Nil.	Nil.	Nil.
(c) Death.	"	Nil.	Nil.	Nil.
13. Communicability of infection.	Possible. A few.	Improbable.	Not possible.	Not possible.
14. Diseases recorded.	Syphilis, Malaria, Filariasis, Allergic states, Influenza.	Syphilis ? Allergic state.	Nil.	Nil.
15. Clinical uses.	Blood diseases. Specially anaemias, Sepsis and severe haemorrhage.	Shock and hypoproteinaemia arising out of haemorrhage of all sorts and burns, etc.	Shock and hypoproteinaemia.	—

shock and hypoproteinaemia have to be combated. Thus to-day the clinician has at least five different transfusion materials, e.g., whole blood, plasma, serum, albumin and other colloids, to choose from. The relative merits and demerits of these are presented in the table given above.

Although transfusion therapy has been developed chiefly in connection with the treatment of war injuries, it is necessary to remember that it is indicated in a variety of clinical conditions associated and unassociated with war. If one takes the sum total of the therapeutic usefulness of the various transfusion materials known in all sorts of clinical

indications like shock and hypoproteinaemia are taken into account then this order of preference can no longer be substantiated as there is very little to choose between the different materials. Again if other considerations, such as, cost, transport, ease of manufacture etc., are taken into account, then the order of preference may even be reversed. It should therefore be emphasised that for each set of conditions one or other of the materials is the best. In choosing the proper transfusion material for any one case the clinician has to take into account the exact need of the patient. The possible needs of cases can be classified into, (i) cases requiring cells, proteins

and liquid, and (ii) cases requiring only proteins and liquid. In the first type of cases as in anaemias and other blood diseases, whole blood is still the best, but in the second type as in the treatment of war injuries where shock and hypoproteinaemia alone have to be combated, the best is frozen plasma, then dried plasma, then liquid serum. This is accepted both on theoretical grounds as well as on the basis of experiments in the laboratory on therapeutic efficiency. Although dried plasma may have certain decided advantages under war conditions over frozen plasma it is being increasingly recognised that ultimately for the routine civilian use in hospitals frozen plasma will hold the field particularly where facilities for freezing and cold storage are available. As regards the question as to whether liquid serum or liquid plasma is to be preferred the answer is liquid serum, because it is easier to keep serum without deterioration than liquid plasma and the anticoagulant in the plasma is more a liability than an asset. But if plasma can be frozen and kept it will serve transfusion purposes best in most cases. It gives rise to few reactions and is quite efficacious therapeutically. It is also economical because larger yields of plasma can be obtained from blood than of serum, and a valuable ready source of plasma is the out-dated blood stored in Blood Banks. Although some workers still feel that the superiority of plasma over serum is yet to be established evidence is slowly accumulating in favour of frozen plasma. Every Blood Bank attached to a hospital of any importance must therefore at least aim at keeping two things—whole blood and frozen plasma, or whole blood and liquid serum. The latter is being practised at the All-India Institute of Hygiene and Public Health at present and the former is aimed at. A modern Blood Bank however should undertake to provide all materials—whole blood, plasma—dried and frozen, serum and albumin just as an ordinary bank has various types of accounts—fixed, savings banks, current exchange, overdraft accounts.

By way of conclusion it must be added that although blood transfusion therapy has made rapid strides within the last decade, the progress has not yet reached its peak. There is yet an enormous amount of work to be done and there is a necessity for effecting advance in various directions. In Calcutta, which is the brain centre of India, there is no dearth of opportunity or material for work. But the contribution made by Calcutta to transfusion therapy has been very little so far. If one investigates the cause of this one cannot but come to the conclusion that it is not due to any lack of enthusiasm or skill on the part of the individual worker but rather it is due to the lack of more frequent contact, better understanding and fuller co-operation between the different workers, and to the absence of a healthy team spirit. During the review of the subject one must have noted that all the advances so far made in transfusion work have been purely due to an united attack by workers interested in different branches of science. The clinician, the bacteriologist, the physiologist, the biochemist, the physicist and the engineer have all contributed their share to the progress of blood transfusion. This team attack which is a healthy feature in all other countries and which has been largely responsible for many a rapid progress and achievement in science, is not prominently present in Calcutta. This is indeed an unhappy position and the chief cause for the slow progress made. Due to the present emergency and isolation of India from the rest of the scientific world an unique opportunity has arisen for showing this team spirit and achieving great things. It may be said that a special challenge has been thrown at the medical men, to show their skill and it is up to them to accept the challenge and prove their mettle. I therefore appeal to everyone concerned to cultivate the true research spirit, to make more frequent contacts with workers and to contribute richly towards the progress of science in general and the good name of Indian medical research in particular.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

INSTABILITY AND LIFE OF NEUTRETTOS PRODUCING MESONS IN A LEAD ABSORBER

It was Arley and Heitler¹ who first pointed out that the increase in the number of two-fold coincidences observed with a vertical counter telescope, when an iron absorber was shifted from its position between the counters to the top of the telescope, might be due to the production of mesons by penetrating neutral particles which were identified by them with the 'neutrettos' of the meson theory. Shonka² also observed that these neutral particles producing mesons can penetrate 20 cms. of Pb without any appreciable absorption and suggested that these neutral particles might be identified with the neutrettos. Rossi, Janossy, Rochester and Bound³, however, concluded from the results of their investigation that the positive results of earlier workers regarding the production of mesons by neutral particles were all spurious and these were vitiated by side showers. On the other hand, Rossi and Regener⁴, working at an altitude of 4300 metres repeated the investigation, using an anti-coincidence circuit and observed that the number of mesons produced by the neutral particles is about 1% of the total meson intensity at that altitude.

The investigation was repeated at Calcutta by Sirkar and Ghosh⁵ who used an anti-coincidence circuit quite different from that used by Rossi and Regener. They observed that the number of neutral particles producing mesons in a lead absorber in the vertical direction was about 2% of the total vertical meson intensity recorded by the same vertical counter telescope as used for recording the anti-coincidences. The discrepancy between these results and those observed by Rossi, Janossy, Rochester and Bound was also explained by Sirkar and Ghosh who pointed out that, as in the arrangement used by the former authors, shower particles produced in the lead absorber increased the number of fourfold coincidences, the number of anti-coincidences observed by them diminished considerably.

The investigation has again been repeated by the present authors at Calcutta, using a slightly modified arrangement, so that the number of 'background' anti-coincidence counts was much smaller than that obtained by Sirkar and Ghosh. Also, in order to investigate whether the neutrettos are unstable, the anti-coincidences were recorded for two orientations of the counter telescope—one vertical and the other making a zenith angle 30° to the east. The results are given in Tables I and II. The arrangement for the vertical and inclined positions is shown in figure 1.

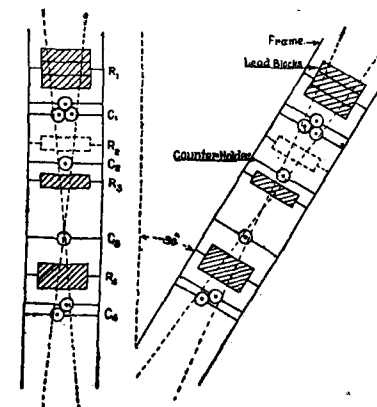


FIG. 1

It can be seen from Tables I and II that in the vertical direction the number of mesons produced by neutral particles is about 1.4% of the total meson intensity and in the direction of making 30° with the vertical the said number is again about 1.4% of the total meson intensity in the inclined direction. The number of mesons in the vertical direction is $15.2 \pm .68$ per hour and this diminishes in the inclined direction to 10.5 ± 0.49 per hour, owing partly to spontaneous disintegration and partly to absorption by the longer path of air traversed in the inclined direction. Since the neutral particles producing

mesons also diminish in number in the inclined direction in the same ratio as the mesons, it appears that the neutral particles or "neutrettos" are unstable and

TABLE I

Zenith angle	Nature of coincidence	Disposition of Pb absorbers	Total time in hours	Total number of counts	Counts per hour $N/T \pm 68\sqrt{N}/T$
0°	$C_2C_3C_4$	$R_1=0$ cm. $R_2=0$ " $R_3=5$ "	15	228	15.2 ± 0.68
	$C_2C_3C_4-C_1$	$R_1=0$ " $R_2=0$ " $R_3=5$ "	128	80	0.625 ± 0.048
	$C_2C_3C_4-C_1$	$R_1=0$ " $R_2=5$ " $R_3=0$ "	132	170	1.288 ± 0.067
	$C_2C_3C_4-C_1$	$R_1=10$ " $R_2=5$ " $R_3=0$ "	105	88	0.838 ± 0.069
30°	$C_2C_3C_4$	$R_1=0$ " $R_2=0$ " $R_3=5$ "	20	210	10.5 ± 0.49
	$C_2C_3C_4-C_1$	$R_1=0$ " $R_2=0$ " $R_3=5$ "	138	80	0.58 ± 0.044
	$C_2C_3C_4-C_1$	$R_1=0$ " $R_2=5$ " $R_3=0$ "	128	144	1.125 ± 0.064
	$C_2C_3C_4-C_1$	$R_1=10$ " $R_2=5$ " $R_3=0$ "	115	83	0.722 ± 0.662

have a life of the same order as that of meson. These results thus settle all speculations regarding the life of neutrettos, because according to Nordheim⁶ they are stable and according to Sakata and Tanikawa⁷ the neutrettos are unstable and have a life of the order of 10^{-16} sec.; the results of the present investigation indicate that the neutretto is

TABLE II

Zenith angle	Thickness of absorber at the top	No. of mesons produced in R_1 per hour	Total number of mesons per hour	Percentage of mesons produced in R_1
0°	0 cm. 10 cm.	0.663 ± 0.082 0.213 ± 0.84	15.2 ± 0.68	4.36 1.4
30°	0 cm. 10 cm.	0.545 ± 0.078 0.142 ± 0.076	10.5 ± 0.49	5.2 1.35

unstable and has a life of the order of 3.7 micro-seconds. This value of the life also explains the fact that the ratio of the number of mesons to that of neutrettos remains the same at all heights.

The authors are indebted to Prof. M. N. Saha, F.R.S. for his kind interest and encouragement during the progress of the work.

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MAGNETIC SUSCEPTIBILITY OF AN AQUEOUS SOLUTION OF COBALT-CALCIUM CHLORIDE

The change in colour from red to blue of an aqueous solution of cobalt chloride on the addition of calcium chloride has hitherto been explained on the hydration hypothesis, which postulates that the colour change is associated with a change in the degree of hydration of the paramagnetic Co^{++} ion. But if one assumes that the crystalline field, existing in the hydrated paramagnetic crystals persists, as is often the case, even in solution, a satisfactory explanation can be given to some of the observed magnetic and optical behaviour of both the red and the blue solution. In the red solution one can thus expect an octohedral distribution of negatively charged oxygen atoms of six water dipoles around the paramagnetic ion, and in the blue solution four negative charges may be assumed to form a tetrahedron around the ion. These negative charges around the ion, in the latter case, are contributed by either four chlorine or oxygen atoms. X-ray analysis, however, of a double chloride, e.g., Cs_2CoCl_6 shows that $[CoCl_4]$ groups exist in the crystal. Hence in the blue solution it is more likely that the negative charges are contributed by the chlorine atoms rather than the oxygen atoms. Our recent study¹ of the absorption spectra of the blue solution also points to the same conclusion.

Gorter², again, points out that under the action of the crystalline field of the tetrahedral distribution of negative charges around the Co^{++} ion, the Stark pattern of the ground level of the ion is reversed; and the lowest level instead of being triplet is singlet. The crystal in that case is magnetically isotropic and the mean susceptibility value is nearer to the "Spin only" value. Both these conclusions are experimentally established by Krishnan and Mookherji³ in the case of the crystal Cs_2CoCl_6 .

If a similar distribution of charges persists even in the blue solution, one can expect a similar lowering of the susceptibility value of the Co^{++} ion, bringing it nearer to the "Spin only" value. The magnetic birefringence of the solution is also expected to be very feeble, if at all there be any, since the group $[CoCl_4]$ is almost magnetically isotropic. The first part is verified in our preliminary measurements of the magnetic susceptibility of the red and the blue solution of cobalt chloride by the Gouy method and the results are reported here.

Ion	Ground State	Solution	Magnetic Moment in Weiss Magnetron (observed)	Temp.	Spin only value (calculated)
Co^{++}	$4F_{5/2}$	$CoCl_2$ in Water	23.26	30°C	19.25
"	"	$CoCl_2$ and $CaCl_2$ in Water	22.17	"	"

Result of Chemical analysis:—

1 c.c. of the blue solution contains

$CoCl_2$ 0.0549 gms.

$CaCl_2$ 0.3960 gms.

From a comparison of the "Spin only" value of the moment with the observed magnetic moment of the Co^{++} ion, as existing in the red and the blue solution, one can thus conclude that there is a tendency of formation of $[CoCl_4]$ groups in the blue solution with a gradual increase in the concentration of calcium chloride added. We soon expect to report on our measurement of the magnetic birefringence of the solution so as to verify the second point. Details of our investigation will shortly be published elsewhere.

The author's thanks are due to Prof. K. S. Krishnan, D.Sc., F.R.S., for his kind interest in the work, and to Dr J. Gupta, D.Sc., of the University

College of Science, Calcutta, for helping him in the analysis of the blue solution.

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FURTHER STUDIES ON 'BLACK-TIP' OF THE MANGO

An experiment verifying the hypothesis that the black-tip disease of the mango crop which is known to occur in orchards near which brick kilns are found to work during the mango season, is caused by the coal fume emitting from the kilns, was reported last year in volume VII, p. 56 of this journal.

The experiment has been repeated and the results have been confirmed this year. Further the following have been established:—

(1) In whatever position the fruit be held, the disease always initiates at the tip—fruits hanging normally with tips downwards, or fruits held with tips vertically upwards or horizontally (Figs. 1 & 2) show no difference as to the point of initiation of the disease or intensity of its attack.

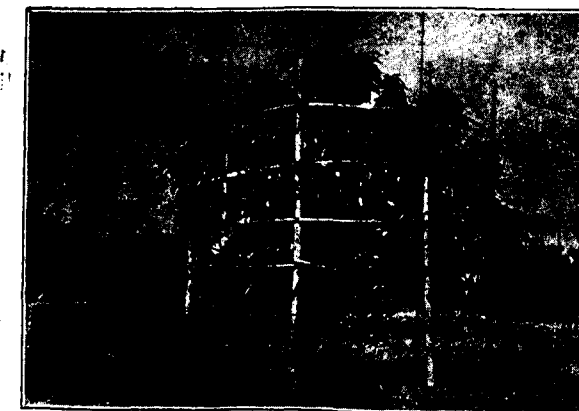


FIG. 1. Showing arrangements for holding fruits with tips in desired position, also showing method of smoking.

(2) The disease is produced only during the period of active development (increase in size) of

the fruit—fruits treated (*i.e.*, exposed to coal smoke) during the stages of active development (between 24th April and 3rd May, 1942) showed the black-tip

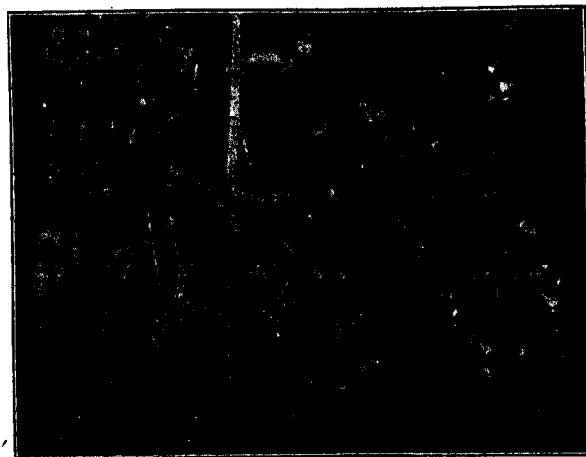


Fig. 2. Showing black-tip of Mango fruit—some having normally, some held with tips upwards.

effect. Those treated after they had attained full size, but yet green (14th May to 28th May, 1942), did not produce black-tip, although they showed a tendency of ripening earlier than their controls.

Thanks are due to the Imperial Council of Agricultural Research, India and the Government of Bihar for facilities.

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A NOTE ON THE GENUS *MANGIFERA* LINN.

The mango tree, which is the most important plant in the genus *Mangifera*, has been known to the people of India from very early times, as is evident from references to it in Sanskrit literature, *e.g.*, in *Bṛhatsamhitā*, *Varaha-Purāṇa*¹ etc., where it has been mentioned as *Amrā*.

Huenthsang, who visited India between 632-645 A.D., seems to be the earliest traveller to refer to it. Further references were made by Friar Jordanus Catalani, Ebn Batuta, Nicolo Conti, Lurdovici de Varthema², and Garcia da Orta³, who named the

mango as *Manga* or *Mangas*, the local name for the fruit in Southern India.

Carol Clusius⁴ is the first botanist to refer to the mango as "*Fructus exoticus 4, a gareto acceptus*". The name *Mangifera* was first mentioned by Jacob Pontius (1658), while referring to the mango as *arbor Mangifera* literally meaning 'the tree producing mango'. In Rheede's *Hortus Malabaricus*⁵, mango is mentioned to occur wild in the forests of Malabar, Goa, Gujrat, Pegu, and Malacca. John Burmann⁶ in his *Thesaurus Zeylanicus* adopted Bontius' name slightly changed as *Mangifera arbor*. Linnaeus⁷ in his *Flora Zeylanica* (1747) retained the name *Mangifera arbor* given to the mango by Bontius and Burmann. It was, later on, changed by Linnaeus himself to *Mangifera indica*, when he finally established his system of binary nomenclature in '*Species Plantarum*' (1753). This name is retained for the species up till now.

The references to the genus, up to this date, were mainly concerning the species *M. indica* (mango, cultivated in India), except that of Rumphius⁸, who mentioned 8 other species occurring in Amboina and the surrounding islands (Dutch East Indies), and referred them to two genera '*Manga* and *Pauw*'. The number of species has since gradually increased, mostly due to the investigation of the flora of the unexplored regions of the world. These were described chiefly by Roxburgh (1824), Jack, Blume (1850), Griffith (1854), Miquel (1859), Hooker (1876), Kurz (1877), Engler (1883), King (1896), Pierre (1897), Ridley (1922), Merrill (1923) and Craib (1931).

The latest revision of the genus was made by Engler¹⁰ in De Candolle's *Suites au Prodromus* where he recognised 32 species of which 28 were valid, and 4 doubtful. Since Engler's revision of the genus, the number of species has increased to 65 according to the authors of the '*Kew Index*'. The writer has therefore attempted a revision of the genus from the materials obtained from the Indian and other eastern herbaria.

After a thorough examination of more than 1000 dried sheets and alcohol materials of flowers and fruits, received from the Philippines, Sarawak, Buitenzorg, Singapore, Maymyo, Dehra Dun, Sibpur, and other Indian herbaria, the number of well-established species has been found to be 41, of which 8 appear to be doubtful, 1 is a '*nominum nudum*', 6 are to be excluded from the genus, and the remaining ones to be reduced to other species. Two new species, two new varieties, and one new combination have been established, while a few others may turn out to be new when the examination of the unidentified sheets will be completed.

Hooker⁹ first divided the genus into 2 sections, based on the characters of the disc. Engler¹⁰ used these characters of the disc for subdivision of the genus but did not recognise any sections. Pierre¹¹ recognised 5 sections, also based on the characters of the disc. Taking everything into consideration, the writer is inclined to accept Hooker's division of the genus into two sections as the natural arrangement. For the delimitation of the species, the writer has mostly relied upon the characters of the reproductive parts. The characters of the leaf (venation, texture, size, shape) have also been taken into consideration in some cases. The distribution of the species according to the area is given below:—

Ceylon—2, India—3, Andaman Islands—3, Burma—6, Siam—10, French Indo China—18, Malay Peninsula—20, Sunda islands (including Sumatra, Java and Borneo)—17, Bali—2, Timor Island—2, Molucca Islands—2, Banda Island—3, Amboina—2, New Guinea—2, Celebes—4, Philippines—9.

Among the species, 16 are endemic. The names and distribution of those species are given below:—

Ceylon—1 (*M. zeylanica* Hk.f.), Assam—1 (*M. khasiana* Pierre), Andamans—1 (*M. andamanica* King), Siam—1 (*M. siamensis* Craib), Indochina—1 (*M. cochinchinensis* Engl.), Malay Peninsula—4 (*M. maingayi* Hk. f., *M. lanceolata* Ridl., *M. longipetiolata* King, *M. gracilipes* Hk. f.), Sumatra—1 (*M. ridida* Bl.), Borneo—3 (*M. Beccarii* Ridl., *M. Havilandi* Ridl., *M. spathulæfolia* Bl.), Philippines—3 (*M. Merrillii* sp. nov., *M. monandra* Merr., *M. philippinensis* sp. nov.).

The anatomy of the floral axis, in particular the number and location of the resin-ducts, is likely to afford characters of diagnostic value. This is being studied, and more definite information will be available when the investigation is complete. The origin and migration of the species, contained in the genus, are being worked out from the phytogeographical data and fossil records. The work will shortly be published elsewhere.

The writer takes this opportunity of expressing his gratitude to Dr S. P. Agharkar, Ghose Professor of Botany, Calcutta University, at whose suggestion the investigation has been undertaken. Thanks are due to the superintendent and curator of the Royal Botanical Gardens, Sibpur, for giving facilities for work in the Sibpur herbarium and for consulting the valuable collections of the library, and to Mr V. Narayanaswami for helpful criticism. Thanks are also due to the directors of the Buitenzorg, Philippines, Sarawak, Singapore and Maymyo herbaria, the Forest Botanist, Dehra Dun, and to the

Botanical Research Officer, Shillong, for the loan of the valuable collections of the genus to Calcutta University, for the present investigation.

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PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON

I

In the conclusion of the above-named article¹ published in this journal the author says: "At the same time they (Physiographic Divisions) will afford a pattern of unity in diversities. They will also stimulate an unhampered intercourse amongst them for the mingling of their cultures. It is also hoped that the physiographic boundaries indicated on the map will coincide with the cultural ones."

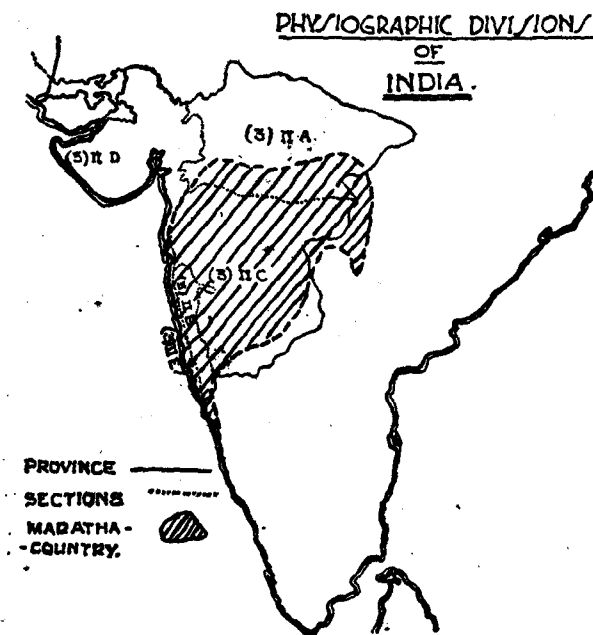
A case, in which the physiographic boundaries of some sections have happily coincided with the linguistic and cultural boundaries, needs some revision in Dr Pithawalla's Divisions. I am here referring to the culture of the Marathi-speaking people. Dr Pithawalla has also referred to this point. The region inhabited by the Marathi-speaking people is approximately covered on the map by oblique lines.

It will be seen that the boundary of this region nearly coincides with a group of sections and sub-sections, proposed by the author, as shown below:

Region inhabited by Marathi-speaking people having one common language and culture for at least one thousand years.	Sections (3) II B
	(3) II C
	(3) II E
	Sub-Section (3) II A (b)
	(3) II A (d)

A part of the Tapti Valley is included in section (3) II C and another part in (3) II A, both having typical Deccan Trap topography. The description of section (3) II A is given in the statement as "Basalt lava rocks and flat hill-top topography." Section (3).

II C is also crossed by two flat-top hill ranges of Basalt rocks, (1) Indhyadri (Ajintha Range) and, (2) Balaghat Range.



I, therefore, suggest that two sub-sections (3) II A (b) and (d), i.e., the Satpuras and the Tapti Valley, be included in (3) II C. These two regions of the Satpura and the Tapti Valley (Berar and C. P. Marathi) are also traditionally and culturally linked with the sections (3) II C, B and E. If this is done, the boundaries of the physiographic sections (3) II B, C, and E will most nearly coincide with the cultural boundaries of the Marathas from the point of view of language.

V. N. PADSALGIKER

627/5, Sadashiv Peth,
Poona No. 2, 5-6-1942.

¹ Pithawalla, M. B., SCIENCE AND CULTURE, 7, 537, 1941-42.
² Pithawalla, M. B., SCIENCE AND CULTURE, 7, 541, 1941-42.

II

Mr Padsalgiker of Poona City has very wisely followed up my scheme of physiographic divisions of the country and tried to fit in the cultural region of the Marathi-speaking people with the majority of the sections of the Deccan Trap Region (Province (3) II). In my next paper I hope to show that most of the linguistic boundaries in India will generally coincide with those drawn by me on the physiographic principles in this manner. For instance, the whole of the ancient Dravidian group of languages fit in admirably into the Province of Archaean rocks, namely South Indian Region, (3) IV, A., B., C., D., E., F., G.,

shown in my map, on page 535. But the difficulty arises when suitable criteria are not chosen for such a co-ordinated research.

Mr Padsalgiker has not indicated on what basis he has drawn the linguistic boundaries for Marathi. Reliable data may be obtained from the Census Reports and literature on philology. He does not state what percentage of purely Marathi-speaking people should be taken to recognise the region as Marathi. It is the border-line areas which will provide knotty problems for geographers. Sections (3) II B., C., E. have been accepted by him. The difference is only with regard to the northern side merging into (3) II A and the south-eastern cut-up. But such borders are bound to occur in the culture regions. They are, in my opinion, 'No Man's Land', a kind of transitional areas which will have to be settled with the common consent and collaboration of local geographers, e.g., the Desert Region boundaries gradually merge into (2) I B (Sindhi) on the one side and (3) I A (Rajasthani) on the other.

I would suggest that unless a good majority of the people (say, at least 75%) speak the same pure language, the whole region should not be termed 'linguistically one'. Section (3) II A falls into Rajasthani on one side and Hindi on the other. Being in the neighbourhood of powerful influences in its outer belts, it has different kinds of Khandesi, Bhili, and Malvi dialects. Though belonging to the Deccan Trap Region, it is one into which the monsoon easily penetrates through the west-east into the Narbada and the Tapti valleys and is partly forested with some changes in human occupation. It differs from Bombay Deccan, Section (3) II C, which is drawn by me from the points of view of its plateau physiography and dryness, as occupying mainly the leeward side of the Ghats with no prominent drainage basins. Such a changed environment must make the regions culturally different. I am prepared to include portions of the Tapti valley and the Satpura sub-sections in Section (3) II C as a cultural region, if Mr Padsalgiker can prove that the required percentage of the people speak pure Marathi and not any mixture.

Otherwise, as I have stated above, small problems of the borderlands will arise, when we start drawing the linguistic boundaries on the map of India and superposing them on the physiographic ones on the same scale. These we shall have to solve on a co-operative basis.

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Karachi, 15-6-1942.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences.

Vol. VIII

SEPTEMBER, 1942

No. 2

Science and War-Effort in Great Britain and India

THERE may be a general impression in this country that in the United Kingdom the best use is being made of science and scientists for a vigorous war-effort, and for laying down a considered plan for post-war reconstruction. This impression is unfortunately not confirmed from a perusal of scientific journals, which have been received recently. In a conference organised by the Association of Scientific Workers, on January 10 and 11, (reported in *Nature* of January 17) opinions far from favourable were expressed by some leading scientific workers. A few may be quoted below:

Prof. J. D. Bernal, dealing with the conference as a whole, stated that attempts by men of science to better the situation would meet with opposition from industry and from the Government. In his view, the opposition to scientific workers in the last few months is equivalent to sabotage and perhaps something rather stronger. He underlined the need for speed in view of the urgency of the situation.

Prof. Bernal plainly indicates two main reasons for inefficiency:—

(a) Governmental red tape and Civil Service mentality, mismanagement and inefficiency in high places (i.e., appointment of inefficient people on account of their "high birth", or party influence to

positions of responsibility which they otherwise do not deserve).

(b) Opposition to measures of reform by vested interests (mostly industrialists), spirit of peace time competition between firms, fear of disclosure of industrial secrets and fear about loss of markets.

Prof. J. B. S. Haldane pointed out that had many of the recommendations of the A. R. P. co-ordinating committee been adopted, not only would there have been immense saving of life, but also a saving of materials and money.

Prof. H. Levy asked for a place for scientific men in the commands of the fighting forces.

Adverse opinions like the above were not only expressed by younger scientific men, but also by senior scientists though in more sober terms. We have, in the columns of SCIENCE AND CULTURE referred to the views of the late Sir W. H. Bragg, at one time President of the Royal Society. He had pointed out that sometimes mere politicians or Civil Service officials were appointed to posts involving knowledge of science or technology. He compared such men with students in the examination hall who have not read their courses throughout the year, and who are therefore unable

to find out answers even if text books are placed in their hands.

Another senior scientific man, Sir Daniel Hall said:—

"The real problem for scientific workers and the Government itself was to find out the machinery which would ensure a proper method of using the expert".

It is probably in response to these widespread complaints that a movement has been set on foot in England to devise a better machinery for the use of science and scientists in the war-effort. Says a Reuter's telegram:—

"Sir Stafford Cripps is taking a special interest in moves to enable scientists to play a bigger part in the war-effort by providing an effective clearing house for their brains. Government's wartime Scientific Advisory Committee under the chairmanship of the Education Minister, Mr R. A. Butler, is actively examining proposals for improving the present organisation.

"There has been a growing demand in Britain that a fuller use should be made of science and technical research in the development of war weapons. Complaints that young scientists and inventors feel a sense of frustration owing to lack of receptiveness in departmental minds and inadequate machinery were denied by the Government spokesman, Lord Privy Seal, in Parliament. But he promised that a number of suggestions would be looked into and the Scientific Advisory Committee will report on them to the Lord President of Council, Sir John Anderson.

"There is considerable support in political circles for the proposal that a whole-time Central Scientific Advisory Board should be created to co-ordinate research on the lines of the Central Technical Office established by Britain in Washington".

Sir Stafford Cripps appears to be the prizeboy, for the present, of British Imperialists. He has been loudly advertized for his socialistic philosophy, for his vegetarianism, and for his sympathy for Indian aspirations before he came out on his ill-fated mission to India, but we are afraid he proved himself to be as good an imperialist as Mr Churchill or Mr Amery. Now he is being advertized for some scientific accomplishments* he picked up 25 years ago. Let us hope that scientific workers in Britain would not have to

* According to the Reuter report:—"Sir Stafford Cripps, besides being a practical scientist and chemical expert, is an authority on complicated Patent Laws. Before devoting himself to the bar, he took a degree as Doctor of Science. It was his practical scientific knowledge which in the last war led to his being transferred back to England after serving with the Royal Army Medical Corps and being appointed chemist at the Government Explosives Factory at Queensberry."

find him a prisoner of Civil Service or of vested interests, as Indians did to their utter chagrin.

We in India are now more immediately concerned with our own interests, our own struggles, and problems of life during the present momentous period. Following the example of the United Kingdom, the Government of India has made belated efforts to make some use of science and scientists in the war-effort. According to the judgment of men in independent position†, these measures have contributed very little to the war-effort and to post-war planning for reconstruction. Let us try to analyse the causes.

The measures in India are really half-hearted. In England as in all independent countries, the interests of the public are identical with those of the persons who constitute the Government. In India on the other hand, the Government exists mainly to safeguard the interests of that vast group of vested interests known as Imperialism, which, as has been emphasized by Indian leaders of all shades, are fundamentally and radically different from those of the Indian public.

The implications of this fundamental difference in all Government actions and policy are not always obvious. For example, it has been our frequent experience while serving in Government committees to find that there are very fundamental differences in composition, objective, policy and procedure between corresponding bodies in England and in India. Take for example, the Department of Scientific and Industrial Research in the United Kingdom, and the Board of Scientific and Industrial Research set up in India in 1940. In the British organisation, the research work is organised and administered by an Advisory Council* of 12 members,

† Vide the article following by Mr G. L. Mehta, and gleanings from the speech of Sir M. Visvesvaraya.

* The Advisory Council of Scientific and Industrial Research of Great Britain for a typical year (1932-33) was as follows:—

Lord Rutherford of Nelson, F.R.S. (Chairman)
Sir A. Balfour, Bt., K.B.E.
Sir William H. Bragg, F.R.S.
Prof. E. J. Butler, F.R.S.
" A. C. G. Egerton, F.R.S.
" A. Fowler, F.R.S.
Lord Rayleigh, F.R.S.
Sir Clement Hindley, M.I.C.E.
Prof. T. F. Silby, D.Sc.
" N. V. Sidgwick, F.R.S.
Mr. J. Henderson, J.P.
Sir F. R. Smith, F.R.S. (Secretary).

Thus of the twelve members, ten were scientists in active work, and most of them were not in Government

of whom at least 10 are active† and mostly non-official scientists; the Chairman is invariably a distinguished non-official scientist (e.g., the late Lord Rutherford), and the Secretary, who is the chief executive, is one who has a distinguished record as a scientist. The Advisory Council plans research, examines all schemes, sanctions grants and supervises the working of the research associations, administers scientific research stations under its control and their decision is final. The Committee of the Privy Council which is technically the superior body, simply lays down the policy, and obtains a grant from the Government. In no case have they been known to interfere with the decision of the Advisory Council.

Let us contrast with this picture the organisation of the Board of Scientific and Industrial Research. The Chairman is the Honourable Member for Commerce. There are two Secretaries, one for the Council or Governing Body, another for the Board proper and none of them is a scientific man. One is a Civil Servant, the other is a Finance Officer. The Board consists of industrialists, Government officials, official scientists, and a few non-official scientists. The meetings must be convened to suit the convenience of the Hon'ble Member who is a very busy man, and the Board is only one of scores of bodies he has to attend to. The procedure is so complex that two meetings of the Board and one meeting of the Council (which amount to consideration of the same item three times by the Hon'ble Member and other high officials) are necessary before any research item can be disposed of. The result is that schemes have sometimes taken eighteen months to pass through all the bodies, and by the time the proposer is informed that his scheme has been passed, he has probably lost some interest in the subject.

service. The Chairman was a distinguished non-official scientist.

The Committee of the Privy Council to which the Advisory Council has to send its reports was composed of Lord Crewe (who was then President of the Council), the Chancellor of the Exchequer, Secretary of State for Scotland, Presidents of the Board of Trade and Education, Viscount Haldane, and two other members of the Parliament with a special secretary. The recommendations of the Advisory Council are to all intents and purposes final. The duty of the committee is merely to see that the policy was being properly carried out.

On account of non-arrival of mails, we have not been able to find out the composition in current years, but probably it has not changed. The present Secretary who is the executive head of D. S. I. R. is Sir E. V. Appleton, a distinguished scientist.

† Active in contradistinction to parlour or society scientists, of which there are too many in this country.

These defects are obvious, but they are justified on the score that conditions in England and India are not identical. The answer, to our mind, hides in a subtle way the plain fact that all Indian organisations must be constituted in such a way as to be subservient to the interests of Imperialism. Otherwise why should the deliberations of the Board which are purely technical in nature, require the presence of the Hon'ble Member, his Secretary (a senior I.C.S. man), and other officials who have generally no familiarity with science? Why cannot we follow the British practice, and ask a non-official distinguished Indian scientist to preside over deliberations of a purely technical nature about research plans, and schemes? Is it not probably due to the inherent suspicion that such a man may lead the Board to activities which will not be agreeable to the imperial interests?

Again, why should the vital secretariat work be in charge of I. C. S. or Indian Audit and Accounts Service officers to whom the deliberations are strange, unfamiliar, and probably boring; who, probably in carrying out their duties have to experience the same kind of mental struggles as those of Sir William Bragg's truant boy who cannot find out the answer to the question in the examination hall even when a text book is placed in his hand. A distinguished scientist who is also conversant with administrative and secretariat work would do the work far better, but probably he cannot be expected to be so faithful to Imperialism as some one in direct Government employ.

The main point to be noted is that while in England non-official scientific men have been given large powers to initiate and organise research, and appoint scientific staff, such powers are denied to Indian scientists. In England the younger scientific workers are not satisfied even with such wide powers; they are demanding more power, larger finance, and quicker procedure and speedier translation of their researches and findings to action.

It is rather unfortunate that in drawing up the constitution, laying down the procedure, and in the appointments of the scientific staff for the B.S.I.R., the Government of India did not profit by the example of bodies like the D. S. I. R. which has twenty-five years of good work to its credit. The large body of Indian scientists, represented by the Indian Science Congress, the senior scientists represented by the

National Institute of Sciences, and other academies and learned societies have simply been ignored. We do not know whether the scientific services were consulted. In the constitution framed, the wooden ideas dear to the bureaucracy were introduced, and the few non-official scientists who represent the vast body of non-official scientific opinion were kept in an out-house, like poor relations of a rich man. In our opinion, this has been equivalent to *sabotage* of war-efforts in India and some day the bureaucracy will discover this unpleasant truth—probably when it is too late!

If India is really and effectively to participate in the fight for democracy, the United Nations must cease to think of her, as Mr T. V. Soong* remarks with respect to Asia, in terms of raw material, raw men, and undeveloped markets. They must acknowledge her right to govern herself, to develop her natural resources and to make her own contribution to the progress of the world.

* The occasion was when T. V. Soong, one of the foremost Chinese leaders, and brother-in-law of Chiang Kai Shek was awarded the doctor's degree in the Yale University U. S. A.

NATURE OF WAR

War is a purely human phenomenon. The lower animals fight duels in the heat of sexual excitement and kill for food and occasionally for sport. But the activities of a wolf eating a sheep or a cat playing with a mouse are no more war-like than the activities of butchers and fox-hunters. Similarly, fights between hungry dogs or rutting stags are like pot house quarrels and have nothing in common with war, which is mass murder organised in cold blood. Some social insects, it is true, go out to fight in armies; but their attacks are always directed against members of another species. Man is unique in organising the mass murder of his species.

Certain biologists, of whom Sir Arthur Keith is the most eminent, consider that war acts as 'nature's pruning hook', ensuring the survival of the fittest among civilized individuals and nations. This is obviously nonsensical. War tends to eliminate the young and strong and to spare the unhealthy. Nor is there any reason for supposing that people with traditions of violence and a good technique of war-making are superior to other peoples. The most valuable human beings are not necessarily the most war-like. Nor as a matter of historical fact is it always the most war-like who survive. We can sum up by saying that, so far as individuals are concerned, war selects, dysgenically; so far as nations and peoples are concerned it selects purely at random, sometimes ensuring the domination and survival of the more war-like peoples, sometimes, on the contrary, ensuring their destruction and the survival of the unwarlike.

Ends and Means—A. Huxley.

The American Technical Mission

GAGANVIHARI L. MEHTA

President, Federation of Indian Chambers of Commerce and Industry.

THE visit of the American Technical Mission to this country during last April and May is an event of importance in the economic and industrial life of India. It was significant in more ways than one. It constituted a realisation of the vital part which India can play in the war effort of the United Nations as an arsenal of the East. It was also evidence of American interest in the mobilisation of India's economic resources and industries for common defence. The Mission consisted of mainly technical persons with Dr H. Grady as its Chairman. It was concerned with India's war production and the extent to which it could be developed with American aid. The Mission was in India for just over five weeks and within that short period, it toured round the principal centres of war production, met some leading industrialists and Chambers of Commerce and surveyed the whole position. It submitted a preliminary report whose official summary was published by the Government of India. The Mission was also to submit a final report after its return to the United States. It must be stated at the outset that any comments on the report can only be based on the press summary because the preliminary report has not been published.

Although several Indian industrialists had an opportunity of meeting and discussing broad issues of policy with the members of the American Technical Mission which tended to remove certain misgivings entertained about its objective, there was no active and continuous association of the representatives of Indian commerce and industry with the Mission, mainly, no doubt, because of the short time at its disposal and the restricted scope and the technical nature of its work. It is essential, however, that representative Indian industrial opinion should be fully taken into confidence by the Government in implementing the recommendations of the Mission and formulating their programme. It is hardly necessary to emphasise that the expansion of

production in India for war purposes can take place only with the active collaboration and co-operation of commercial and industrial interests in this country. The existing political conditions tend to handicap war effort in this country and it is all the more desirable, therefore, that the Indian public should be made to feel that there is no distrust or feeling of isolation between the Government and the people in such vital matters.

LACK OF A LONG-TERM POLICY

It is not necessary to review within the short compass of this article the various recommendations of the Mission which have already been published in the press. It must be stated, however, that the Mission has taken too short-range a view of war production and that all its proposals and recommendations have been based on this assumption. Since the commencement of the present war, any long-term policy in respect of development of heavy and defence industries in India has been regarded with disfavour by the Government of India and by His Majesty's Government. It has been argued, for example, during the last three years that unless India could produce any required material within a specified period of time, it would not be useful for war purposes and could not, therefore, be encouraged. On the contrary, reliance has been placed on American aid in equipment even before American production was placed on a war basis and despite the fact that it was not forthcoming in the immediate future. Nevertheless, such long-term facilities were not denied to Australia which was expected to supply the requirements of the Eastern Group on the basis of a long-term programme of industrial development. The Governments of the Dominions of the British Commonwealth have made it clear that in developing and expanding war production, they are laying the foundations of future industrial progress and it is in

this spirit that the Government in India should also shape their industrial policy during the war. But even in the third year of war, India cannot manufacture ocean-going merchant vessels or automobiles or tanks or locomotives and can but assemble a few aeroplanes. It is clear that the assumption of the need of a very short range policy of augmenting war production has also been the basis of the preliminary report of the American Technical Mission. For example, the Mission has advised concentration upon repairs rather than new construction in respect of aircraft and ships. Yet proposals for developing shipbuilding, aircraft and automobiles have been before the Government since the commencement of the present war and even in some cases, prior to it. We can never accept the position that we should restrict ourselves to repairs of aircraft and ships instead of embarking on new construction. Besides, as Sir M. Visvesvaraya stated recently, "while India has had to be content with industries connected with the feeding and clothing of the army, it is not entrusted with the production of military equipment and war armaments in which Indian engineers and workmen could acquire practice, capacity and skill."

NEED FOR A LONG-TERM PROGRAMME FOR PRODUCTION

The Japanese control of the South-West Pacific and parts of the Indian Ocean and her conquests in the Far East have, in fact, completely altered the situation whereby India could hope to obtain her vital supplies from Australia or any other Member of the Eastern Group. In fact, difficulties of sea transport alone have thrown India upon her own resources rendering essential a long-term programme of national self-sufficiency for defensive no less than economic purposes. It is admitted that shipping is the principal "bottleneck" so far as carriage of war supplies and provision of immediate assistance at the various fronts are concerned and the development of basic industries in India is consequently quite essential in order to meet such serious impediment. It is not known whether questions of long-range policy have been discussed by the Mission in their final report but in any event, the Government of India should not ignore the importance of long-term factors of war production in India.

It is also essential to emphasise that there cannot be in the circumstances of India, a demarcation between industrial production and war production

or between civil needs and military requirements. Not only the complexity of industrial production but even the need for maintaining ordinary civil life and normal economic relations render impracticable such a distinction. The elementary needs of the mass of people in this country even for such articles as food and clothing still remain unsatisfied and their fulfilment is not less fundamental even from the viewpoint of war economy than that of military requirements. Civilian morale, moreover, is of fundamental importance particularly in a total war. The question of war production in relation to India must, therefore, take into account all these factors which must determine any policy to implement the recommendations of the Mission.

NECESSITY FOR A WAR PRODUCTION BOARD

It is rather difficult to express any views on the suggestions made by the Mission in regard to governmental organisation. In the first place, it is not quite clear whether the Mission has itself expressed any considered opinion, except in so far as favouring one of the alternatives submitted to it by different parties. Moreover, one easily transgresses into politics in discussing this matter because it is primarily a question not of administrative shuffle or the establishment of a new department but a more fundamental one of the outlook and policy of the Government and of their own freedom from the superior control and interference of Whitehall. Nevertheless, it would be desirable, if production is to be augmented, to establish a War Production Board consisting predominantly of Indian industrialists having as its full-time Chairman an Indian public man, preferably an industrialist, possessing "drive" and enjoying the confidence of the Indian commercial community and the public assisted by two or three capable American experts as advisers. The Chairman of this Board should be independent of any Government Department and should have direct access not only to the Viceroy and the Commander-in-Chief but also to the War Cabinet and the Pacific War Council. The mere existence of a Member of Production or even a War Production Board would not be sufficient; everything depends on what powers a Member or the Chairman of such a Board possesses and what he is permitted to do. After repeated refusals, the British Government have had to agree to the creation of a separate Department of Production with a Minister at its head while in the United

States, there functions a War Production Board with an eminent businessman, Mr Donald Nelson, as its Chairman. The reason why it is necessary to have a Department of Production or a War Production Board in India with wide powers is that the present system of production is not adequate to elicit the best energies of the people or to organise effectively war effort and mobilise the economic resources of the country and it cannot be put right except by an organisation empowered with much more than ordinary departmental authority.

THE WAR RESOURCES COMMITTEE

The War Resources Committee such as has been constituted comprising merely the present members of the Council who are at the head of Departments cannot really improve the present position. If this Committee, by whatever name it is designated, is merely to continue the past policy, the change will be of little benefit to the economic front at home. At least three of the members of this Committee are Britishers and even the post of the Secretary has been filled by an officer of the British Army, although the post could easily have been filled by a competent Indian member of the Civil Service, if not some distinguished non-official Indian. It is, no doubt, important to establish the best possible machinery for co-ordination in the production of war supplies but the fact cannot be ignored that such co-ordination by itself will not augment war production unless the business of production is itself rightly organised and placed on a war basis. It is evident from the press summary of the Mission's report that the Mission is not satisfied with the present pace of war production in the country. Although they have refrained from suggesting any precise governmental reorganisation presumably as a matter of courtesy, it is not difficult to infer that a complete overhaul of Government's administrative machinery and a radical change in their outlook and policy are essential for achieving maximum production. For this purpose, industrialists themselves should be permitted to handle problems of industrial production as an integral part of war effort.

BUREAUCRATIC DOMINATION
TO SHARE RESPONSIBILITY

As Sir M. Visvesvaraya stated in his recent speech at Bombay, "the one circumstance which

differentiates India from countries like Canada or Australia is that in the latter countries leading industrialists and public men control policies and plans, while in India, the Government is taking upon itself full responsibility to do things without consulting the wishes or the interests of the taxpayer". Even in respect of appointment of Controllers, there is an admixture of permanent Civil Servants with businessmen in the United Kingdom instead of depending only on official personnel. According to Sir Bertram Stevens who until recently was Australia's representative on the Eastern Group Supply Council, "the Government in Australia established contact with the industry through various Boards appointed by Government and at the head of which were placed some of the country's leading industrialists". It is now evident that the industrial policy of the Government in the pre-war period was characterised by short-sightedness and timidity which is almost incredible in retrospect. Even in normal times, it is the cult of the Civil Servants to do things slowly and to find good reasons for doing nothing; these men cannot give up their habit and adapt themselves to war time needs of speed and responsiveness to new ideas, much less to originate them. But the gulf between the bureaucracy and the people is all the more disastrous in this country where the economic interests of the country are, in vital matters, subordinated to those of Britain. If, however, a War Production Board could be set up with the active assistance and co-operation of Indian industrial interests, it would help to step up war production. Such a Board could consider questions which have been raised in the report of the Mission relating to the changes in production technique and the need of mass production as also those relating to labour training programme. It would render unnecessary the continuance of the Eastern Group Supply Council which is already superfluous in view of war developments in the East. This organisation can be dissolved and its experience and personnel can be utilised by the new War Production Board.

REGIMENTATION AND RATIONALISATION OF INDUSTRIES

The Mission has also raised important and delicate questions of regimentation and rationalisation of industries. It must be frankly stated that measures of this character can be devised and executed only by an authority which can inspire

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confidence and reassure the public that it functions in the wider interests of the country. That, emphatically, is not the case at present. There is no guarantee, for example, that the permanent economic interests of India may not be compromised in any such programme or that the measures adopted would be free from discrimination as between Indians and non-Indians. It is evident that in the present stage of industrial development and in view of the existing constitutional position, such regimentation as is apparently favoured by the Mission is hardly feasible and might, in fact, produce contrary reactions and undesirable repercussions. Indian industries are already subjected to several controls in respect of imports and exports as well as in their dealings with the Supply Department and are suffering from many handicaps owing to the past policy of the Government. The experience of Indian industries and particularly their apprehensions of discriminatory treatment arising out of India's economic subservience make them naturally hesitant and cautious in approving or supporting any policy of regimentation. The adoption of any such broad or long-term policy depends, in the last analysis, on the establishment of an authority deriving its strength and power from the people of the country.

TRANSPORTS

The Mission has stressed in their report the serious position of the internal transport system in the country and have urged the development of alternative modes of transport such as waterways and roads. This view has been emphasised by public men, Indian commercial bodies and legislators during the last several years, but, unfortunately, without any appreciable effect. Shipping, both coastal and inland, as well as roads have in the past been neglected and their healthy and full development discouraged by the authorities in this country owing to a bias for railways in their transport policy. An integrated and co-ordinated transport policy for the full and effective utilisation of railways, waterways and roads has been continuously urged by the Indian public but the Government have been mainly anxious for augmenting earnings from railways even to the detriment of other forms of transport. The apathetic attitude of Government towards river and canal navigation and towards the building up of an adequate Indian merchant marine are eloquent proofs of their lop-sided transport policy. As regards roads,

a special measure was passed only a few years ago which, in effect, tended to restrict and hamper motor transport and it was frankly avowed that the Government desired to restrict motor competition in the interests of railways. Even under the present abnormal conditions, there is scope for the effective development of water-borne transport in the canals and rivers of India; that would afford an economic means of carriage, particularly for articles in bulk and would tend to relieve the congestion on railways. The Government should immediately give their attention to this important problem and take all feasible measures to encourage its development while refraining from adopting any measures that would impede such traffic on the plea of war exigencies. The development of power alcohol and alternative fuels might also help road transport. There is a definite scarcity of motor vehicles and during the last two years, India has imported nearly 8000 vehicles less than her normal imports and of the existing 45000 vehicles, about 5000 are being used for the training of mechanics and another 5000 for urgent defence works, while quite a number of these vehicles must now be old and on the verge of being unserviceable. The Government, however, have discouraged the project for establishing an automobile factory in India. As regards railways, during the last ten years the number of locomotives in India has decreased by over 600 while over 200 locomotives and 10,000 wagons and other vehicles have been sent out from the country to meet military requirements in the Middle East and elsewhere thereby causing a severe shortage of stock which is the main cause of dislocation of railway transport. No efforts, on the other hand, were made to establish a locomotive industry despite the experience of the last war and insistent public demand. The railway workshops have been devoting their attention almost exclusively to war work thereby presumably neglecting repairs work necessary to keep the railway system in an efficient condition.

REORGANISATION OF RAILWAY SERVICE

The Mission has recommended the loan from the United States of an outstanding railway administrator with two other experts in operation and maintenance as also of the services of technicians and industrial executives. The services of such experts must be for a clearly defined purpose and on a temporary basis in order to advise Government Departments or to

train labour. As regards the railway system, there have been several committees of enquiries and investigations in the past followed by the appointment of special experts, most of whom have been brought from the United Kingdom. The present difficulties have arisen partly owing to abnormal conditions due to war and partly also to serious errors in the Government's transport policy, as pointed out above, and to the short-sighted view in regard to manufacture of locomotives and wagons. Although better co-ordination and avoidance of waste and leakage are undoubtedly desirable, the appointment of non-Indian experts who, however, proficient in their technical knowledge, would be necessarily ignorant of Indian conditions and requirements, may not solve the difficulties. Several practical difficulties and maladjustments could be remedied if the railway authorities acted in consultation and in close co-

operation with representatives of the public and the commercial and industrial interests.

The specific proposals made by the Mission in regard to certain industries such as power alcohol or electric power or aluminium are welcome. It is hoped that all necessary help would be rendered without delay by the authorities for establishing or expanding such industries through assistance in respect of import of machinery, machine tools, raw materials and technical personnel. Moreover, the Government should also realise the imperative necessity for the establishment and development of such industries as those for the manufacture of automobiles, ships, tanks and heavy chemicals and explosives in the country. American assistance could be secured through the Lend-Lease procedure because such development would be in the interest of the defence of the United Nations.

RUSSIA WITHOUT ILLUSIONS

In an evaluation of the Soviet war potential, Mr Maurice Dobb, author of 'Soviet Economy and the War' gives these useful figures:

German coal output reached in 1938 some 186 million tons against 133 million in the U. S. S. R.; pig iron, 18 million tons against 15 million; steel, 23 million tons against 18 million. If we add to the German figure that of countries occupied by or in alliance with Germany . . . we raise the level of German controlled output in each case to about double that of the U. S. S. R.

Mr Dobb points out, however, that a deficiency in one ingredient of a properly balanced war economy may be fatal to its total structure. This is true both of Germany, which has less oil, copper and manganese than the U. S. S. R., and of the U. S. S. R., which through the destruction of the Volkhov aluminium works must import aluminium to supply its aircraft industry. To destroy the synthetic oil plant at Leuna would profit the Allies more than the destruction of Cologne. To send 5,000 tons of aluminium to the Soviet Union might be of more service than to send 50,000 men.

Soviet war potential is governed by the general organisation of the U. S. S. R.—its Central Plan, its budget, its trade unions and its Party.

With acknowledgment to *The New Statesman and Nation*.

Sir M. Visvesvaraya on the Recommendations of the Grady Mission*

INDIAN INDUSTRIES IN WAR TIME

"AFTER going round a good number of war industries in the country, The American Technical Mission has stated in its preliminary report that it discovered shortage of material, machinery, plant and personnel, that many of the engineering workshops were actually jobbing shops, that a basic change in production and technique was needed, and that rationalization, regimentation and mass production methods which were not known to Indian practice should be introduced as a means of accelerating production.

"The principal recommendation of the Mission was the establishment of a War Cabinet with a strong secretariat to control war production in all its phases. A second proposal was the separation of Production and Supply Departments and the establishment of a new Production Department with an independent head. The maintenance of a high-powered control independent of the established Government agency on the American model, the expansion of the steel industry and the manufacture of power alcohol were among the other specific recommendations made by the Mission.

"The Supply Member of the Government of India in voicing the views of that Government announced that a War Resources Committee with His Excellency the Viceroy as President and himself, that is, the Supply Member, as Vice-President, had been appointed in place of the suggested War Cabinet. The Government of India according to him did not consider that the separation of supply and production agencies was desirable. He brushed aside some of the important methods recommended for speeding up production as inappropriate for the conditions of this country.

"If the country is to attain the status of a Dominion at the close of the war, it is not understood why the Government, instead of utilising the unique opportunity afforded by the war to promote industrial advance, should persist in following their own time-worn traditions and old fashioned methods to the detriment of the material interests of this country's population."

POST-WAR RECONSTRUCTION

"Much importance is attached by all the belligerent nations, in spite of many trying experience connected with the war, to the preparations to be made in the midst of the war for post-war reconstruction, that is, for restoring normal conditions when the war is over, including the transfer of the business activities of war time to peace time conditions.

"Preparations for post-war reconstruction are an urgent problem also in this country. In June last year the Government of India announced that under the Chairmanship of the Commerce Member four committees had been set up to deal with the various phases of post-war work. Two meetings have been held and some inkling was given to the public of the policies Government had in view. After studying those policies, I have explained how inadequate those policies were. Its chief defect is that industrial which ought to form the most important measure post-war activities does not find a place in the reconstruction programme. Another defect is that the work of the committees will continue to be shrouded in mystery. Secrecy is justifiable as regards war measures but there ought to be none in regard to post-war measures. A third defect is that the control and direction will not be with industrialists or representative public men as is the case in Canada or Australia.

"Considerable importance is attached to post-war reconstruction in England. Sir John Anderson, the

British Home Secretary recently remarked, that 'he was convinced that the effective conduct of the war was hardly more important than the effective preparations for peace'."

"Unless the defects pointed out are removed, the aims and procedure of Government committees are clearly defined, and Indian industrialists are placed in control, the post-war reconstruction committees judging from past experience will be of little value to the country, and money should not be spent on them."

INDIAN INDUSTRIES AND WAR ORDERS

"In normal pre-war times orders for heavy goods and machinery such as locomotives, required by the Indian Government, were placed in the United Kingdom and if the manufacturers there were busy, the orders went to the United States of America or Germany, but no support or concessions in this respect were given to Indian industrialists to manufacture such goods in India.

"In the three belligerent countries associated with the Allies, namely, the United States of America, Canada and Australia, orders for heavy machinery and war material required during this war, both for Great Britain and the country concerned, were placed with local industrial firms in the respective countries. But this good fortune did not come to Indian industrialists in this war. If it be stated that Indians were inexperienced, I may add that several of the firms or industrialists in the three countries named who were the recipients of similar orders have confessed that they too had to learn the

* This undoubtedly reflects the opinion of the Cabinet, for a Reuter's telegram, dated August 16, contains the following interesting news:—"A five-year plan for the development of Britain's rural land and appointment of 'a Minister of National Planning' is recommended by the Committee on Rural Land Utilization appointed by the Ministry of Works and Planning which under the chairmanship of Lord Justice Scott issues a report to-day (Saturday).

Pointing out that "we do not want the countryside which behind a smiling face hides much human poverty and misery", the Committee urges setting up of a central planning authority. Five years should see completed, the report suggests, a definite number of houses for rural workers; and programmes for electricity, water and gas extensions.

Scotland's problems such as the future of highlands ought to be faced by the United Nations, the report states, adding "Scotland seems likely to suffer continued depopulation and migration of industry if planning is carried on independently." (Footnote is ours).

actual technique and manufacturing processes after they had accepted the particular war orders. The same might have been done in India.

"In the matter of steel production in spite of war opportunity, Indian steel production remains practically where it was before the war, that is, about 1¼ million tons a year. The United States of America which has one-third of India's population is capable of manufacturing nearly 100 million tons in a year. The annual steel production both in Canada and in Australia has increased to 2 million tons in this War. Steel would have been very serviceable for Indian industries and the increase would have been greatly appreciated by the public had Government encouraged the expansion of steel production in India. This country can manufacture pig iron and steel cheaper than any other country in the world. In spite of this, merely for lack of Government support, the necessary expansion has not taken place. At the present moment, steel prices are exorbitant (Rs. 600 or more per ton while normal prices averaged about Rs. 110) and, to add insult to injury, Government are now arranging to import steel from America to meet war needs.

"For a long time past the production of alcohol from molasses in this country has not been permitted although in several European countries the mixing of alcohol with petrol for motor fuel is enforced by law. The Government of Mysore has done the same, but the Government of India for reasons best known to themselves have not encouraged this industry."

"A couple of years ago a Board of Scientific and Industrial Research was established by Government to help industrial development but the measure has not resulted in starting a single major industry yet.

"The total amount of war orders placed in India both by the Government of India and the British Government comes to about Rs. 300 crores, whereas it is recorded that in Canada the value of similar orders placed with Canadian firms by the Canadian and British Governments, since the commencement of the war, has amounted to \$3,600 million, or over 1,100 crores in Indian money.

* Since this was written, the Government of India has published a decree legalising the admixture of power alcohol to petrol to the extent of 30 per cent. The measure, needless to add, is very much belated. (Footnote is ours).

* Being gleanings from Sir M. Visvesvaraya's Presidential Address at the First Quarterly Meeting of the Central Committee of the All-India Manufacturers' Organization held in Bombay on 21st June, 1942.

"Almost any article can be manufactured in this country. Foreign manufacturers are willing to give their advice or start branch factories in India on reasonable terms. What the country needs is a proper industrial structure and organization backed by Government and by the joint strength of the leaders of industry and trade, or at least by one of these agencies."

RECOMMENDATIONS

"That the Government is not much in favour of industries or of post-war reconstruction is evident from the arrangement still in existence, namely, to treat the work associated with industries and post-war reconstruction in this vast country as subsidiary activities of the Commerce Department, and to leave the work of all these three nation-building departments in charge of a single Government Member. This they have continued to do, although new Members have been added to the Viceregal Council, and even though some of the latter seem underworked."

"The recommendations of the Mission that a war cabinet should be constituted is a sound one. A separate production department is also necessary."

"At the end of this war it would probably be necessary to launch industrial schemes involving an outlay of, say, Rs. 1,000 crores or more on a five-year plan. This sum is not large considering the vast resources of this country and the enormous size of its population. Canada which has a population of only 3 per cent of that of India, has already developed industries in which over Rs. 1,100 crores of capital has been invested."

WHOM TO BELIEVE?

"The country is handicapped because there is no industrial policy and no sound industrial structure."

Sometime ago I quoted an observation of His Excellency the Viceroy that

"India is, and for a long time yet, likely to be, mainly an agricultural country."

I have also quoted a statement of the Right Hon'ble the Secretary of State to the effect that

"India was one of the great industrial countries of the world."

"While there is such extreme divergence of view between high authorities, it cannot be said that there is any considered plan or policy to guide industrial production in this country. As the essential statistics required for stock-taking are not maintained, it is feared that the authorities themselves have no true conception of the magnitude of the country's industrial interests and needs. The development of industries is a work of great national importance."

APPEAL

"We appeal at this juncture to the political and industrial leaders to come together, frame a plan and programme, and give a lead to businessmen and workers in every corner of the country in order to maintain industrial activities of industries by leaving their guidance and control in the hands of leading industrialists and businessmen of the country, as is being done in Canada and Australia, by constituting Boards, Councils or Committees of such men,—particularly of men trusted by their people and giving them the help of Government funds and an executive staff."

"At the end of the hostilities, belligerent nations will have considerable replacements to make for their own needs. They will not be able to spare for us industrial machinery and shipping space to the extent that we will require. We must, therefore, plan to make our own industrial machinery with the help of machine tools freed from munition manufacture both in this country and abroad. At present we should push on with the extension of machine tool-making in India for the same purpose."

War Problems of the Physics Teacher

"I believe the statement that in this war a hundred physicists are worth a million soldiers" said Dr A. H. Compton, Charles H. Swift distinguished professor of Physics, University of Chicago, in presenting before the American Association of Physics Teachers and the American Physical Society, at Princeton, the first Richtmyer Memorial Lecture on 'War Problems of the Physics Teacher'. Those who have acquaintance with the working of magnetic mines, radiobeams for locating night bombers, the various devices for locating submarines and landmines, not to speak of the general use of the radio and telephone will appreciate the full significance of Prof. Compton's statement and admit the great contribution the physicists are increasingly making towards developing new devices for defence and offence. While it is natural to applaud technical men and scientists connected with technological research who have these inventions and discoveries to their credit, we very often lose sight of the great role the physics teachers are playing towards the cause of war and peace often incognito. Prof. Compton has particularly drawn our attention to this fact and laid stress on the ever increasing importance of teaching in physics and physics teachers in his Richtmyer Memorial Lecture. "Who would say", said he, "that the physicist who develops an important application of electric waves that may be useful in war communication, is performing a more valuable function than the man who trains the physicist who can do this and a thousand other tasks". As a matter of fact, at no other time, in human history did we feel the supreme necessity of turning out physicists in greater number. In fact physicists have to play such a vital part in various capacities in the present war, that it has been described as the physicists' war by no less a person than President Compton of the Harvard University, himself a chemist.

A clear conception of the basic and fundamental principles of physics is imperative for everyone who has, as a physicist, handled problems connected with the war.

It is true that technical and specialised training is always necessary to solve the immediate practical

problems; but unless the nation appreciates the view point that a knowledge of science is essential for efficient technological training, it cannot have valuable scientific men. Any programme of instruction must have as its objective the training of students in the fundamentals of physics. It is evidently a long term business which less thinking men in their haste might suggest to dismiss in favour of some short-cut method. But they should clearly recognise that it is a question of training and making of scientists whose work is not exhausted in a year or two, but who will be responsible for the progress and forward march of the coming generations.

In order to acquaint the students with these principles of physics, time is sufficiently ripe for abandoning the old traditional methods of teaching and introducing new methods of presentation suited to the present altered situation. Now the teacher's and student's time is precious. The material of the course should be presented in a form that can be clearly and quickly grasped instead of in the way it was used to be done in the past involving wastage of valuable time and energy.

While encouraging the idea of an intensive study of physics being undertaken by students in ever greater numbers, Prof. Compton was not blind to the question of merit and natural aptitude for the subject on the part of the students. So far as laboratory and field tasks are concerned men and women with average capabilities may be sufficient. But the students to be trained for research work must need come from superior stock who alone can be expected to make useful contributions. "It thus becomes especially important for us" remarked Prof. Compton, "to draw into the physics fold the most capable available young men and young women, and to weed out those whose promise is so low that their special training will be of little value to the nation's strength".

Prof. Compton believes that this mortal struggle in which the nations of the world to-day have become involved will not come to an end even with the con-

clusion of some treaty or peace, but will continue for decades, nay for generations so long as peoples do not abandon nation worship, and dethrone their national gods. Granted that the United Nations will come out victorious in the end, 'defeat of the Axis' armies will not mean that the national gods are destroyed, that nations will no longer seek prosperity by trying to enslave their neighbours'. It is in the physicists, Compton is of firm conviction, that the nation's strength lies to-day. And this strength can only be increased by intensifying the programme of the training of physicists.

A slackening of this unusual demand for physicists created by the exigencies of the war might be expected in the post-war period and consequently unemployment among the physicists may be appre-

hended on first thinking. But to all intents and purposes such anxieties are without foundation. During the last Great War people thought similarly of the chemists whose number swelled beyond all proportions under the pressure of war. But the period of reconstruction that followed with unprecedented growth in chemical industries not only absorbed them but wanted many more. There are reasons to suppose that the post-war period will witness the introduction of physical techniques in industry on a scale never experienced before and that the physicists will assume leading industrial positions when the country will be in need of ever greater number of physicists.

SCIENCE AND INTERNATIONAL POLITICS

"By modern use, science has come to signify natural philosophy, or verifiable knowledge acquired by observation and experiment. When its field of work is thus defined, there is an impermeable membrane between science and politics. The partition is dissolved when science—the domain of reason—is defined as systematic and formulated knowledge in all fields of human understanding—natural, moral, social and political. At all stages of civilization, these factors have determined the conditions of human life in varying degrees; and in modern times scientific knowledge has been the chief element in the constitution of man's outlook and the greatest power for social and political action.

"The view that the sole function of men of science is to study and discover natural facts and principles without regard to the social implications of the knowledge gained can no longer be maintained. It is now widely acknowledged that science cannot be divorced from ethics or rightly absolve itself from the human responsibilities in the use of its powers in economic or political planning. Men of science neglect their duty if they continue to retain the monastic habits which society commonly assigns to them, and are content to remain isolated from the structure of civilisation built up from materials provided by them. It is their obligation as citizens to assist in the establishment of a rational and harmonious social order out of the welter of human conflict into which the world has been thrown because the powers they have released have not been rightly used in the services of mankind as a whole"—so writes Sir Richard Gregory, Bart F.R.S., in his article on "Science and International Politics".

Obituary

Professor Jean Perrin, N. L.

THE death of Prof. J. Perrin at New York on the 17th April, 1942 at the age of 71 has removed not only a great scientist but also a man who has rendered eminent services to the development of science in France by his advocacy for providing more funds for scientific laboratories, institutes and fellowships. He was born at Lille on the 30th September, 1870. He started his career as a student of the late Sir J. J. Thomson at Cambridge and was the first to show experimentally, by a simple experiment as early as 1897 that the cathode rays (electrons) carry a negative charge. At the present time, one may not think much of this work, because it is so obvious, but at that time, it was regarded as a crucial experiment which once for all decided that the cathode rays were not e. m. waves, but material particles.

After his return from Cambridge he was appointed Maître de Conférence, i.e., Reader in Sorbonne and was put in charge of the newly created department of Physical Chemistry (Chimie Physique). In 1904 he published a classical paper on the charge of colloids and definitely established that the charge depended on the nature of the medium in which the colloid was suspended.

From 1905 onwards he carried out his celebrated researches on Brownian Movement and the experimental determination of Avogadro's number "N". This was a work of a difficult and painstaking nature requiring a good deal of ingenuity and the writer was told by Prof. Perrin at Sorbonne that frequently starting with 1 kilogram of gamboge or allied substances he could prepare only a few c.c. of sol of gamboge the particles of which could be considered to be more or less of uniform size and suitable for his experiments. The size of the particles was estimated and their displacement, rotational energy and distribution at different depths were carefully followed. Calculations were made according to the deductions of Einstein and Langevin and values of Avogadro's number were obtained.

This work is of fundamental importance and has given a great impetus to the development of atomic physics and chemistry. His work is too well known to students of physics and chemistry to require a mention here in detail. This work on Brownian movement afforded a direct verification of the main conclusions of the kinetic theory of gases enabled a fairly accurate estimate of Avogadro's number and established the reality of molecules as pictured by the kinetic theory. It is of interest to note that Wilhelm Oswald, one of the founders of Physical Chemistry and an individual endowed with a great personality was at that time preaching the doctrine that energy was real and matter a mere hypothesis as our perceptions depend on energy changes and the existence of atoms and molecules is a theoretical assumption based on such perceptions. A reference to this doctrine is implied in the title chosen by Perrin for his book describing his work which was entitled, "Brownian movement and molecular reality". He was awarded the Nobel Prize in Physics in 1926 for his work on the discontinuity in the structure of matter and in particular for his discovery of the equilibrium of sedimentation. His classical publication, "Les atomes" (Atoms) is a clear and lucid exposition of the then position of the atomic theory and gives a vivid popular account of his own researches. Perrin took great pains in writing many scripts and he used to say that the greater the labour that is put in writing a book or an article the greater is its value. In France usually the writers take great pains in the actual writing of papers and books, and that is why French publications are usually so clear and easily readable. A very important publication was his last book on "Grains de matière et de lumière" in 1935.

During the last War Prof. Perrin served in the Army as Commandant Perrin, designed apparatus for detecting submarines and carried on other important works in the allied scientific services.

After the War, Perrin became interested in chemical kinetics and published a classical paper on

this subject in 1919, the origin of which may be seen in his book on "Atoms" published in 1913 in which he stated that light is the chief factor which dissociates molecules. He postulated that the velocity of a chemical reaction is due to the temperature radiation of the system. This view point though subsequently known to be untenable undoubtedly gave a great impetus to photochemical studies.

During the last European War, he felt very much that the laboratories in France were not as well equipped as those in Germany and he agitated for better laboratories and for providing ampler facilities for research in France. He persuaded the Government to accept these suggestions and create fellowships for scientific research. He wrote numerous articles on these topics and later the opportunity came to him when he was appointed a deputy Secretary of State for scientific research and inventions. Chiefly due to his efforts and writings, when new institutes were built in Paris for researches in physical chemistry, biochemistry, engineering chemistry and other allied subjects and in these laboratories fundamental researches which have since become famous on induced radio-activity, nuclear physics and chemistry were carried on by Madame Curie-Joliot, Prof. Joliot, Prof. Auger, his son François Perrin and others. Prof. Perrin was very proud of his new institute of Physical Chemistry and when the writer and his wife visited France in 1931 in which these researches were carried out, he took them through these laboratories and showed them all the researches carried on there in 1931. He used to impress on his visitors that the facilities for research in France were then as good as those in Germany. Prof. Perrin had a high opinion of the contribution of Indians in the past to civilisation. He was friendly to Indians especially on account of the help which India rendered to the allied cause during the last World War. He carried out his

pioneering researches on Brownian Movement and equilibrium of particles in a very poorly equipped laboratory situated near the stairs of the Sorbonne chemical amphitheatre. He had a clear insight regarding Nature's secrets and having great enthusiasm for work, he was able to tide over difficulties and made discoveries of the first importance. When he spoke in learned societies he did it with so great emotion and fervour that the late Prof. Arrhenius who attended some of these discussions frequently used to say that Prof. Perrin spoke as if inspired. A great lover of science and its applications and a man of sterling qualities, he will be remembered for his great discoveries, and for his services in organising French science. He was instrumental in bringing into existence a Palace of Science in which all the leading discoveries in science were exhibited. He was very anxious to maintain this Palace of Science as a permanent house for scientific discoveries. Having got his first inspirations under that great teacher, Sir J. J. Thomson he was lucky to have as colleagues and friends, such brilliant men as the late Prof. Curie and his wife Madame Curie, Prof. Langevin, the late Prof. Urbain, the late Prof. Job and Prof. Debiere, Prof. Fabry and Cotton. He had a strenuous time in course of the present war and after the fall of France he was forced to leave his motherland, and take refuge in the United States. This contributed to his early death.

Perrin was the recipient of many prizes of which may be mentioned the prize of the Royal Society (1896), Vallaurie prize of Bologna (1912), and La Craz prize of the French Academy. He became a professor in the Sorbonne in 1910 and was honoured by many Universities and learned Societies. He was created a Commander of the French Legion.

Oxidation and Stabilization of Vitamin C (Ascorbic Acid)

K. V. GIRI

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IN 1928 Szent-Gyorgyi isolated from the cortex of the adrenal gland and later on also from plants, a crystalline substance which showed strong reducing property. In 1932, C. G. King isolated an identical substance from lemon juice and found that it cured animals from scurvy. Simultaneously Szent-Gyorgyi tested his substance for anti-scorbutic properties and found that it cured guinea-pigs from scurvy. To this substance the name ascorbic acid was given. This discovery was immediately followed by the elucidation of its constitution by the Birmingham school led by Haworth. It has since been a material of much absorbing interest to everyone engaged in the study of its role in plant and animal life. In spite of the conspicuous advance recently made in the investigation of the function of vitamin C in plant and animal metabolism, there still remains much obscurity regarding its role in respiratory activity, and its relationship to other biologically important substances and other catalytic systems in the living cell.

Among the vitamins, it is the most labile substance, and it is very easily oxidised in presence of catalysts like Cu . This remarkable property is attributed to the presence of the two hydroxyl groups attached to the doubly linked carbon atoms which are capable of easy oxidation and stepwise dissociation into hydrogen ions. Strictly speaking, ascorbic acid is not an acid but a lactone with strong acidic properties. It occurs in living tissues, always associated with other factors, which destroy the vitamin by catalytic oxidation. In tissues and biological fluids it is, however, present mostly in its reduced form. It is clear, therefore, that it is protected from such oxidative destruction by certain other factors present in the tissues. The object of this review is to outline the work on the various

factors relating to the oxidation of the vitamin, its protection against such oxidative destruction, and the mechanism of these reactions.

In order to give a proper setting for discussion the subject has been classified as follows:

I. OXIDATION OF VITAMIN C:

- (1) Autoxidation.
- (2) Catalytic oxidation by metals like Cu , etc.
- (3) Reversible and irreversible oxidation.
- (4) Photochemical oxidation and decomposition.
- (5) Inductive function of vitamin C.
- (6) Tissue oxidation of vitamin C:
 - A. In plants: (a) Ascorbic acid oxidase.
(b) Phenolases.
(c) Peroxidases.
 - B. In animals: Indophenol oxidase-cytochrome system.

II. REDUCTION OF DEHYDROASCORBIC ACID:

- (1) In animal tissues.
- (2) In plants.

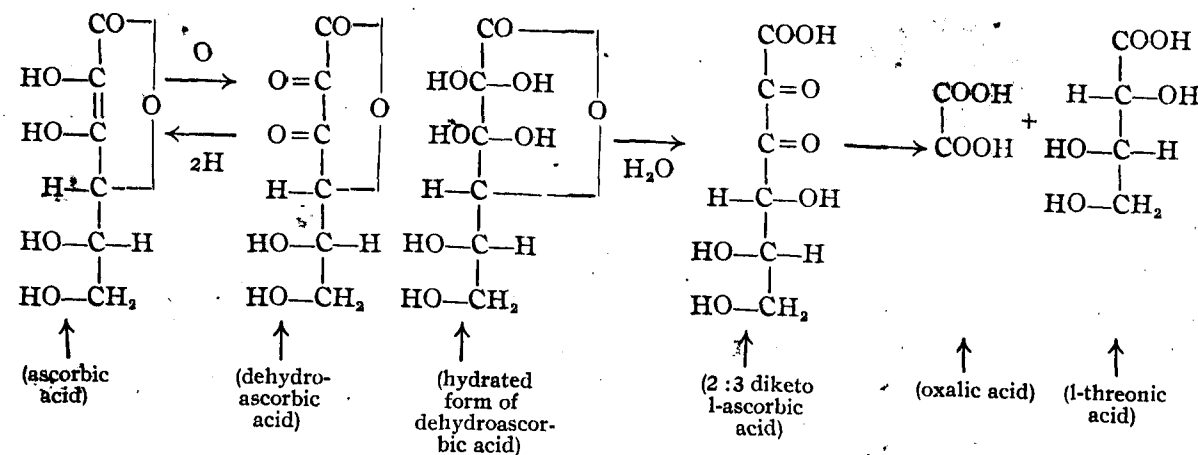
III. INHIBITION OF VITAMIN C OXIDATION:

- (1) In animal tissues.
- (2) In plants.
- (3) Influence of biologically important substances on the oxidation of vitamin C.

IV. RELATIONSHIP BETWEEN THE OXIDATION OF VITAMIN C AND OTHER CATALYTIC SYSTEMS IN THE LIVING CELL.

OXIDATION OF VITAMIN C

The oxidation of pure ascorbic acid in aqueous solution may be represented as follows:



The first stage of the decomposition of ascorbic acid into dehydroascorbic acid requires oxygen, while the decomposition of reversibly oxidised ascorbic acid does not require the presence of oxygen.

Autoxidation: Autoxidation is the reaction with molecular oxygen. The first oxidation product of ascorbic acid is dehydroascorbic acid and it is generally agreed that it may reversibly be reduced to the fully active vitamin. Whether ascorbic acid is capable of spontaneous autoxidation or not is the subject of controversy among workers on vitamin C oxidation. Kellie and Zilva (1935) found that ascorbic acid is quite stable in pure water distilled from quartz vessels. Barron *et al* (1936) showed that the vitamin is not autoxidisable at any pH below 7.6, whereas at pH 5.15 its oxidation is actively catalysed by minute amounts of copper. The vitamin is autoxidisable only in alkaline solutions, the rate of oxidation increasing considerably as the alkalinity increases from pH 8 to pH 10. Ghosh and Rakshit (1936), however, found that purified synthetic ascorbic acid, when dissolved in purest water, gave results which did not agree to the observations of Zilva and Barron and their co-workers. They found that autoxidation was estimated in Warburg apparatus, oxidation between 70–90 per cent took place in an hour within the pH range 5.8 and 7.2. They claim that ascorbic acid is capable of spontaneous autoxidation (Ghosh, 1938). Apart from the observations recorded by the above authors, a num-

ber of papers have appeared in which it is shown beyond doubt that the autoxidation of ascorbic acid is not true autoxidation but is catalysed by copper.

which is invariably present in minute quantities in the reaction mixture used for measuring the rate of oxidation of the vitamin.

Catalytic oxidation by metals: In 1928 Szent Gyorgyi first recorded the catalytic action of copper in the oxidation of ascorbic acid. He found that Fe^{+++} and Mn^{++} had no effect upon the rate of oxidation. Subsequently number of workers (Euler Myrback and Larsson, 1933; Kellie and Zilva, 1935; Barron *et al*, 1935–36; Bersin, Koster and Juszat, 1935) reported that minute amount of dissolved copper catalyzes atmospheric oxidation of vitamin C. The catalytic effect of copper was noticed with the addition of such a minute quantity of copper as 46 micrograms per litre (Barron *et al*, 1936). This extraordinary catalytic power of copper probably explains the oft-repeated reports about the autoxidizability of ascorbic acid. None of the metals—manganese, iron, nickel, cobalt and calcium act as catalyst for the oxidation of ascorbic acid. Copper is universally distributed in all plants and animal (Lindow, Elvehjem and Peterson, 1929) and the catalytic activity of this element in the oxidation of vitamin C may explain how the presence or absence of minute traces of it can bring about profound changes in plant and animal life.

The mechanism of the oxidation by copper has been explained as follows (Barron, *et al*, 1936). The ascorbic acid is oxidised to dehydroascorbic acid and the catalyst is simultaneously reduced

The reduced catalyst is in turn oxidised by atmospheric oxygen, thereby acting as oxidising catalyst. Hydrogen peroxide is formed during the reoxidation of the catalyst and it is decomposed into water and oxygen. Recently Dekker and Dickinson (1940) have studied the mechanism of oxidation of ascorbic acid with cupric ion as catalyst. In the initial stages the reaction mechanism is assumed to consist in the slow oxidation by cupric ion of the ascorbate ion to anion with a semiquinone-like structure, followed by the immediate oxidation by oxygen of this semiquinone-like ion into dehydroascorbic acid. The cupric ion is maintained constant through oxidation by oxygen of the cuprous ion formed. An observed increase in the specific reaction rate during the course of the reaction is attributed to the accumulation of H_2O_2 formed through the oxidation of cuprous ion by oxygen. The authors have observed a marked increase of the rate of the reaction on the addition of ferric ion.

Reversible and irreversible oxidation: The first oxidation product of ascorbic acid, namely dehydroascorbic acid can be reduced by H_2S and reconverted into the original reduced product, i.e., ascorbic acid. This reversible oxidation of the vitamin can be brought about by H_2O_2 , 2:6-dichlorophenol indophenol, by oxygen in acid solution in the presence of ions of heavy metals or charcoal (Fox and Levy, 1936), and also within the physiological pH-range up to pH 7.6 (Kellie and Zilva, 1935) by iodine and bromine if a large excess is avoided. The degree of reversibility, however, depends on the hydrogen-ion concentration and is independent of the nature of the oxidising agent (Barron *et al*, 1936). Up to pH 5.0 the oxidised form can be completely reduced by H_2S and above this pH the degree of reversibility gradually decreases until pH 7.6 only 4 per cent of the oxidised form can be recovered as ascorbic acid.

The temperature coefficient for the oxidation of ascorbic acid by oxygen with copper as catalyst is found to be 1.65 (Barron *et al*, 1936).

Photochemical oxidation of vitamin C: The photochemical oxidation of vitamin C has been the subject of fewer investigations than the catalytic oxidation but presents some features of great interest. The oxidation of ascorbic acid is catalysed by visible light in the presence but not in the absence of certain sensitizers. Lactoflavin is found to act as sensitizer in the oxidation of ascorbic acid when exposed to solar radiation (Hopkins, 1937, 1938). Thus one

vitamin acts as a catalyst in the oxidation of another. Reduced glutathione inhibits the oxidation. Vitamin C and flavin are present together in milk, and, therefore, the vitamin C in milk is easily oxidised by the flavin when it is exposed to sunlight (Hand *et al*, 1938).

The photochemical oxidation of the vitamin can be brought about in the absence of sensitizers, by ultra-violet light. Even oxygen is not necessary for this reaction (Kellie and Zilva, 1938; Arcus and Zilva, 1940). Lactoflavin has no action on this photochemical oxidation in the absence of oxygen. It is assumed that ascorbic acid is decomposed into substances which dehydrogenate the undecomposed ascorbic acid. Glutathione is found to protect the photochemical decomposition of the vitamin, and this action is attributed to its absorption capacity for the active radiation.

Inductive function of ascorbic acid: As ascorbic acid is very easily oxidised, it can induce the oxidation of other substances when present together. An interesting case of such coupled oxidation is that of the oxidation of ascorbic acid and haematin (Lemberger, *et al*, 1938). It is found that when ascorbic acid and haemochromogens are present together a very rapid oxidation of both compounds simultaneously occurs with uptake of oxygen. The haemochromogen catalyses the usual oxidation of ascorbic acid and undergoes at the same time a coupled oxidation to a bile pigment haemochromogen. The porphyrin ring is opened to give a bile pigment. This reaction probably plays an important part in bile-pigment formation.

The oxygen uptake of unsaturated fatty acids is increased by ascorbic acid, and an induced oxidation of sugar is brought about by the vitamin (Holtz, 1936).

Tissue oxidation of vitamin C, in plants: In addition to Cū plants contain other catalytic systems which oxidise vitamin C. Ascorbic acid is oxidised by means of at least three different catalytic systems.

(a) **Ascorbic acid oxidase:** It is an enzyme present in *cucurbita maxima*, cabbage, cauliflower and in many other vegetables. It is a specific oxidase which oxidises only ascorbic acid without any action on phenols.

(b) **Phenolases:** These enzymes oxidise mono and polyhydric phenols to their corresponding quinones

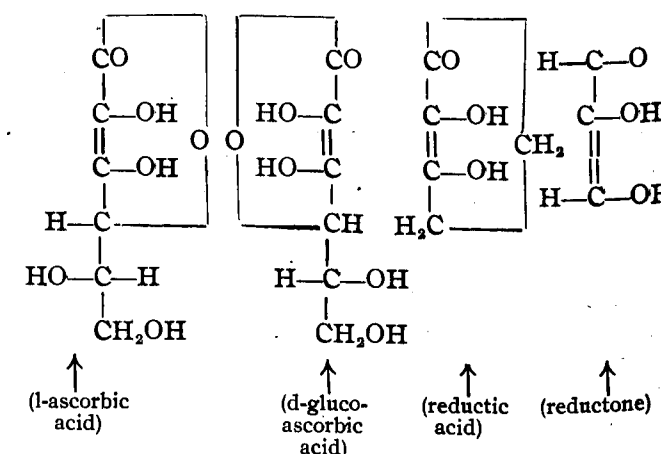
which in their turn oxidise the ascorbic acid (Johnson and Zilva, 1937). These are present in the apple and potato. The capacity of oxidising the vitamin is brought about by the addition of catechol to the juice. In a like manner, the highly purified mushroom oxidase oxidises the vitamin very rapidly, provided a trace of catechol is added (Keilin and Mann, 1938). In all these cases the catechol is alternately oxidised by the oxidase and oxygen and reduced by the ascorbic acid, thus acting catalytically. Another enzyme, laccase (crude and partly purified) from the latex of *Rhus succedanea*, is found to catalyse the oxidation of ascorbic acid without the addition of a carrier such as catechol (Keilin and Mann, 1939). The pure laccase, however, oxidises ascorbic acid only after the addition of a trace of *p*-phenylenediamine; catechol being inactive. Polyphenol oxidase, on the other hand, whether crude or pure, oxidises ascorbic acid only through a carrier like catechol.

(c) *Peroxidases*: These enzymes oxidise ascorbic acid in the presence of quinone-forming combinations. Purified preparation is without action on ascorbic acid. But in presence of substances (*i.e.*, vanillin) which form quinones with peroxidase, the vitamin is oxidised (Szent-Gyorgyi, 1928). A typical example of the interaction of ascorbic acid and peroxidase is given by Tauber (1936). In this case vanillin- H_2O_2 and peroxidase oxidise the vitamin.

Unlike peroxidases and phenolases, ascorbic acid oxidase does not require peroxide or any other compound for its activity. The existence of such an enzyme in cabbage was first demonstrated by Szent-Gyorgyi in 1930 (Szent-Gyorgyi, 1930 and 1931). Subsequently a number of workers have isolated and studied the properties of the enzyme obtained from various sources (Zilva, 1934, Bromley's seedling apples; Tauber, Kleiner and Mishkind, 1935, *Cucurbita maxima*; Sreenivasan, 1936, Drumstick; Chakraborty and Guha, 1937; Krishnamurthy and Giri, 1941 *b*).

The enzyme oxidises ascorbic acid into dehydro-ascorbic acid, which may be reduced by H_2S to the original vitamin. Snow and Zilva (1938) have shown that the action of the ascorbic acid oxidase (from

dialysed cucumber juice) is not confined to l-ascorbic acid alone, but also to d-glucoascorbic acid, and cyclic dienols with an oxygen bridge. The oxidation of a cyclic dienol without an oxygen bridge, reductic acid and an acyclic dienol, reductone, both of which are capable of reducing indophenol, are catalysed by the enzyme.



The behaviour of the enzyme accords with the definition of an oxidase. It is fully cyanide sensitive and it has a high affinity for its substrate.

In recent years the question as to whether Cu is an essential part of the enzyme has been the subject of intense study. Some workers (Stotz *et al*, 1937; Lovett-Jamison and Nelson, 1940, Ramasarma *et al*, 1940) have obtained evidence to show that the enzyme is a copper-protein compound, while others (Spruyt and Vogelsang, 1938) believe that the enzymic oxidation is not to be ascribed to the presence of Cu. The presence of other agencies or an activation of copper in the organic complex has been suggested as being responsible for the activity (Banga and Szent-Gyorgi, 1938).

Tissue oxidation of vitamin C, in animals: Animal tissues do not contain a "specific oxidase" for vitamin C. The vitamin is, however, slowly oxidised by liver brei, and the agent responsible for this oxidation has been found to be the indophenol oxidase-cytochrome system (Stotz *et al*, 1938).

(To be continued)

Agricultural Research in India*

THE present report under review of the Imperial Council of Agricultural Research† (see footnote for a brief description of its constitution) is the eleventh one "presented by the Governing Body under the Rules and Regulations of the Council". It is a

* Being a review of the Annual Report of the Imperial Council of Agricultural Research, 1940-41. Government of India Press, New Delhi. The report is divided into seven chapters and contains ten appendices. Three of the latter deal with the annual accounts, statement of expenditure, and financial position and allocation of funds; three others with the personnel of the administration, of standing and *ad hoc* committees, and of scientific and commodity committees.

† The policy and executive means of the Imperial Council of Agricultural Research are decided finally by the Governing Body of the Council which has the following constitution. Member of the Viceroy's Executive Council in charge of Education, Health and Lands is the Chairman. The Vice-Chairman who directly deals with the working of the Council is at present a senior member of the Indian Civil Service. The other members are: the Commerce Member of the Executive Council, two representatives of the Imperial Secretariat, the Ministers of Agriculture of provinces (at present advisers to the Governors in some cases) and representatives of some of those States which contribute to the expenses on research schemes of the Council, one member of the Council of State, two members of the Central Legislative Assembly, two representatives of the commercial community, two representatives of the Advisory Board and a member of the Indian Civil Service as the Secretary to the Council.

The executive body of the Council consists of the Vice-Chairman, the Secretary and the Agricultural and the Animal Husbandry Commissioners with the Government of India. There is an advisory body which consists of the following in addition to the Secretariat: Agricultural Marketing Adviser, heads of the Agriculture and Veterinary Departments of the provinces and States, representatives of the Inter-University Board, Tea Planters, Indian Central Cotton Committee and a nominee representing the Co-operative movement, director of Scientific and Industrial Research and Economic Adviser to the Government of India and a few private individuals. All research schemes are recommended by the Board for consideration by the Governing Body. Besides the above bodies, the Council is assisted at present in its work by the Sugar and the Editorial Standing Committees appointed by the Governing Body. The advisory body is empowered to appoint *ad hoc* committees and during the year under report there were ten scientific committees on different aspects of agricultural research and fifteen commodity committees. Recently a central agricultural and livestock economic committee has been appointed to examine the various schemes submitted to the Governing Body with due regard to claims of the different sciences and commodities in the light of prevailing or probable economic conditions in India and to prepare for the consideration of the Governing Body a statement of the order of priority and preference for these proposals. In a committee of eight, two representatives of the Chambers of Commerce and two nominees of the Chairman of the Council representing agriculture and animal husbandry assist the 'official' experts.

convincing witness to the great progress in agricultural research, using this expression in its broadest sense, which has resulted from the initiative taken by the Council. In fact the administration of the activities of the Council must now have developed its own distinctive characteristics and demand strenuous exertions of the Vice-Chairman and the technical and administrative staff.

Experience suggests new adjustments and during the year under report "the Governing Body decided to dissolve all standing committees except the Sugar and Editorial committees and empowered the Advisory Board to set up instead such committees as it thought necessary provided that the membership of any such committee did not exceed 10 or in special cases 12, apart from the head quarters staff of the Council". Accordingly, ten scientific and fifteen commodity committees were set up. Their titles indicate the main channels along which the deliberations of the Council and research encouraged by it are guided. They are detailed below:

Scientific Committees—(1) Soil Science, (2) Plant Mycology, (3) Plant Entomology, (4) Plant Breeding (Botanical), (5) Plant Physiology, (6) Plant Management (Agronomy), (7) Developmental Research, (8) Animal Breeding, (9) Animal Diseases and Pests, (10) Animal Nutrition.

Commodity Committees—(1) Rice, (2) Wheat and Barley, (3) Pulses and Millets, (4) Oil-seeds, (5) Tobacco, (6) Fruit and Fruit Products, (7) Vegetables (including potatoes), (8) Miscellaneous (including fibres, drugs and spices), (9) Fodder and Grazing, (10) Milk and Milk Products, (11) Wool, (12) Poultry and Eggs, (13) Livestock, (14) Fish, (15) Hides and Skins.

NEGLECT OF SOIL SCIENCE

It appears that a disproportionately greater stress is being laid on the plant as compared to soil and other factors. This contrast does not constitute an isolated instance and the reason is perhaps to be

sought in the fact that the training of the majority of the men now constituting the personnel of agricultural departments has been more specialised on the plant side (excluding forestry) than on the soil and other aspects of agricultural research.

Erosion does not seem to receive separate recognition. Agronomy has been bracketed with plant management and it seems that soil has not much of a place in schemes of plant management or rather agronomy whereas the latter undoubtedly rests on properly co-ordinated systems of soil and crop management. The caption of plant management is perhaps too broad as agricultural research deals more with crops than with plants in general. It seems some subjects have been split up more than others.

ANALYSIS OF EXPENDITURES

From appendix 7 it appears that the actual expenditure up to 1940-41 was Rs. 1,33,77,832 in round figures. Of this amount Rs. 31,73,687 have been spent on completed schemes. The balance of Rs. 1,02,04,145 relates to expenditure on schemes in progress up to 1940-41 and was spent under the following broad heads: (1) agricultural projects, Rs. 45,28,000, (2) animal husbandry, Rs. 13,30,000, (3) combined agriculture and animal husbandry schemes (it includes statistical section of animal husbandry), Rs. 2,19,000, (4) statistics, Rs. 2,20,000, (5) contributions to international and Imperial Agricultural Institutions, Rs. 3,10,000, (6) library and publications, Rs. 96,000, (7) accounts, audit and travelling allowance of non-official members and visitors and miscellaneous, Rs. 2,53,000, (8) sugar schemes, Rs. 22,86,000.

The distributions over sub-heads are:

I. *Agricultural Schemes*: (a) Rice research, Rs. 9,54,000, (b) wheat and barley, Rs. 3,04,000, (c) millet and pulses, Rs. 13,000, (d) oil-seeds, Rs. 2,47,000, (e) tobacco, Rs. 1,13,000, (f) fruits, Rs. 7,48,000, (g) vegetable, Rs. 1,12,000, (h) fibres, Rs. 10,000, (i) other crops (medicinal plants), Rs. 79,000, (j) dry farming, Rs. 5,93,000, (k) plant physiology, Rs. 72,000, (l) locust research, Rs. 7,11,000, (m) virus diseases, Rs. 43,000, (n) sub-station at Pusa, Rs. 2,52,000, (o) soil studies, Rs. 2,43,000.

II. *Animal Husbandry*: (a) Cattle breeding, Rs. 5,500; (b) goat and sheep breeding, Rs. 1,35,000; (c) animal nutrition, Rs. 2,33,000; (d) animal pest and diseases and cure, Rs. 8,25,000; (e) dairying, Rs. 7,900; (f) poultry, Rs. 51,000; (g) fish, Rs. 11,000; (h) wool, Rs. 3,200; (i) hides and skin, nil; (j) animal husbandry bureau, Rs. 55,000.

III. *Sugar Schemes*: (a) Breeding and agronomy, Rs. 16,92,000; (b) pests and diseases, Rs. 3,93,000; (c) technology, Rs. 1,51,000; (d) miscellaneous, Rs. 48,000; (e) marketing, Rs. 11,35,000; (f) cold storage, Rs. 42,000.

Perhaps the distribution of the expenditure does not always reflect the relative importance of different subjects in the economics of Indian agriculture. Evidently the manner in which the schemes at present come up before the Advisory Board has something to do with the present position. The distribution reflects more the initiative of individuals or groups of industrialists, administrators (either in the agricultural departments or outside them) or scientists and their interest in particular subjects. While such initiative in progressive matters should secure encouragement there are matters of general policy which should be based on a planned scheme of agricultural research suitable to our needs. Such a scheme and policy could perhaps be formulated. They would be of immense value in guiding the Council's activities along more rational channels.

EMERGENCE OF A BODY OF SCIENTIFIC WORKERS

The report itself shows one thing very clearly, namely, that a body of scientific workers has come into existence who are dealing with various aspects of agricultural research. It is certainly one of the main achievements of the Council which has not only provided a machinery for encouraging agricultural research but also created an atmosphere of agricultural research and a body of workers devoted to it.

NECESSITY FOR PERIODIC REVIEW OF RESEARCHES

It is however unfortunate that the scientific information in the report is a collection of the summaries of the results obtained under different schemes as written by the workers themselves. While it has a value as a compilation it is not a report of the type which will be helpful either to those who want to

have readable accounts of the actual contributions to basic knowledge or to agricultural improvements made through the work under the schemes. To those who want information about what has been or is being done under a scheme the progress reports supply ample material and a collection of summaries given in the progress reports could easily be compiled and published separately to serve this purpose. What is required is not the details of what has been done during the year often without reference to what has gone before and still oftener dealing with investigation at different stages of completion but a readable account of definite contributions in relation to existing knowledge. Such account in the form at least of periodic reviews will be very much appreciated. People would certainly be interested to know what has come out of the different schemes and neither summaries of unfinished research nor a bare account of the author's own work can meet this purpose. It is definitely necessary to point out the main contribution made and its relation to existing practice or scientific knowledge.

The structure has been laid down and it is humming with the activities of trained men, but as mentioned earlier sooner or later the question of guiding these activities in terms of a comprehensive and planned programme and of a co-ordinated policy will have to be faced by the Council. With the experience it has gathered and the talent at its disposal and if need be with help from outside its own circle it would not be difficult for the Council to undertake the task and evolve a planned programme of research in which the fundamental requirements of Indian agriculture are reconciled.

CO-ORDINATION OF ACTIVITIES OF SCIENTIFIC AND COMMODITY COMMITTEES

A comparatively simpler matter of policy which perhaps the Council will have to take up without much delay is the question of co-ordination of the activities of the scientific committees and of the commodity committees within each of these two groups and between them so that definite conclusions can be reached as to the major lines of research which require to be encouraged. Problems of agricultural research are of a complex nature and cover a number of interrelated factors. For practical reasons these have often to be tackled in isolation or in groups but too rigid a classification into groups ignores the

broader and sometimes the fundamental aspects and leads to the piecemeal treatment of problems. A clearing house to serve the purpose of co-ordination is definitely needed. It should have sanction for its activities and assurance that its conclusions will have a normal chance of translation into action.

Among individual items of interest contained in the report mention has been made below of a number of them chosen at random. Some of these illustrate the contributions made during the year towards the progress of agricultural research through the activities of the Council. It is believed that these matters of general policy are engaging the attention of the Council.

SOME RESEARCH ITEMS

Two monographs have been published dealing with cereal rusts.

A co-ordinated programme of research on pulses has been prepared based on the information furnished by provinces and States.

"Cinchona cultivation.—The Council felt that in view of the large cost involved, it would not be possible to undertake research work on cinchona without special financial help from Government. A reference was accordingly made to the Government of India on the subject."

"As the Government of Bengal had a scheme of work on cinchona under contemplation, it was considered that the scheme originally put up would need revision in the light of the Bengal scheme. The matter is under consideration."

"All-India soil survey.—The Council approved a two years' scheme for carrying out work preliminary to a soil survey, i.e., to ascertain what data exist at present in regard to soils and to collect and collate the same and to find out where there are gaps and determine what steps should be taken to fill them up. The aims and advantages of a soil survey are set forth below and may be of interest."

"The crop plant lives in two environments, the air and the soil. The soil anchors the plant and provides it with water and important elements of plant food. Practical experience from the beginning of time has shown that soils differ markedly in the

way they will grow crops. It is only, however, since the soil came to be studied for itself that any light has been thrown on the causes of these differences. Such fundamental study of the soil has shown it to be an amazingly complex thing, and some of the most recent and most recondite parts of soil science have explained crop failures and have been the basis of land reclamation."

"The identifying and mapping of soils in the field according to some kind of system has been the aim of soil scientists in all countries. In India also this has been done in many provinces and the States have done a great deal of such work. Such surveys have dealt with limited areas and have generally had a limited objective, such as, for example, to determine whether a soil in a new area is fit for irrigation, or the recent survey of soils on which cinchona grows to determine the relationship between soil composition and the success or failure of cinchona."

"An All-India survey would be above both limitations of area and of objective. With so much scattered work done all over India it seems highly desirable to fill in the gaps and get a complete soil map just as one has a complete geological map, and it is both science and common sense to require that such a survey should be done in a uniform and fundamental manner. A survey based on the principles of soil classification recently developed in Russia (the so-called genetic system) which considers the soil as a whole and also takes account of the processes which have formed it, appears the best and most comprehensive for this purpose, and hence has been recommended by the Special Sub-Committee dealing with this subject, and also by the Advisory Board. Given a basic body of knowledge like this, the responses of each class of soil to management and of crops to each class of soil can be investigated (in many cases forecasted) and results made comparable throughout India".

"The Soil Survey Division of the Department of Agriculture in America has for some years been engaged in the mapping of the soils of that country. These maps are accompanied by accurate descriptions from field notes and many laboratory analyses. Recently tables showing how these soils are regarded from the point of view of productivity have been worked out. These soil maps are, in America, regarded as essential to every agency interested in land use, and can be used to give the individual farmer

sound information to supplement his own experience in planning farm management practices."

THE VICEROY'S CATTLE IMPROVEMENT DRIVE

From the information received from provinces, it appears that on 31 March 1940, 2,904 bulls were maintained out of donations (in cash or kind) received in response to His Excellency's appeal, and there was an unspent balance of Rs. 1'38 lakhs out of the cash donations available for the purchase or maintenance of stud bulls. Thus, as compared with the previous year, there was an increase of 100 in the number of bulls maintained and of Rs. 6,000 in the total money available."

"The number of approved bulls which were constantly in service in the provinces in 1935-36 was approximately 10,000. As a result of His Excellency's appeal an increase of about 29 per cent had resulted by the end of 1939-40."

"The provincial Governments have also shown keen interest in the matter of livestock improvement. Livestock improvement associations have been formed in almost all provinces. A livestock improvement board has been constituted by the Madras Government who are also contemplating enacting a livestock improvement bill. A similar Act already exists in Bombay and the Bengal Government are contemplating legislation for increased provision of stud bulls and veterinary hospitals in Bengal."

"Sheep breeding (Bombay) * * * A study of wild pasture legumes was made and it was found that their nutritional value on a dry basis was higher than that of lucerne. An analysis of the useful bushes showed that they were very valuable in making up part of the mineral deficiency of the grasses."

"Veterinary Investigation Officer, Bengal.—* * * The study of susceptibility of buffaloes to rinderpes revealed that mortality in buffaloes in Bengal was almost double that of cattle of the plains."

"Veterinary Investigation Officer, Hyderabad * * * Further investigation of osteomalacia showed deficiency of phosphorus in fodder as well as in soil."

"John's disease, Mysore—An epizootological survey was undertaken to assess the incidence of

John's disease in the cities of Bangalore and Mysore." * * *

"Control of ticks.—* * * Cultivators showed great interest and enthusiasm at the time of starting the operations but they created trouble and ceased to take further interest in the operations when their animals showed ill effects of arsenic bath. Strangely enough, this attitude was more marked in villages where spraying operations were undertaken on a no-cost basis so far as the villagers were concerned than in those where cattle dipping tanks were constructed partly or wholly at their cost. Dipping system of controlling ticks was more popular and easy of operation than the spraying one. Where dipping operations were carried out cultivators maintained a sustained interest in the operations even in spite of ill effects produced. They agreed to dipping operations of such of their cattle as were found infested with ticks but required a lot of persuasion to have those cattle which were not apparently infested with ticks dipped. The experience gained was indicative of the possibility of controlling tick infestation in a village by dipping the majority of cattle including those infested with ticks. Substantial evidence has been collected to show that cattle dipped regularly put on

greater body-weight and grew more than undipped cattle. It has also been observed that dipped animals were less liable to harbour ticks than undipped ones and that stunted growth resulted in undipped animals due to tick infestation."

"Inquiry into the indigenous system of veterinary medicines.—The enquiry was completed and the report of the same published."

"Mixed farming.—The Board had recommended a model scheme for mixed farming research. Four such schemes (one each in the United Provinces, Central Provinces and Berar, North-West Frontier Province and Sind) have been sanctioned. The main idea behind these schemes is to introduce the keeping of milk or other animals on certain holdings with the object of feeding the animals from the holding, increasing the fertility of the land from the farm yard manure obtained, and enriching the cultivator by the sale of the milk and milk products and other animal products or young stock. Holdings on which this will be done will be compared in all respects with similar holding not so treated."

J. N. Mukherjee

Notes and News

OBITUARY

SIR FRANCIS EDWARD YOUNGHUSBAND

DEATH has occurred to Sir Francis Edward Younghusband, the famous soldier explorer of Tibet, at the ripe old age of seventy-five following a short illness. Sir Francis had a chequered and fruitful career and lived a life which is almost novel reading. Born at Murree in May, 1863 he was educated at Clifton and Sandhurst. His father J. W. Young-husband was a Major-General and accordingly Young-husband, Jr. had to choose a military career for himself. In 1882 he joined the first Dragoons and served in India. But military routine never suited Sir Francis who showed greater interest in exploration and political work. Earlier in his career he undertook a series of perilous explorations in the then unknown territories of Manchuria and Turkestan and was the first European to cross the famous Mustagh Pass (19,000 ft.) while trekking to India from Peking through the Gobi Desert and Chinese Turkestan. When in the nineties of the last century Tzarist Russia were evincing signs of suspicious design on the Afghan and Chinese territories, Younghusband was despatched to the Pamirs to examine the situation and found that a Russian force had already set to annex the unsettled region between China and Afganistan stretching right up to the very frontiers of India. He quickly reported the matter to the head quarters with full emphasis on the gravity of the situation. This led the then premier Lord Salisbury to take such a strong attitude that Russia had to abandon her designs.

He had a distinguished career as a political diplomat. It was through his efforts that the well-known expedition to the forbidden and then unknown city of Lhasa, the capital of Tibet, was successfully led and the friendship of the hostile Lamas for Britain secured. Sir Francis was one of those few men whose activities were not confined within the bounds of official work. He was for some time president of the Geographical Society and

formed the Mount Everest Committee which organised the first Everest Expedition. He took a deep interest in comparative religions and was a great admirer of Indian philosophy and religion, culture and civilisation. He presided over the Congress of Faiths in Paris in 1939. His last visit to India was in 1936-37 on the occasion of the Sri Ramakrishna Centenary celebrations when the first session of the Parliament of Religions was held in Calcutta. The Sanskrit College in Calcutta accorded him the title of 'Karma' Keshori, an honour which he valued most in his life. He always cherished a friendly attitude towards India and viewed Indian cause with sympathy as is amply evidenced by his remarkable letter published in *The Times* in October 15, 1941, wherein he wrote:

"We have blundered badly in India. While we have expressed our intention to free every other country, we have made special reservations about liberating India. And this has caused the deepest resentment among Moslems and Hindus alike. Why do we hesitate? Because we fear that if we relax our hold, India will fall to pieces. But why have such fear? Indians are no fools. They have as much political and military sense as the Chinese, the Japanese and the Russians. And they are an exceedingly proud and sensitive people. . . . To myself personally, who is born in India and have for the last 59 years been closely connected with Indians, it comes as a bitter reproach that we should treat Indians as anything else than the most loyal comrades and affectionate friends"

SURVEY OF INDUSTRIAL RESEARCH IN AMERICA

THE Government of the United States of America have recently published a report of a special committee of the National Resources Planning Board dealing with physical, chemical and biological research in the laboratories of the American industrial organisations. The report is a most valuable survey of the position which industrial

research occupies in the United States and covers 369 pages of large quarts size of fully illustrated matter.

The body of the report consists of a series of monographs prepared by specialists in their respective spheres, preceded by a summary of findings and recommendations of the committee.

It has been brought out that a total of over 70,000 research workers are at present engaged in industrial research in 2350 laboratories with an estimated annual expenditure of about \$300,000,000 which works out at \$4000 per worker per annum. Taking a group of representative manufacturers it was found that an average of 2 per cent. of gross income is spent on research. This figure, however, comes down to '6 of one per cent if considered in terms of gross income of all manufactures. The committee emphasize this fact as indicating the scope for expansion of research activities in concerns where the value of investigations has not yet been fully realised. It is recommended that the leaders of such industries should put themselves in touch with the National Research Council for advice with regard to the possibilities of organizing systematic research in their concerns. For their part the Government are advised not to tolerate any tendency to capitalize research expenditure for taxation purposes as it may prove dangerous to the future of industrial research. The committee suggest that the Government should take steps for wider circulation of scientific literature, support further researches on standards and provide facilities for joint deliberation between scientific men and technical workers.

The monographs are divided into seven sections:—

Section I is on introduction describing 'The scope of Research in relation to Industry' and mentions the main points brought to light by the studies which follow.

Section II under the main title "Research in the National Economy" contains eight articles with titles:—'Development of Industrial Research in the United States', 'Research on source to small Companies', 'Co-ordination between Industries in Industrial Research', 'Technical Research Trade Associations', 'Fundamental Research in Industry', 'Careers in Research', 'Research as a growth factor in Industry', 'Industrial Research expenditures'.

Section III gives 'Examples of Research in Industry' and under three sub-heads describes:—'Aeronautics', 'Petroleum', and 'Iron and Steel'.

Section IV under the title 'Location and extent of Industrial Research activity in the United States'

describes the development of research activities in relation to industries, personnel and finances.

Section V in 'Research Abroad' gives descriptions of industrial research and laboratories supported by Government and private firms in foreign countries.

Section VI under the title 'Men in Research' covers a number of sub-sections viz., 'Chemistry in Industrial Research', 'Physical Research in Industry', 'The Role of the biologist in Industry', 'Industrial Mathematics', 'Metallurgical Research', 'The Chemical Engineer in Industrial Research', 'Industrial Research in the field of Electrical Engineering', 'Industrial Research and Mechanical Engineers', 'The significance of Industrial Research in border line fields'.

Section VII is devoted to a historical development of the Normal Research Council in regard to the Industrial Research activities.

As will be observed from the titles of the sections and sub-sections given above the report covers in a comprehensive and authoritative manner a very vast field. The urgency of a systematic reorganisation of the apparatus for industrial research is fully realised and therefore all fundamental aspects of the quarter have been critically considered by the best available scientific authorities. The Report must have a special significance for us in this country where public interest has only just begun to be roused to an understanding of the importance of research for industrial regeneration. A report like this, carrying the weight of the highest scientific authority, should serve as an excellent guide pointing the way to the method to be adopted for an understanding of our own problems. If the problem is clearly understood a solution will be found.

It is to be hoped that the Report will receive a wide publicity in this country as it is bound to be of immense educative value and would greatly help any future organisation for a survey of the character.

THE SECOND LARGEST METEORITE CRATER IN U. S. A.

THE excavation work of the second largest meteorite crater in the United States and two other smaller ones some nine miles south west of Odessa, Texas, believed to have been formed about 40,000 years ago, has recently been started under the direction of Dr E. H. Sellards, director of the University of Texas's Bureau of Economic Geology. The excavation re-

sults, yet incomplete, have caused a sensation among geologists and tourists who are mustering strong in ever increasing numbers in the prairies of the western part of the States. The giant crater has been discovered a few years ago and has been receiving systematic study and exploration since 1939, the initiative being taken by the University of Texas all through. The smaller craters are, however, recent discoveries (last autumn) which have renewed the interest in the matter and intensified excavating activities. The main crater is about 500 feet in diameter and 50 ft. deep, but the principal mass of the meteorite, according to Dr Sellards, is estimated to be at a depth of about 170 ft. below the original ground surface. The newly discovered craters are similar in formation, of which one is about 70 feet in diameter and 17 feet deep, the other being slightly smaller. Dr Sellards has estimated that the bigger of the two new craters contains about six to seven thousand meteorites. Most probably these meteorites originally formed a closely packed swarm instead of the other alternative of a large meteorite being crushed to fragments on impact with the ground.

The survey of the main crater and its surrounding region clearly indicates that the meteorite crashed to the ground with a terrific speed and produced concussions resembling that caused by modern high explosives. As a matter of fact, rocks from even 70 feet below the surface were thrown out as a result of the impact. Also the rock strata forming the crater walls suffered dislocation and were peculiarly folded which all unmistakably pointed to the violence of the impact. The great age of the meteorite has been proved by the fact that teeth and bones of an ancient type of American horse has been discovered in the crater. This type of American horse, however, is known to have become extinct long before the introduction of Spanish horse into America.

IRRIGATION RESEARCH COMMITTEE'S MEETING

THE annual meeting of the Research Committee of the Central Board of Irrigation recently took place at Simla. Various problems of river behaviour, its training and control, prevention of silt accumulation in rivers and canals and soil mechanics were important subjects for discussion among other things. In a new discussion on the subject of 'River Behaviour, Training and Control' stress was laid on the importance of a thorough knowledge of river meanders, without which many problems of river control cannot be effectively tackled. Fixing the river course at one place has effect on the position of the river both up stream and down stream. This has occurred in the case of the Jumna near Delhi which is now held up

stream of the Railway bridge by the construction of stone bathing ghats with the consequence that the river left the right bank where the New Delhi pumping station is situated. The question of bringing the river back to the original position is now being investigated at the Central Irrigation and Hydrodynamic Research Station, Poona. "Sampling of sand carried in suspension and along the bed by rivers and canals" constituted another important subject for discussion. The silting of reservoirs within a few years of their construction is an acute problem in some parts of the country for which some new methods of sampling suspended silt and bed sand were proposed. But perhaps the most important discussion was about 'Soil Mechanics' which threw new light on the problem of canal embankments. So long works in connection with canal embankments were based on classical formulas for earth pressure and angle of repose. But recent researches, mostly carried out in the River Physics laboratories in America, have indicated better and more efficient methods. The traditional method of the rule of thumb followed in the compaction of earth in canal embankment must now be given up in favour of scientific laboratory tests to determine the best moisture content for the degree of compaction. Research has further indicated that slips in embankments, primarily caused by rainfall, are not due to an increase in weight of the soil above, but to a reduction in internal cohesion of the wet surface owing to negative capillary pressure.

Besides these papers contributed on various subjects the reports of the five research stations in India were presented. In the Central Irrigation and Hydrodynamic Research Station, Poona, various new designs have recently been perfected and put into operation with success. Mention may be made of the construction of the new Approach Channel above the Sukkur Barrage for the exclusion of sand from the Right Bank canals. The work, completed in 1941, produced the desired results during last year's flood and has removed the menace which threatened the future of the Right Bank canals in 1938. The siphon spillway for the Jamshedpore water supply reservoir is another important design made at this station, which proposes to discharge high floods while maintaining the high water level in reservoir with an efficiency not attainable with only an open waste weir. In the research stations of Sind and the United Provinces a number of model experiments have been performed in connection with canal regulators and distributory heads to study how best the entry of silt into channels can be controlled. The Land Reclamation section of the Punjab Irrigation Research Institute has concentrated greater activities to reclaiming more lands for growing more food. In the Deccan yet larger volumes of water than the storage reservoirs could supply are

required to feed the canals. Tapping of the Nira and the Godavari is limited by the high percentage of salt in their waters unsuitable for irrigation purposes. The Poona Irrigation and Research Division has investigated some possibilities of feeding the canals with river water.

We note with satisfaction various research works and attempts at the solution of important river and hydrodynamic problems carried on in the different irrigation research institutes of India which came up for discussion at the annual meeting of the Research Committee of the Central Board of Irrigation. While irrigation and hydrodynamic problems of different parts of India received consideration at the meeting no reference was made to the river and irrigation problems of Bengal. Are we to understand that this was because Bengal had no river problems of her own? Even the official experts have admitted the gravity of the river and irrigation problems of this province, as it appears in crystalline clarity from a series of articles by Mr. S. C. Majumdar, Irrigation Engineer, Government of Bengal, published in our paper a few years ago. As early as 1930 the Irrigation Department Committee, Bengal, declared, "It may be the case that deterioration has already proceeded so far that it cannot now be checked, that the tract in question (Central Bengal) is doomed to revert gradually to swamp and jungle." It is indeed something unusual and inexplicable to miss the slightest reference to the irrigation problems of Bengal which are assuming gigantic proportions as years roll on at the annual meeting of the Central Board of Irrigation.

NATIONAL ASTROPHYSICAL OBSERVATORY OF MEXICO

WHEN Europe reports the ruthless bombing and destruction of Research Institute like the Pulkovo Observatory which did useful service for centuries towards extending the bounds of human knowledge, news reaches us from America of the dedication of the National Astrophysical Observatory of Mexico. "The purpose of the Mexican Government is to contribute to the maintenance, in the American continent, of the progress of science and culture, and thus counteract as much as possible the paralysis of scientific and cultural activities in the countries devastated by the war" said President Manuel Avila Camacho of Mexico in his invitation to the scientists on the occasion of the dedication of Mexico's new national observatory. At other times perhaps such a remark would have been easily dismissed as empty conventional phraseology, but in the light of the present international situation it has naturally breathed significance and sincerity of pur-

pose of no mean order which we may do well to take note of.

The National Astrophysical Observatory is however situated near a small town of Aztec origin called Tonanzintla wherefrom one can command the view of the famous peaks of Popocatepetl and Ixtaccihualt looming on the horizon. The land was provided by the Government of the state of Puebla. It lies about 80 miles east of the city of Mexico. Situated in the latitude of $+19^{\circ}$ the observatory has all the advantage of studying effectively the southern sky inaccessible to observatories situated further north. Among the important modern observatories the new observatory of Mexico alone commands a view of the entire Milky Way. The observatory is equipped with modern instruments of which the major instrument is the 27-31 inch Schmidt telescope constructed in the United States of America, which is similar to the Jewett telescope of the Harvard Observatory. The optical parts of the telescope were made by the Perkin Elmer Corporation of Glenbrook, Conn. The telescope mounting was designed in the shops of Harvard College observatory. This is by far the most powerful telescope in the tropics and will soon be a great aid in the study of variable stars, meteors and the sun which Dr Luis Enrique Erro, the director of the observatory, has proposed to undertake as its future programme.

On the occasion of the dedication of this new national observatory an inter-American Scientific conference was invited and opened by the President Camacho. The conference lasted for a week and its sessions were held at Tonanzintla, the University of Puebla and the University of Mexico. Eminent scientific men of international fame from both north and south America joined the conference and presented various interesting papers of original investigations in astrophysical problems. The galaxy of scientists included men like Dr Walter S. Adams, Dr Otto Struve, Dr H. N. Russell, Dr J. A. Pearce, Dr Harlow Shapley, Dr R. W. Wood, Dr R. D. Evans, Dr M. S. Vallarta, and many others. The papers presented were both in English and Spanish. Of the various papers presented, mention may be made of Dr Russell's paper devoted to the Bethe theory of Stellar evolution, especially in its application to main sequence stars, Dr Shapley's address on "Time and Change in the Metagalaxy" reporting recent galactic explorations, Dr Evans' paper on "Measurements of the Age of the Solar System" putting the age at about 2 billion years so far as it appeared from the study of iron meteorites and Dr Vallarta's paper on "The Emission of Charged Particles by the Sun". Besides Dr Carlos Graef's (Assistant Director of the Observatory) paper dealing with a technique for the measure-

ment of Stellar colours and Dr Wood's talk on large objective gratings were highly informative. But perhaps the most significant contribution to the conference was Dr George D. Birkhoff's discussion of "The Mathematical concept of Time" in course of which he recorded his apprehension that theoretical physicists were not giving sufficient attention to the special and general theories of relativity in their relation to quantum mechanics. Dr Birkhoff who has already succeeded in deriving the Schroedinger's equation from general relativity pointed out that the well known results for the advance of perihelion of Mercury and the curvature of light in its passage by the sun could be derived on the basis of special relativity. After the conference the scientists had a pleasant sojourn through some of the lovely and picturesque places of which there is no dearth in Mexico.

FLUORESCENT FABRICS

CURIOSLY enough the scientific brain of America has of late been exceedingly keen on solving problems associated with blackouts. In our last month's issue we have referred to new blackout techniques developed in United States. Here is the news of novel fluorescent-dyed clothing provided for workers in factories and pedestrians in traffic. The Calco Chemical Division of American Cyanamid company has placed at the disposal of those responsible for the defence of U. S. citizens dyes of various shades with fluorescent properties which can be applied to fabrics for clothing. Such fabrics will fluoresce in the ultra-violet spectrum. The use of such fabrics as garments, however, necessitates the control of traffic by invisible ultra-violet light and the use of ultra-violet lamps in the headlights of vehicles. The obvious advantage consists in the fact that while the presence of persons wearing fluorescent clothes can be detected at short distances without any difficulty the feeble fluorescent radiation will not affect a distant observer's impression of a complete blackout. It is a novel idea indeed. But we wish America could concentrate more on perfecting her blackout techniques.

AMERICAN NATIONAL MEMORIAL TO MARCONI

A triangular park in Washington is being converted to an American national memorial to Marconi,

who by birth and domicile belonged to another nation, but whose achievements in the field of science and contributions to the progress of the human race made him a citizen of the world. There in granite and bronze, the memory and accomplishments of G. Marconi—inventor of wireless telegraphy—the medium of communication which encompassed all space surmounting the barriers of mountain and sea will be enshrined for ever. In this dark period of the world's history, it is encouraging to note that U. S. A. finds time to pay tribute to one who by birth belonged to an enemy country, viz., Italy, but who dedicated his labours to advance the standards of human civilization. Marconi was born in Bologna on April 25, 1874 of an Italian father and an Irish mother. After experimenting for sometime at his father's estate in Bologna he went to England where on June 2, 1896, he took out the first patent for wireless telegraphy. In March, 1898, he first sent a message across the English Channel and on December 1901 he succeeded in transmitting and receiving signals across the Atlantic. The present memorial will take the form of a double pedestal of stony creek granite, arising from a base of the same material. The lower of the two pedestals will support a bronze bust of the inventor. Behind this will arise a broader and taller pedestal surmounted by the bronze figure of a woman carried on a half globe suspended in clouds, through which ethereal waves are passing. The memorial is being erected under authority of Congress by the Marconi Memorial Foundation of New York.

ANNOUNCEMENT

Mr S. R. Palit, M.Sc., Physical Chemist, Indian Lac Research Institute, Ranchi has been admitted to the Degree of Doctor of Science of the University of Calcutta, on a thesis entitled "Fundamental Physical Investigation of solutions of Resin, Cellulose Derivatives and Soaps.

We deeply regret to announce the death of Professor Nibaran Chandra Ray, Emeritus Professor of Physics of Scottish Church College, Calcutta. He was a member of the Syndicate of Calcutta University and was associated with this journal as a life-member of the Indian Science News Association.

SCIENCE IN INDUSTRY

HOMOGENISED MILK

WHEN a bottle of milk is allowed to stand for some time, the cream layer separates at the top. This is due to the rising of the fat globules slowly through the bulk of the liquid. The effect therefore renders the milk rich at the top which pours off in the first cup, leaving less nutrition for others. These creamy richness contains most of the vitamins A, D and E which are fat soluble and hence remain in the fat globules.

The idea of homogenizing milk struck the French technologist, Gualin some forty years ago. The same method is now employed only with perfected machineries. The fat globules are ordinarily less than 1/100 mm. in diameter but they coalesce and grow in size to rise up and form the cream line. The idea of Gualin's method of homogenizing milk is to break up the globules into size of about 1/500 mm. This would prevent the rising and separation of cream layer.

The breaking up of the tiny fat globules are accomplished by forcing the milk through fine slit-like jets under pressures of about 2500 pounds per square inch against a polished concave surface of metal. The fat globules, shattered into finer fragments make the milk homogeneous in fat and vitamin contents throughout the bulk. This makes the milk more palatable too. It is also possible to homogenise milk by setting up ultra-sonic waves through them. These ultra high frequency ripples are equally effective in fragmenting the fat globules.

It has also been found that properly homogenised milk produces soft and falky curd in the stomach so that it is more easily digested.

K. R.

TASTE OF ICED FISH AND MEAT

ICED fish and meat are often tasteless. This is experienced particularly in those which are trans-

ported under ice packing, and sometimes with ice and salt. It has been found that the solubility of protein in meat and fish is very much affected at this range of temperature, and the change takes place most rapidly between -2° and -3°C . This insolubility of protein makes the frozen fish and meat dry tasteless.

It remained a problem as to the cold storage and transport of fish and meat in tasteful condition. It has later been found that it is necessary to pass this range of temperatures as quickly as possible by sudden chilling down to about -20°C and holding the material between -20° to -30°C . This rapid freezing retains the desired solubility of protein and maintains the taste all right.

K. R.

UTILISATION OF LIGNIN WASTE

MODERN Industrial chemistry has more than once demonstrated how a country's greatest waste often becomes the richest source of valuable materials of everyday use. This has once more come to pass in the case of lignin, the dark, resinous substance which until recently was regarded as a waste by-product of the paper industry. Lignin, as is well known, is present in the cellulose-walled cell of all plants making them woody and constitutes as much as 25 per cent of the coniferous trees, the chief starting material of paper. Making of good sulphite paper necessitates its removal from the pulp, and as the chemist could not for a long time effect any utilisation of this product there was no other alternative but to allow it to run to waste. From the beginning of the present century the colossal waste of lignin engaged the serious attention of chemists who, after 60 years of research, have succeeded in making a partial utilisation of this by-product. The utilisation is yet insignificant in-as-much as not even 05 per cent of the 3 million tons of lignin available annually from U. S. and Canada can be converted into useful derivatives. As a matter of fact, in the paper mills

of United States alone 12 million gallons of lignin waste are drained everyday.

Despite the present meagre utilisation lignin waste, as researches indicate, bids fair to produce important derivatives and forms the basis of great chemical industries. Already the Marathon Paper Mills of Rothschild has attained a great measure of success in producing a number of important derivatives from calcium lignin sulphonate precipitated from waste liquors by the addition of lime. Of the various derivatives mention may be made of vanillin, tanning chemicals, water softening agents, lignin plastics and road-binding material. One half of the vanillin required in United States was produced from lignin last year. Tanning chemicals synthesised from lignin have proved more efficient than tanbarks. Lignin plastics, the most important of all derivatives, can be used for making table-tops, refrigerator and airplane doors, parts for ships, tanks, planes, bomb fuses and cases for shipping shells. The laminated form of lignin plastic which is one fifth the weight of steel has the same strength of steel weight for weight. Furthermore the product is cheaper and requires less phenol (2 or 3 per cent). It is expected that the utilisation of lignin will increase the production of U. S. plastics, now reckoned as important raw materials, to double the present amount. In places like New Jersey and Washington road-binding material prepared from lignin has successfully replaced tar. Chemists are of opinion that in the near future lignin waste is destined to play a great role like coal tar in the chemical industries of a country.

SYNTHETIC FUEL

A report published in a recent issue of the *Chemical Age* reveals that the French has almost succeeded in developing a method of manufacturing synthetic coal from leaves. For some time past shortage of fuel was being experienced in France, which instigated research in the direction of perfecting a method of synthesising coal from organic matter. This new synthetic coal has been termed Carbofeuille. The experiments reveal that about 1 cwt. of fuel can be obtained from the leaves of an average tree. It has been estimated that all the trees of Paris, totalling over 89,000 would produce 4450 tons of fuel. Owing to the heavy cost of collection and transport, utilisation of the trees in a big city like Paris will be hardly economical. The scheme, however, bids fair to produce fuel economically if the method be carried on in or near a forest like the Bois de Boulogne. Manufacture of synthetic coal on a commercial basis has not yet been attempted. But as it appears from the report, the Vichy Government

is very keen about making this method a national asset to solve the fuel problem.

The method may be briefly stated as follows: The leaves are collected and carbonised. In the process they give rise to a gas, pyroligneous acid and a tar, of which the gas after mixing with coal gas is utilised in carbonising other leaves. The carbon so formed is finely crushed, to which water and coal tar are added. The mass is then pressed into the shape of nuts and left to dry for a few days, when it is ready for use as a fuel. The heat of combustion of this new synthetic fuel is estimated at 4800 calories. The consumption of coal tar and coal gas in the process is very small. For instance, 70 lbs. of tar can produce one ton of the nuts. Further by increasing the size of the plant the amount of coal gas required can be reduced proportionately.

A NEW METHOD OF INCREASING TURBINE EFFICIENCY

THE use of mercury vapour in turbines to increase its power producing efficiency has been one of the most remarkable technical triumphs in recent years. Late William LeRoy Emmett first conceived the idea of operating turbines with mercury vapour in 1912. In a steam turbine steam is allowed to operate the rotors and then suffer condensation during which process much of the heat is lost irretrievably. In consequence of the loss of heat involved in this process the most efficient steam turbine can hardly convert more than 33 per cent of the fuel heat to energy. By running two turbines simultaneously, one by mercury vapour and the other by steam, the wastage of heat can be greatly minimised. In the first turbine mercury vapour (975°F) is blasted through the rotors and allowed to raise steam during condensation, to be used in the second turbine. Though the loss of heat involved in the condensation of steam in the second turbine cannot be prevented, the advantage is that the process ensures the heat loss of one turbine while two are in operation.

Success of this new method was not, however, forthwith. Following the researches of William Emmett, Hartford (Conn) Electric Light Co., Public Service Electric and Gas Co. at Kearny and G. E. at Schenectady erected mercury plants which unfortunately did not work efficiently. The difficulty was ascribed to the fact that mercury absorbed rust and did not flow uniformly through the boiler tubes which, therefore, suffered unequal heating. A close examination by experts attributed the cause to the peculiar surface tension of mercury. Due to its tendency towards drop formation mercury fails to

effect a good contact with the metal tubes and frequently admits oxygen with the consequent unequal heating and frequent rusting of the tubes. It is plain enough that the problem admits of an easy solution if this undesirable property of mercury can be somehow got rid of. At last it was discovered that by putting traces of magnesium and titanium in mercury it can be made to wet the tubes.

In the light of this new knowledge, the mercury plant installed by the Public Service Electric and Gas Co. at Kearny in 1922 was reconstructed in 1940. The plant is now reported to have scored an efficiency of 37 per cent and requires 1,300 B. T. U. less than any steam plant to produce one kilowatt-hour. The engineers are of opinion that there is yet enough scope for further improvement, and the combined use of mercury and steam will increase the thermal efficiency to as much as 50 per cent. A rough idea as to the consumption of mercury in this new turbine is available from the fact that about 310,000 lb. of mercury is required in the 20,000 kw. Kearny turbine. Though at present an adequate supply of mercury is difficult the problem will cease to exist on the return of normal times when the present war time demand for mercury will be considerably relaxed.

Further the advantage of using such turbines in ships has been pointed out. In 1938, the Sun Shipbuilding and Dry Dock Co. drew up a plan to build a ship on the basis of this new power generating device, but owing to mercury problem the scheme had to be put off for the time being.

NUCLEAR PHYSICS IN AID OF DETECTING IMPURITIES IN STEEL

It is interesting to note that nuclear physics has ceased to be an unmixed laboratory curiosity and is gradually finding larger applications in the wider fields of industry and technology. Thanks to the atom-smasher, methods have now been developed to detect the presence and location of minute traces of substances like phosphorus, sulphur, carbon, manganese and silicon in steel. The underlying principle is simple and consists in rendering the elements to be detected artificially radio-active by bombardment with projectiles. Emanations from these elements are allowed to imprint themselves on the photographic films which, on subsequent examination, clearly reveal the presence and location of these impurities.

W. M. Shoupp, research physicist of the Westinghouse Company recently performed experiments to prove the concentration of phosphorus on the surface of small air pockets or blow holes. In carrying out the experiment he introduced radio-active isotope of phosphorus, obtained by bombardment with an atom smasher, into molten steel and exposed the photographic film to the emanations. He showed that this process does not impair the chemical properties of phosphorus. On either side of the steel disc photographic films were placed and clamped with brass plates from outside. The operation was conducted in a dark room and the whole thing loaded in a tin can to prevent entry of light. On development dark patches on the film at once indicated where activated phosphorus had concentrated.

Alloy Steels

S. C. LAHIRY

METALLURGY as an art is very old, its antiquity cannot be over-estimated but as a science it is very young. Although the idea of improving the iron by alloying appears to have been known since earlier days, it was only in the last part of the 19th Century that some attempt was made by Sorby to study it scientifically with the help of the microscope. The first binary iron-carbon equilibrium diagram of any reasonable accuracy was drawn by Carpenter and Keeling in 1904 although they missed the delta region of the present day diagram. Hadfield discovered manganese steel about 40 years ago but we have not got the quantitative ternary diagram of iron-carbon and manganese yet. Same remarks apply with regard to Brearley's stainless steel, a ternary alloy of iron-carbon and chromium.

However, during the last Great War, and since then, some progress has been made especially after Von Laue's classical experiments with X-Rays and also after the production of single crystals of metals. More recently the spectroscopic has been successfully used for the quantitative estimation of small amounts of impurities and also for the analysis of segregates in steel. Electron diffraction methods are also being tried for the study of the surface films on steels. The vacuum fusion method is being used for the accurate analysis of dissolved gases in steel, *e.g.*, oxygen, nitrogen, hydrogen etc. Scientific knowledge is being increasingly applied to practical steel-making in order to produce cleaner, sounder and better steel free from inclusions. We are now in a position to understand the effect of the inherent grain size of steel on the quality of the finished articles. These are some of the more important aspects in the field of modern ferrous metallurgy.

Pure iron solidifies at 1535°C. and after this major arrest in the time-temperature curve (fig. 1) two more arrests, one at 1400°C. and the other at 900°C., are observed. (There is however another bulge starting at 760°C. and going down to about 500°C.). We say iron solidifies as delta iron and then changes to gamma-iron at 1400°C and at 900°C gamma-iron again changes to alpha-iron. Beta-iron was supposed to have existed between 900°C to

760°C but modern metallurgy has discarded this idea. X-ray studies have shown regular arrangements of atoms within the iron and two forms of

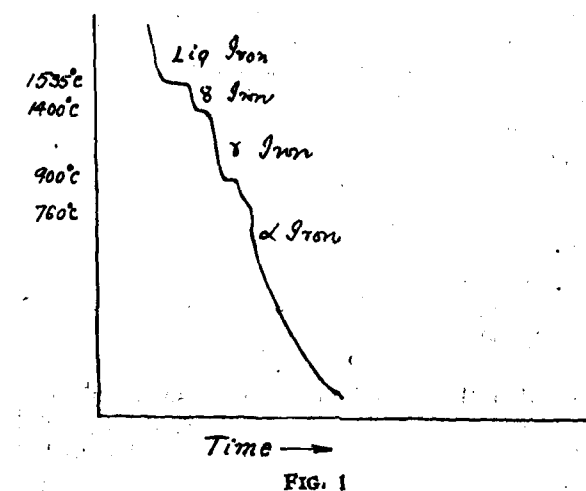


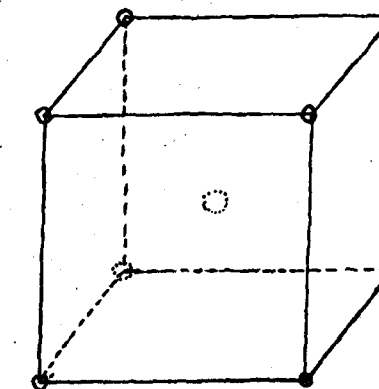
FIG. 1

unit cell, *viz.*, the body-centered cube, (the alpha-iron) and the face-centered cube, (the gamma-iron—more compact and dense) have been observed (Fig. 2). Delta-iron is the same as alpha-iron (high temperature formation) and beta-iron is the same as alpha-iron (but non-magnetic). The old definition that the crystal is a solid bounded by plain faces has broken down and it has been proved beyond doubt that the irregular polygonal grains seen under the microscope are composed of crystals.

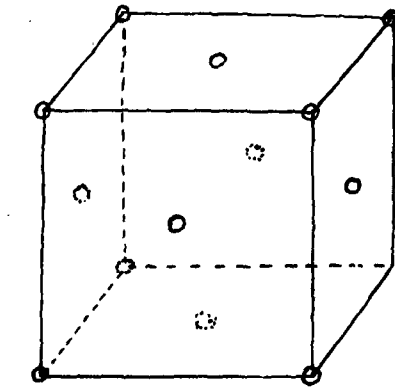
In iron-carbon alloys (Fig. 3), as the carbon increases, the delta-gamma transformation takes place at a higher temperature and the gamma-alpha transformation at a lower temperature. We say carbon is a gamma-retaining element; so are manganese, nickel and copper; these elements more or less occur in solid solution with iron and make it stronger and tougher. Manganese is the most effective gamma-retaining element. Nickel has about half the effect of manganese and copper is the least effective of the three. On the other hand chromium, tungsten, molybdenum, vanadium, aluminium, etc. are alpha-retaining (also called loop-forming) and carbide forming elements and so they do not produce any

effect in the absence of carbon. But when present along with carbon they give the alloy more strength and hardness.

The strength of the steel depends on its carbon content. A carbonless iron will pull 20 tons, with 0.3% carbon the steel will pull 30 tons. If to a



Body-Centered Cube



Face-Centered Cube

FIG. 2

in an alloy steel containing nickel and chromium, nickel, manganese and carbon tend to keep the iron in the gamma-state whereas chromium, molybdenum, vanadium etc. tend to keep it in the alpha form.

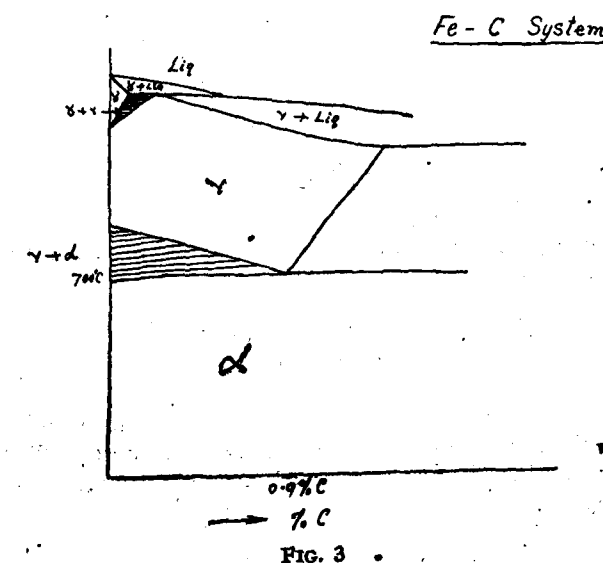


FIG. 3

To a certain extent the final product will have a resultant effect together with special effects of the alloying elements. The effect of chromium, for example, will be to make the steel more resistant to corrosion besides giving a more complex carbide which will increase the strength, surface hardness and resistance to abrasion of the steel than if only carbon were present.

0.3% carbon steel 3% nickel is added, the strength will be increased to 40 tons. If now 0.7 to 1% chromium is added to this, it will easily pull 55 tons without much loss in ductility. But one cannot increase the strength of iron merely by alloying it. Carbon is also necessary. One reason for this increase in strength is the finer structure obtained by alloying. A single crystal of iron is very soft, ductile and weak. With more crystals in one specimen of iron it becomes stronger. With still more crystals the iron will be more stronger—Unity is strength.

Another example of alloying is that in a soft carbon steel containing less than 0.1% carbon the iron will be present in the alpha condition at ordinary temperature and the article will rust easily. In order to make this iron reasonably stainless, at least 11% chromium must be added. If more carbon is present more chromium is needed; unfortunately however if the steel contains more than 17% chromium and the usual amount of carbon is 1 to 15%, it is not heat treatable as it remains ferritic (alpha-iron) at all temperatures and its mechanical properties are poor. If now 8% nickel is added, the above steel consists of austenite (gamma-iron with all the chromium, nickel and carbon in solid solution). When heated to 900°C. and if rapidly cooled the austenite is retained undecomposed. This type of steel is commonly described as 18/8 austenitic stainless steels. These are remarkably tough and ductile besides being stainless. Moreover 8% nickel increases the resistance of corrosion of the alloy in alkaline media.

Under the microscope pure iron shows an irregular polygonal network of grains. With some

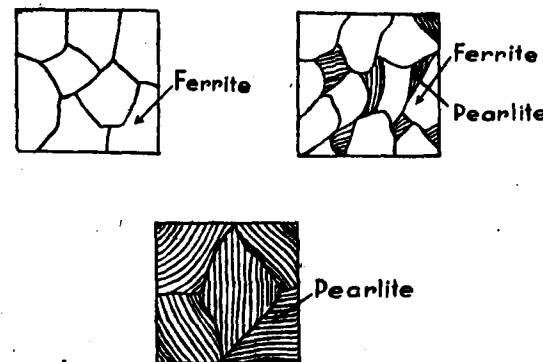


FIG. 4

carbon in it two constituents appear ferrite, and pearlite and with 0.9% carbon again one constituent is seen and that is pearlite for a particular carbon content. With 0.7% carbon and 1% manganese the appearance under a microscope will be similar to 0.9% carbon steel. Moreover the laminations will be finer. (Fig. 4.)

Carbon steel as used for large jobs, such as buildings, bridges, railway wagons, cranes, ships etc. contains usually 0.15 to 0.25% carbon (with about 0.6% manganese and 0.1% silicon), and is used in the "as rolled" condition because it does not pay to heat-treat these articles. Its mechanical properties are—yield stress 15 to 18 tons per square inch, maximum stress 28 to 32 tons per square inch, elongation 30 to 40%, Izod* value 90 to 70 foot pounds (the yield stress and the maximum stress increase and the elongation and the Izod value decrease as the carbon content rises).

In many structures, e.g., long-span bridges, tall buildings and all kinds of moving structures weight-saving is highly important. Therefore, there has been an increased demand for the ordinary structural type of steel possessing increased yield stress and maximum strength, within a reasonable price which could be fabricated "as rolled" or normalised.

The cheapest means of getting increased strength by increasing the carbon, say 0.4%, is ruled out because of low ductility and low toughness accompanying such carbon content. Adding 3% of nickel

* "Izod Impact figure serves as an indication of the notch toughness, i.e., the resistance to fracture of a notched specimen. No direct use is made in design of these measures of toughness and ductility, although indirectly they are employed as a safeguard against premature failure and failure under conditions of abnormal loading."

to structural carbon steel may solve the problem fairly. But the steel will be rather costly. Moreover, such a steel will corrode nearly as easily as an ordinary mild steel. For safety, high tensile structural steel should stand corrosion better than carbon steel. Copper is a cheap alloy element to improve the corrosion resistance of steel and so it is present in most of the high-tensile structural steel.

Such steels are most economically obtained with 1.5% manganese with 0.5% copper or with 1% manganese and 0.5% chromium and 0.5% copper, together with about 0.2% carbon and in the 'as-rolled' or normalised condition usually give a yield stress of 25 tons per square inch, maximum stress 37 to 43 tons per square inch, elongation from 20 to 30%, and they can be fabricated as easily as any mild steel.

We shall now consider the cooling of a 0.9% carbon steel rod of 1" diameter:—

Furnace-cooled from 900 C. The steel will be in its softest state. From one grain of a gamma-iron 3 colonies having laminations of alternate layers of soft pure iron (ferrite) and hard carbide called

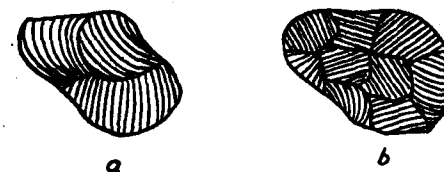


FIG. 5

"Cementite" have developed. This laminated structure is known as Pearlite. (Fig. 5a.)

Air-Cooled: More colonies and thinner lamellae from one grain of gamma-iron are seen. (Fig. 5b.)

Cooled in air blast: Colonies still smaller mostly not resolved at 500 X-patchy structure called Sorbitic-Pearlite are observed. Steel—stronger and tougher.

Cooled in hot oil: No trace of lamination at 500 X-patchy structure but lamination can be seen in some colonies at 1500X. Sorbite—stronger and tougher still.

Cooled in cold oil: No lamination visible—colonies tend to have a rounded dark nodular shape, commonly seem to have a fan-like appearance at 1500 X. These are composed of very fine lamellae of ferrite and cementite, radiating from the centre

of the fan but can only be resolved when the angle of inclination is very favourable.

Hot water: Some nodules are formed at 650°C and the rest for the gamma-iron cools unchanged to about 200°C and then changes to martensite (acicular structure). Martensite is an enforced (super-saturated) solid solution of carbon in alpha iron.

Cold water: The gamma-iron grain cools down to 200°C without any change and then changes as a whole to martensite.

Cooling curves of steel containing 0.9% carbon heated to about 900°C and cooled in different media show the temperature at which gamma iron is changing to alpha iron, also the effect of the increasing amounts of manganese on the surface-cooled specimen of ½" diameter is shown in (Fig. 6).

A hardened or quenched steel consists of martensite. When it is heated the carbon is precipitated as carbide in the form of globules. At low temperature, say 200°C, the globules are too small to be visible. When tempered at 400°C practically all the carbon is precipitated, although it still retains an acicular appearance. At about 550°C the globules increase in size and structure really consists of carbide

The effect of alloying elements in general is to lower the transformation temperature so that drastic quenching is not required. Some alloy steels may be as hard as a water-quenched carbon steel only when air-cooled. These elements tend to give better depth-hardening to the steel and thus offset the effect of the size of the article. But in order to derive the fullest benefit, such steels must always be used in the heat-treated condition (i.e., properly hardened and tempered).

An illustration of steels used for the same job by six different motor car manufacturers is given below.

Type of steel	Steering knuckles					
	C.	Mn.	Cr.	V.	Mo.	Nickel
Manganese ..	0.4	1.75	—	—	—	—
Chromium ..	0.4	0.7	1.0	—	—	—
Chrome-Molybdenum ..	0.3	0.7	0.75	—	0.25	—
Chrome-Vanadium ..	0.4	0.7	1.0	0.15	—	—
Nickel-Chrome ..	0.4	0.7	0.75	—	—	1.5
Nickel ..	0.4	0.7	—	—	—	3.5

All steels mentioned are quite satisfactory for the job when properly heat-treated, because it is on the microscopic structure of the steel that its mechanical properties largely depend. The reason

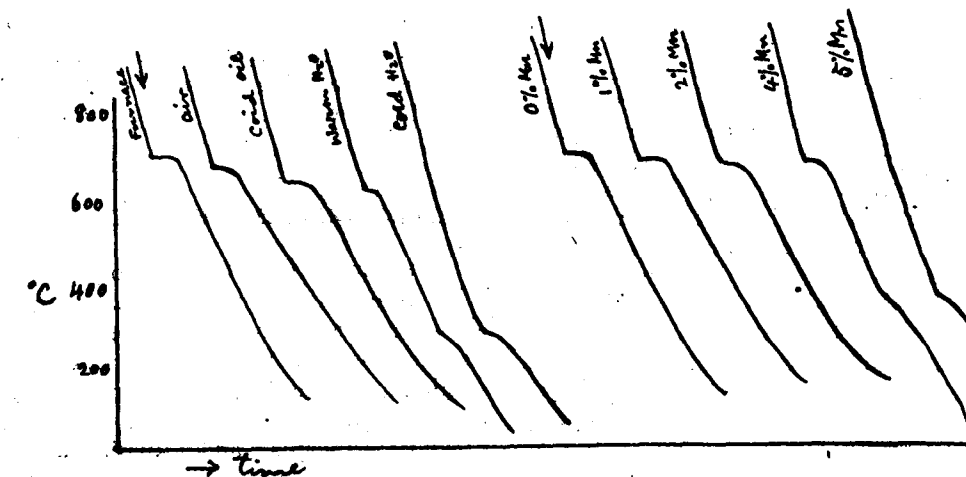


FIG. 6

globules in the ferrite matrix. The steel now has about the same strength as a sorbitic steel but has a higher Izod value. In tempering, the temperature must never be above the gamma-alpha transformation temperature. Otherwise gamma iron will be formed, which will give laminated pearlite on cooling. The good mechanical properties of the tempered steel is due to the fact that the cementite is in the form of small globules and not plates.

why more expensive steels like nickel-chrome-molybdenum-vanadium, are used for such parts is the fact that these alloys tend to give better depth-hardening and also more uniform and finer structure, together with any special advantage, e.g., machinability. In order to produce such a quality product, a high degree of skill combined with scientific knowledge of higher metallurgy and research are needed.

TUBERCULOSIS AND THE WAR

It is a well-known fact that the incidence of tuberculous disease and death rate due to tuberculosis rise in war time owing to physical and mental strain, overwork, privations, ill-spent leisure, overcrowding and more opportunities for contact with "open" cases of pulmonary tuberculosis. This was witnessed during the War of 1914-1918 and is also being experienced during the present war. In England, taking the year ending mid-1939 as the standard, the increase in deaths from respiratory tuberculosis amounted to 6 per cent in the first year of war and 10 per cent in the second year. The rise in tuberculosis is, therefore, a special wartime problem, and should be tackled with the sense of urgency that is being given to other wartime problems.

Tuberculosis is an old and dangerous enemy. It attacks particularly the young, whose services to-day and after the war must be of supreme value to the nation. It is a common knowledge that in tuberculosis symptoms do not often appear until the disease is well developed, and frequently not until the disease is too advanced for treatment. By the time patients voluntarily come for treatment, such patients, who constitute over 50% of the total number in India, have perhaps infected numerous healthy people. It may be that most patients are apt to ignore the mild warnings indicating the need for medical advice, or they may be tempted to conceal the apprehension by persuading himself that he is perfectly well. The result is that many undiagnosed tuberculous patients are at large in the community at considerable risk to themselves and to others.

If patients are detected in early stages before they become infectious, not only do they get well quickly without much dislocation of work and finances but they are not able to spread the disease in the community. The only method of detecting tuberculosis before it produces symptoms is by X-ray examination of the chest. Formerly, the methods of making these examinations were not only time-consuming but costly. But recently, the introduction of miniature radiography has reduced both

these factors and has made it possible to examine large numbers of school and university children, staffs of commercial firms and offices, groups of recruits for the army, police and labour force. The Trade Union Congress in England have urged on the Government to insist on a thorough examination not only of all children on leaving school but also of all entrants to factories or workshops, repeating the examination once a year until adult age is over.

These measures presuppose, of course, not only the financial help of the State and local bodies in X-ray-equipping centres for proper examination but also public education and co-operation in the matter, as also the manufacture of a sufficient number of machines at small cost. In India, the seriousness of the problem has hardly attracted the attention of the public health and administrative authorities and of the commercial firms and big employers of labour, such as the Railways, Police, Tramways etc. It is time that something is done to prevent a havoc during and after the war.

INFECTIOUS DISEASES IN THE PRESENT WAR

The most notable infections so far have been mild influenza and cerebrospinal meningitis; typhus showing some activity in eastern Europe. Increase in cerebrospinal meningitis prevalence occurred in England, Germany, Hungary, Yugoslavia and Switzerland. A recrudescence of typhus occurred in Poland, Rumania and Russia and accompanied refugee movements. There was an outbreak of dysentery in the German army during the Polish campaign. Finland was the only country to show an increase of the typhoid group.

In England the total incidence of infectious disease was lower in 1939 than in 1938, although a rise had been expected to follow the movements of evacuation and mobilization. The expected measles epidemic did not materialize; only chicken pox and rubella reached epidemic proportions. In 1940 there were increases in the prevalence of the typhoid

group, dysentery, tuberculosis and respiratory infections, respectively. The latter affected chiefly the older age groups. In 1940 the figure for cerebrospinal meningitis (12,500) surpassed the records in the past, but the mortality was low. In the army, epidemics of influenza, rubella and chicken pox occurred. Increased prevalence of venereal disease was not comparable to that which occurred in the early stages of the last war. In short, the changed character of the infections of war and the recession of past scourges reflect the results of scientific research and control. (*Bulletin of War Medicine*, Vol. II, No. 2, 1941, Nov., p. 123).

BLOOD TRANSFUSION SERVICES IN GERMANY

A Ministry of the Interior circular dated the 5th March, 1940 lays down the terms of service for blood donors for the whole of Reich. It is estimated that one donor is required per 1000 inhabitants, or 60,000 donors for the whole country. Since the number of hospitals is 3000, each hospital has been instructed to have at its disposal about 20 donors. It has been advised that these donors should be in approximately the same proportions as those of the general population, viz., O group—40%; A group—40%; B group—15%; AB group—5%.

Persons—men and women, who are between 21-50 years are asked to donate blood, provided they are found to be physically fit and are accepted only after a double examination of blood at recognised State Institutes. The donors, when accepted, carry a card, in different colours for each group, bearing their photograph and particulars of blood and haemoglobin examinations. The donors receive 10 Rm. for the first 100 c.c. of blood taken and 5 Rm. for each subsequent 100 c.c., besides his cost of transport and compensation for loss of wages. These expenses are borne by the patient receiving the blood if he can afford to pay, or if he is insured, by his insurance society; if he is without means, they are met by the Government and local bodies.

As regards supplementary diet, blood donors, during the fortnight following the giving of blood, have a right to a supplementary ration of 250 gm. meat and 100 gm. of farinaceous foods per week, on condition that they have given at least 200 c.c. of blood.

PROTECTION OF CHILDREN IN WARTIME GERMANY

In order to prevent the present war from having serious repercussions on the future of the nation,

special regulations have been enacted to look after the health of children. Children are compulsorily vaccinated during the second year of life and again at the age of twelve with animal lymph prepared at the State Vaccine Institute. A large number of children have been housed in children's colonies where special precautions are taken to prevent infectious diseases. Frequent health examinations are made with the assistance of laboratory and other technical methods. The inmates and the staff who are found to be suffering from tuberculosis or are carriers of diphtheria, infantile paralysis, scarlet fever typhoid, paratyphoid or dysentery, and those suffering from contagious skin diseases, gonorrhea and parasitic infections are not permitted to stay in the colony. Preventive inoculations against these infections have also been enforced upon. Germ carriers are not employed by dairies, butchershops, food factories and bakeries and they are not allowed to be occupied as a hair-dresser, nurse or a cellarman. Expectant and nursing mothers and infants and children receive special cards for supplementary diet suited to their respective needs. Special emphasis is laid on the training of children's nurses, who receive a thorough training about household duties including cooking and public health for 18 months and a further period of six months each in a children's hospital and with the child welfare service. For the protection of the race, doctors and midwives are obliged to notify certain congenital affections of infants to the Health Offices, such as microcephaly, hydrocephaly, idiocy, mongolism, congenital defects of the limbs, spina bifida, paralysis and mental defects. Special institutions are being organized to treat these cases. Milk Reception centres have been organised where human milk is being supplied, on medical advice, to infants suffering from acute enteritis or chronic dystrophies and to premature infants; syphilitics are excluded, as the racial principles of the Third Reich are opposed to any attempt to preserve the life of the unfit.

MAGNESIUM IN WOUNDS

We are familiar with the type of gas gangrene, a serious war wound danger, generally caused by germs. A new type of gangrene—the chemical gas gangrene, has been reported, which is equally dangerous. Here the causative organism is not a germ, but the metal magnesium. Wounds contaminated with metallic magnesium or some of its alloys and not properly cleaned to remove their traces very often develop a gaseous condition resembling the bacterial gas gangrene and prove fatal. It is reported that in 1939 there were 5,000 gangrene cases of this type in German industries alone. The nature

of this gangrene has been studied by Dr C. P. McCord, Dr S. F. Meek, and Dr G. C. Harrold, all working in the Chrysler Corporation. Animal experiments with rats reveal that the introduction of magnesium metal in wounds gives rise to the generation of hydrogen gas in the tissue and may lead to gas gangrene if the gas evolved be profuse in quantity and not

taken care of. Particles of metallic magnesium in wounds have further been found to produce the hydrogen from the very fluids of the tissue system and, if not removed, eventually develop a gaseous tumour. Immediate medical care and preventive measures against magnesium particles may remove the danger of gangrene development.

Some Problems of Maternal and Child Health in India Under War Conditions

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THERE are problems connected with war which in Asia can be solved by applying the solution worked out in Europe to meet similar circumstances. Unfortunately there are many problems which cannot be solved in this way. This is particularly true of problems connected with the medical protection of mothers and young children created by the war.

Lessons must be learnt from the bitter experiences undergone in England and Europe, but the solutions must, in this country, be sought within the social and economic patterns of India. Excluding the mother working in war industries it is expectant mothers, mothers of young babies and children up to 12 years who form the only section of the population for which special care can be sought in time of war. Older children and women have to be considered along with the general population. It is true, they may be considered as "ineffectives" (although three years of war have greatly modified the application of that term) and so invited to evacuate themselves to 'safe' areas, but the state then washes its hands of them unless total civil evacuation is ordered.

For the special group upon whom the effects of war may fall most severely provision has to be made. Maternity and childhood have to be rendered as safe as provision and resources can make them. During bombing attacks, while fleeing from danger, even

while living in a 'safe' area away from familiar surroundings, amongst civil problems theirs comes first, (if only from the selfish motive of protection of the race).

The dangers which confront mothers and from which they must be protected are failure of skilled aid at the time of delivery and little or no after-care. For the infant the problem is insufficient nourishment or even failure of breast milk which are likely effects of anxiety and lack of rest upon the mother and the difficulty of obtaining medical care, medical supplies, and especially the problem of milk foods is a further complication. Exposure during journeys, too much handling and movement will take their toll also. For the older infant and young child there are the horrors of physical and emotional exhaustion, the dangers of under-feeding and lack of essential vitamins, exposure to any of a dozen infectious diseases due to unsuitable or unclean food, contaminated water, biting insects or from being crowded with other human beings of insanitary habits, or under conditions of indifferent sanitation. Educational facilities may not be available at a time when complete change of household environment and daily routine may demand a rapid adjustment for which the young child is ill-prepared. The need for providing institutional educational facilities is also of first rate importance.

In England the steps taken to solve the problems are the encouragement of voluntary evacuation to 'reception' areas under billeting and housing schemes, registration of expectant mothers for evacuation under threat of bombing, the conversion in these 'safe' areas of necessary buildings, likely or unlikely, into maternity homes, convalescent homes, resident nurseries for children, day nurseries and creches accompanied by the expansion of educational facilities. The transportation of midwives and health visitors to these areas, often along with the mothers and infants, was arranged and provision made for delivery service on trains and at railway stations. A further step was the mobilisation and training of local 'ineffectives' both adult and adolescent, to provide staff for the new institutions, as well as to cope with the many problems—social, sanitary, and medical of a 'reception' area.

Gradually the local welfare authorities, the Ministries of Health, Food, and Transport, the Education Authority and the voluntary organisations have developed a service, partly liaison and partly incorporate, to synchronise activities, to close gaps in the system of care and preclude overlapping. Mistakes have been made, confusion has been created by the unheeded in-pourings of nearly half a million foreign refugees, even tragedies have resulted, but a great social and medical triumph is in process of achievement.

But the case is different in India. Such a concerted plan, not far removed from socialised health welfare, would meet with certain serious obstacles in this country. Voluntary evacuation has been advised and has proved relatively easy, for very few town dwellers in India have no stake in the mofussil districts. The fact that most of the people have got a 'safe' place in villages and can retire there in times of danger has meant that no scheme of 'reception' areas could readily be formulated in this country.

A town family in England, when it has to live with strangers in the country, is largely indifferent to its place of stay and a selected and prepared area seems more satisfactory than any other. To advise an Indian family however to go to live in a selected area would in nine cases out of ten prove unsuccessful, because the family roots are planted elsewhere.

If a plan based on British experience were outlined what would be its logical form in India?

The Indian population evacuated from large towns and coastal areas has distributed itself to overcrowded many hundreds of undeveloped small urban and rural areas. Where ten reception areas could

have been prepared to take two lakhs of women and young children, 200 small places cannot be so prepared. The solution of the problems so raised can only be reached by the local bodies themselves in close co-operation with the local population and the evacuees, formulating their specific problems of transportation, housing, food, health protection and education, for the consideration of the associated departments of Government, so that by combined action a general minimum standard of welfare can be attained. If evacuees are not to flood back into the danger zones on the high tide of over-confidence in enemy inaction and failure of adaptation to mofussil conditions, no time should be lost in studying these problems so that difficulties especially of food, health and education can be met.

Among the evacuated population are teachers, educated women, students, boy scouts, girl guides, members of societies devoted to the development of physical culture and health, sympathisers with organisations pledged to social service. Teachers and other workers in large coastal towns are being dismissed from service as a result of the falling population. Cannot some of them be sent to open small schools, to take care of young children, and help in immunization problems and in advising the population on simple matters of hygiene throughout the rural areas with the object of smoothing out some of the conspicuous differences which exist between the amenities in the town and those in the country? There is no lack of willingness to help; but this hesitation is perhaps due to the absence of direction and concrete planning.

With regard to the provision of staff for maternity and child welfare trained health visitors are few, but there are many branches of maternity and child welfare, in which instructed staff can be employed, especially in war time. Trained health visitors can assist medical, sanitary and education officers in holding classes to instruct those who volunteer for work such as the care of groups of children, the establishment of play-rooms and open air play grounds and the setting up of nurseries in the areas crowded by evacuees. Such workers after instruction can assist doctors during the medical examination and with the after-care, of young children, and also in popularising vaccination and other forms of immunization. Holding classes in physical culture for older children and supplementing insufficient educational facilities will offer real opportunities for good work to many who are already trained.

Maternity hospitals in large towns are almost empty, not entirely in anticipation of air-raid casualties. Midwives, ayahs and even women doctors who

can be spared are needed elsewhere. Their clientele has left and they can only follow it. Many younger obstetricians in private practice, both men and women, are unable to earn a livelihood in the larger towns under present conditions, and the army has little need for them. Is it not possible to mobilise such medical workers for service in evacuee areas as touring and training officers? Medical students whose training may be interrupted will learn much and gain largely by contact with the problem of medicine among the masses, if they can be spared from other duties and given work under the supervision of their teachers.

It would seem, then, that the kernel of prevention of flight back to the towns is the rapid crystallization of the local problems in each district where the population has been increased by 10 per cent or more through evacuation from danger zones or by influx of refugees, inspection of the area by a committee representing the education, health and rural reconstruction authorities of the province and the utilization of all available trained, instructed and voluntary personnel for the work of amelioration both by tapping local talent and by drafting staff from larger towns.

Buildings existent or temporary structures of bamboo and mud will be needed for schools, for improvised nurseries and nursery schools for holding physical culture classes, and to provide living quarters for the staff. Small maternity homes and childrens' clinics will be required with personnel to staff them. For these simple standard plans for the buildings, local contributions in money, kind, or labour, with efficient supervision for construction, is all that is needed to provide the new structures or to convert the old. The usefulness of these little institutions in times of stress will decide whether they will cease to exist when peace comes or whether their establishment will form the spur of an all-India demand for better amenities in our villages. Improvement of the environmental conditions and ensuring of a sufficient supply of food must take effect at the same time. The grow-more-food campaign in itself should stimulate local effort and help to interest these temporary dwellers in the rural areas in the problems of food production in the villages.

As regards the non-technical staff of the temporary institutions, a high degree of training is not essential, although if each evacuee is asked to register with the local body stating his or her qualifications and whether he desires to aid in the local plan of improvement and reorganisation, perhaps it would be easier to organise local efforts. For success much depends upon understanding the local problems, the people and their psychology and striving

ingeniously to meet the needs of the moment with as little disruption as possible of the normal tenor of living. In such a scheme the citizen with good will towards his fellow citizens and resources to lend, is offered many opportunities of service nearer home. Nor need the amount of trained staff be very large for minimal standards. A touring physician with obstetrical experience should be able to visit six centres, each serving a population of 10,000 by paying a weekly visit of 8 hours' duration, to hold the necessary pre-natal, infant and children's clinics, carry out inspections and confer with the local authorities, the whole being considered as health welfare work.

A trained health visitor could supervise the maternity and child welfare activities in a population of half that size, visiting each centre for a whole day twice a week, one of her visits coinciding with that of the doctor. As regards resident staff, a nurse, a trained *dai*, and an *ayah* should prove sufficient to implement such an emergency maternity and child welfare programme both as regards institutional and domiciliary service under conditions of close co-operation with the local medical services in an area of 10,000 population. Instructed and voluntary staff would fill all other needs. In concrete form the scheme may be outlined briefly in the following manner:

Local Body's Contribution:

- (1) Registration of evacuees.
- (2) Enrolment of volunteers.
- (3) Formulation of the local problems in regard to all aspects of maternal and child health, health protection, medical aid, and home follow up for the mothers and pre-school group, conservation of the supply of cereals, milk, fruit and vegetables for expectant mothers and young children, environmental hygiene, transportation, educational facilities etc.

Provincial Government's Contribution:

- (1) Discussion of the problems and the extent of the maximum local contribution towards their solution after inspection of the area by a committee representative of the Departments of Public Health, Public Instruction and the Medical Department of the provincial Government.
- (2) Drafting of the necessary personnel trained or instructed, to the area and the provision

of standard plans, funds, etc. to bring the local facilities up to the planned minimal standard.

- (3) Periodic inspection of the area by the committee accompanied by a discussion with the local body; adjustment of the scheme from time to time as conditions alter in the area.

This would entail the preparation by the provincial Government of standard plans and estimates for temporary structures to be used as living quarters, hospitals, maternity homes, refugee camps, primary schools, nursery schools, day nurseries, halls, and play grounds for provision to any local body. It would also entail the organisation of courses of instruction to volunteers of matriculation standard in certain aspects of maternity and child welfare work,

community hygiene, immunisation, health propaganda and in the rudiments of physical culture.

This scheme would follow closely the British plan, adapted to Indian conditions: the degree to which provincial Governments have already considered it is not known.

China has shown the world that a poor agricultural people need not be bowed down by the devastation of war and that the Asiatic country-side can yield amenities if the available resources are first studied and then fully utilised. The will of China to survive has been welded into an iron resolve by the sacrifices and ingenuity of her village people.

In India the time for thinking and planning is now, action may be forced upon us at any time.

PERMANENT ARMY CAMP BUILT IN ONE DAY

The United States Army is giving Australia something to talk about by pushing on at bewildering speed the job of settling down their forces.

In less than 24 hours a paddock where sheep had been quietly browsing became a city of huts and canvas, with an army in possession and everything complete—even to installation of electric light in each tent and building.

Carpenters, plumbers, road-builders and electricians descended on the paddock like a swarm of grasshoppers. Within the first hour they had pegged out roads and blocks, and inside four hours the frame work of the buildings was up. In six hours from the start, they had a permanent water system installed, with hot and cold water laid on to the bathrooms.

Only eight hours had passed when electric light was on in tents and buildings and there was a complete drainage and sanitary system. And the camp had been inter-linked by radio and telephone communication.

Within 12 hours an army had moved in to occupy the camp finding their cooks waiting for them with hot meals.

By then, the carpenters, plumbers, road-builders and electricians had packed up and were on the move to the next job.

—Austral News.

BOOK REVIEW

Organic Chemistry—By P. B. SARKAR, D.Sc. and P. C. RAKSHIT, M.Sc., Ph.D. Published by H. Chatterjee & Co., Calcutta, 1942. Crown 8vo. 562 pages. Price Rs. 5/-.

The book will be found useful for B.Sc. Pass students of the Indian Universities for whom it is intended. The presentation is clear and logical and the individual members of each type of organic compound have been carefully chosen so as to make the book fairly comprehensive without being burdensome to the memory. Particular emphasis has been justly laid on the functional groups and on the inter-relations of the different types of organic compounds.

A novel feature of this book is the special stress which has been laid on the processes for the manufacture of organic compounds which have industrial applications coming within its scope.

We share the authors' hope that the book will rouse a genuine interest in its young readers in the practical applications of organic chemistry.

P. C. M.

Experimental Physical Chemistry—By W. G. PALMER, M.A., Sc.D., D.Sc., Cambridge University Press, 1941, Pp. 321. Price 12s. 6d net.

To quote the author the course of work outlined in the book is based on the following considerations: "First, that students both at universities and in schools cannot often afford to devote more than limited periods to practical work in any one scientific subject. The provision of detailed instructions is therefore imperative, in order that a satisfying result may be reached without a discouraging waste of time. Secondly, that while being capable of yielding reasonable accuracy, the apparatus ought to be simple enough to be assembled or constructed by the students themselves from ordinary laboratory equipment. Further, that an approach to many important principles through the laboratory, rather than by way of lecture, more easily stimulates interest, and more certainly ensures comprehension." "Most of the exercises have for many years past formed part of a course of physical chemistry at the University Chemical Laboratory at Cambridge. While much of the course has been found suitable for beginners in the subject, who are candidates for an Honours Degree through the Natural Sciences Tripos a number

of experiments are described which are appropriate to more advanced students." "These examples are all based upon data obtained in the Cambridge laboratory from actual materials and apparatus described in the text. They . . . demonstrate the possible accuracy attainable, and assist in encouraging an orderly and significant exposition of the data."

The last consideration is of great practical utility and has been followed in the writer's laboratory. If adhered to, it gives the students self-confidence and also enables them to have a grasp of the sources of errors by comparison of their results with standard data.

The experiments are grouped under the following headings: The densities of gases and vapours, Crystallisation and the properties of crystals, Solutions and solubility, Dilute solutions, Thermodynamics, Ionization, Velocity of chemical reaction, Surface chemistry.

The book is well written and the experiments well chosen. It will be of help to teachers and students interested in this subject. The reviewer feels a special interest in the experiments described under crystallisation and properties of crystals, mutual solubility and surface chemistry. Some of the experiments in chapters II, III and VIII will be included in the students' course in this laboratory.

There are two criticisms that might be made. One of them is that the attempt to confine experiments to simple apparatus has its limitations. If over-emphasised, there is a danger of students carrying away the idea that such accuracy as is attainable with these apparatus is quite useful for most purposes. The other is that a student of modern chemistry of the standard intended and especially of physical chemistry should have full opportunities to be familiar with complex physical apparatus, principles of their construction, the theoretical principles underlying their use and accurate measurements with them. And a course of experiments in physical chemistry cannot be very complete if such opportunity is not afforded. It is of course true that part of this work is done in the course in physics but there are special aspects which are not likely to be dealt with there.

In the experiments on viscosity of gelatine reference should have been made to the distinction between Newtonian and non-Newtonian flows.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

A NOTE ON SUBSTITUTES FOR CORKS AND CORK SHEETS

In view of the need for corks and cork-sheets which is being felt by the various institutions and the public alike, some work¹ has been done at the Forest Research Institute, Dehra Dun, where Dr D. Narayanamurti with his collaborators has invented some substitutes for corks. He has reported (i) corks made of *Cryptomeria Japonica* wood suitably slotted and softened by chemical treatment, (ii) composition corks made of disintegrated tree barks, bagasse fibre, etc., with various cementing materials, and (iii) the pitch corks for hypodermic tabloid tubes. The first two methods though useful are laborious, lengthy and costly when compared with the original corks and the third one is meant for only a particular kind of purpose.

Stress has been laid on finding a suitable natural substitute rather than an artificial substitute, for the former is likely to be cheaper and more readily available than the latter. A number of woods and substances were tried. It was found that cobs (cobs without grains) of the Indian maize (*Zeemayes*) constitute a good substitute for the corks if properly finished. These cobs are conical in shape, light in weight, and compressible in structure. Their density is almost comparable with that of cork. The cross-sectional area can be easily reduced to a great extent by means of a cork presser and the natural conical shape helps in fixing them well in the bottles as bottle stoppers. Thus much of the labour for tapering them is saved.

The cobs are cut into pieces of any desired length with a sharp and thin weapon (a razor blade with a suitable handle can serve the purpose well) vertically across their axes. Their rough surface is smoothed with a sand paper. Then, they are soaked in molten paraffin for about a minute or two and are ready for use. Much sand-papering is not required, for the tiny loose projections on the surface of the cobs set them well tight in position in the bottles, when suitably pressed into them. Cobs so

prepared have sufficient resilience as well. If more resilience is required, the same process² used for the artificial corks of wood can be used.

The use of these cobs in their natural condition is well known in the hills (where corks are mostly unknown to the people) and have been in use for the last several centuries. When properly finished, they serve the purpose well and are perhaps the cheapest substitute for corks. Further, the utilisation of the cobs in the manner described above will bring an additional income to the farmers, because at present they are either thrown away as a waste or burnt as cheap fuel.

The cork-sheets which are generally needed in science laboratories are equally important. The natural substitute for them is not available in this country. After a trial with various mixtures for their substitute, sheets of cowdung cakes of about 1 to 2 cms. thickness, well pressed and dried slowly by the sun's rays, have served well. The density of this sheet is about 0.32 gms. per c.c. which is almost equal to that of cork (0.24 gms. per c.c.). When dry, it is a good insulator of heat and electricity and its hardness and conductivity are comparable with those of the corks.

Trials with some other composite mixtures, such as, cow-dung powder, Plaster of Paris, paper, saw dust, cotton, etc. have also proved effective. A pulp of cow-dung powder in water containing about 5% loose cotton fibres and about 5% strips of thin paper is one of the best mixtures for making the sheets. This mixture may be heated slowly till it forms a thick paste and then spread on a glass surface having four sides of any required depth and pressed from above. It may be allowed to dry up either by direct sun's rays or by any other slow process of heating. Sheets so formed serve the purpose of cork-sheets well.

As the cow-dung is a good absorbent of moisture from the moist air and apt to decompose and give out bad smell, the sheets of cow dung as prepared above, are dried very well so that no moisture is

left in them and are later on dipped in molten paraffin wax for about two minutes. The molten wax gets into the pores of the sheets and give a thin coating on the surface. This process renders them non-absorbent of moisture from the air as well as from any other direct contact. It also avoids decomposition of the material. The sheets so formed neither decompose and give bad smell nor absorb moisture from any external agent. Further work on this problem is in progress and the improvements, if any, shall be published later on.

The author takes this opportunity to thank His Highness' Government, Patiala, for providing facilities to carry out the above work in the Physics Research Laboratory, Mahendra College, Patiala. He also expresses his grateful thanks to S. Harchand Singh, Director of Agriculture, Patiala State, for his useful suggestions and interest in the work.

L. D. MAHAJAN

Physics Research Laboratory,
Mahendra College,
Patiala, 15-7-1942.

¹ D. Narayanamurti, J. N. Pande and D. C. Roy—"Note on some experiments on cork substitutes", Leaflet No. 6 (Utilisation) of the Forest Research Institute, Dehra Dun, 1941.

² loc. cit., p. 2.

A STUDY ON THE MAGNETIC BIREFRINGENCE OF CuSO_4 SOLUTION

The magnetic birefringence of aqueous solution of some of the salts of iron and rare earth groups has been studied in detail almost simultaneously by Haenny¹ and Chinchalkar². When measured on the scale of nitrobenzene, most of the paramagnetic solutions were found to show large negative birefringence, agreeing very well with the structure as revealed by the magnetic anisotropy data of the corresponding hexahydrated paramagnetic salts. Incidentally it may be remarked that the large magnetic anisotropy of these salts arises, according to Van Vleck, from the asymmetric crystalline field acting on the central paramagnetic ion, surrounded by six negatively charged oxygen atoms forming approximately a regular octahedron.

In the case of the solutions of the rare earth salts Chinchalkar² established a close relationship between the orbital moment of the paramagnetic ion and the magnetic birefringence. But the actual mechanism of the contribution of the orbital moment to the birefringence was not then clearly understood.

Recently, however, Krishnan³ attempted an explanation of the phenomenon on the theoretical results obtained by Jahn and Teller and on the assumption that the symmetry of the crystalline field, as existing in the corresponding solid state, persists to a certain extent even in the aqueous solution of these paramagnetic substances, the geometry of distribution of the water molecules around the ion being determined by the central paramagnetic ion. Following Jahn and Teller he showed that for the stability of the system there should be just enough asymmetry in the distribution of the water dipoles about the ion as to remove any degeneracy in the electronic state (particularly the orbital degeneracy) of the ion. The asymmetric groups thus formed in solution are both magnetically and optically anisotropic and they exhibit the magnetic birefringence in solution.

Copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) is one such paramagnetic crystal which shows a large magnetic anisotropy, the magnetic ellipsoid being approximately an oblate spheroid. X-Ray analysis of the structure of the crystal shows that Cu^{++} ion is surrounded by an octohedral distribution of six negatively charged oxygen atoms, four of the atoms belonging to four water molecules and the other two contributed by the two sulphate groups. The octohedron is only approximately regular. The crystal field acting on the Cu^{++} ion, therefore, deviates considerably from cubic symmetry.

It can, therefore, be expected that this asymmetric field acting on the Cu^{++} ion persists even in solution of copper sulphate. One direct consequence of the existence of such asymmetric groups in the solution would be a large magnetic birefringence exhibited by the solution. We studied the magnetic birefringence of the solution for two different concentrations of the substance, and the preliminary results obtained are given here on the basis of the birefringence of nitrobenzene ($= +100$).

Concentration per c.c. of the Solution.	Magnetic Birefringence on the scale of Nitrobenzene $= +100$.
0.1335 gm.	-2.1
0.1649 gm.	-3.46

The negative sign of the birefringence fairly agrees with the magnetic anisotropy data for $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ obtained by Krishnan and Mookherji⁴. The two values obtained show that the proportionality law does not strictly hold at that concentration. However, our observations support Krishnan's view regarding the persistence of the crystalline field in solution of paramagnetic salts.

In conclusion, the author acknowledges his grateful thanks to Prof. K. S. Krishnan, D.Sc., F.R.S., for suggesting the problem and for his kind interest in the work.

D. C. CHAKRAVARTI

Physical Laboratory,
Krishnagar College,
Krishnagar, 20-7-1942.

¹ Haenny, C. R., 193, 931, 1931; 195, 219, 1932.
² Chinchalkar, S. W., *Ind. Jour. Phys.*, 6, 1931.
³ Chinchalkar, S. W., *Phil. Mag.*, 20, 856, 1935.
⁴ Krishnan, K. S., *Nature*, 143, 1939.
⁵ Krishnan, K. S. and Mookherji, A., *Nature*, 140, 896, 1937.

PRESERVATION OF BOOKS AFFECTED WITH DRUG-STORE BEETLE AND MILDEW

Thirtysix volumes of Turkish manuscripts badly affected with a grub (*Gastrallus Indicus Anobiidae*) were received in the Imperial Record Department in March, 1942. Most of the manuscripts were in an extremely brittle condition. The volumes are composed of ordinary hand-made paper, leather and binding cloth. All the manuscripts are written in carbonaceous ink without any trace of iron. The ink is washable but is still in a bright condition. In addition to the larvae and adult beetles, mildew growth in certain volumes was also detected.

The volumes were first fumigated in an air-tight chamber with thymol vapour for 72 hours at a temperature higher than 80°F . The volumes were then taken out and the mildew growth removed gently with a clean piece of linen. The volumes were again fumigated with paradichlorobenzene in an air-tight steel cabinet for a period of ten days. It has been found from experiments carried out that paradichlorobenzene exterminates the drugstore beetle and, what is equally important, does not react on the paper so as to destroy its sizing or otherwise cause a decrease in its tensile strength. The ink also remains unaffected. The manuscripts have been kept in a closed almirah with enough of naphthalene flakes and bricks. The larvae and adults have surely perished in the fumigation. The eggs in burrows might have escaped penetration by the lethal gas but upto now there is no sign of fresh attack and it may be presumed that the eggs had no chance to hatch up under the unfavourable environment. The quickest and the most effective method of dealing with all sorts of insects and fungi is vacuum fumigation. The fumigants used in the concentrations given and said to be 100 per cent. effective in killing all storage insect pests within 24 hours are: (i) hydrocyanic acid

gas from 1 lb. of sodium cyanide per 1,000 cu. ft.; (ii) ethylene chloride-carbon tetrachloride, 14 lb./1,000 cu. ft.; (iii) carbon disulphide, 6 lb./1,000 cu. ft.; (iv) ethylene oxide-carbon dioxide, 30 lb./1,000 cu. ft.; (v) methyl formate-carbon dioxide, 28 lb./1,000 cu. ft.

Regarding Mr M. Basu's note¹ on 'Preservation of Books affected with Insects' it may be mentioned that fumigation by formalin for five minutes only is almost certain to leave the eggs intact. The period should be at least 4 hours. The country made preservative powder consisting of cloves, cinnamon, etc. is quite good for small libraries but it is costly for big libraries and archives because considerable labour is required when a large amount of the preservative has to be mixed and put into bags.

S. CHAKRABORTI

Research Laboratory,
Imperial Record Department,
New Delhi, 21-7-1942.

¹ SCIENCE AND CULTURE, 12, 617, 1942.

A FOSSIL DICOTYLEDONOUS WOOD FROM BHANUGACH RESERVE FOREST, SYLHET DISTRICT, ASSAM

In April, 1940, Mr R. N. De, Botanical Forest Officer, Assam, collected a small fossil wood from Bhanugach Reserve Forest, Assam. He sent that specimen to Mr P. C. Datta of the Geology department, Presidency College, Calcutta for identification. Mr. Datta, kindly handed over that specimen to the present author for investigation and report.

The specimen is barely six inches in length and one inch in breadth. It appears to be a portion of a dicotyledonous wood very badly preserved. It soils the fingers with a yellowish-white powder. As the specimen was highly decomposed it had to be subjected to prolonged boiling in Canada balsam before it could be studied either with a lens or a section could be made for microscopical examination. An anatomical description of the wood is given below:—

1. *Growth rings*: Not distinct.
2. *Vessels*: They are uniformly distributed throughout the wood; distinctly visible to the naked eye as dots against the ground tissue. Mostly

medium sized and are either solitary or in radial pairs of 2-4.

3. *Tracheids*: They are vasicentric. Usually in a single row, flat and parallel to the walls of the vessel.

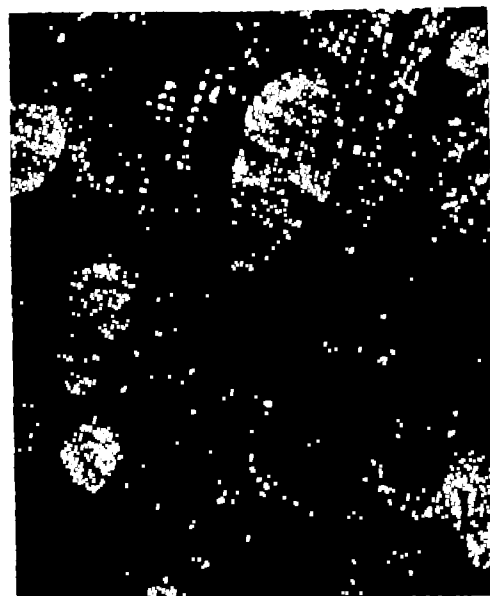


FIG. 1. Transverse section showing general structure of the wood, distribution of vessels, tracheids around vessels and parenchyma $\times 70$.

4. *Fibres*: Irregularly arranged, small, tapering at both ends. Some show resinous contents.

5. *Parenchyma*: Fairly abundant. Three types are noticed:

(a) *Paratracheal*—in bands, intercepted by tracheids.

(b) *Metatracheal*—confined between two vessels, commonly 5 to 8 cells in a row.

(c) *Diffuse*—scanty.

6. *Rays*: Distributed through the wood. Three types are noticed.

(a) *Uniseriate*—one row of upright cells.

(b) *Biseriate*—procumbent and upright cells.

(c) *Multiseriate*—rare, heterogeneous.

7. *Gum ducts*: Vertical ducts surrounded by parenchyma are observed.

The above anatomical description agrees with the general diagnostic feature of *Dipterocarpaceae* as described by Chowdhury¹ who has recorded as

follows: "The diagnostic anatomical features of this are: vertical gum duct, tracheids adjacent to vessels, vasicentric parenchyma in thin intercepted bands, metatracheal parenchyma in short or long rows at unequal distances and heterogeneous rays." It will be observed that the fossils under investigation show all these anatomical features. The object of this note is to put on record another occurrence of fossil wood of *Dipterocarpxylon* type from Assam besides *Dipterocarpxylon garoense*. Details of the fossil wood will be published elsewhere.

Thanks are due to Dr M. Chatterjee, Senior Professor of Geology, Presidency College, Calcutta, for facilities given to me to work in his laboratory. I am also indebted to Mr A. K. Ghosh of the Botany Department, Calcutta University, for his guidance and Mr P. C. Datta for the specimen.

ANIL MUKHERJEE

Geological Laboratory,
Presidency College,
Calcutta, 29-7-1942.

¹ Chowdhury, K. A., *Rec. G. S. I.*, 73, 247, 1938.

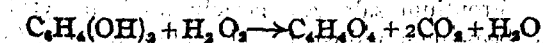
OXIDATION OF RESORCINOL BY MEANS OF HYDROGEN PEROXIDE IN PRESENCE OF TUNGSTIC ACID SOL

The author in his previous publications¹ has carried out the oxidation of sulphhydryl bodies and phenols by means of hydrogen peroxide in presence of tungstic acid and molybdic acid sols. In this communication the oxidation of resorcinol by means of hydrogen peroxide in presence of tungstic acid sol has been described.

Carbon dioxide and maleic acid have been found out as end products of the oxidation of resorcinol by means of hydrogen peroxide in presence of tungstic acid sol. Carbon dioxide has been estimated quantitatively by absorbing in dry soda lime. The mechanism of the reaction as regards the intermediate products and any other final products are in the course of investigation. The velocity of the reaction has also been measured by observing the pressure of carbon dioxide developed during the course of the experiment. The velocity coefficient has been determined by means of the expression

$$K = \frac{1}{t_2 - t_1} \log \frac{P_\infty - P_{t_1}}{P_\infty - P_{t_2}}$$

where P_{t_1} , P_{t_2} and P_∞ are the pressures of CO_2 at time t_1 , t_2 and when the reaction is complete according to the stoicheometric equation:



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Dacca University,
Dacca, 3-8-1942.

B. C. KAR

¹ Ghosh, J. C. and Kar, B. C., *J. Ind. Chem. Soc.*, 11, 485, 1934; 14, 249, 1937; Kar, B. C., *ibid.*, 14, 291, 1937.

INTRA-CARPELLARY FRUCTIFICATION IN *CARICA PAPAYA* LINN

Harris¹ has mentioned several cases of intra-carpellary fructification or internal proliferation in *Carica papaya* as described by Muller, Prain, and Urbina. Bergman² recorded the presence of a sessile stigma on some of the intra-carpellary fruits and in



FIG. 1. Showing the intra-carpellary fruit. A centimeter scale has been placed alongside.

one specimen the presence of a style surmounted by a capitate stigma. Sayeeduddin and Bari³ also reported a few cases of secondary fruits in this plant.

Recently the writer found a papaya fruit containing a single intra-carpellary gynaecium (fig. 1) which appears to be the result of the proliferation of the vascular axis. The most interesting feature, which has not been recorded previously, is the presence in it of a distinctly trilobed stigma borne on a well-developed style around which the lobes appear twisted. In the normal flowers the five stigmatic

lobes rise over the style forming a depression at the point of junction, but in the specimen described here

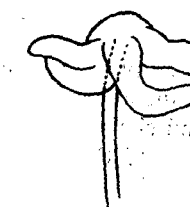


FIG. 2. Showing the trilobed stigma highly magnified.

the lobes come out of a mass of tissue on top of the style and appear to be pendant (fig. 2). The style is delicate, terete, very much elongated and curved, measuring about 17 mm. in length. The ovary is a basally dilated conical body about 10 mm. in length and 15 mm. in diameter at the base. It is a solid mass of thin-walled tissue with a vascular cylinder consisting of six small loosely aggregated stelar strands which run towards the apex. Near the base of the carpel a large number of similar strands radiate from the central column and, following a peripheral course in the body of the carpel, run towards the apex.

M. A. SALAM

Department of Botany,
Muslim University,
Aligarh, 22-7-1942.

¹ Harris, J. A., Proliferation of the fruit in *Capsicum* and *Passiflora*, *Report Ms. Bot. Gdn.*, 17, 143, 1906.

² Bergman, H. F., Intra-ovarial fruits in *Carica papaya*, *Bot. Gaz.*, 72, 97, 1921; An unusual intra-ovarial fruit in *Carica papaya*, *Bot. Gaz.*, 76, 222, 1925.

³ Sayeeduddin, M. and Bari, A., Internal proliferation in *Carica papaya* Linn., *Current Science*, 4, 740, 1936.

ON THE DISCOVERY OF CELESTITE IN CIS-INDUS SALT RANGE

During an inspection tour to the salt outcrops of Ainwan, in one of the nullahs of sulphurous water, situated a little further up, a piece of white stone was brought to my notice, which seemed to be baryte on account of its high sp. gravity. But later it has been confirmed to be celestite, the strontium sulphate ore. Following the traces of the mineral up-hill I came

across a few veins of celestite at a point situated about two miles west of Jaba near the foot-path leading to Khairabad in the Mianwali Tehsil-survey Sheet No. 38 $\frac{P}{7}$.

There are two sulphurous springs in the area occurring at the unconformable junction of the Murree sandstone and shale with the Laki limestones. They form the source of the "Karki Wahni" (bitter stream). In the high precipices of the hill of nummulitic limestone about 300 ft. above these two springs the celestite veins occur.

Gypsum also occurs in large quantities in reticulated veins in Laki limestone. The gypsum veins are from a few inches to three feet in thickness. At one place the mineral is widely disseminated among the limestone. Gypsum is also found in the form of enclaves in the limestone.

Regarding the reserve of celestite, the mineral occurs in fairly large quantities. I roughly estimate that about 10,000 (ten thousand) tons of celestite will be available from the deposits near Jaba within easy depths.

The celestite is of extremely pure quality. One sample on analysis yielded 99.98% strontium sulphate.

Krishnan¹ reported the occurrence of strontium minerals from Madras (Trichinopoly District), Sind (Thana Bhula Khan) and Kohat (in red clays near Surday). But the Kohat deposit is insignificant. The present find appears to be the first discovery of

strontium mineral in the cis-Indus Salt Range in large quantity.

Strontium salts are largely used in pyrotechnic and beet-sugar industries. If obtained pure, fine, air floated, powder of celestite (250 to 300 mesh) can be used in paint in the same way as baryte (sp. gr. 4.5). It can be used as a filler and as an "extender" of paints. Krishnan says that about 2000 to 4000 tons of celestite (sp. gr. 3.9) are used as paints and fillers in Great Britain every year. The price paid in U. S. A. is about Rs. 50/- per ton. No celestite containing less than 90% SrSO_4 is marketable. Celestite is used in distemper and 'lake' colours while metallic strontium and various strontium salts are used in the metallurgy of copper, lead, zinc, tin and steel; they are also used in ceramic industry, in the manufacture of heavy mud for oil-well drilling and medicine.

I am thankful to my Professor S. K. Roy of Indian School of Mines, Dhanbad for his help in the preparation of this note.

B. S. LAMBA

Superintendent,
Central Excise, Salt Dept.,
Kalabagh, 17-1-1942.

¹ Krishnan, M. S., *Rep. G. S. I.*, Vol. 76, 1941. *Bull. Econ. Mineral No. 3 "Strontium".*

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

OCTOBER, 1942

No. 4

Twenty-five Years of the Soviet Union

"The philosophers have only interpreted the world, it is our business to change it."

—Karl Marx.

THE titanic struggle which the Soviet Union has been putting up against the most powerful military machine of all times has been a surprise to most Governments and peoples of the world including even Germany. The history of a State which began to industrialise itself barely two decades ago and which has proved a near match for Germany, which is one of the leading industrial and militarised countries with hundreds of years of technical and scientific efficiency, is a matter well worthy of study by every country, which wishes to get on in the present-day world. Twenty-five years ago the proletariat came to power in Russia, emancipated all the colonies of Czarist Russia, consolidated their revolution against heavy odds, both external and internal, and set to the task of industrialisation and modernisation on a scale unheard of in all history. It is opportune at the present moment to make a brief resume of this historic revolution achieved twenty-five years ago.

*According to Encyclopædia Britannica, the Soviet Revolution started from October 26, 1917, when the Petrograd (now Leningrad) Soviets began to issue their own orders against that of the provisional government. Lenin was actually installed as Chairman of the Peoples' Commissars on November 7, 1917.

The Revolution embracing all phases of human activity may be divided into:—

1. A technological revolution—passage from age-old agriculture and palaeotechnic† method of production to modern industrial methods based on science and neotechnics.
2. A political revolution—passage from Czarism to what was termed at the time as the Dictatorship of the Proletariat.
3. A socio-economic revolution—passage from capitalism and private property to communal ownership, and abolition of private interests.
4. A religious revolution—passage from different forms of established religion to a new system based on Darwinian picture of the world.

The Russian Revolution was rightly regarded as the most momentous experiment with human society,

† Palaeotechnics and neotechnics are used in the sense given to them by Louis Mumford in his 'Technics and Civilization'. Palaeotechnics mean industrial operations based on tools, and individual workers formed into artisan classes. Neotechnics mean operations based on science and technology and factory system, and full and rational development of country's resources in power, minerals, and agricultural products.

as no other previous movement could approach it in the extensiveness of its programme, in the radical nature of its doctrines, and in the stupendousness of the scale of operations. The movement was hailed with unbounded enthusiasm in some quarters, and was denounced with equal bitterness in others. Even people with apparently no motives of self-interest to vitiate their judgment, were profoundly sceptical. Flames of controversy were incessantly raised round each action of the Soviets, and it was difficult to see the essential from the non-essential. It was the veteran socialists Beatrice and Sydney Webb, who were among the first to give a clear account of the doctrines, the programmes, and lines of action of the Soviets, and cleared the way for a just appraisal of the Soviet Experiment. And after 25 years, it is now possible to judge the Soviets on the surest criterion of experiments, *viz.*, actual results.

Now, what were the major elements in the Russian programme? Opinions have varied according to the training and make-up of the critic, and to the particular incident on which attention was focussed for the time being. But if we take an objective view of the case, there can be no doubt that of the four revolutions, the first is the most elemental one, and in a sense the parent of the other three, for the first task of man is to live, and organise for living. The other activities, political, economic and religious have grown mainly round attempts to live.

TECHNOLOGICAL REVOLUTION

Judged from this point of view, there cannot be the slightest doubt that the Soviet Experiment has been an unqualified success. Before the Great War of 1914, Russia was mainly an agricultural country; 94% of her people lived in villages dispersed over the great plains, and only 6% were city-dwellers. Russian industry was in a very backward condition. As an index of her backwardness, we can refer to her production of electrical power which was only 2,500 million units; this was exceeded at that time even by tiny Switzerland, and the per capita power consumption was 1/100 of countries like U. S. A. or Norway and not much better than present-day India. Other essential heavy industries, *e.g.*, chemical, metal, and engineering, were equally undeveloped, and Russia had to depend on foreign countries for all the essentials of modern industrial life, *e.g.*, heavy chemicals, locomotives, electrical machinery, telephone and telegraph equipments, etc.

Whatever small industrial establishments were there were mainly controlled by foreign capital and had to depend entirely on foreign technicians for their running. As regards paucity of scientists and technicians, we may refer to the case of the physical science. In the whole of vast Russia, there were not more than 15 trained physicists, having the intellectual calibre of a London Ph.D. The same may be said of other sciences and technical subjects.

The collapse of Russia after two years' war in 1916 was due not so much to the inefficiency of the Government and the military system as to the breakdown of her industries and her transport system. The Czarist Government, learning from her defeat by Japan in 1905, had concentrated on the perfection of the military machine, had raised and drilled huge armies, but had failed to see that the modern military machine is integrally connected with the industrial life of the country and had paid no attention to the development of her internal resources.

The Soviet Government, when they forcibly took over power from the previous regime, had in the forefront of its programme the technological revolution, and in spite of Civil Wars inside, invasions from outside, open hostility of foreign exploiters, and jeers of doubting *Pundits* like H. G. Wells and Will Durant, they kept to the programme with single-minded devotion. As we have mentioned earlier, the success of their programme (known popularly as the various five-year plans) is exemplified by the magnificent resistance which Soviet Russia has offered against the mightiest military machine the world has ever seen, but figures will be more convincing to an objective mind. Before the outbreak of her war with Germany, Russia had increased her production of electrical power by 20 times (from 2500 million units in 1916 to 50,000 million units in 1939); she had developed her mineral industries (oil, iron, coal) nearly as many times. She had built up her heavy industries—including chemicals, automobiles, aeroplanes, and transport, from almost nothing to a fair degree of self-sufficiency with exclusively Russian capital and Russian technical personnel. Her internal resources had been accurately surveyed, and this has revealed that potentially she is as rich in natural resources as the United States of America. Nor has she neglected agriculture. She has made large-scale use of science for the rational development of her agriculture, has introduced new and revolutionary methods like vernalisation, developed huge tracts of cultivable waste. The standard of living has risen

very appreciably and wealth has been much more evenly distributed. Even her enemies, declared or undeclared, have paid a compliment to her by copying in part her methods of production, development of natural resources and control and distribution of the wealth so created.

The Technological Revolution started in Western Europe with the discovery of the steam engine, but has been a slow and gradual process in these countries and the U. S. A. It has gradually led to the immense increase in their material and moral power. Older countries like China, Russia, Eastern Europe, and Latin America remained wholly or partly unaffected for a long time, and this indifference led to their decline in political power and to their exploitation by the various West European nations and U. S. A. It was only Japan which early awoke to the danger, and set herself to the task of assimilating unreservedly the lessons of the Technological Revolution.

We must therefore conclude that as far as the Technological Revolution is concerned, the success of Russia has been completed and unqualified, and if Russia were allowed to develop her resources undisturbed, she would have attained a prosperity and a strength unequalled in the history of the world.*

The reader might ask: why did not the Czarist government undertake to effect a part at least of the Technological Revolution, which, if properly carried out, would have saved them. This could have been achieved without a radical change in the political or the economic organisation, and as a matter of fact, far-seeing scientists like the great Mendeleef had again and again called the attention of the Czarist ruling class to the urgency of the Technological Revolution. But theirs was like the voice of Cressida, uttering prophecies which ultimately turned to be true, but which were never believed at the time, probably because it was against the psychological make-up of these persons. Any how, a perusal of contemporary history shows that the Russian rulers did not appreciate the advantages to all classes arising from the Technological Revolution, or dreaded the incre-

* It is sometimes considered that the conflict between Russia and Germany is wholly due to conflicting ideologies of Fascism and Communism. This may be true but there is also the reason of the traditional rivalry between the Slav and the Teuton and also the race theory of the Nazis. If Russia were allowed another 5 years to develop herself at the rate she had shown since 1929, no combination of powers in the world could have defeated her. It was an appreciation of this knowledge which perhaps led to the precipitation of the Russo-German conflict.

ment of power to the common man which would accrue from such a change and even the best amongst them were suffering from intellectual confusion caused by half-theatrical writings of men like Leo Tolstoy. Anyhow, the Czarist rulers could not persuade themselves to change their mind, and went straight to their doom. Their stiffneckedness* precipitated the Political and Economic Revolutions which brought untold miseries upon the population during the transitional period. Had they been reasonable, or appreciated the advantages of the Technological Revolution, and acted with energy for this end, the political and economic transformation might have been quite gradual, and unattended with the violence, which has given the Revolution a bad name. But as events happened, the violence could not be avoided.

POLITICAL REVOLUTION

The Political Revolution in Russia was described for a time as transition from autocracy to dictatorship of the proletariat but some observers are at pains to point out that actually it was merely a substitution of dictators like Lenin and Stalin for Czar Nicholas at the Kremlin. A little observation shows that the criticism is entirely superficial. Czarism stood for a privileged class, a corrupt and slow-moving bureaucracy, and had no programme for industrial or agricultural development. As Sydney and Beatrice Webb have pointed out in their searching analysis the communist party machine, which monopolizes the political power, corresponds in its ideal and composition almost to Plato's Philosopher-Rulers: 'a set of rulers carefully chosen for their character and powers of leadership, having almost ascetic habits, and with a psychological make-up against the chance of having their judgment vitiated by private or privileged class interests.' Very few people can conform to such high standards, and the Soviets have to weed out undesirables periodically by a critical examination of the actual records of each member.

As regards officers of the State, according to the fundamental principles of communism, people are selected to posts according to the records of their

*As an index of the stiffneckedness of the Russian ruling class, may be mentioned the fact that hardly a week before the Czar was forced to abdicate, and was put in confinement, he sent a telegram to his military governor at Petrograd to shoot down ruthlessly the strikers, and food-processionists. This was obeyed and 130 strikers were shot down. But next day, the Cossacks and the police refused to shoot on the strikers, and the revolution broke out. A week later, the Czar and his family were arrested and taken to Eastern Russia.

actual achievements, while in capitalistic countries (like England), the accident of birth plays a great part, in so-called democratic countries (like England or U. S. A.), the higher posts go to men occupying high positions in a political party, formed on the basis of worn-out principles. It reduces to the preference of birth or talking power to work. The nearest superficial approach to the Soviet system is the Institution of Civil Service, but both in England and U. S. A., they occupy a rather subordinate position and are not allowed to take any initiative and essentially owe allegiance to the propertied class. In India the Civil Service enjoys more power, but they have been more like Turkish Janissary guards*, recruited at an early age from amongst youths of England (educated mostly in the reactionary public schools) and to some extent of India, and drilled by an iron discipline to the services of a reactionary and unprogressive Imperialism. Such Indian Civil servants who show too early independence of character, or betray some regard for their country's interest are usually switched off to the sanctuary of the "Judiciary", or some other innocuous job. Such as happen to come to the higher administrative posts are usually men who in the phraseology of Lord Curzon "have proved themselves to be as safe as Dead Mutton".

ECONOMIC REVOLUTION

The Socio-economic Programme of the Revolution involved the nationalisation of the means of production both of factories and land. The sudden change-over from a capitalistic system and outlook to socialism and collectivisation was indeed such a terrific jolt that some mistakes born of inexperience were committed in the early stages of the economic revolution. When the Bolsheviks first assumed power, all private property particularly in the means of production was abolished, with the result that

* The Ottoman Turks who rose to supreme power in Asia Minor about 1300 A.D. were originally a mere handful. According to one estimate, they consisted originally of 444 horsemen and their families. The second prince, Sultan Orkhon perceiving the danger of the numerical inferiority of his own tribe, instituted the system of Janissaries. Boys belonging mostly to Christian, but also to other Mahomedan communities, who were captured in raids or in wars were very scrutinised regarding their physical and mental capacity and such as proved the test were taken early into the service of the State, given an adequate military and civil education, and were trained by an iron discipline to loyalty to the person of the Sultan. They formed the higher military and civil officers of the State, and were responsible for the unrivalled efficiency of the Turkish military machine during the Middle Ages which kept scores of races in Eastern Europe, Western Asia and Northern Africa in bondage for 400 years.

production and supply of even essential goods were seriously affected; interchange of goods between cities and the country came practically to a standstill. It was as if the circulation of the life-blood of the State had nearly stopped. The reason for this deadlock was not purely mechanical failure but the sabotage by the counter-revolutionary bourgeoisie and landowners, the persistence of the old capitalistic and individualistic psychology and traditions, and the intervention by about a dozen capitalist powers of the world. Fortunately Lenin sensed the danger in time, and introduced the New Economic Policy (NEP), which allowed liberty of production and of sale to peasants, small manufacturers, and retail businessmen, keeping in the hands of the Government all foreign trade, heavy and medium industries, control of transport, banking, and all public utility services. This saved the country from an impending disaster, but led to the creation of Kulaks, or rich propertied peasants and small manufacturers in the villages. The Soviet leaders sensed a danger in the emergence of a new propertied class, which they tried to extirpate by rigid control and confiscation of properties. This led to destruction of grains, and slaughter of animals on the part of the misguided infuriated peasantry, who like peasantries all over the world, were more alive to their immediate possessions than to any visions of a prospective paradise. The result was a terrible shortage of food-stuff and livestock throughout the years 1930-1932, which caused death according to the Rightist press through starvation of millions of men.* Ultimately Soviet Russia had to make a compromise. It has kept all external trade, heavy industries, banking, transport, communication, mining and power industries in its own hands, and left the small dealer, manufacturer and peasant in undisturbed possession of his property. It has tried to meet the Kulak menace by large scale collectivisation of agricultural farms. Gone is also the uniformisation of all ranks within a factory or what Molotov† once humorously described as 'Complete planning outside the factory, and complete chaos inside'. Now the hierarchy of managers, directors, engineers and scientific workers, foremen, skilled and unskilled labour has been introduced, on graded scales of

* There is a controversy regarding the extent of this "Famine". The Bolsheviks admit the existence of food shortage, over greater part of Russia, but do not admit the accuracy of the death roll. The Webbs give a discussion about this controversy on pages 252-270.

† At first following the principle of unlimited democracy, all operatives in a factory from the manager to the humblest labourers were placed in the same category. If a manager

remuneration, thus ensuring to each man proper recognition of his merits. They have however, insured against the emergence of a propertied or privileged class by keeping all 'big business' under Government control. The essence of this long history of travail and re-construction against heavy odds is this. The Bolsheviks, right at the beginning of the Revolution, sought to go over to a communist system as nearly as possible, whose principle is "To every man according to his needs: from every man according to his capacity". This did not work because the necessary output of material production had not been effected. The slogan "To every man according to his ability" has therefore been adopted in order to stimulate production during the present period, which according to them, is essentially transitional. They claim to be marching towards full-fledged communism when the psychology of the people is gradually changed by education and when material production has advanced sufficiently to satisfy all men's reasonable needs.

RELIGIOUS REVOLUTION

Of the fourfold revolution, the religious one is the most difficult to judge, and the application of its lessons to other countries will be risky. Most of the age-worn religions are based upon a picture of the world and of ultimate realities which modern science has proved to be far from true. They look upon the Earth as the centre of the Universe created at the caprice of an Almighty Being about 5000 years ago according to the Christian scriptures and they look upon man as fashioned in the image of the Creator. They ascribe the troubles of mankind to some vague doctrine of original sin, or to some constant contention between the principles of good and evil. This picture is contradicted by modern theories of cosmogony, Darwinian theory of natural evolution, and discoveries of prehistory and ancient history. Though old forms of religion still claim millions of devotees, it is sure that with the spread of universal education, of scientific knowledge, and with the growth of industrial life, people will gradually outgrow the older superstitions and be guided by more rational principles in life. The religious controversy in Russia reached white heat, because prior to the Revolution, the Church proved to be a subservient tool of the Czarist Regime. The Czar was the head

proved obnoxious to his operatives, they could fire him off by the mere raising of hands. This is what Molotov described as "Chaos inside the factory". "Complete planning outside the factory" referred to the elaborate "five-year plans."

of the Church, "the Little Father", and the clergy always exerted their influence on the side of autocracy and fostered ignorance and superstitions by the performance of "miracles", organisation of Church services, festivals dedicated to saints and pilgrimages to holy places possessing miraculous ikons. The Bolsheviks, be it said to their credit, left the Church at first undisturbed, but when the clergy began to range themselves on the side of the counter-revolution, they had to relieve them of their franchise, withhold State patronage, and ultimately to close the churches, and to convert them to schools and educational museums. Not content with that, they organised godless societies and demonstrations in which the ridiculous parts of the old religions were exposed. They tried to organise, in a crude way, new festivals and new calendars. Thus the festival of St. John became the festival of the war on Superstition, that of St. Ilya the festival of Natural Science and the Electrification of Russia. A new generation is claimed to have now grown up to whom the old religion is a matter of history. With the spread of education, and of scientific knowledge, the old religion, having few votaries left, has been dying a natural death.

CONCLUSION

We have given a short and objective review of the Russian Revolution, because we believe that as regards political thought, this country appears to be in the same stage as was Russia of 1900, or China of 1911. The ruling class has shown itself to be determined opponents of "Technological Revolution" to a greater degree than to political or economic reforms, probably because they fear that if the economic condition of the common man is substantially improved, power will slip from their hands. The 'Patriot groups' suffer from intellectual confusion—some are guided by the obsolete half-theatrics of a Tolstoyan ideal, others utter only some unmeaning slogans copied from other countries, but not applicable to the conditions of this country. Worst are the divisions, and parties formed on religious basis. There is a great dearth of Directive and Creative Political Thought, as post-war Russia had in Marxism or China has since 1923, in the famous 'Three Principles of the People' (San Min Chao) enunciated by Sun Yat Sen, the father of the Chinese Revolution. Politicians in this country mostly emphasize the non-essential and neglect the essential and a lack of political and economic direction is palpably felt.

Oil and Invisible Imperialism

M. N. SAHA and S. N. SEN

A FUNDAMENTAL requirement of modern life is an adequate supply of power, and hence of fuel. The march of civilisation is indeed one for increased power, better organised and harnessed by scientific ingenuity. Here power, however, is used in the sense in which it is used in the scientific literature and should not be confused with its political meaning. Coal was until recently the main-spring of all power and it still remains a principal factor, though other sources are now available. With the invention of the Diesel and the Otto engines we have discovered in mineral oils another new source of power, hitherto untapped but tremendous in potentiality, which has ushered in a new era in the history of civilisation. In fact, the present age might best be described as the age of oil. The chemists used to say that the consumption of sulphuric acid was the index of a country's prosperity. It is now equally true of mineral oils. The phenomenal prosperity of America in recent years is to a certain extent largely due to her unique reserve of mineral oils distributed throughout the country, and to their development by her industrialists, technologists and scientific men. In a sense the statement that the present war is a war for oil is not far removed from truth when U. S. A. and Great Britain's share of world mineral oils is compared to that of the totalitarian states. The British Empire produces only one fiftieth of the World's petrol, while about a fifth of it is under British control. As a matter of fact, Britain and America, leaving aside Netherlands, have formed an impregnable Anglo-American oil tangle controlling the produc-

tion and distribution of over ninety per cent of World's mineral oils. This has been a vital factor in promoting international strife and dissension ever since the beginning of the present century.

INDIA'S POSITION AS PRODUCER AND CONSUMER

Unsatisfactory as the position of India is with regard to her mineral resources in general, she is strikingly poor so far as her reserve of mineral oils is concerned. Oil production in India is at present confined to the Potwar Basin near Rawalpindi in the Punjab where the two small fields, Khaur and Dhulian, are being operated by the Attock Oil Company and to Upper Assam oil fields worked by the Assam Oil Company, a subsidiary of the Burma Oil Company. The position of India with respect to oil was not, however, so gloomy before 1937 when Burma, formerly a British Indian province, was separated from India with her significant reserve of mineral oils by the India Act of 1935. For instance, in 1935 India (Burma included) produced 322 million gallons of mineral oil, while since the separation her output has dwindled to about 84 million gallons only. This output is insignificant compared to the growing needs of the country, and India has to import several hundred million gallons annually. In 1939-40 she imported 463 million gallons of mineral oils of various kinds valued at 17 crores of rupees mainly from Burma, East Indies, Iraq, U. S. A. and other countries. An idea of the amount of mineral oils of various descriptions imported into India from foreign countries can be obtained from the following table:—

IMPORTS OF MINERAL OILS INTO INDIA BY SEA FROM FOREIGN COUNTRIES*

	Gals. (000) 1937-38		Gals. (000) 1938-39		Gals. (000) 1939-40	
Fuel oil		128,048		136,788		146,448
Kerosene—						
In bulk	201,433	202,646	181,896	182,054	193,330	193,486
In tins	1,213		158		136	
Lubricating oils		39,970		32,761		35,191
Benzene, bensol, petrol, etc.		102,056		85,821		86,244
Paints, solutions and compositions		164		156		196
Other kinds		2,062		1,131		1,406
Total mineral oils		474,948		438,711		462,950

* Review of the Trade of India in 1939-40.

The war has intensified the oil problem of India beyond all proportions inasmuch as the supply from Burma and the Far Eastern countries (which had a major share in India's import) has been completely stopped and from other countries greatly curtailed. Besides even when peace is restored the demand for mineral oils in India is bound to go up by leaps and bounds with the gradual industrialisation of this country; and national interest requires that all possibilities of discovery in India itself should be explored by means of up-to-date prospecting methods.

POSSIBILITY OF EXISTENCE OF OIL IN INDIA

We have mentioned in the foregoing paragraphs which parts of India are at present producing mineral oils. The existence of oil in the vast alluvial plains of Northern India has been suspected for some time from the occurrence of natural gases in certain Himalayan regions and from the general geological layout. It is interesting to note that the geodetic work of the Survey of India together with a certain amount of prospecting work carried on by interested foreign companies has recently revealed theoretical possibilities about the existence of oil in the vast alluvial plains and in the foothills. Materialisation of these possibilities, though as yet somewhat speculative in character, will undoubtedly go a long way in solving the problem of India's mineral oils.

LICENCES TO FOREIGN COMPANIES

But what has caused deep anxiety among us despite the existence of these vast possibilities is the knowledge of the fact that foreign companies have been granted exploration licences in the suspected area. Not only British but American companies have been called upon to carry on exploration work and scientific prospecting in the vast alluvial plains of Northern India and in the foothills using geophysical and geodetic methods. We simply wonder at this inexplicable granting of licenses to foreign companies instead of entrusting the entire prospecting operation to the Geological Survey of India which has a rightful claim in this matter. It was the necessity of such prospecting work and estimating the mineral wealth of the country which called into existence the Geological Survey of India; the survey has proved quite an efficient organisation and has done much useful work since its inception. All that it requires now is the addition of a Geophysical Section;

properly staffed and fitted with all modern equipments. The Geophysical Section can then undertake the oil prospecting work for the Government of India. This practice is followed in the other British dominions; for example, Australia has organised a geophysical prospecting department since 15 years with vast advantages to herself. But the best example is afforded by Soviet Russia which, having expelled after the Revolution of 1919 the foreign financiers who controlled the Caucasian Oil fields, was for a time severely handicapped owing to absence of qualified technical staff, but took up the challenge bravely, trained a technical staff, and set the fields working again; not only that, but, as Dr C. S. Fox informed the readers of SCIENCE AND CULTURE, they had organised a large geophysical section for finding out minerals. The labours of the section have resulted in the discovery of undreamt of potential resources in oil, which are said to exceed even those of U. S. A. in quantity. With such an example before us, the invitation extended to British and American companies to encroach upon the activities of the Survey appears to be superfluous and is most likely to engender serious suspicions. A justification for the granting of such licenses might be sought in the superior technical knowledge and efficiency of foreign companies with well founded tradition in the matter of oil exploration, but what we are afraid of is whether it is not another example of imperialism slowly making its headway and whether invisible forces are not once more active in organising a vast scheme of economic exploitation of which instances are not wanting in current history.

Our apprehension has been intensified by some recent American writings on the problem of mineral oils. Mr G. M. Lee's article entitled "The Search for Oil" appearing in the Annual Report of the Smithsonian Institution for the year 1940 is an instance in point. The author has briefly described the world's position of the reserve of mineral oils and has recorded his genuine apprehension as to the early shortage of this most important geological commodity, a vital factor in modern civilisation in the American continent. According to him the American oil problem is destined to assume gigantic proportions in near future inasmuch as the exhaustion of its oil reserve is well within sight and there is every likelihood of this reserve being depleted in course of about 12 years if the production continues at the present rate. The article, we admit, has been written in good faith; but the author has unconsciously given a bit

of the Imperial American mind and has revealed certain facts which will be anything but pleasant reading to us Indians, nay to Asians at large.

AMERICAN INTEREST

But long before Lee's article was written American oil interests awoke to the menace of oil shortage in their country and turned their attention to carrying on scientific prospecting for oil in foreign lands, notably in Asia. Asia's negligible share of 9.4 per cent in the world's production of mineral oils is generally ascribed to scanty exploration work done in this vast backward continent. It is generally believed that intensive prospecting work which has been carried out in the United States of America and the European countries has revealed almost all the hidden resources, and that further exploration work holds little or no promise for future discovery of new oil fields. But such work can be profitably undertaken in Asiatic countries which offer yet enough scope for the discovery and development of new fields. The recent phenomenal developments of the oil fields of Iraq, Iran, East Indies and the Asiatic U. S. S. R. clearly bear out the potentialities of Asiatic countries in the reserve of mineral oils. But everywhere in Asia from the shores of the Mediterranean and the Red Sea to the Pacific Ocean, except in the territories under U. S. S. R. and Japan, this black underground treasure has been actively worked and exploited mainly by the British and Dutch Companies on the strength of their politically advantageous position in the East since the beginning of the present century. Thus in the Mosul area the concession is enjoyed by the British Oil Development Company. The Iraq Petroleum Company which developed the important oil fields of Kirkuk is shared between the Anglo-Iranian Oil Company, the Royal Dutch Shell and American and French interests. The Royal Dutch Shell Company and Unilever Limited are associations of British and Dutch interests in the utilisation of mineral oils among various other things in East Indies.

The entry of the United States in the general exploitation of world resources of oil is of comparatively recent date. Hitherto with her lion's share of world's mineral oils she did not feel the necessity of meddling in Asia about oil affairs though the hands of her oil magnates have weighed heavily on Mexico for over 25 years. On account of her growing oil

problem she has recently become keen on securing concessions in Asia and elsewhere. Mr Lees writes:

"A decline in total production from the great oil-fields of the States is however in sight within a measurable number of years, and a realisation of this fact is responsible for the recent intensification by American interests of the search for oil supplies elsewhere in the world, knowing that 5 or 10 years are required to explore and develop a foreign concession to the point of commencing export. Exploration is particularly active in South America and Asia. * * * Asia is at present producing 9.4 per cent of the total world supply, but without question this proportion will increase substantially in future years. British and British-Dutch companies have been active in oil exploration in Asia for many years and have many notable discoveries to their credit. Then recently, however, the search has been considerably intensified and the American interests have entered the fields on a much larger scale than hitherto."

These lines give us a clear insight into the American mind and remove all illusions about their intentions.

MEXICO UNDER OIL IMPERIALISM

In this connection we are naturally reminded of the bitter and painful history of Mexico's struggle against the U. S. oil magnates over the question of expropriation of U. S. oil interests in Mexico. This story should be better known as unchecked capitalistic exploitation by a foreign company and may produce the same effect in India in the years to come. Towards the end of the nineteenth century oil mining rights in Mexico were sold to foreigners by Porfirio Diaz (1877-1911), the first dictator of Mexico after the achievement of her independence in 1830. Diaz confiscated the lands belonging to the Red Indian villagers and granted concessions to foreigners. In fact, the foreign concessionaires were so favoured that by the mining laws of 1892-1909 they were allowed the right to exploit the sub-soil, an act hitherto unknown in Mexican history, the nation being under all circumstances the unquestionable owner of the subsoil deposits. Diaz thought the poverty was the main problem in Mexico, and this could be removed only by industrialisation; but as the Mexicans were backward, he opened the country to foreign capital in the honest hope that the general economic condition of the Mexicans would thereby be improved. Needless to point out that this dream was not realized. "The wealth of Mexico flowed down the pipe-lines to enrich the magnates of the

United States", and the Mexicans remained as poor as ever. Nay, the economic life of Mexico was completely dominated by oil interests, and the United States continued to be the dominant factor in Mexican politics. The Mexicans could aspire only to be a peon in an oil establishment, when even that was not available, to turn a bandit. After the expulsion of Diaz, Mexico, on account of her poverty, fell into a maelstrom of revolutions, and the oil magnates began secretly to play the monkey amongst the warring cats. When in the turmoils of Mexican revolution General Victoriano Huerta established himself in the city of Mexico, President Wilson refused to recognise the General's government and sell arms to his followers. But he had no scruples to sell arms to his enemies and on one occasion on a slight pretext sent Admiral Fletcher with a fleet to Vera Cruz, who bombarded the town and captured the Customs House. With the gradual rising of national consciousness the Mexicans found to their great bewilderment that of the total amount of capital invested in Mexican oil combined American and British capital amounted to the colossal figure of 960 million dollars and constituted as much as 95%, the remaining 4% going to minor imperialists like the Dutch and barely 1% to the Mexicans (in 1922). They clearly realised that their revolution would never succeed and the country would not have a stable government as long as this foreign economic exploitation continued unabated. The realisation of this idea is clearly embodied in the new constitution drawn up in 1917 by an assembly called by President Carranza, which strongly asserted *inter alia* that all land belongs to the state and that foreigners could enjoy no rights in Mexico which the Mexicans could not themselves possess. President Carranza with the little power he had could not, however, legalise the new constitution in the face of strong opposition from U. S. oil men who had formed a National Association for the Protection of American Rights in Mexico.

In 1920 Mexico found a forceful leader in General Obregon whom United States, Britain and many other European powers refused to recognise as president of Mexico. The following year the Washington State Department made a diplomatic gesture by offering to recognise Obregon officially as Mexico's president provided the General agreed to end land and oil concessions to foreigners. The United States refused to do so until Obregon agreed to end land and oil concessions to foreigners. The United States refused to do so until Obregon agreed to end land and oil concessions to foreigners.

guarantee the property rights of U. S. citizens in Mexico. Obregon replied:

"the Government of Mexico proposes to eliminate by the natural development of its political and administrative policy the necessity for promises which might humiliate it and proposes to follow this line until the field appears sufficiently free of obstacles to permit its being recognised without prejudice to its natural dignity and sovereignty."

And the field soon appeared free of obstacles. In order to enforce the clauses of the constitution of 1917 a new land law was enacted on the strength of which

"only Mexican citizens might own land or obtain concessions to exploit the sub-soil or if foreigners received the same right they must agree . . . not to invoke the protection of their Governments in respect to the same."

This was simply a bomb-shell thrown amongst foreign exploiters enjoying property rights in Mexico. There was nothing unjustified about the Land Law as it was merely copied from a similar law in vogue in the U. S. A. state of Arizona according to which

"no person may acquire titles or property in Arizona unless he be a citizen of the United States or has declared previously his intention of becoming such."

But Obregon had forgotten the story of the wolf and the lamb and according to American oil magnate's logic, what was good for the great U. S. A. could not be good for weak Mexico. Tremendous was its reaction to American Press and Mr Hampden-Jackson writes, "The American Press clamoured for war with Mexico; oil magnates damned the Mexicans as robbers, bankers damned them as anarchists." But Mexico, in spite of all bullying, remained unshaken in her resolve.

In October, 1927, Dwight Morrow was sent to Mexico as Ambassador to settle the dispute over Land Law and, thanks to his able mediation, the deadlock came to an end on U. S. Government's recognising Mexican Government's responsibility to protect U. S. citizens in Mexico and the right of the Mexican Supreme Court to declare on the rights of U. S. oil companies. The Supreme Court was wise enough to recognise at once the property rights of oil companies.

But the Mexican oil question was not to be settled so long as the oil properties held in Mexico by the foreigners could not be expropriated in their

entirety. The compromise of 1928 through Dwight Morrow's intervention was only a passing phase of the bitter struggle launched against the foreign exploitation of Mexico's sub-soil. After a period of quiescence oil controversy was resumed with renewed vigour which culminated in the expropriation by the government of the oil properties of seventeen British, American and Dutch companies. The decision in favour of expropriation was first arrived at by a board of arbitration to whom the dispute over the oil question was referred. The oil companies appealed to the Supreme Court which rejected the appeal on March 1, 1938, and the decision of the Supreme Court was at once followed up by a decree passed by President Cardenas, the strong man of Mexico expropriating the properties of foreign oil companies. The state governors unanimously adopted the decree and agreed to co-operate in compensating the foreign companies. Never was the position of any president of Mexico so strong, nor did any one receive such a unanimous popular support over a politico-economic question as on this occasion of the vindication of the national right over oil properties. The properties seized by the Government came directly under the control of the National Petroleum Administration, known as *Petroleos Mexicanos*. Needless to say that this confiscation of oil lands had serious repercussions on Mexico's foreign relations. Mexico had to break off relations with British Government on the latter's demanding an immediate compensation. Relations with the Governments of United States and the Netherlands were equally strained. As a result of pressure by these great powers the foreign market was lost, entailing severe economic depression in the country. Oil production was greatly curtailed though new oil markets were created in Germany, Italy, Japan and Sweden.

The curtain has been finally dropped on the Mexican oil controversy with the Supreme Court's declaring, on December 2, 1939, the 1938 expropriation legal, admitting the right of foreign companies to claim compensation 'for capital directly and legitimately invested' and allowing the Government to defer payment for as many as ten years. This declaration left no room for any further legal recourse and the Mexican oil controversy, raging for the last few decades, can now be looked upon as settled to all intents and purposes. Mexico is now master of her oil and her economics, thanks to the refusal of her leaders to be bullied by foreign interests.

THE EXAMPLE OF THE SOVIET UNION

Before we conclude, we like to suggest that India should follow the example of Soviet Russia in developing her resources of mineral oils. Like Mexico, Tzarist Russia adopted a policy of industrialisation towards the end of the last century and invited foreign capital, particularly British and French, to develop her mining and heavy industries. This paved the way for foreign exploitation which played no small part in expediting the revolution of 1917. The allied armed intervention immediately after the revolution when Russia was thrown into the turmoils of civil war was provoked by the repudiation of the old debts by the new regime. When the country was thus rid of the foreign financiers, the Soviets set to planning for industrial reconstruction. The Council of Commissars invited technical experts, numbering several hundreds, which constituted a body, known as 'gosplan'. Its function was to examine the general annual production of various mines and factories, carefully consider plans for increased production and devise for the whole of the Union an industrial scheme most practicable under the existing circumstances. At first the scheme was laid down for a period of five years, by which the country was to reach the estimated level of production. The scheme worked admirably, thanks to the revolutionary zeal and ardour of the Soviet workers, and the industrialisation of Russia was pushed in course of five years to a stage which other western countries of Europe required several decades to attain. Confining our attention to petroleum only, we find that before 1921 Russia was the third biggest producer of mineral oils after U. S. A. and Mexico; by 1931 U. S. S. R. became the second biggest producer. According to League of Nations' World Economic Survey, 1933-34, the production of petroleum in U. S. S. R. increased from 11.6 million tons in 1927-28 to 22.2 million tons in 1932 as a result of the First Five Year Plan, the planned estimate being 28 million tons. According to the estimate of 1938, U. S. S. R. now produces nearly 30 million tons of petroleum. Far more fruitful was the intensive geodetic and geophysical work recently carried on by Soviet experts. It has indicated a proved reserve of 700 million tons and a proved plus possible reserve of 6,376 million tons, which far outweighs the oil reserves of U. S. A. (proved reserve: 2,000 million tons). The final issue of the present war is yet difficult to forestall. If it does not adversely affect U. S. S. R. evidences are

that she will take the lead in the production of petroleum in not very distant future.

The recent discussions in the symposium organised by the Faculty of Science of Marx House at the London School of Hygiene and Tropical Medicine have thrown a flood of light on the progress of science and technology in the Soviet Union. According to Prof. J. D. Bernal, the number of trained Soviet physicists increased from forty in 1920 to tens of thousands in recent years. Dr N. F. M. Henry revealed how the Soviet Government paid special attention from the very outset to the science of geology which is now playing a fundamental part in the building of a socialist economy. In Tzarist Russia there were a few geologists, while at present the permanent scientific staff of the Central Institute for Geology numbers 500. The total number of geologists and prospectors working under its control is, however, 10,000 which is being constantly added to. The Soviet Government also spends a colossal amount of money on geological work. According to the official estimate, the Government spent 1,000 million roubles (about £38,000,000) in 1936 which was to be increased to double its amount by 1938, with the result that the Soviet mineral resources like oil, coal and iron have been organised and developed to a degree which even the British and American technologists have begun to envy.

Thus in course of twenty-five years the people of a vast backward country with agriculture as the principal occupation of its people, with little or no industrial development, having a standard of living ridiculously low compared to that of any European country and having no tradition of industrial efficiency or technical ingenuity, achieved a measure of success unique in history in a specialised field of industry like petroleum. They had to achieve this in the face of overwhelming odds and all possible difficulties imposed by foreign capitalist countries who carried on a ceaseless crusade of bitter criticism of whatever the Soviets did and proposed to do and painted them in the blackest possible hue. Our problem has much

in common with the problem which confronted the Soviets and lends itself to the solution chalked out by their Government. The Soviet experiment has completely exploded the imperialistic theory that a politically and economically backward country cannot organise its resources and prosper except under the tutelage of a strong foreign power. That our heavy and mining industries cannot be developed if left to ourselves is an entirely wrong supposition propounded and much advertised to suit imperialistic designs and has, as a matter of fact, no foundation in truth.

The case of Mexico's struggle with the foreigners over the oil question should be an eye-opener to the people of any country over which Imperialism of any stamp threatens to spread its invisible tentacles. Particularly we, in India, should take a leaf out of this history which has pointed out in an unmistakable way what foreign concession in a politically backward and economically undeveloped country means. The Americans, as we have noted, have made no secret of their intentions so far as the securing of oil concessions in India is concerned. It is in the face of these facts that we have been watching with great uneasiness and suspicion the activities likely to follow the recommendations of the American Technical Mission which proposes American technical assistance to develop India's industrial resources. The Government of India was positively averse to developing heavy industries like the ship-building and the automobile industries before the outbreak of the war and refused to patronise Indian enterprise. Now it suddenly wakes up to the necessity of developing India's industrial resources and invites American technical assistance. Then there is the Lease and Lend Scheme applicable to India by which Britain has managed to pay for U. S. assistance in her war effort. And here is the fact of important concessions granted to American oil companies by virtue of which they can explore the sub-soil. If we sift all these factual evidences, the picture which logically emerges will not prove to be pleasant to any body who thinks seriously of India's future.

Meteorology in Peace and War

READERS of SCIENCE AND CULTURE are aware of the persistent advocacy by this journal of the need for expansion and reorganisation of meteorological service and research, both for peace as well as for war (see articles entitled *Meteorology in India* in SCIENCE AND CULTURE, I, 689-692, 1935-36; 3, 542-544, 1937-38).

METEOROLOGY IN INDIA

A subject like meteorology cannot be neglected in these momentous times. According to a notice published by the London Physical Society, the Government of the United Kingdom is making a serious effort in this direction as will be evident from the following paragraphs.

METEOROLOGICAL RESEARCH COMMITTEE OF THE AIR MINISTRY

"The importance of meteorology to aviation has necessitated an extension of the state meteorological service far beyond the modest dreams of meteorologists of the last generation. At the present time meteorological forecasting is a vital element in the national war effort, especially in the conduct of the offensive; but the return of peace and the renewed expansion of civil aviation will maintain the need for weather prediction, which also has great importance for agriculture and many other branches of national economy.

The science and art of weather prediction have made great progress during the present century, but it remains uncertain whether even now all the fundamental factors that determine the weather changes have been discovered, and also whether the programme of observation yet includes all the elements necessary as a foundation for prediction. The problems both of observation and of theory are extremely complicated. It is, therefore, desirable that, along with the day-to-day application of the knowledge already available, proportionate efforts should be made to improve our knowledge and our methods.

For this reason the Secretary of State for Air has recently appointed a Meteorological Research Committee* to advise and assist in carrying out the meteorological investigations.

At present the Committee will naturally be concerned chiefly with problems directly concerned with the war effort, and such work must for the time being remain secret, though any incidental results not likely to be of service to the enemy may be published.

The Committee would welcome contact and co-operation with university departments or other institutions engaged in work that bears on meteorology; as a result of enquiries in the United Kingdom, information concerning such work and offers of assistance have been received from several universities. Correspondence† is invited from any other university or research institutions which can assist in this work.

METEOROLOGICAL RESEARCH IN THE ROYAL SOCIETY

"The formation of a Meteorological Research Committee by the Air Ministry, reported above, is an important and very welcome advance in the organisation of British meteorological research. The Air

* The Committee is composed of:
Prof. S. Chapman, F.R.S. (Chairman)
Prof. D. Brunt, F.R.S.
Dr G. M. B. Dobson, F.R.S.
Prof. G. I. Taylor, F.R.S.
Director of the Naval Meteorological Office
Representatives of Air-staff and Civil Aviation
Director of Meteorological Office.

† The Committee thus consists of distinguished workers in different branches of atmospheric research. Prof. S. Chapman, the Chairman, is noted for his researches on geophysical problems, e.g., terrestrial magnetic variations, earth currents, distribution of gases in the upper atmosphere, ionisation of same by solar radiation, etc. Professor Brunt is a noted meteorologist and is the writer of an authoritative treatise on same. Study of the distribution of atmospheric ozone in the middle atmosphere is associated with the name of Dr Dobson, Reader in Meteorology in the University of Oxford, and an important recent contribution of Professor Taylor is the correct explanation of the so-called atmospheric oscillations.—Editor.]

† Addressed to the Secretary, Meteorological Research Committee, Meteorological Office, Air Ministry, Kingsway London, W.C. 2.

Ministry Committee will at present confine its work chiefly to those problems which have an immediate practical application and are likely to be solved in a fairly short time. The Royal Society has been invited by the Air Ministry to co-operate with the Meteorological Research Committee by undertaking research on certain aspects of meteorology which, though of fundamental importance for the advance of the subject, may not have an immediate practical application.

The Council of the Royal Society have agreed to this request, and have entrusted the immediate responsibility for the work to the Gassiot Committee. This Committee, first constituted in 1871, was originally appointed to administer the Gassiot and other Trust Funds applicable to the maintenance of certain British meteorological and magnetic observatories, and to make recommendations as to their work. The terms of reference have now been enlarged to include the supervision of fundamental meteorological research such as has been asked for by the Air Ministry. The personnel* of the Meteorological Committee of the Royal Society is:—

Dr G. M. B. Dobson, F.R.S. (Chairman).

Sir Edward Appleton, "

Prof. D. Brunt, "

Prof. S. Chapman, "

Prof. A. C. G. Egerton, "

Sir Henry Lyons, "

Sir George Simpson, "

Sir Gilbert Walker, "

Prof. G. I. Taylor, "

The Astronomer Royal.

President of the Royal Astronomical Society.

Director of Meteorological Office.

Treasurer and Secretary of the Royal Society.

NEED FOR A FUNDAMENTAL RESEARCH

"These arrangements seem eminently suitable, because pure fundamental research which may have to be continued over a long period, and which requires the co-operation of many independent workers in university departments and laboratories, can probably be organized more easily by the Royal Society than by a Government Department, however much the latter may be in sympathy with the object

* The name of Sir Edward Appleton is well-known as a pioneer of research on the ionosphere, while those of Sir Gilbert Walker and Sir George Simpson are familiar in this country as former Directors General of Observatories.

of the researches. The Royal Society has already shown its willingness to further such work by appointing Dr E. Gluckauf to a Mackinnon Studentship, to enable him to carry out meteorological research under the general guidance of the Gassiot Committee.

The general research in which the Air Ministry has sought the co-operation of the Royal Society is that of radiation in the atmosphere, with special reference to radiation equilibrium conditions in the stratosphere. It is fairly generally accepted that the average temperature of the stratosphere—as of the warm region above it—is determined by an equilibrium between the energy absorbed, from both the downward solar radiation and the upward terrestrial radiation, and the energy radiated by the air in the stratosphere. Observations have shown that there are large variations of temperature in the stratosphere both with time and with place, but we know little as to why such variations occur. Few meteorologists, for instance, would care to be dogmatic as to why the stratosphere is some 50°C. colder in equatorial regions than in polar regions.

The principal gases of the atmosphere are mostly very transparent to radiation, and the radiative conditions are largely governed by such minor but polyatomic constituents as water vapour, carbon dioxide, ozone, and possible others. To understand the radiation equilibrium in the atmosphere it is necessary to know (a) what gases are present which have important absorption bands for radiation; (b) in what proportions they are present at different levels; (c) how gases such as ozone are formed and decomposed; (d) the absorption coefficients of these gases for different wave-lengths, and whether the absorption and emission spectra have a continuous or fine line structure. Finally, when the above facts are determined, it will be necessary to calculate the radiation equilibrium temperatures at different levels and to determine how rapidly the temperature will change when the conditions alter.

The Gassiot Committee has been fortunate in enlisting expert help in particular branches of the subject involved, and has formed three sub-committees to deal with different aspects of the above question. It is hoped that the available relevant knowledge will be collected in this way and that those questions which require more experimental work may be defined, so that arrangements can be

made for the work to be done, so far as this should prove possible under present conditions.

Dr Dobson is the Chairman of sub-committee A, which will deal with the chemical analysis and the observation of the amounts of the polyatomic constituents of the air at different levels; other members of this sub-committee are Professors H. Dingle and F. A. Paneth, and Dr E. Glückauf.

Sub-committee B will deal with the photo-physics and photo-chemistry of the atmosphere, from the highest levels downwards, and, in particular, with the changing equilibrium of ozone and any other variable polyatomic constituents.* The Chairman of this sub-committee is Professor H. W. Massey, and

[* It may be interesting to note that study of the variation of atmospheric ozone by a radio method was developed and made for some time at Calcutta. (See SCIENCE AND CULTURE, 3, 496, 1937-'38.) We understand that the study had to be discontinued for want of proper facilities.—Editor.]

the members are Professor K. G. Emelius, Dr W. C. Price, and Dr J. Sayers.

Sub-committee C will consider the radiation balance in the atmosphere; its Chairman is Professor S. Chapman, and its members are Professor D. Brunt, Dr G. S. Callendar, Dr T. G. Cowling, Dr A. R. Meetham, Sir George Simpson, and Dr G. B. B. M. Sutherland.

There will be few who will not agree that the first meteorological problem thus selected for attack is a very important one, and still fewer who will dispute its difficulty. It is hoped that the scientific effort which the Royal Society can bring to bear upon this work will lead to substantial progress.

The Gassiot Committee is aware that at laboratories and institutions in many parts of the world work has been undertaken that bears on these problems, and the Committee would welcome co-operation in cases where the continuance of such work is possible in present circumstances."

WORLD PRODUCTION OF SYNTHETIC FIBRE

Preliminary estimates of world production of rayon and staple fibre show a total for 1941 of 2,503,500,000 lb. against 2,340,000,000 lb. in 1940 and 2,151,000,000 lb. in 1939. Estimates (some of which are necessarily provisional) reveal the following position in the leading countries (in million lb.):

	1941	1940	1939
Germany ...	725	676	555
United States ...	578	471	384
Japan ...	500	510	535
Italy ...	375	375	290

Production in the United Kingdom apparently fell under the concentration scheme, but on the other hand, there was an increase in both Argentina and Brazil.

—The Chemical Age.

Oxidation and Stabilization of Vitamin C (Ascorbic Acid)

K. V. GIRI

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(Continued from last issue)

REDUCTION OF DEHYDROASCORBIC ACID

(1) *In Animal tissues:* Dehydroascorbic acid is antiscorbutically active, and its administration leads to increased urinary excretion of ascorbic acid. This observation together with the fact that storage of ascorbic acid occurs in guinea-pig tissues after the administration of dehydroascorbic acid, led to the view that the animal organism possesses a mechanism for the reduction of dehydroascorbic acid. It has been suggested by some workers (Borsook *et al*, 1937) that glutathione is mainly responsible for the reduction of dehydroascorbic acid. Others have shown that acid insoluble SH compounds exert similar protection, indicating that these SH compounds are the important factors in the reduction (Schultze *et al*, 1938). Blood is found to contain an enzyme which reduces dehydroascorbic acid (Roe and Barnum, 1936).

The reduction of dehydroascorbic acid by reduced cozymase (dihydrocozymase), which is thermodynamically possible, is of great interest, because it would indicate the role of ascorbic acid as a possible respiratory carrier in those dehydrogenase systems which depend on the cozymase for their activity. Euler and co-workers (1938 *a* and *b*) have referred to unpublished experiments in their laboratory indicating that dehydroascorbic acid had been reduced by reduced cozymase. Schultze, Harrer and King (1939), on the contrary, showed that reduced cozymase did not reduce dehydroascorbic acid *in vitro* at pH 7.2, either in pure solution or in the presence of dialysed suspensions of rat liver and muscles.

(2) *In Plants:* The fact that vitamin C is not destroyed in certain vegetables, which are exposed to the oxygen of the air, led to the assumption that every

vegetable and fruit must contain some type of reducing mechanism that serves as a protection against the oxidation of ascorbic acid. An enzyme which catalysed the reduction of dehydroascorbic acid in presence of cysteine was shown to be present in potatoes (Pfankuch, 1934). Cauliflower and similarly related plants (brassica) are found to contain an enzyme which reduces dehydroascorbic acid in the presence of glutathione (Hopkins and Morgan, 1936). The existence of a reducing system in legume seeds (peas, lima beans and navy beans) which reduces dehydroascorbic acid has been demonstrated (Kohman and Sunborn, 1937).

INHIBITION OF VITAMIN C OXIDATION

A current problem of much theoretical interest, as well as of practical importance, is the inhibition of vitamin C oxidation and the mechanism of the inhibition. Concluding, from the foregoing discussion, that the vitamin is extremely labile, particularly in presence of Cu which is widely distributed in all living cells together with the vitamin, we now proceed to inquire into the problem of accounting for the existence of the vitamin in all living tissues, without being destroyed by other catalytic influences.

(1) *In animal tissues:*—It was first suggested by Green (1933) that living tissues possess some anti-oxidative mechanism for vitamin C. Later several workers (De Caro, 1934; De Caro and Giani, 1934; Mawson, 1935) showed that most animal tissues contain a protective mechanism against the oxidation of vitamin C. The nature of the protective mechanism is, however, little understood. It was suggested by some workers (De Caro and Giani,

1934) that glutathione was the substance which caused stabilisation of vitamin C in tissues. Mawson (1935), however, found that the protective action is due to several substances, some of which can be removed by dialysis and some precipitated by mercuric acetate or trichloroacetic acid or, by boiling. But it was found that the protective mechanism was not altered much by such treatment. Later Giri and Shourie (1940) investigated the nature of the protective mechanism existing in tissues of scorbutic and normal guinea-pigs which protects vitamin C against catalytic oxidation by Cu . It was found that the protective mechanism was mainly confined to the colloidal constituents of the tissues. By dialysis and centrifugation of the tissue extracts, a solid residue was obtained which contained all the protective constituents of the extract. The degree of protection exerted by brain extracts was found to be much lower than that of the extracts of other tissues—kidney, liver and adrenals. No significant difference was observed in the degree of protection exerted by the tissues of scorbutic and normal guinea-pigs.

(2) *In plants*: Although the existence of a protective mechanism against the oxidation of vitamin C in animal tissues has been established, it has not been found to be of such wide occurrence in plants. Recently Giri and Krishnamurthy (1940) and Krishnamurthy and Giri (1941b) have shown the existence of a protective mechanism in plants which protects vitamin C against oxidation. It is found that both the enzyme ascorbic acid oxidase and the protective factor occur together in certain vegetables, and the two factors have been separated from one another. The protective factor is found to protect vitamin C from oxidation both in presence and absence of added copper. Some of the typical plants which are found to contain these two factors are *Cucurbita maxima*, *Cucumis sativus* and *Luffa acutangula*. Further investigation on the nature of the protective factor existing in plants led to the discovery of several new compounds of biological importance, which exert powerful protective action against the oxidation of the vitamin. An account of these compounds is given below.

(3) *Influence of various biologically important substances on the oxidation of vitamin C*: It is well known that glutathione, cysteine and cystine (De Caro and Gianni, 1934; Bersin, Koster and Jusatz, 1935; Barron, Barron and Klemperer, 1936;

Ghosh and Rakshit, 1936; Hopkins and Morgan, 1937), which are widely distributed in plant and animal tissues, protect vitamin C from oxidation through the agency of catalytic metals such as Cu . In addition to these compounds, pyrophosphate (Giri, 1937, 1938; Krishnamurthy and Giri (1941a); Yio Tsung Ku, 1938), chlorophyll (Rakshit, 1938), protoporphyrin (Schreus and Schümmer, 1940), adrenalin (Yamamoto, 1936), inhibit the oxidation of the vitamin. Recently Giri and Krishnamurthy (1941) while investigating the effect of various biologically important substances of very diverse nature, on the oxidation of vitamin C in presence and absence of added Cu have made some observations regarding the influence of purine derivatives, creatinine and creatine on the oxidation, which offers useful information regarding the nature of the protective mechanism existing in plant and animal tissues. It is found that the oxidation of the vitamin is inhibited by the purines—xanthine, uric acid and theophylline in a final concentration of 0.00014 — 0.00017 M, while caffeine and theobromine even at higher concentrations have no influence on the oxidation. The imino group appears to exert influence on the inhibiting action of the purines, as only those whose imino groups are free (xanthine, uric acid and theophyllins) inhibit the oxidation, while those whose imino groups are all methylated show no inhibitory effect (caffeine). Further the presence of methyl group in position 7 completely prevents the inhibiting action of the purines, although the other imino groups are free (theobromine). The imino group in position 7 of the purine derivatives, therefore, exerts a decisive influence on the oxidation of vitamin C. An interesting difference between creatinine and creatine, the two important constituents of the muscle is revealed by their influence on vitamin C oxidation. Although creatine has no influence, creatinine exerts protection against the oxidation. Loss in the protective action, therefore, results from the breakdown of the ring structure. The protective action of the purine derivatives furnishes a test for distinguishing theophylline from theobromine and caffeine. Unpublished results of further experiments carried out by the writer indicate that the pyrimidine part of the purine molecule has no influence, while the imidazole component is essential for the inhibiting action of the purines and other compounds investigated. From the foregoing discussion, it is clear that in addition to glutathione which is known to protect the vitamin against oxidation, the presence of purine derivatives and creati-

nine in the body may insure the existence of reduced vitamin C or prevent the oxidation of the vitamin by Cu .

Among the carboxylic acids oxalic acid exerts the greatest protection. The protective action of oxalic acid against the catalytic oxidation of the vitamin possesses an interesting feature and it reveals an important function of oxalic acid in plant tissues (Watanabe, 1937; Krishnamurthy and Giri, 1941 c).

As regards the nature of the protection exerted by the substances investigated, several possible mechanisms may be suggested; namely,

1. The substance may form a complex with Cu , thereby preventing the catalytic action of the ionised Cu on vitamin C. Citric, tartaric and oxalic acids may exert their action in this manner.
2. The substance may function as hydrogen donor, thereby reducing the oxidised vitamin back to reduced vitamin, and this reduction being much faster than the oxidation, the substance may function as a protector (e.g., glutathione on the enzymic oxidation of vitamin C, Hopkins and Morgan, 1936).
3. The substance may form a compound with vitamin C, which is more stable and less rapidly oxidised by Cu than the free vitamin.

However, little is known regarding the precise mechanism involved in each case of the substances studied. Some of the substances like citric, and the amino acids are known to form complexes with Cu , and the protective action exerted by these substances may be attributed to this cause.

RELATIONSHIP BETWEEN THE OXIDATION OF VITAMIN C AND OTHER CATALYTIC SYSTEMS IN THE LIVING CELL

As we have now surveyed the various catalytic systems existing in plant and animal tissues which, on the one hand, oxidise the vitamin and on the other, protect it from such destruction, it will be necessary before concluding to discuss the possible inter-relationship with other cellular catalytic systems. Certain advances in recent years have been made in connection with the possible influence of vitamin C on certain enzyme systems. Nothing, however, is known definitely concerning the rela-

tionship between the oxidation of the vitamin and the activity of enzymes, beyond the fact that the vitamin either in association with metals like Cu , Fe , or alone inhibits or activates the enzymic activity.

Giri (1938b and c) showed for the first time that the oxidation of vitamin C by metallic catalysts like Cu and other oxidising agents brings about the inhibition of the activity of plant phosphatases. Substances like glutathione, cystine, cysteine, H_2S and reducing agents like KCN and sodium hydro-sulphite which retard the oxidation of vitamin C, prevent the inhibition of the activity of the phosphatase by vitamin Cu complex. It was also found that the hydrolysis of pyrophosphate, which protects vitamin C from oxidation (Giri, 1937, Giri and Doctor, 1938a, and Krishnamurthy and Giri, 1941a) is less affected by the vitamin C— Cu complex than that of glycerophosphate. The study was later extended to animal phosphatases (Giri, 1939). Similar to plant phosphatases the activities of the alkaline and acid phosphatases of kidney, liver and brain are inhibited by the vitamin C— Cu complex, and the inhibition is entirely or partly annulled by glutathione and other sulphhydryl compounds and reducing agents. Courtois and Manouerier (1939) have also reported similar observations on the hydrolysis of various types of phosphoric esters. It is clear from the foregoing that the oxidation of vitamin C induces the inhibition of the activity of phosphatases, and factors which prevent the oxidation of the vitamin, protect the enzyme from inhibition by vitamin C— Cu complex. Vitamin C, Cu and protective substances which occur together in all living tissues, thus play an important role in the regulation of the activity of phosphatases.

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Obituary

Gauripati Chatterjee, M.Sc. F.N.I.

GAURIPATI CHATTERJEE was born at Calcutta on March 4, 1892 of a Brahmin family (originally hailing from Mahesh, a village near Calcutta) which had produced a number of Sanskrit scholars of eminence. His father Asutosh Chatterjee took to business, and rose to be the premier stevedore of Calcutta. Gauripati was the fourth son. He received his early education in the Bangabasi Collegiate School from where he passed the Entrance examination in the year 1909, securing a second grade scholarship. He had shortly afterwards an attack of meningitis which permanently wrecked his health and left its legacy in acute myopia. Though thus seriously handicapped in his studies, he passed the Intermediate examination in Science from the Presidency College in the First Division in the year 1911. His health broke down almost completely and he could not sit for his B.Sc. examination for three years successively and the doctors advised that for the sake of his health further studies should be discontinued. His brothers suggested that he should join their stevedoring business, but as he had from his early boyhood cherished a desire for a scientist's career, he could not persuade himself to take to business, though the prospects were quite rosy. He sat for his B.Sc. examination against doctors' advice and passed it with distinction in the year 1916. His health further deteriorated and he could not appear at the M.Sc. examination until 1919 when he got a First Class First in Physics and was awarded the University of Calcutta Gold Medal and Matilal Mallick Gold Medal. While in B.Sc. class he enjoyed the intimate friendship of many of his classmates who subsequently achieved great distinction in scientific life, viz., Prof. S. N. Bose, (Professor of Physics, Dacca University), Dr J. C. Ghosh (Director, Indian Institute of Science, Bangalore), Prof. J. N. Mukherjee (Ghose Professor of Chemistry, Calcutta University) and Prof. M. N. Saha (Palit Professor of Physics, Calcutta University).

After getting his M.Sc. degree he worked as a Research Scholar in the Presidency College under

Prof G. H. Harrison, and showed great aptitude in repairing delicate scientific instruments and devising new ones for the college laboratory. His mechanical and scientific talent was highly appreciated by Dr Harrison, and he was recommended by him to the then Director-General of Meteorology, Sir Gilbert Walker, who was looking for an assistant to Mr Field, then in charge of the Upper Air Observatory at Agra. He received the appointment of Assistant Meteorologist on the 15th April, 1921 but so impressed Mr Field by his ability and devotion to work that on his recommendation he was appointed Meteorologist from the 28th February, 1922, and Meteorologist-in-charge from the 1st April, 1928 with a special allowance. He took up his residence at Agra from 1921, and this was to be his home for eighteen years.

The foundations of the Upper Air Work in India were laid by Mr Field in course of the years of the last war, and when in 1924, he was called upon to become Director-General of Observatories, he handed over the charge of the Agra Observatory, and the Upper Air Work to Mr Chatterjee. This charge he continued to hold until June 1942 when he had to go on leave owing to the illness to which he succumbed. He had thus for eighteen years the charge of one of the biggest aerological organisations of the world, comprising out-stations as far apart as Bahrein and Nicobar and as Minicoy and Peshawar. According to competent authorities, the whole was administered remarkably smoothly despite the inherent difficulties involved in maintaining such a farflung network. He was selected as one of the Superintending Meteorologists in October 1938 almost on the eve of the transfer of the Upper Air Observatory from Agra to New Delhi. He died at Calcutta on the 10th July at the age of 50.

Mr Chatterjee's activities are thus linked up more or less with the expansion of civil and military aviation in the East. The upper air data now used for daily weather forecasting work and for aviation

purposes are the velocity and the direction of winds at various heights above the ground observed at and disseminated from a net-work of over 40 stations. From the small observatory, workshop and office at Agra that Mr Chatterjee took over from Mr Field in 1924 to the large headquarters in New Delhi, with over 40 observatories providing all the upper air and ground data that modern war conditions demand of them, and with a total staff running into some hundreds, is his achievement in 18 years of skilful planning and direction, with unfailing care and unremitting thought and effort.

Mr Chatterjee's contributions in the realm of aerological investigations in India are also noteworthy, specially his work relating to the technical developments leading to fruitful methods of exploration of the upper air. For detailed observations of pressure, temperature and humidity at various levels above ground he designed an improved type of Dines' meteorograph which is particularly suitable, on account of its enlarged scale, for sounding the lower layers of the atmosphere (Fig. 1). He also



FIG. 1. Modified Dine's Type Meteorograph fitted with dry and wet temperature elements.



FIG. 2. Clown-Balloon Meteorograph.

designed a hygrograph for obtaining continuous records of dry and wet bulb temperatures in the lower heights developing also the necessary technique for launching these instruments with specially designed balloons, called "Clown" balloons (Fig. 2). Temperature indicators, based on the principle of the

bi-metallic thermometer, were invented by him for investigating the thermal structure of the atmosphere a few kilometers above the ground (Figs. 3a, 3b). Besides these, he was the inventor or designer of a large number of devices calculated to make upper air observations more reliable and accurate

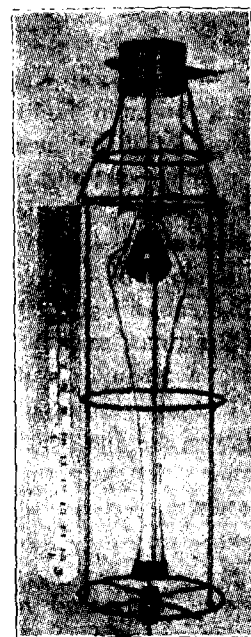


FIG. 3 (a) Single Temperature Indicator.



FIG. 3 (b) Multiple Temperature Indicator.

while he also effected many adaptations in the already available instruments and existing methods of work with a view to making observations at out-stations more trustworthy.

The observations in the upper air, both as regards soundings and wind measurements, throughout the country were all made with material and equipment most of which were supplied by the Upper Air Observatory, Agra (or New Delhi), which under the able guidance of Mr Chatterjee developed the necessary technique. These observations, together with those made by Mr Chatterjee and his co-workers at Agra, have been analysed and discussed by himself, K. R. Ramanathan, N. K. Sur and their collaborators in a number of papers published departmentally or extra-departmentally. It was from these observations that it first came out that the temperature curve in the tropical stratosphere was quite different in form than that in the temperate regions.

In the Nor'wester season, April-May, of the year 1929, Mr Chatterjee went as the leader of an

expedition to Jhikargacha in the Jessore district, Bengal for sounding the upper-air there by letting off special balloons with recording instruments, and also to obtain at the same time detailed observations of meteorological elements at the surface. The object of the expedition was to collect intensive and reliable data for an investigation into the nature and possible mechanism of the Nor'wester storms (Kal-Baisakhis) in Bengal. The data that were obtained in the Jhikargacha expedition have been analysed and discussed by him and N. K. Sur in a departmental memoir published in 1938.

An account of some of Mr Chatterjee's scientific works can be obtained from over a dozen papers published either by himself, or jointly with others, as departmental memoirs and scientific notes, and in extra-departmental scientific journals in India and abroad. A list of titles is appended below.

- (1) On a Demonstration Apparatus for determining Young's Modulus.—*Jour. & Proc., Asia. Soc. of Bengal* (New Series), 10, 51-56, 1914.
- (2) Origin of Nor'westers. (— and S. C. Roy).—*Nature*, 124, 481, 1929.
- (3) Probable Origin of the Cold Wave in India, February, 1929. (— and S. C. Roy).—*Nature*, 124, 793, 1929.
- (4) Balloons for Upper Air Work.—*Nature*, 124, 793, 1929.
- (5) An Upper Air Temperature Indicator for use with Pilot Balloons.—*Gerl. Beitr. Geophys.*, 24, 343-352, 1929.
- (6) Eine einfache Abwurfvorrichtung für Ballonmeteorographen aus bestimmter Höhe. (— and S. C. Chakravarty).—*Met. Zts.*, 47, 118-119, 1930.
- (7) A Recording Plate for use with Meteorographs of Dines' type.—*Jour. Sc. Inst.*, 7, 130, 1930.
- (8) The Thermal Structure of the Free Atmosphere over Agra. (— and N. K. Sur).—*Gerl. Beitr. Geophys.*, 25, 266-278, 1930.
- (9) An Improved Method of Sounding the Lower Layers of the Atmosphere.—*Ind. Met. Dept. Sc. Notes*, Vol. 4, No. 35 (1931).
- (10) Contrivance for lifting the Pens off the Recording Plate of the Dines' Balloon Meteorograph during its descent. (— and P. M. Neogi).—*Ind. Met. Dept. Sc. Notes*, Vol. 4, No. 36 (1931).
- (11) A Note on an Apparatus for Catching Spores from the Upper Air.—*Ind. Jour. Agri. Sci.*, 1, 306-308, 1931.
- (12) On Some Instruments for Sounding the Lower Layers of the Atmosphere.—*Gerl. Beitr. Geophys.*, 34, 252-263, 1931.
- (13) Discussion of results of soundings at Jhikargacha in Bengal during April and May 1939, N. K. Sur.—*Mem. Ind. Met. Dept.*, Vol. 26, part 9.

In 1930 the Agra University introduced meteorology in its course of studies for the M.Sc. degree in Physics, and from that year to 1941, when he shifted to New Delhi Mr Chatterjee held the part-time post of Honorary Professor of Meteorology at

the Agra University. He was one of the Founder-Fellows of the National Academy of Sciences, India and was elected a Fellow of the National Institute of Sciences, India.

Combined with his abilities as an organiser and skill as a scientific inventor, designer and experimenter, Mr Chatterjee had acquired considerable technical knowledge of materials, machine-tools and workshop equipment. The results of his talent, with its decided bias towards engineering, are nowhere better illustrated than in the efficient organisation of the Hydrogen Factory at Agra, which he extended and improved and which is the source of supply of hydrogen for all balloon ascents in India and the neighbouring countries, and in the equipment of the workshop which is able to-day to manufacture and repair a large part of the numerous equipment necessary for running the upper air observatories and for undertaking most of the non-routine aerological work and upper-air research in this country. All his steps concerning the development of the workshop, the organisation of the Hydrogen Factory and the arrangement of the stores were planned with vision and foresight; and as a result of his anticipation of the coming requirements of the growing science of aerology in India, he was always ahead of the actual needs when they arose. Never content with merely accomplishing a thing, he constantly strove to effect further improvements in it; this urge towards perfection was the outstanding character of all his work. "Our curve of efficiency", he used to say, "should never be a line parallel to time-axis, but a curve with an upward slope". It was his constant endeavour to raise the working potential of the organisation under his charge, both in respect of its capacity to run efficiently its routine work and its ability to undertake specialised work for scientific investigation. His success was in no small measure due to his careful choice of his mechanics and operatives, the care spent on their training, and his firm but sympathetic handling of them. Besides the bigger workshop, he maintained a small miniature workshop where with the assistance of his private mechanic, Mr Farrukh Hussain, he used to make experiments with his own ideas. When the preliminary results were found satisfactory the results were made over to the larger workshop. Professor Millikan, in whose experiments on Cosmic Rays in India in 1939-40 the Upper Air Observatory at Agra rendered its active co-operation, had the highest praise for Mr Chatterjee's organisation and in the capa-

bilities of the observatory as a first class scientific institution.

Mr Chatterjee was never blessed with a strong constitution or robust health, but nevertheless in his untiring energy and zeal and devotion to work and in his capacity for undertaking and achieving more and more he was difficult to beat. Of late, even when in indifferent health, he untiringly worked for the shift of the Upper Air Observatory from Agra to New Delhi, which not only meant difficult and prolonged hard work but also the most meticulous care and planning to the minutest details. This alone could ensure a smooth transfer of the observatory with its many workshop tools and equipment and huge stores of a very diverse character without any break in the functions and the routine activities of the office even for the shortest time.



FIG. 4. Prof. Millikan with Mr Chatterjee and others.

Immediately after the shift of the observatory to New Delhi, and although in a very indifferent health when rest was most needed, Mr Chatterjee engaged himself, amidst directing the reorganisation of the observatory in its new home, in the development of an adaptation of the Harvard type radiometeorograph for radiosonde ascents in this country. He had already developed the necessary technique for manufacturing very light and compact inert cells required for the high and low-tension batteries for use with the radio-transmitter unit, and for making the clock-work part of the meteorograph in the observatory workshop; and just before the closing days of his life he was busy in constructing the meteorograph

unit to which he had only to put the finishing touches. Unfortunately, however, before it was entirely complete he had to leave this last work owing to his illness from which he never recovered.

Apart from his work in the laboratory, the workshop and his office, his only other hobby was gardening, horticultural and allied experiments on a small scale. For the last 4 years he had taken up systematic work for giving a concrete shape to his ideas of experimental farming by acquiring extensive lands in the village of Rohta in the district of Agra and laid the foundation of what was to become a unique institution where he wanted to educate the children of the soil to take to scientific farming which he believed will bring the economic salvation of India for the coming generations. His death, so soon after starting this phase of his activity, cut short his experiments.

In his private life Mr Chatterjee was a man of extremely simple habits, almost severely so, and entirely unconventional. On account of bad health, he refrained from undertaking the responsibilities of married life. He was intensely patriotic yet had a rational outlook on life and its problems, and, having originality of thinking and courage of his convictions, he was able to rise above conventions and custom whenever he was convinced of the need to do so. His honesty and integrity won for him universal respect. His make-up was more in the nature of a practical idealist, possessing a very kind heart and most generous impulses and his charities were many, liberal and sustained. Always ready to discuss his own actions, he was never hesitant to acknowledge and rectify any mistake as soon as he realised it. Assessing merit and bestowing open praise for it and judging faults and condemning them openly was his successful method of dealing with his employees whose love and esteem he won to a most remarkable degree. One of the reasons of his success was his extremely sound judgment in perceiving talent of any kind, and he never failed to bring out and encourage ability in whomsoever he found it, be the person high or low in official position or social status.

In his premature death the India Meteorological Department has lost one of its most distinguished, resourceful, painstaking, skilful and valuable officers, and meteorological science the creator of some of the most ingenious, delicate and yet serviceable instruments for upper-air work.

The untimely death of Mr Chatterjee evoked profound and heartfelt grief amongst his colleagues of the Meteorological Department. Some of the tributes paid to his memory are quoted below:

DR C. W. B. NORMAND: "The qualities in Rai Bahadur that appealed to me most were his powers of organisation, his resource in the laboratory and workshop, his loyalty and power of taking responsibility. He ran his great upper air organisation like clockwork; and behind that success were foresight, planning, orderliness, thoroughness and attention to detail, all of a higher order. The thoroughness could be seen in the packing of an instrument, the preparation of a handbook of observatories, the habit of having 'three strings to his bow'; by that I mean that in any plan of action he loved to make sure of the result by having two other lines in reserve, if the first line of action failed. About his resourcefulness, if you are ever inclined to forget it, just remind yourself of the gadget for releasing the pens from the meteorograph plate, the one which uses the simple but powerful delayed-action force in the freezing and melting of a small quantity of water. In the quality of his service I shall always recall with gratitude his strict loyalty and pray that I was always as fair and just to him. I respected his own sphere of power and left him to himself as much as possible within it, because responsibility seemed to sit so easily on his shoulders. He never asked any unnecessary advice about things which he knew were within his own power to settle, because he appreciated to a nicety exactly what was within his function and what outside. Another outstanding feature was his unwillingness to put on paper any work that he did. He would be ready enough to talk but needed a lot of tactful persuasion to write about it. The result is that, like Mr Field before him, his published papers do not give an adequate view of his originality."

DR N. K. SUR: "Remembering that he, as the head of the Upper Air Observatory at Agra, was responsible for maintaining and developing an organisation for collecting pilot balloon observations from all over India, Burma, Persia, Baluchistan and the Andaman Islands, he had to be very vigilant over the performance of the staff in every observatory under his control to ensure that each ran efficiently; and he succeeded in the task wonderfully well."

MR S. P. VENKATESHWARAN: "His achievements were due not only to technical skill but also to unusual fore-

sight. He had a plan for everything, many of them being long-range. He picked up young boys with a talent for technical work and in course of time made them into skilled workers. He purchased stores so judiciously that they would come in handy in times of need. He designed instruments ahead of actual need, so that he had the necessary machinery ready to be put into operation when the need arose."

DR K. R. RAMANATHAN: "The Upper Air Observatory at Agra was nothing much as a building. It was kutchabuilt and was intended to stand for 5 years although it actually served for more than 25 years under the loving care of Chatterjee. Once you got within the compound of the observatory, you ceased to think of the building. The creative personality of Chatterjee permeated the whole atmosphere. The well-arranged garden with its neatly-kept lawns and plants and its carefully laid-out paths gave the place an atmosphere of quietness and comfort. It is only when one got within the walls of the humble-looking buildings that dotted the area and saw the intense and varied activity going on everywhere that one realised that here was a place right in the forefront of intensely alive, progressive India."

Mr Chatterjee leaves several brothers and other relations to mourn his loss. One of them, Mr Sailapati Chatterjee is the Chief Executive Officer of the Calcutta Corporation. His brothers and nephews are fortunately all well-placed in life and we hope they will try to perpetuate his memory in a befitting manner. His best memorials are of course the Agra and its successor, the Delhi Meteorological Observatory, and the instruments he designed, but he always cherished a desire of returning to Calcutta and devote himself to the service of the country in his own way.*

* We are indebted to Mr S. Basu, Meteorologist for most of the subject matter of this article; and to the deceased's elder brother Mr Sailapati Chatterjee, M.A., Chief Executive Officer of the Calcutta Corporation for his early life. We are also indebted to the India Meteorological Department for an account of a condolence meeting held in the department when tributes by his colleagues were paid to the deceased's memory.

Notes and News

MANUFACTURE OF OPTICAL GLASS IN AUSTRALIA AND CANADA

OPTICAL glass is a great necessity of modern life, as it is needed for all kinds of scientific apparatus used in peace and in war, in particular. Before the last War, the manufacture of optical glass was almost wholly monopolized by Germany, and this was a great handicap to the allies. During the last great War and in the years following it great efforts were made by allied countries to produce optical glass, and in some cases a certain amount of success was achieved. But the British dominions were not so fortunately placed. Their supply was greatly handicapped, but they early realized the danger and took steps to meet it. The recent numbers of *Nature* have given a graphic description of the efforts made by some of the dominions in the British Empire to manufacture optical glass. The success with which Australia is now producing quite a different varieties of optical glass within her own boundary has been revealed by Prof. E. J. Hartung of the University of Melbourne in an article contributed to a recent issue of *Nature*. Before the outbreak of the present war Australia had to depend largely upon foreign countries for her supply of optical glass. As the war progressed it became increasingly difficult to obtain her supply of good optical glass even from Great Britain and U. S. A., and consequently she had to fall back on her own resources and technologists. Australia adopted the decision to produce some varieties of optical glass essential for the manufacture of optical instruments for armed forces, as part of the extensive programme of munitions production towards the closing months of 1940.

The production of six standard types of optical glass was originally planned, of which four could so far be successfully placed on a production scale. But all the six, however, met with laboratory success. The initial difficulties centred round the availability of suitable raw materials for the glasses and good fire clay for the pots. The first problem could easily be solved as Australia was fortunate in good sand containing 0.01 per cent of iron oxide, which

guarantees freedom from colour and turbidity. The second problem did not so easily admit of a solution. As many as eighty specimens of fire clay obtained from various parts of the country were subjected to a close scrutiny regarding refractoriness, texture, workability, chemical composition with reference to iron and titanium content and other factors, before ten specimens having the requisite properties could be selected. Small fire clay pots capable of containing about 2 lb. of glass were first designed and the glass fused in them to carry on test experiments for pot contamination. The success of these initial experiments led to the construction of large pots which are now turning out optically homogeneous glass successfully and economically. The yield of glass per pot is as high as 55-60 per cent. The report of the examination of Australian glass by the National Standard Laboratory of Australia indicates a remarkable constancy in optical properties throughout the mass and a good freedom from striation and other defects and recommends its use in the manufacture of optical instruments for the military.

It is barely a year and a half since Australia started manufacturing optical glass. Her effort has been carried to a successful issue through the close co-operation between the chemistry department of the University of Melbourne and Messrs Australian Consolidated Industries Ltd., undertaking the actual manufacture. She also received substantial technical assistance from the National Bureau of Standards, Washington. In any case it can hardly be disputed that the measure of success she achieved in so short a time in the difficult field of manufacturing optical glass involving expert knowledge and considerable research work is unique and nothing short of marvel. She is now not only producing optical glass of standard quality, but has been able to meet the entire demand of her optical glass with a surplus production for export.

A similar progress in the manufacture of optical glass has been recorded in Canada, another dominion in the British Empire. In October 1939, immediately after the outbreak of the present hostilities,

General Mac Naughton pointed out to the War Supply Department that Canada should undertake to manufacture optical parts. The suggestion could not, however, be immediately put into operation owing to certain practical difficulties. But in view of the increasing pressure of demand for war instruments like binoculars, range-finders etc., Research Enterprises Ltd., working under the Ministry of Munitions had to be organised as a wholly Government owned company in August, 1940. It is needless to point out the overwhelming difficulties that encounter a newcomer in such a specialised field of manufacture. Research Enterprises Ltd., carefully studied the difficulties the Americans were put to in 1918 in their endeavour to manufacture optical glass and the way in which they solved them and finally decided upon following the methods of Chance Brothers & Co. Ltd., in England. The Canadian research body, however, received all possible technical assistance from the British Company and also had its personnel trained in the factory of the Chance Brothers & Co., Ltd. Canada turned out its first melt of optical glass in June 5, 1941 and by January, 1942 she was producing roughly 12,500 lbs. per month. Additional furnaces, it is reported, are being installed, and the total monthly production of optical glass in Canada will soon reach a figure of 20,000 lbs.

It is interesting to note that Research Enterprises Ltd., started on September 3, 1940 with only two employees which, by January, 1942, only after sixteen months of its inception, numbered about 3,000, of whom 700 were women. The staff consists of 100 members of whom 84, all bachelors in science, come from Canadian Universities with degrees in engineering, physics and chemistry. In the first month of the current year some three thousand optical instruments valued at about £120,000 were made. The degree of success attained by Research Enterprises Ltd., is more eloquently expressed in the fact that, besides producing standard optical glass, the body is now busy producing and perfecting various secret devices.

It is superfluous to add that supply of all kinds of glass, particularly of optical glass to India, has been very severely curtailed owing to the war, and the attention of the Government was drawn to the problem in early days of the war. The problems of manufacture of glass in India on a self-sufficient basis were discussed in two articles in *SCIENCE AND CULTURE* where it was shown that India possesses almost ideal conditions for glass manufacture,—plenty of raw materials, a good market, and nucleus of trained technicians. We understand from some newspaper reports that the Board of Scientific and Industrial Research appointed some committee some

two years ago to tackle this problem. But no visible result is forthcoming. Probably the committee is still deliberating in the right Anglo-Indian fashion or probably the high officials with whom all initiative in India lies had not yet time to read the various reports! But Indian manufacturers of glass did not wait for Government lead, and in some cases have achieved remarkable result, on their own initiative. We may refer to the successful manufacture of neutral glass by Prof. N. C. Nag of the Scientific Indian Glass Co. Ltd., (Sigcol) of Calcutta. But they had refrained from experiments on the manufacture of optical glass, as these are very costly and require a large technical and scientific staff. But what have the government organisations done in the vital matter of optical glass manufacture? Probably when the question will be pressed, we shall have the usual "large promises to be followed by vague excuses."

A NEW AIR-PLANE DETECTOR

THE technicians of the U. S. Army Signal Corps and the members of the Aircraft Warning Service have recently recommended the use of a new air plane detector which, it is claimed, can be effectively operated even by a novice. The new device, designed by the Zadig Patents, is pre-eminently meant for use by a single man and has a great simplicity of construction to its credit. The headpiece consists of an earphone and a parabolic concentrator made of thermoplastic material, which has at its focus a microphone of special design. Both the earphone and the concentrator are conveniently supported by a tight fitting head band. Other accessories like the amplifier and the batteries are enclosed in a shielded drawer and can be slung from one side. Three miniature tubes are used in the amplifier. Filters are used to eliminate undesirable noises which may tend to draw the more important sound proceeding from the plane to be detected. The operator's attention is first drawn by a feeble low-pitched sound heralding the approach of a plane, and he turns his body so as to effect the reception of the loudest sound. He has then really faced the direction whence the plane is coming. The carrying of the whole equipment causes the operator no more physical inconvenience than a gas mask container.

THE VOLGA IMPROVEMENT SCHEME

THE Soviet Government has recently adopted some hydrodynamic projects with a view to improving the lower reaches of the Volga, Russia's principal and Europe's longest river. The river with a

navigable length of some 7,000 miles and a drainage basin of about half a million square miles supporting some fifty million people flows into the land-locked Caspian Sea. The main problems of the lower reaches of the Volga are, (1) insufficient water, (2) a vast delta and (3) lack of access to the open sea, to which the delta offers the major difficulty. On account of the shallowness of the distributaries, Caspian steamers cannot penetrate into the delta beyond thirty-five miles from the mouth. This made the shipping of petroleum extremely difficult and the Caspian tankers from Baku had to unload into barges to be towed by tugs to Astrakhan. The difficulty has been further considerably accentuated by the gradual falling of the Caspian sea level in recent years. The Sea is, moreover, provided with a poor hinterland.

The solution, as it has been proposed, consists in directing a portion of the Don water to flow through the Volga and reach the Caspian Sea. The Don discharges its volume of water into the sea of Azov, and a diversion of a portion of this volume will not only feed the Volga in its lower reaches, but will help stabilise the level of the Caspian. Near Stalingrad where the Russo-German conflict is now raging, the river Don comes within 50 miles of the Volga. The projected scheme proposes to effect a union of these two rivers by dredging a canal. In order that the Don should remain navigable 6 locks have to be constructed on the river. The scheme has also made provision for three hydro-electric stations which will be a considerable addition to the electric power of the Soviet Union. There is another contemplation to drive the waters of a number of Arctic rivers *e.g.*, the Pechora and North Dvina to the Caspian through the Kama and the Volga by constructing dams, which will greatly improve the shrinking level of the sea.

The scheme for improvement in the middle Volga is of a more comprehensive character. The construction of a number of dams in a step-like series to act as reservoirs has been proposed. The dam at the great Samara Bend where the present capital Kuibyshev stands will, it is contemplated, create a lake of 2,900 square miles. The two hydro-electric stations to be constructed here will alone generate eight times the total electric power produced in the whole of Russia under the Tsars in 1913. The dams will control the volume of water discharged by the Volga and will effect irrigation of some ten million acres of land now lying fallow north of the Caspian. The success of the projected scheme will remove navigation difficulties due to lack of proper depth in many places of the river, and it is expected that at the end of the Third Five Year Plan the

Volga steamers will find to their satisfaction a depth of 9 feet from Astrakhan right up to Moscow.

The hydrodynamic schemes formulated above are undoubtedly thorough and magnificent and characteristic of the Soviet people. But the spread of the war into the very zones where these schemes were to work has set up serious impediments to their successful operation, if it has not completely upset the plans, and as such the final result is unfortunately yet shrouded in uncertainty.

THE REPORT OF THE CARNEGIE INSTITUTION OF WASHINGTON

THE annual report of the Carnegie Institution of Washington, just published, has revealed the details of the Institution's progress in various fields of investigation during the session beginning on July 1, 1940 and ending on June 30, 1941. An important feature of the report is the creation of the office of Scientific Research and Development as a part of the office for Emergency Management, necessitated by the war time urgency of effecting a proper co-ordination of the research effort in the United States. The president of the Carnegie Institution is also the director of this office. It is satisfactory to note that though the Institution's research work is now mostly concerned with the solution of problems directly connected with defense and offense, it has tried to preserve intact some of the more important threads of fundamental research. In this connection mention may be made of the new large cyclotron, now in the process of construction, with which the Institution proposes to attack problems of human genetics and many others lying on the border line between physics and biology. The Department of Terrestrial Magnetism is now mostly actively engaged in the research work on Government problems and the staff of the research workers has to be doubled to meet the increasing pressure of work. Even this department has made substantial progress on some fundamental problems. The studies of the upper air include important investigations on the electrical and chemical conditions of the air at great heights and various magnetic and solar properties having an important bearing on the problems of radio transmission.

Important and interesting results have been obtained in the Geophysical Laboratory in connection with the study of the effect of high temperatures and pressures on silicate minerals in presence of water. The experimental equipment consisted essentially of an electric furnace within a strong closed chamber in which the silicate minerals were exposed to the action of steam at pressures of several thousand pounds and

at temperatures several degrees above that corresponding to red heat, and made the study of the minerals under conditions prevailing in the earth's interior possible.

The Division of Plant Biology, another department of the Institution, has made considerable progress in the studies on photosynthesis. The results of investigation carried out in this department pointed to the insufficiency of the existing explanation of the chemical interaction involved. Important works have also been done in the Nutrition Laboratory of which the co-operative studies of carbohydrate metabolism with reference to diabetics deserve special mention.

NEW DEPOSITS OF BAUXITE IN INDIA

THE occurrence of bauxite and other ores of aluminium in various places in India has been suspected for a long time. For sometime past the Geological Survey of India intensified its activities in the exploration of bauxite and undertook survey work with varying degrees of success. Mr A. K. Dey has reported in the Records of the Geological Survey of India, issued in March, 1942, the occurrence of bauxite and aluminous laterite in Jashpur State in the Eastern States Agency. Jashpur State lies to the Western part of the Chota Nagpur plateau. The Khuria high lands, long known to have some geological importance, was examined by the late Mr Hiralal as early as 1888-89. The work of Mr Hiralal revealed the occurrence of laterite in this part which was mapped from the standpoint of laterite deposits. But in this early exploration work consideration was not made of the possibility of the existence of bauxite in this part, and as such the credit of discovering bauxite in Jashpur goes to Dr C. S. Fox. According to him, the deposits occur in the Burha and the Kusang hills and the Bhairamurio. Dr Fox's hints as to the occurrence of bauxite in the Khuria highlands were taken up by Mr Dey who was employed by the Jashpur State Durbar from November 1, 1935 to December 31, 1939 to complete the geological survey of the State started by Hiralal. The success of this preliminary investigation which resulted in the discovery of a number of bauxite deposits unfolded the possibility of bauxite deposits in other parts of the State and stimulated intensive survey work. The result of these investigations, as Mr Dey reports, has proved the existence of bauxite in Uparghat, in various places of the Khuria highlands *e.g.*, Pandrapat, Thutapani, Bhasrapat etc. in Nichghat, and in several places throughout the State in varying concentrations. All the laterite areas have not been worked out, and there

still remain some areas which require investigation and stand some chance of further discovery of bauxite deposits.

The bauxite in Jashpur State is generally found in laterite cappings. Besides aluminium oxide the deposit contains the oxides of iron, titanium, calcium and magnesium. The percentage of aluminium oxide varies from 51 to 60. The percentage of titanium oxide is sometimes as high as 14%. Mr Dey is of opinion that titaniferous bauxite of good quality is available in several parts of the State and can be successfully exploited. But the main difficulty which stands in the way of immediate exploitation is the absence of facilities for cheap transport to the nearest railway stations. The places of occurrence lie in remote, almost inaccessible regions far from any railway station, there being as a matter of fact, no station within a radius of eighty miles from any place of occurrence.

SCIENCE AND TECHNOLOGY IN CHINA

THE Central Union of Chinese students in Great Britain has brought to light a booklet entitled, "China To-day: The Thirty-first Anniversary of the Chinese Republic" in which well-informed Chinese students have reviewed the recent trends of events in China. The review has brought home to us, among other things, the great importance the Chinese people have attached to science and technology in their nation-building activity and in their gigantic effort to keep the powerful enemy at bay. The realisation of the importance of planned economy in China is amply demonstrated by the creation of the National Economic Council which is entrusted with the responsibility of economic planning. The Ministries of Economic Affairs, Agriculture and Forestry and Communications are responsible for the execution of plans placed before them. There is a number of research institutes, functioning under them, to carry on original work in specialised subjects like hydraulic engineering, mining, metallurgy and industrial technology. The National Agricultural Research Institute, under the Ministry of Agriculture, is concerned with agricultural research in the country. The planning and the different executive bodies freely draw on the results of research work done in these various institutes. The universities also play a great part in furthering research work of the country, but long term research work is generally carried on by the National Academy and the Academia Sinica, the latter being responsible, through the National Research Council, for the co-ordination of research and scientific activities.

But the most satisfactory progress is recorded in the field of medical research and medical service. The peculiar attachment of the Chinese people to the old and traditional knowledge and forms of medical practice remained and still remains the most serious obstacle in the way of effecting any improvement in the general medical service. Despite this difficulty the National Health Administration has succeeded in establishing a series of public health stations and clinics all over the country which are rendering medical service to the Chinese people along modern lines. The Army Medical Service has considerably improved and the National Institute of Health is primarily concerned with medical research.

China is now steadfastly pursuing a strong policy of technological and engineering development essential for the prosecution of her war with Japan. As China entered the second stage of the war she transplanted something like 386 factories in the safer zones in the interior and developed some 1,378 factories in addition in several parts of unconquered China. The progress of science and technology in China is further manifest in the fact that the number of higher educational institutions, including universities and technical colleges, increased from 108 before the war to 113 in 1940. These are significant facts which clearly indicate that China of Confucius and Lao Tse is fast sloughing her old skin and emerging as a powerful and energetic nation equipped with the new philosophies and techniques of the age.

CHEMICAL INDUSTRY IN SWEDEN

The great strides Sweden has made since the beginning of the war towards developing her chemical industries have been revealed by Dr Ragnar Winbladh, director of the chemical department of the Swedish Industrial Commission, in his recent survey of Sweden's progress in chemical industries. Invasion of Norway and the subsequent military events in Europe seriously disturbed the sea-borne trade of Sweden and compelled her to pursue a strong industrial policy to make herself self-sufficient in many essential chemicals. Thus a great increase in the output of chemical products like sulphuric acid, nitric acid, hydrochloric acid, sodium sulphate, chlorine and many organic chlorine derivatives has

been registered in recent months. Chemical compounds, formerly imported from abroad, but now produced in Sweden, include zinc salts, chromium compounds, potassium permanganate and certain phosphates. Besides, the recent expansion of the Swedish metallurgical industries like copper and aluminium, and of the charcoal and wood distillation industry has favoured the spontaneous development of many subsidiary chemical industries.

But the success of the Swedish Navy department in producing oil fuel from shell deserves more than a passing notice. The plant was originally designed by the Swedish mining engineer, Sven Bergh. Sulphur is obtained in the process as an important by-product which is used in the rayon mills. The extraction of the oil leaves a residue containing coke in a quantity sufficient for the supply of power to the works. Moreover, several tons of steam are available from the plant for use in the gasoline and sulphur works which require sufficient quantity of cheap steam for economic running. Swedish chemists are also active in recovering a number of other useful by-products which will make the shell-oil production more economic and enable it to survive post-war competition.

The shell-oil works in the province of Narke, recently started by the Government, have already recorded a production of nearly 30,000 tons of oil annually. A new electrical method of extracting oil from shell, guaranteeing a greater efficiency, has met with experimental success and will be soon put into operation. The production of shell oil is yet insignificant and falls far short of the needs of the country. As a matter of fact, Sweden used to import nearly a million tons of oils of which a small fraction can now be obtained from abroad owing to shipping difficulties.

ANNOUNCEMENT

MR SASANKA SEKHAR DE, M.Sc., of the Department of Applied Chemistry of Calcutta University has been admitted to the Degree of Doctor of Science of Calcutta University on the merit of his thesis entitled "Physico-Chemical studies on Crystalline Haemolysin isolated from Cobra Venom". He is at present continuing his investigation under a scheme of research financed by the Indian Research Fund Association.

SCIENCE IN INDUSTRY

A NEW PROCESS OF IRON RECOVERY

A NEW process, based on electrolysis, of the recovery of iron from low-grade ore containing only 20 to 30 per cent of the metal has recently been perfected in the research laboratory of Henry Ford with great possibilities of commercial success. Recovery of iron from ore containing less than 40 per cent of iron by the usual smelting process is not commercially feasible owing to the greater cost of production involved in the working out of low-grade ore. Of the various methods tried the electrolytic method has the required commercial promise. The process is, in fact, one of electro-plating and depends for its success on the supply of cheap electric power. Iron is dissolved out of the ore in a chemical solution which is subjected to electrolysis when metallic iron deposits on the electrode. The purity of iron obtained in this way exceeds 99 per cent. The metal can be removed in the form of sheets which contain some amount of hydrogen. The gas can be removed by heating when the metal becomes ductile. When its use in powder metallurgy is intended the sheets containing hydrogen can be easily pulverised.

Electrolytic iron is characterised by some special properties which lend themselves to some important industrial use. Iron, obtained in this way, has been particularly useful in the growing field of powder metallurgy. The iron powder can be moulded into precision gears that do not require any machining. The magnetic properties of electrolytic iron show less retativity, and as such, unlike ordinary iron, it has high spark output at all speeds. Besides, the metal is more ductile and resistant to corrosion.

SEAWEED AS A FODDER

RECENTLY in an article contributed to *Nature* J. Beharrell discussed the fodder value of seaweed and suggested that seaweeds can offer a satisfactory solution to the acute problem of food supply for livestock. The fodder value of seaweed in the form of

dried meal is known for a long time to the people of China, Hawaiian Islands, Lapland, Faroe Islands and many other places, who import dried weeds from the sea coast and use them as an important fodder for cattle, sheep, pigs and poultry. Though various species of seaweeds are known to have great fodder value mainly from experience, systematic analysis of these weeds with a view to ascertain more thoroughly the nutrition value of various species was not undertaken until recently. Several years back a comparative study of the food value of oats and a meal produced from dried *Laminaria flexicaulis* was made which established the superiority of dried *Laminaria* meal to oats. The results showed that 3 lb. of meal was equivalent to 4 lb. of oats and that one million ton of seaweed would give rise to a dried meal equivalent to 150,000 tons of oats and to about 1,200 tons of fertiliser rich in potash. In 1939 Dr Bernard Dyer and Partners of London carried on a systematic analysis of seaweeds collected from the Norwegian and the Scottish sea shores and determined the percentages of organic and mineral substances of great importance. The results are as follows:—

	Parts per million.	
	Norwegian	Scottish
Moisture	13.58	15.50
Oil or fat	4.40	1.50
Albuminoids	6.90	10.90
Digestible carbohydrates	53.95	35.30
Fibre	5.07	9.30
Ash	16.10	27.50
Phosphoric acid	0.46	0.83
Lime	2.15	3.51
Magnesia	0.17	0.38
Sodium chloride	2.70	6.73
Soda in other forms	1.64	—
Potassium iodide	0.07	0.65
Potassium chloride	—	4.98
Potassium in other forms	1.98	3.98
Iron oxide	0.10	0.32
Silica	0.20	1.40
Carbon dioxide, sulphur trioxide, etc.	6.63	4.72
Carotene	6.2	0.3

The presence of sodium, calcium, magnesium, potash and small quantities of barium, strontium, lithium, rubidium, titanium, aluminium, iron, manganese, silicon and copper in the ash was confirmed by spectrographic analysis carried out in the Macauley Institute for Soil Research.

Various methods of drying and preparing the meal are resorted to in different places according to the nature of the seaweeds available. At Stronsay in the Orkney Islands where *Laminaria* is used, the seaweeds are thinly spread and dried by sun and air as quickly as possible in order to avoid decomposition. The weeds, as some suggest, may be washed to remove the adhering salt. Curiously enough the iodine and mineral value of the weeds has been found to be the highest in the late summer and autumn collections. A more elaborate procedure is followed in the north of Scotland. The seaweeds are as usual dried by sun and air for several days, sliced with special cutter and ground to a fine grist. It is then subjected to a varying temperature from 350°C—450°C for forty minutes and further finely ground when the stuff is ready for use. The use of one to two per cent weeds in this form with the meal, or slightly more, has been observed to produce the most satisfactory results. It is interesting to note that the Overbrook Dairy Herd in U. S., making extensive use of dried seaweed in the animal fodder, recently established the world's (Herd) record for milk production.

In California, whose shores are particularly fortunate in the luxuriant growth of giant seaweeds (500 ft.), the Scottish method of preparing the dried meal is closely followed. The 'kelp meal', as it is called there, is further mixed with fish meal and sold. The utilisation of seaweed as a food for livestock is still on a meagre scale, and not even one tenth of the kelp collected on the Pacific coast is at present used for this purpose.

ROTENONE BEARING VEGETABLE INSECTICIDES IN INDIA

MR T. P. GHOSE of Forest Research Institute, Dehra Dun discussed in a pamphlet, recently issued by the Institute, the occurrence of derris and other rotenone bearing vegetable insecticides in India and the possibilities of their cultivation in this country. It is well-known that the rotenone bearing vegetable insecticides are now generally employed with effect in controlling and eradicating several kinds of agricultural and horticultural insect pests in preference to chemical insecticides like lead and copper salts, arsenic, nicotine etc. which are poisonous to man as

well. Rotenone, the principal toxic constituent, has been found in a number of species of plants belonging to the N. O. Leguminosae-Papilionaceae, namely Derris, Lonchocarpus, Tephrosia, Millettia, Mundulea, Spatholobus and few others. Lonchocarpus and Derris with some of its varieties which constitute the chief source of rotenone are cultivated in Brazil, Ecuador, Venezuela and other South American countries and in Malaya, East Indies, French Indo-China and Philippines respectively. In addition to rotenone, derris also contain ether soluble and amorphous resin, marked also by toxic properties, which has great commercial value.

Search for rotenone bearing plants in India resulted in the discovery of a number of species, namely, Derris ferruginea, Millettia pachycarpa and Tephrosia candida. Of these, the last two do not belong to the derris species, but constitute good sources of rotenone. Derris ferruginea is the most important of the several derris species that grow in India. This species generally grows in Assam as a wild plant. Millettia pachycarpa also grows in Assam and Bengal. Rotenone content of these only two indigenous species is, however, not greater than 2.5 per cent which is quite poor compared to the 6 per cent rotenone content of commercial derris from Malaya, East Indies etc. But the fact remains that so far only the wild varieties have been investigated and that there is yet enough scope for improving the rotenone content of the indigenous species by proper selection of strain and cultivation. Even this low percentage of rotenone has not removed the prospect of preparing insecticide of standard quality. The standard powder contains 0.75 per cent of rotenone. It has been calculated that a mixture of 70 lbs. of clay and 30 lbs. of root powder prepared from roots containing 2.5 per cent of rotenone will be as efficient as the standard variety prepared from commercial derris with 5 per cent rotenone.

The fact that India grows derris species, though poor in rotenone content, suggests the possibility of its plantation from cuttings of better Malayan derris. The physical conditions required for a healthy growth of derris are 90—130 inch rainfall annually, average humidity of 80—90 degrees and a temperature of 80°F. Many localities in Bombay, Madras, Bengal and Assam conform satisfactorily to these requirements and hold promise for successful plantation of commercial derris. Cultivation of derris elliptica and D. Malaccensis, collected from Malaya, was attempted in Dehra Dun, Mysore, Cochin State and Assam with varying degrees of success. The results indicate that while the climate of Dehra Dun is unfavourable for the purpose, the rest undoubtedly offer

good climatic conditions. As a matter of fact, D. Elliptica grown in Mysore and Cochin State developed in each case 7 per cent of rotenone and in Assam 6 per cent of rotenone. The amount of ether solubles varied from 16.3 per cent to 22 per cent (commercial derris: 6 per cent rotenone and 18—20 per cent ether solubles). These facts unmistakably point to the promising future of derris cultivation in India.

WELDING IN SHIP CONSTRUCTION

THE technique of welding has advanced considerably in recent years,—its most outstanding development being in ship construction. The result of impetus, given by the war to the shipbuilding drive, can be seen in the springing up of new shipbuilding and repair yards both in the United Kingdom and U. S. A. wherein the latest electric arc methods of welding are extensively adopted. In these methods as against the usual rivetted form of construction two major considerations arise. In the first place there should be skilled labour and an efficient plant, wherein the joints and sections can be positioned in such a way that all welding operations can be done with the maximum ease, that is, the welds should preferably be in a down-over or vertical plane. In the former plane, relatively heavy deposits can be put down at one run, using comparatively heavy-gauge electrodes, which eliminate the possibility of undercutting the parent plate, and thus results in a saving of material and reduction in welding costs. Secondly, in order to take the best possible advantage of the new process, the structural design and even the fabrication should not be merely copied from the rivetted form of design but should be adequately changed to facilitate the electric arc-welding process.

Various types of stresses are encountered by floating vessels. Almost all types of vessels from towing-barges to ocean-going liners are subjected to the structural and local strains according to their size, capacity and nature of construction. The structural strains cause the ship to bend in a longitudinal direction, distort it transversely, and bring about complex secondary stresses due to propulsion. Local strains are generally a result of heavy concentrated weights of machinery, guns, armour, masts etc. and those produced by vibration and racking. Under stresses due to these conditions the rivets slacken considerably, and the vessel has to be dry-docked for repairs. In the case of welded structures such strains do not creep up and there is no possibility of the members getting weakened at the joints, due to the absence of rivets. The only types of stress which a welded ship may be subjected to are those due to

a wrong welding procedure or faulty design, which, it is anticipated, will be eliminated as further experience is gained and more information regarding the technique of arc-welding is made available. On the other hand, a properly designed welded joint can carry a comparatively greater load than a rivetted one that is, welding would reduce the size of the member under consideration, and still carry the same load with better stress distribution. The construction of ships is based on the longitudinal or the transverse system or sometimes on a combination of both. In the latter, the welded transverse and longitudinal bulkheads are a valuable contribution to the strength of the vessel, providing resistance against racking in heavy seas. The adoption of welding in hull structures has resulted in an increase in the efficiency of oil tankers by the elimination of faying flanges, plate laps, brackets etc. and an increased oiltightness in the general structure. In U. S. A. several tankers have been constructed with arc-welded internal and hull structures, some of which are nearly 500 ft. in length, thus assuring us that electric arc-welding will play the principal role in America's contribution to the fleet of the new cargo vessels which very soon will be flying the British flag.

S. K. G.

WAX FROM SUGAR-CANE

DURING the war of 1914—18, sugar-cane wax was obtained as a by-product in South Africa; the manufacture continued up to 1930 when it was no longer a paying process. During the present war, U. S. A. is attempting to manufacture it at Louisiana, the estimated amount is stated to be 6-7 million pounds.

The wax is present on the stalks of sugar-cane as a thin layer; the amount, however, is very small, even less than 2 lbs. per ton of sugar-cane (i.e., less than 0.1 per cent). The dried press-cake of mud from the clarification of cane-juice, is solvent extracted—the wax representing 5—17 per cent of the cake. Some fat always accompanies the wax, and makes the latter sticky. It also lowers the melting point of the wax. This fat suffers putrefaction to some extent on standing, and a harder wax is possible to obtain therefrom. But the unpleasant odour associated with the wax thus obtained has been found to be largely due to the putrefied fat. Toluene has been suggested as a suitable solvent, practically all of which can be recovered. Efforts are being made to separate the fat from the wax. This can be done by a cold diffusion process using acetone as a selective solvent. It has been proposed to set up a pilot plant in

Louisiana to study the problem on a semi-industrial scale.

It seems worth while whether or not the problem can be taken up by the Imperial Institute of Sugar Technology at Cawnpore. In case the process proves successful in India, it will, to some extent, reduce the cost of production of cane-sugar and may thereby mean some relief to the poor consumers of sugar in this country.

P. B. S.

FLAME-PROOFING WITH AMMONIUM SULPHAMATE

FATALITIES due to clothing catching fire through careless handling of flames, fireplaces etc. are common-place experience. Recently, for the first time, a method of flame-proofing textiles and fabrics has been developed, which will go a long way in averting accidents of this type. The chemical which is credited with such flame-proofing property is an ammonium derivative of sulphamic acid, namely, ammonium sulphamate. The sulphamic acid is a crystalline powder and was first prepared by Berglund, a Swedish chemist more than sixty years ago. The early method of preparation was laborious and costly and could not be improved upon for a long time. It was only in 1939 that the Experimental Station of the Du Pont Company could successfully strike out a method of producing sulphamic acid

economically. Since then the chemical ceased to be a mere laboratory curiosity, and research chemists became increasingly interested in finding out possible industrial uses of sulphamic acid and its derivatives. Some dozen important uses of this acid and its derivatives are now known, of which the use of ammonium sulphamate as a flame-proofing chemical is the most outstanding.

The process requires that the textiles and fabrics to be flame-proofed should be dipped in a solution of ammonium sulphamate or sprayed with the same and subsequently dried. The thin layer of ammonium sulphamate, itself incombustible, will render the fabrics incapable of supporting fire. In contact with fire textile clothing may char, but will not burst into flames. As a matter of fact, the fabrics remain flame-proof so long as they are not washed with water to dissolve out the adhering layer. In that case the process has to be repeated. Dry cleaning, however, does not impair the flame-proofing property of the linen previously treated.

On account of the satisfactory protection the fire retardant guarantees against flame and sparks, it is increasingly coming into use in airplane manufacture, in workmen's clothing in such factories as are easily susceptible to fire accidents, in paper making for decorative purposes and the like. It is expected that the wide use of this new chemical as a fire retardant in inflammable fabrics will greatly reduce the incidence of fire accidents.

ACETYLENE FROM COAL GAS

A new method of preparing acetylene from coal gas has been reported by Briner, de Werra and Jacob (Helv. Chim. Acta, 1941, 24, 1010). The process involves the passing of a high frequency electric discharge through the illuminating gas, containing 21.2 per cent carbon monoxide, 47 per cent hydrogen, 17 per cent methane, 9 per cent nitrogen, and 2.4 per cent higher hydrocarbons, maintained at a pressure below 200 mm. A greater yield of acetylene is ensured by a reasonable increase in electrode spacing with low current density. Thus by placing the electrodes 15 mm. apart and using a current density of 115 mA, the yield was 105.5 g per Kwh, while with an electrode separation of 25 mm. and a lower current density the yield was 180 g. Kwh. Their results of research further indicate that the use of aluminum electrodes leads to a much stabler arc than is possible with copper electrodes.

Disposal of Scrap of Important Non-Ferrous Metals

G. C. MITTER

Chief Assayer, His Majesty's Mint, Bombay.

THE absence in our country of an industry producing "primary" non-ferrous metals from their ores has never been so acutely felt as it is at the present moment. Excepting gold and copper, and very recently antimony on a small scale, no attempt has been made so far to produce "primary" metals, though considerable supply of certain mineral resources are available in this country. The industry of non-ferrous metals in India to-day is such that by far the largest quantity of minerals of such metals as manganese, chromium, aluminium, titanium, magnesium and some others are mined only for the purpose of the export trade. The more serious nature of the situation is that no important ore deposit of such strategically important metals such as copper, zinc, tin, lead and nickel—metals for munition and defence armaments—have so far been located. Excepting the ore deposit of Singbhum in Bihar yielding 6000 tons of copper per year no other important copper mine is known. Practically therefore our entire need of non-ferrous metals of this class is met by import. Here again it is not possible to obtain supplies in times such as the present owing to the shortage of shipping and the increased demand of war materials all over the world and the consequent restriction put on export.

It will not be correct, however, to declare India completely devoid of minerals of such metals e.g., copper, zinc, lead and tin. Copper at one time used to be smelted in large quantities in Southern India, Rajputana and in the regions along the foot of the Himalayas, e.g., Kulu, Kangra, Sikkim and Bhutan. Reports of stray copper deposit are still current from some of these areas. Lead is reported to exist in many places such as Singbhum, C. P., Central India, Rajputana and Hazaribagh. There are tin deposits in Hazaribagh and zinc has been located in Kashmir. Very recently nickel has been reported to exist in the snow-bound regions of the Himalayas near Nepal. There is, therefore, no doubt that the country has got resources in these metals but they have not been fully prospected. The new creation of a "utilisation" branch of the geological survey is not too soon and we hope that through their efforts and the efforts of

enterprising private bodies like the "Tatas" valuable ore deposits of metals which have been so long scarce would be discovered and worked. Some of these deposits may not be so rich or extensive as to warrant large-scale exploitation. But to start at some of the centres small-scale works, smelting 5 to 15 tons (or even less) of metal per day, are within the realms of possibility and should not be overlooked.

The present situation of the country with regard to these strategically important metals being so desperate and the present shipping difficulties proving to be an alarming factor, it is obvious that the fullest possible use of all our resources is essential in order to lessen our dependence on imports from overseas. A plan of conservation of metals calls out for being put into immediate effects. The object can be attained in two ways:

- (1) by encouraging the use of substitutes, both metallic and non-metallic, wherever possible in place of these deficiency metals and their alloys, and
- (2) by a system of strict control of the use not only of the primary metals but also of scrap.

A well organised system of metal control must deal with the question of the disposal of scraps, which are but the inevitable product of any operation that has got to be carried out in the process of manufacture of finished articles. The object should be to re-utilise the scrap to the greatest benefit and with the least loss of time, labour and material.

The problem of the most efficient use of secondary materials is one which in normal times is of great importance to any country or concern. In times of war it assumes a national interest of the first magnitude. This holds good particularly to countries like India possessing no important mineral resources of such strategic metals. The efficient use

of scrap material can only be possible if the system of collection, sorting, grading, remelting, etc., are thorough and carried out as quickly as possible. The metal control is responsible for the direction of such a system in an emergency such as the present. A metal control shall necessarily perform the following functions:—

- (1) to collect secondary material as soon as available thus avoiding contamination and mixing;
- (2) to arrange for the conversion of this material into most suitable form to handle as soon as possible;
- (3) to arrange to store this material in a clean dry place and in such a way that alloys similar in appearance but of different composition have remote possibilities of mixing and contamination;
- (4) to take such precaution that materials are separated and classified in such a way that none goes to inferior use that could be used for higher grade product; and
- (5) to avoid unnecessary transport.

In the non-ferrous industry the largest portion of raw materials in the form of virgin metals is melted into alloys and subsequently worked into forms which become raw materials for fabrication of miscellaneous articles for the benefit of the user. Each one of these processes brings in its trail some class of scraps which can be classified as follows:—

1. Scrap from melting and casting shop practices, e.g., skimmings, drosses, spillages, gates, scales, etc.
2. Scrap from machine shop practices, e.g.,
 - (a) Shearing, tagging, borings, turnings or swarfs etc.;
 - (b) Webbing, from which has been pressed or drawn certain component parts;
 - (c) Rejects made in the pressing or drawing processes, parts mechanically associated with other metals;
 - (d) Defective materials.

The disposal of such articles should generally be regulated as follows:—

1. (a) Skimmings are generally too impure for remelting and should be sent to the refiner.
- (b) Drosses including sweepings generally contain dirt and should after treatment with a magnet be converted into pigs and used judiciously in small quantities with each fresh charge of the same description.
- (c) Gates have the same relative composition as the ingot but hold more impurities. One "gate end" may be used with each new melting.
2. (a) Shearings, tag ends, borings etc., when carefully collected and used immediately can go direct to the melting pot.
- (b) Webbing scrap must be a compulsory return from the fabricator to the rolling mill and that other scrap arising during the processing of sheet, strip, plate and tube shall in the first place be offered to the supplier of the original metals. The scrap thus returned shall be used in the manufacture of the same quality of material as that from which it originated.
- (c) Rejects and parts mechanically associated with other metals: As assembly of parts and machinery operations take place, the problem of handling this class of materials becomes more difficult. Mixing of different metals becomes unavoidable. As separation of such mixed metal would be impossible these scraps must go to the refiner or be used for making low grade alloys.
- (d) Defective materials should be assayed to find whether the defect is due to impurities. If the defect is not due to impurities these can go back straight to the melting pot. Otherwise it must be sent to the refiner.

The method of disposal so far discussed, relates to the kind of scrap called "the process scrap". This is to differentiate it from another class called the "collected scrap". The "collected scrap" is mostly made up of discarded household utensils, broken

objects of art, household fittings and other miscellaneous articles.

The "process scrap" from the nature of its origin can easily be traced to important metal factories and workshops of government departments such as the Railways, the Post and Telegraph and the Ordnance factories. Direction for its collection and economic disposal is comparatively easy in the case of an organisation such as a "metal control". But it is with respect to the "collected scrap" that it is difficult to obtain any idea as to both its quantity and quality. The traditional brass and metal workers who constitute an important artisan class, use chiefly material of this description for turning out with the help of their primitive equipment, wares, decorative and useful, which command even now a fairly good market within their respective area. Also the improved type of urban metal manufactures who employ fairly up-to-date equipment consume a good portion of such scrap. 12,000 tons of domestic utensils were thus made from such scrap in U. P. in the year 1922-23. The total quantity of brass and bell-metal wares manufactured in Bengal in the same period was about 5,000 tons valued at Rs. 54,00,000.*

For the supply of this quantity of scrap there are private concerns already doing thriving business in all important towns and some of them are also experts in the collection, classification and distribution of the material. The help and co-operation of such bodies will therefore be necessary for work of this nature.

The efficient working of the above system of collection and disposal of both the "process and collected" material ultimately gives rise to two types of scrap:—

Type 1 represents the carefully handled and correctly graded material which can be remelted and goes into immediate use in castings that do not require metals of extreme purity.

Type 2 is the remaining portion of the scrap including objects such as mixed gun metals, brasses and copper, domestic utensils, brass scrap etc., which is not suitable for direct further use and which perhaps lies idle or is not used to the best advantage. This is fit only to be treated in a refinery.

The need of a refinery and specially of an electrolytic refinery for copper arises not only from treatment of scrap of the above description but also from the fact that it alone can yield metal from scrap or crude material of such purity as is required for many essential services, the most important of which are the armaments and electrical industries. As such it must be considered as an industry of strategic importance.

The problem of refining such a heterogenous lot of scrap is difficult. An electrolytic method of refining copper directly from scrap (brass and bronze) is said to work successfully in Austria and U. S. A. In one of the methods referred to the case of brass, bronze and monel metals, electrolyte was cuprous chloride, cathode was a sheet of pure copper and the anode was the brass to be refined. During the electrolysis the electrolyte was circulated through reaction towers which were packed with the scrap material to be treated. This was necessary as the electrolyte was rapidly stripped of its copper content in the refining cell because more copper, was deposited at the cathode than was dissolved at the anode.¹

A method for refining bronze was developed by P. Weise in 1922.² He used a modified copper sulphate electrolyte in which the electrolyte was circulated over copper scales to reformatify the electrolyte with copper, the tin content of the scrap being collected as SnO₂ in the slimes. This process is also known as the Lewin process and is protected by a U. S. A. patent.³

A. Hollard refined bronze electrolytically in a modified electrolyte of the customary type but in order to maintain the proper cell conditions steam and air were blown into it.⁴

The electrolytic refining of the lead-bearing copper has been simplified by Kühle who eliminated dense coating of PbO₂ by adding HNO₃ and keeping the temperature at 50°C.⁵

Some of the methods enumerated above certainly look promising. But the heterogenous character of the scrap that will be available in this country for

* M. Hosenfeld and G. Hänsel, U. S. Pat., 1, 757, 047, May 6, 1930.

¹ Z. Electrochemi., 28, 327-41, 1922 and German Pat., 312, 941 (1917).

² U. S. Pat., 1, 574, 043 (Feb. 23, 1920) and 1, 890, 856 (Dec. 13, 1932).

³ U. S. Pat., 2, 016, 718 (Oct. 8, 1935).

⁴ Ph.D. Thesis, Tech. Hochschule, Breslau, Germany (1931).

* Survey of Brass and Bell-metal industries in Bengal. (Dept. of Industries, Bengal).

refining is certainly not suitable for treatment by any of the foregoing methods.

The best alternative therefore is to refine the scrap in two stages.

In the first stage blister copper is produced by treating the scrap in a converter and the second stage consists in refining the blister copper by the customary process of electrolysis.

For the manufacture of blister copper it is necessary to instal a converter and a dust filter plant. A recent French patent* (No. 537,021—S. A. des Saltpetres et Produits Chimiques de Bordeaux) describes the action of such a converter for the treatment of brass and bronze thus:

A gas is passed through a copper base alloy in the molten stage so as to separate from the copper the metal alloyed therewith, the more volatile metal being vaporised without oxidising the copper, and the vaporised metal then being recovered. The apparatus consists of a furnace *A*, having a refractory lining *B*, which can rotate about its longitudinal axis on the roller *D*. An opening *G* is provided, and multiple tuyeres *T*, controlled by valves *J*. Successive different positions of opening and tuyeres are indicated by G_1, G_2, G_3 and T_1, T_2 respectively. The metal scrap is melted in the furnace, the tuyeres occupying position T_1 during this process. The furnace is then inverted, the tuyeres taking up position T_2 . When treating brass, combustible gas is then injected by the tuyeres. This gas, charged with zinc oxide, escapes by way of the opening G_2 and proceeds by way of the hood *H* to the recovery plant. In the case of bronze, a current of steam is injected, when a tin-rich dross forms on the surface of the metal, this being collected when the opening is brought back to the position G_1 . (Fig. 1.)

The metal oxides (of tin, antimony and lead) recovered from the bag house, is briquetted and treated in a shaft furnace or directly reduced in a reverberatory furnace to a lead-tin-antimony alloy, which may be used for white metal, tin solder etc. The oxides of preponderately brass charges are either

chemically treated for zinc salts and for the recovery of the small parts of lead and tin content or the

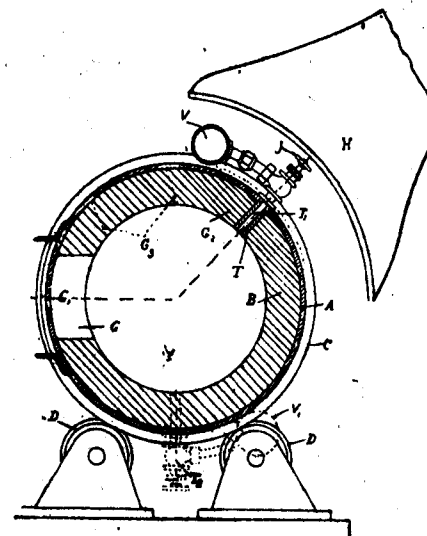


FIG. 1.

oxide mixture, which is usually of a grey colour is used for the manufacture of grey paints.

For copper of high purity used in certain essential services such as the electrical and armament industry, the blister copper obtained from the converter treatment is subjected to electrolytic refining by either the multiple or the series system. The choice of a system will have to be made from a consideration of (1) quantity and quality of blister copper, (2) availability of equipment and power, (3) supervision and (4) labour.

In many countries in Europe and in Japan which have no raw material (ore) basis of their own there are thriving refinery industries based on scrap, some of which are exported from this country. The margin of the metal value in the scrap and the virgin metals is enough to guarantee success to such an industry in India. Even if the scrap quantity in India is not sufficient scrap could be imported for refining. Therefore, in the interest of national economy and for reasons of strategy and self-sufficiency a refining industry such as outlined above is not only urgent but also imperative.

* *Metal Industry Magazine*, 59, 363, 1941.

MEDICINE & PUBLIC HEALTH

PREVENTION OF BED-BUG INFESTATION IN AIR-RAID SHELTERS

THE following insecticide formulae have been recommended by the Medical Research Council of Great Britain for use in air-raid shelters:

1. *Pyrethrins in Kerosene*—The preparation should have a guaranteed content of 0.6% to 0.8% of the pyrethrins. Alternatively, a weaker pyrethrin solution made equally toxic for bugs by the use of an adjuvant and harmless to human beings may be accepted.

2. *Thiocyanates*—(a) Lethane in kerosene should have a guaranteed content of 6 per cent "lethane 384" and (b) Lauryl thiocyanate in kerosene requires a guaranteed content of 3% of lauryl thiocyanate.

3. *Heavy Coal-tar Naphtha with Cresylic Acid*—Cresylic acid (5 per cent) to be dissolved in heavy coal-tar naphtha should comply with the following specifications: (a) Specific gravity at 60°F; not less than 0.835 or greater than 0.910, (b) Distillation range (S.T.P.T.C. apparatus) not more than 10% at 160°C and not less than 99% at 190°C, (c) Flash point (Abel) not less than 100°F, and (d) Tar bases not exceeding 0.25%.

As regards the methods of application, power sprayers in large shelters and hand sprayers of the "flit" or similar type have been advocated. A brush might be used for cracks and other readily accessible places which might harbour bed-bugs. Much may be done to prevent infestations by the obliteration of places likely to harbour bed-bugs and for the latter purpose cement-washing, distempering and painting may be employed. Where a high standard of cleanliness is maintained in shelters, the risk of serious infestation by bed-bugs is greatly lessened.

The precautions to be taken during use of the above preparations are as follows:

- (1) They should be only used when a shelter is empty, and an interval of at least two

hours should be allowed to elapse before the shelter is again occupied.

- (2) To avoid any possible risks of fire the use of naked lights and smoking should be strictly prohibited while handling and spraying these insecticides.
- (3) Owing to the interaction of hypochlorites and pyrethrine, or even traces of cresylic acid, air disinfection of shelters cannot be carried out concurrently when either formula 1 or 3 is used. Several days should elapse between the two forms of treatment.
- (4) Owing to the possible solvent action of heavy naphtha, care should be taken when using formula 3 to prevent its coming into contact with rubber.

MEDICAL SUPERVISION OF YOUNG PERSONS IN GERMANY

SINCE 1940, a "Service for the health of young persons" has been created for the purpose of following up the child from the age of 6-18 years. Although a "health card" is kept for each child from the age of 1-18 years, it was felt that the interval between leaving school and the 18th year was being neglected. For example, whilst the school child enjoys 85 days of vacation per year, the apprentice has only 18; the school child works for 3-6 hours daily, the apprentice not less than 10. It was thought that this change in the habits of life called for a strict supervision of health. It was, therefore, advised that medical check-ups should take place five times:—(1) on entry into school (about 6 years of age), (2) at the age of 10 years, (3) at the age of 14 years, (4) at the age of 15 years, and (5) at the age of 18 years, besides a "dental call-up" every year. The examination at 10 years of age serves the double object of school medical inspection and the examination for entry into the "Jungvolk" from whose ranks the Hitler Youth is recruited. The object of the examination at 14 years

is four-fold:—(1) school-leaving period, (2) admission into the Hitler Youth, (3) fitness to follow a trade, (4) fitness to undertake the year of agricultural labour. It should be remembered that since September, 1939, pupils of secondary and higher schools who have passed the age of 16 are required to serve as agricultural assistants during their vacations and girls are employed as household assistants or in organisations concerned with charitable objects or health.

A close liaison has been arranged between the school medical inspection service and the service concerned with the health of the Hitler Youth Organization. The school medical officers have been styled as "Youth Doctors". The "Youth Doctor" has to prepare health cards which are kept at municipal or State Health Office.

Under a police order of the 18th March, 1940, persons under 18 years of age have been prohibited, (1) to remain in the streets during black-out periods, (2) to enter cafes, cinemas and music halls after 9 P.M. unless accompanied by their relatives, (3) to consume spirits and fermented drinks unless accompanied by relatives, (4) to smoke in public places, (5) to frequent dancing halls alone and, if accompanied by parents, not later than in the night, and (6) to have promiscuous sexual relations including homosexuality. The penalties laid down for breach of these regulations include detention for the children and a fine for the parents. Persons caught in the act are handed over by the police to the Youth Offices who decide the penalty. Any breach of the regulations is notified to the school authorities and to the Hitler Youth.

Although children have been voluntarily evacuated to safer areas, their medical care is entrusted to the Government, if the parents are not members of a sickness insurance society. The same principles apply to mothers accompanied by young children.

CHINESE MEDICINE: ANCIENT AND MODERN

As Chinese civilisation is one of the oldest in the world, one would expect a voluminous body of information about the system of medicine which prevailed in the country. It is difficult, however, to obtain authentic sources of information, and the subject is ignored in some works on the history of medicine, which begins with the Greeks in 500 B.C. Chinese medicine is much older than that, and some of its records go back to the third millennium B.C. and to three famous rulers—one of them still the patron saint of Chinese drug stores—each of whom wrote a book on diseases and their remedies. Dr

George Hoan Hsing Woo in an interesting address on the subject at the China Institute in London described how ancient Chinese medicine was based in part on the theory of two principles, the male and the female, whose equilibrium signified perfect health. The male and female principles were even extended to the classification of drugs. Another theory supposed the human body in health to correspond to the harmonious proportion of the five fundamental elements (apparently, in China, wood is added to the Aristotelian four).

Dr Woo spoke also of four standard methods of diagnosis in the old Chinese medicine namely, observation, interrogation, auscultation, and palpation. By observation was meant the study of the complexion and the facies; by interrogation, the history; by auscultation, only the strength and tone of the voice of the patient; and by palpation, the pulse. The feeling of the pulse was greatly elaborated in old China; more than 130 volumes were written on this subject. There was a special technique for it; the use of a silk cushion, the noting of the difference between the right and the left, the careful disposition of the fingers in taking the pulse. Many elaborate deductions, as to the state of the patient were also drawn by these practitioners, who had "eyes at their finger-tips".

On the treatment of diseases Dr Woo referred to the famous work of Pen Tsao on the materia medica, which was produced in the third century A.D. and re-edited in 1578. Dr Woo claimed for the Chinese that they were early practitioners in endocrinology. Thousands of years ago a deficiency in gland—the thyroid, for example, was treated by the use of gland from an animal. Animal liver was prescribed for diseases of the blood. Pig's stomach was given in a concentrated bouillon for general weakness or anaemia; also for anaemia an infusion from a piece of rusty iron wrapped in gauze or silk was given. The bones of the dinosaur, which had been dug up in the desert and were rich in calcium, were used in the treatment of children suffering from fits. The Chinese drug *ma huang*, from which ephedrine was first prepared was given in cases of asthma. Behind the crudity of much of the treatment was an acute and subtle observation and what may be called clinical instinct, although the scientific background was lacking.

Dr Woo then spoke on modern medicine, which might be said to date from 1835, when Dr Peter Parker of the American Mission Board opened the first hospital in Canton, where Sun Yat-sen more than sixty years later started his medical studies. For three-quarters of a century, until the establish-

ment of the Republic in 1912, medical organization and the teaching of medicine were in the hands of missionaries. Sun Yat-sen created a Bureau of Health in Peking in 1912, but not until 1927, when the Central Government of General Chiang Kai-shek was established in Nanking, was a Ministry of Health set up. Until then, while there had been an almost violent enthusiasm for Western knowledge, it had not been properly canalized. It took the form of a blind copying of Western methods, and the various medical schools took their colour—American, British, French, German, as the case might be—from the country in which their teachers had been educated. By 1933 an official medical curriculum was established by the Ministry of Education for all medical schools.

By the year 1934 a system of State Medicine was instituted in China. The opposition to State medicine in England according to Dr Woo, was understandable in view of the deeply rooted traditions of the voluntary system, but in China, of course, it had virgin soil. If it was argued that a State medical service tended to be bureaucratic and impersonal,

was there not, on the other hand, a danger in competitive private practice?

In medical education China has now established two kinds of training, one lasting for four years and one, with a higher degree, for six. There are about 10,000 qualified and registered medical practitioners—a fantastically small number for a population of 480 millions. The Sino-Japanese War and in fact every major military event in it has brought new problems for the medical service. Infectious diseases account for 41 per cent of all mortality, and it is to the problem of prevention of these diseases that the medical service is addressing itself. He added that the National Government was encouraging the growth of the new medicine in China, one indication being its categorical refusal to register the schools of the association of native practitioners. "This is all part of the transformation," he said, "whereby China is turning itself into a major modern State in the family of nations. Its progress, while not always obvious, has been consistent". (Abstract from B.M.J., Feb. 7, 1942).

Evacuation—Its Public Health Aspects

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EVACUATION as a mass movement of individuals, upsets the state of biological balance in a community, and thereby exerts a very great influence on public health. The present war has caused many such biological experiments on man, to be conducted in different parts of the world, and instances are quite common where the civil population had to evacuate hurriedly in front of an advancing enemy with whatever belongings they could carry, dragging the aged and the sick, over hills and jungles, without proper food and water. Many are the sad stories they had to tell, many had their journey in this world completed on the way, while many more fell after they had reached safety. Much of their

misery could have been relieved by previous arrangements and forethought.

Even before the war began in 1939, the Government in England had made elaborate arrangements for an evacuation scheme. The country was divided into, (i) evacuation areas, (ii) reception areas, and (iii) neutral areas. It was estimated that about three million persons of the 'priority class' would be evacuated from the dangerous areas. It was apprehended that any large scale evacuation might lead to outbreaks of epidemic diseases, and the Evacuation Department of the Ministry of Health and other health organisations, both official and private, all

got ready to meet such an emergency, and the necessary arrangements were made at the reception areas. It was at first decided that all the evacuees would be examined before leaving for the reception areas. In practice, however, this could not have been fully given effect to and they were all examined, though in many cases hurriedly, before reception. Extra hospital arrangements were found for the sick. Most of the evacuees were received and billeted in private families. The sanitary staff in the reception areas were increased and additional sanitary arrangements were made where necessary.

Out of the expected three million evacuee mothers, children and accompanying teachers, etc. only a total of about one and a quarter million actually moved out in the beginning. However, there was soon a drift back and within six months three-fourths of the evacuated mothers and accompanied children returned. Some of the reasons for this drift back were:

- (1) Delay in the occurrence of the expected air-raids,
- (2) Expenses of running two establishments,
- (3) Considerations for husbands and other dear ones left behind,
- (4) Inconvenience of sharing houses,
- (5) Monotony and dullness of rural life.

Thanks to the efficiency of the public health services in England, the result of such an intermingling of people from town and country was, however, not followed by such evil consequences as were previously anticipated. In some instances there were epidemics of measles and diphtheria amongst the children and there was an universal complaint that the evacuee children from towns were more dirty, and in one area 36 per cent. of the school children examined had some degree of verminous infestation, actual lice being detected in 13 per cent. On the whole, however, outdoor exercise and fresh air improved the health of the children and most of them gained in weight. The public health services in England have won the laurel and the soundness of her environmental hygiene has been proved.

England has stood the test. Can India take it? The Burma episode is still green. The flood of refugees from Burma has not yet completely died down. After the first *blitz* in Rangoon, about 40,000 people evacuated the city intending to cross over to India on foot. Due to insanitary conditions and want of proper food, cholera and sickness collected a merry toll. When on February 20th, 1942, orders were issued for evacuating the city of Rangoon within 48 hours, "thousands of Indian labourers again set out on foot, carrying their humble belongings in bundles on their heads, the sun beating down

pitilessly upon them by day, and at the mercy of the dacoits in the Burmese jungles at night." The road back to India and its romances are better imagined than described.

War is knocking at India's door. We have already had experience of evacuation from some of the big cities. It is believed that since December, 1941, over seven lakhs of people left Calcutta, for safer places. With the onset of the monsoon the tide has again turned and the reasons are:

- (1) Non-occurrence of the expected air-raids,
- (2) Financial burden of maintaining two establishments,
- (3) Insanitary conditions in the rural areas and expected outbreaks of malaria with the onset of the monsoon.

In England they said, "Pray that your flight be not in winter", in Bengal we pray that it be not during the monsoon.

Conditions in England and India vary widely. India is so wide a country and its railways, roads and other facilities of transport are so meagre that any large-scale evacuation must necessarily be on foot and in many cases over irregular paths and tracks. Unlike in England, the problem of water supply in rural India is a serious one. The problem here is on the whole a difficult one. The arrangements for evacuation will depend on the local conditions, characteristics of the people and such other factors.

India lives in her villages. The number of big cities and industrial areas which may be subject to severe bombing are fortunately very few. Before deciding upon any scheme of evacuation, the country must be divided into, (a) dangerous areas, (b) neutral areas, and (c) reception areas. This classification, which must necessarily be a flexible one to suit any changing circumstances, must be decided upon jointly by the civil and the military authorities. Co-operation should be a key-note in all civil defence work.

In the dangerous areas the classification of persons into 'essentials' and 'non-essentials' must be well defined. Children, and women not otherwise engaged; school and college students not engaged in any work of civil defence, and persons who are without employment, may all be classed as non-essentials. These people may well be advised to evacuate from class (a) areas, to class (c) areas. The public health problem of evacuation divides itself into three parts, (i) that in the evacuation area itself, (ii) that in the reception areas, and (iii) camp sanitation in the evacuation route.

(i) *Evacuation Areas*: The foremost necessity in such an area is that arrangements must be made to keep going all the essential services, under all conditions. The water supply for the city might become inoperative, and alternative sources of supply must, therefore, be available. Tube-wells operated by hand pumps, distributed throughout the city, would serve very well. Any existing tanks or open wells must be disinfected, as in case of an emergency people are likely to use any kind of water available. Mobile emergency squads must be formed who would immediately after an air-raid search for any damaged water supply mains or sewers, and promptly repair and disinfect them. The city sewerage system might also go out of action, and therefore the possibilities of providing alternative facilities like bored-hole latrines or chemical closets must be investigated. A contaminated water supply may lead to outbreaks of epidemic diseases like cholera and typhoid, and steps should be taken beforehand for mass inoculation.

Arrangements must be made for rehousing people whose homes might have been destroyed in the raids. Arrangements must also be made for proper supply of not only raw food-stuff at reasonable rates, but also for sale of cooked food for essential workers. The number of persons who will stick to their posts under emergency conditions will increase in proportion to the degree that satisfactory arrangements have been made for a continuation of the normal facilities, and supply of normal requirements of daily life.

(ii) *Reception Areas*: As most of the big cities in India have developed due to migration from the villages, majority of the people who would evacuate therefrom would be having some kind of village homes of their own. In many cases, however, their homes are likely to be in dilapidated conditions for want of care for a long time. Those who have got the means, will, of course, make them habitable. For construction of sheds, plenty of building materials like bamboos, timber, straw and reeds would be available in all villages. Those who have no ancestral homes of their own might find accommodation with relatives or friends. Many more would put up in rented houses, although the number of available houses are very limited. In some cases, however, people will have to be assisted in finding accommodation, by finding land for them to build upon or by constructing for them permanent camps.

The question of additional water supply in rural areas is a real problem, as the means of most of the local bodies are very limited. Government must find funds for them to sink tube-wells or wells for the

public. Conservancy or excreta disposal problems are easily solved in rural areas.

The greatest difficulty might arise with regard to supply of essential commodities. Steps must be taken to ensure a regular supply of essential food-stuff at reasonable rates. Alternative sources of supply should be tapped, and the necessity for ensuring economy and preventing wastage must be impressed on all, while the campaign for growing more food should be intensified.

Extra medical facilities must be found, and mobile medical units might be formed to serve a given area consisting of a group of villages.

(iii) *Evacuation Camps*: Notwithstanding advice for previous voluntary evacuation of non-essentials from dangerous areas in an orderly manner, many people would prefer to wait till the first air-raid takes place. Again, the actual raids might break the morale of many people, and make them run away, although they might have at first decided to stick to their posts. As soon as the first raid occurs, all these people in a body would try to evacuate all on a sudden. A sudden rush of evacuation may also occur due to military or strategic reasons. These evacuees must be conducted safely out of the dangerous areas in an orderly and organised manner. Temporary camps should be established along all the possible routes of evacuation. The necessity of making proper and adequate sanitary arrangements for these camps cannot be overstressed, as owing to their temporary nature they are likely to be neglected. In the absence of proper sanitary arrangements, the evacuees would not only suffer themselves but would also carry their infections into the length and breadth of the country, resulting in serious outbreaks of wide-spread epidemics.

The arrangements that are made to meet the exigencies of an onrush of evacuation should be designed to meet all conditions of weather and season. During the summer months many evacuee camps were established which could not stand heavy rains and had to be remodelled.

The details of the sanitary arrangements that should be made for these temporary evacuee camps on the evacuation route, are indicated below. The same principles also apply, in general, to permanent camps in reception areas.

(i) *Accommodation*: Establishments of rest camps are necessary on the evacuation route every 8 to 10 miles apart. The layout should be on high ground so that the area may not get flooded during the rainy season. It should be easily approached, and

not far off the evacuation route. Sheds may be of a temporary nature. Bamboo poles and sloping roof thatched with straw and side walls of bamboo matting or *hogla* (a kind of reed) are quite suitable. The roof should be well tied so that it may not be blown away. The floor should be raised with earth at least a foot above the ground level and well rammed. Bamboo matting may be spread on the floor for people to sit on or lie down. Drains around the sheds are necessary so that water is easily led away.

A minimum floor space of 40 square feet per person is the standard for permanent camps, but for the temporary evacuee camps a minimum of 32 square feet per person is recommended. The width for the type of sheds described may conveniently be 16 ft. divided into two rows of 8 ft. each. The length of each shed may not be more than 100 ft. Each shed requires numbering and separate sheds properly marked for men and women are necessary.

(ii) *Water Supply*: A safe supply of drinking water is essential, as water is an excellent vehicle for transmission of epidemic diseases like cholera, typhoid etc. Under the existing conditions in India, piped public water supplies do not exist in rural areas. In the alluvial soils, as in the Indo-Gangetic plains, tube-wells are quite successful, and if properly protected would be ideal for the camps. The tube-wells after construction, and also at regular intervals, require disinfection; bleaching powder being widely used for the purpose. Spare parts for tube-wells should always be kept in stock and repair mistries should also be available when needed. Protected open wells after disinfection should be covered and provided with a common rope, pulley and a bucket for drawing water. Tanks as sources of drinking water supply are not satisfactory and where there is no other alternative, these should be cleaned, protected, disinfected and kept reserved. No one should be allowed to get down into the water, and for collection of water a pipe connection leading to an ordinary hand pump would be ideal.

Next, in respect to the storage and distribution of water supply, decentralisation of storage system of water for a camp should be reduced to a minimum. The system of storage of drinking water in earthen vessels placed in each shed is unsatisfactory, as any one may dip any vessel and thereby contaminate the water. Galvanised iron drums with covers and fitted with taps at the bottom would serve the purpose well. As an alternative, masonry tanks may be constructed on high ground, and taps fixed around it at the bottom. There should be covers for these tanks, and before water is let into them they should be washed, cleaned and disinfected with bleaching powder solution.

(iii) *Excreta Disposal*: In rural areas in India there are no latrines, and people use the fields and vacant land for the purpose. In the older scriptures of India it is laid down that when a person wants to answer a call of nature he is to throw an arrow towards the leeward side and go at least as far as the arrow flies (i.e., far away from human habitations) and dig a small trench about nine inches deep and cover up the night-soil after evacuation. Night-soil must not be exposed to the flies which may be vectors of many infectious diseases. Further, excreta must not be disposed of in any way as to contaminate any source of water supply. The alternative forms of disposal available for camps in a rural area are (a) Trench latrines, (b) Bored-hole latrines, (c) Bucket latrines.

(a) Trench latrines should be situated farthest from the kitchen and not too close to the camp. However, they should not be very far away, not more than 100 yards from the camp, as otherwise they will not be used and people would soil the adjoining ground. The trenches may be one foot in width and dug to a depth of eighteen to thirty-six inches, depending on the nature of the soil. Separate compartments are to be made by screens of bamboo matting or *hogla*, each seat being not less than two feet six inches, preferably three feet in width. The latrines must be kept in a sanitary condition, otherwise they will not be used. Night-soil should be regularly sprinkled with lime, and covered with earth and ash. Washing facilities are to be provided near the latrines. Some kind of shed would be necessary over the latrines as a protection during the rainy season. Separate latrines must be provided for men and women.

(b) The bored-hole latrine is a circular pit usually sixteen inches in diameter bored to a depth of about six feet below the subsoil water level. "Where the soil is pervious and soft, permitting the boring of a hole whose sides will not cave in, or can be easily supported, and where the subsoil water level is five to fifteen feet below the ground level, the pit has admirably fulfilled all expectations. It is cheap to make and well suited to the needs of a single household, it needs no elaborate supervision to ensure efficiency and cleanliness, its narrowness makes the water surface dark and thereby prevents fly breeding, offensive smells are absorbed by the earth sides of the narrow hole, and as a result of the septic action in the pit, with digestion of excreta, the hole lasts several years if it is not overloaded."

Bored-hole latrines have been successfully used in many countries specially in the Philippines, but in India they may still be considered to be in an

experimental stage. The common belief that they do not require any attention is not quite correct. In the Punjab, in one instance, about 3,000 bored-hole latrines were installed as an experimental measure, of which only about 5 per cent. were actually used. In England, since the beginning of the war, suggestions for the introduction of bored-hole latrines in evacuee areas did not meet with favourable reception.

There is a possible danger of these latrines polluting sources of water supply such as tube-wells and tanks. This point was originally investigated by Yeager (1929) and later by Caldwell and Parr (1937). Recently the problem is being studied by Dyer (1941) in the Punjab and in Bengal, leading to interesting results. Pending further investigations on the subject, bored-hole latrines should not be installed indiscriminately, specially near wells, tube-wells (shallow), and tanks.

(c) Bucket latrines are not likely to be suitable for the camps as it is very difficult to secure the required number of sweepers for removing the night-soil which has to be trenched or otherwise disposed of.

(iv) *Urinals*: Urinals are necessary, specially for women. In many cases all that is done is to dig a drain on the bank of a *doba* with an enclosure of bamboo-matting. Such a system must not be adopted. Soakage pits should be provided for the purpose. These may be 4 ft. in diameter, and 6 ft. deep, filled with *jhama* (overburnt bricks) chips of graded size from two inches at the bottom to half inch on the top. One such pit can be divided by partitions into four urinals.

(v) *Refuse Disposal*: Arrangements for collection and disposal of refuse are necessary. Some kind of dustbins should be provided for each shed or at least one for two adjacent sheds and cleared as often as possible, at least twice a day.

In the dry season the refuse may be dried and burnt in the fields away from camps. Burning will be difficult during the monsoon, and refuse material should then be dumped in pits dug on high ground away from camps, sprinkled with lime and covered with earth.

(vi) *Isolation Ward*: There should be separate camps for isolation of cases of infectious diseases, like cholera and small-pox. These camps are to be situated as far away as possible from the general camps and other houses. Two separate blocks are essential, one for cases of cholera and another for

small-pox, each block being subdivided for men and women. There should be a separate tube-well or other source of water supply for the isolation camp. Separate latrines, subdivided for men and women, are also required for the two wards. Further, for the cholera ward arrangements are to be made for disinfection, and disposal of dejecta of patients by trenching (after disinfection), or incineration.

(vii) *Kitchen and Food*: The kitchen should be situated away from the latrines. Great care must be taken to prevent flies from coming into contact with any food, as flies have been known to transmit diseases like cholera, typhoid, para-typhoid, bacillary and amoebic dysentery, diarrhoea and enteritis. All food must be kept covered.

Any uncooked food material may become polluted, and if eaten in this state may become the vehicle of disease. Cooked food, if properly handled, is of the highest hygienic value, as heat destroys bacteria and harmful organisms, so much so that in Germany even tuberculous meat is allowed to be consumed if sterilized under government supervision. Cooked *khichuri* (rice and *dāl* boiled together in water) would be ideal for the evacuees. Dry rations, like flattened rice and molasses, though very convenient for distribution, may not be suitable from the hygienic point of view. The cooked food must be properly stored and kept covered. In many cases masonry tanks are constructed in the kitchen for storage of water and cooked food like *khichuri*. These tanks should be thoroughly washed, cleaned and disinfected before use, and provided with covers. Care must be taken so as not to contaminate the food in handling during distribution. Dining sheds should be erected near the kitchen, and space must be provided for those who want to do their own cooking.

(viii) *First-aid, Medical and Other Arrangements*: A first-aid post should be established in the camp and the necessary equipments and medicines should be kept ready. Stretchers may be improvised from gunny bags and two bamboo poles. A small maternity ward should be provided with cots, and the necessary arrangements made to ensure aseptic conditions. Disinfectants, like bleaching powder, phenyle and lime should be kept in stock in sufficient quantities. For sterilization of clothes etc., in the isolation ward, fire and containers for boiling, like empty kerosene tins or buckets, should be provided. Hospital facilities may be provided for by supplementing any existing hospitals or dispensaries with extra stocks of medicines and beds. The services of local medical practitioners should be secured, by giving them a small retaining fee if necessary. There should be lighting arrangements at night, but not to

an extent as to contravene any black-out restrictions. Hurricane lanterns are quite suitable. Arrangements should be made for the disposal of dead bodies, in case any one dies in the camp.

(ix) *Malaria*: It had been pointed out by Ross that, other factors remaining constant, the amount (*ratio*) of malaria in a given locality tends towards a fixed limit determined by the density of both malaria carrying mosquitoes and human population, it being directly proportional to the former and inversely proportional to the latter. Other factors remaining constant, changes in human density might therefore greatly affect the malaria index. Evacuation reduces the human density in evacuated areas and increases that in the reception areas. If from an area of low endemicity people are evacuated, the number of anophelines per person left behind will greatly increase, which may result in a flare up of malaria. Calcutta in this respect is in danger of an epidemic of malaria if it remains evacuated of nearly half its population for any considerable time, and if additional measures are not adopted for the control of malaria (return of infected people may make conditions worse). On the other hand, the introduction of more people into areas of low endemicity (at least below 50%) may tend to bring down the malaria rate; but if the original malaria index in the area is already high (over 50%) then the introduction of more non-immune susceptible people will make conditions worse and more people will suffer, the reduction in the malaria index being negligible. From this, it will be readily understood, how evacuation may make the problem much more complex in a country in many parts of which malaria is *Public Enemy No. 1*.

In selecting a site for a temporary evacuee camp the status of malaria in the given locality should also be taken into consideration. Temporary measures of larval control near about the camps as well as adult spray killing should be adopted wherever possible, but under the existing conditions how much real work can be done in this direction, remains questionable.

(x) *Administration*: There should be a central well-defined single authority in charge of administration. The Public Health Engineer and the Medical Officer of Health should be responsible for the sanitary arrangements in all the camps under their jurisdiction. There should be one Sanitary Inspector-in-charge of each camp, and therefore the permanent

staff should be reinforced, where necessary, by the appointment of additional sanitary inspectors. All the sanitary inspectors require a preliminary training, if they are not already trained. Sufficient number of sweepers, cooks and servants should be employed beforehand, as it is very difficult to secure their services, all of a sudden at the time of emergency. Services of local doctors should be secured by giving them a small retaining fee. Volunteers are to be enlisted and divided into sub-groups under supervisors to help in the various works, such as looking after water supply, kitchen, distribution of food, nursing the sick etc. All the workers should be supplied with authoritative identity cards, and regular parades are necessary so that they may remain in touch with their respective duties. Cycle messengers are very helpful and a group may be formed whenever possible.

Police protection along the evacuation route as well as in the camps is necessary not only to enforce the sanitary regulations but also to protect the evacuees from any law-breakers.

All workers, including cooks, sweepers, and servants should be compelled to take vaccination and cholera inoculation.

In this paper the problem of evacuation has been discussed in a general way. The writer hopes to present in a subsequent paper, the application of these principles in particular areas.

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LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

ALGAL FLORA AND MOSQUITO LARVÆ

Mosquitoes consume quite a large amount of algae during their aquatic phase of life. The higher plants, particularly the floating larger aquatics (Macro-phyto-plankton) provide protection and shelter for the mosquitoes, whereas the unicellular, colonial and delicate filamentous members of Blue-Green algae, Green algae and Brown Diatoms either epiphytic on the submerged water plants or floating freely as plankton serve as food to the mosquito larvae. There is close association between mosquito larvae and diatom flora in certain habitats. In fact, Diatoms sometimes form the chief food of some of the species of mosquito larvae such as *Mansonioides* larvae.

The Blue-green and Green algae such as unicellular and colonial members of *Chamaesiphonaceae*, *Chroococcaceae*, *Oscillatoriaceae*, *Nostocaceae*, *Rivulariaceae*, *Eugleninaceae*, *Volvocaceae*, *Chlorellaceae*, *Hydrodictyaceae*, *Chlorococcaceae*, *Oocystaceae*, *Characiaceae*, *Zygnemataceae*, *Desmidiaceae* and *Diatomales* have frequently been observed in a disorganised state in the matrix forming the gut-contents of larvae. Some of these are easily digestible and difficult to identify. These algae are observed only in their entirety if the larvae are dissected immediately after they swallow the algae. Thus *Chlorella vulgaris*, the alga which is an indicator of rather *polysaprob* or *mesosaprob* medium, that is, somewhat insanitary water, is one of the most common species of green algae found in the gut-contents of larvae. Zoopores of green algae, particularly of the families of *Volvocaceae*, *Ulotrichaceae*, *Chaetophoraceae*, and *Cladophoraceae* are frequently found as food of the larvae. The larvae, however, avoid large, coarse, long filamentous members of *Oscillatoria*, *Lyngbya*, *Scytonema*, *Cladophora*, *Pithophora*, *Ulothrix*, *Stigeoclonium*, *Draparnaldia*, *Chaetomorpha*, *Tribonema*, some species of *Oedogonium*, *Spirogyra*, *Zygnema* and others, which, often floating as *Trichoplankton*,

serve as ideal retreat and foraging ground for the mosquito larvae. The larvae seem to have also special fascination for the slimy, unicellular and delicate filamentous Blue-green and some species of Green algae, particularly the members of the well-known *Micro-phyto-plankton* species and a few other species attached to the floating and submerged aquatic plants. Some of the common species found to serve as food to larvae, are the following:—

Microcystis aeruginosa, *M. flos-aquæ*; *Chroococcus minutus*; *Glœcpsa quaternata*; *Aphanocapsa Grevillei*; *Merismopedia convoluta*; *Chamaesiphon incrustans*; *Spirulina major*, *S. tenuis*; *Oscillatoria tenuis*, *O. Agardhii*, *O. amphibia*, *O. quadripunctulata*, *O. salina*, *O. brevis*, *O. splendida*, *O. princeps* (more as shelter); *Phormidium tenuis*, *P. papyraceum*, *P. autumnale*; *Lyngbya aeruginæo-cœrulea*, *L. ochracea* (iron bacterium); *L. æstuarii* (for shelter), *L. majuscula* (for shelter); *Microcoleus Chthonoplastes*; *Schizothrix rivularis*; *Nostoc commune*; *Anabaena sphaerica*, *A. indica*, *A. circinalis*, *A. flos-aquæ*; *Aphanizomenon flos-aquæ*; *Glœotrichia pismus*, *G. natans*; *Scytonema crispum*; *Euglena sanguinea*; *Chlamydomonas* sp.; *Phacus* sp.; *Carteria* sp.; *Gonium pectorale*; *Pandorina morum*; *Volvox aureus*; *V. globator*; *Chlorella vulgaris*; *Characium Pringsheimii*, *C. subulatum*; *Pediastrum tetras*, *P. clathratum*, *P. simplex*, *P. Ehrenbergii*; *Scenedesmus quadricauda*, *S. acuminatus*, *S. bijugatus*, *S. perforatus*; *Oocystis solitaria*; *Tetradron minimum*, *T. caudatum*, *T. bengalicum*; *Ankistrodesmus falcatus*; *Selenastrum gracile*; *Kirchneriella lunaris*; *Dimorphococcus lunatus*; *Coelastrum cambricum*, *C. sphaericum*; *Chaetophora elegans*, *C. pisiformis*; *Oedogonium* sp.; *Cosmarium granatum*, *C. Meneghinii*; *Closterium* sp. (small forms); *Staurastrum dejectum*; *Diatoms—Synedra ulna* (var.), *S. affinis*, *S. affinis* var. *fasciculata*, *Asterionella formosa*, *Achnanthes* sp., *Navicula* sp. (smaller sp.), *Gomphonema constrictum*, *Cymbella*

sp., *Amphora ovalis*, *Rhopalodia gibba*, *Nitzschia* sp. and some of the delicate species of *Spirogyra*, *Zygnema*, *Desmidium spondiliosum* and *Hyalotheca dissiliens* and others. Some species of anopheles have specialised breeding spots. These selective habitats are again dependent on the availability of a particular type of algal flora favourable to the growth of a certain species of anopheles or other genera of mosquitoes. Elimination of certain type of algal flora serving as food or shelter to mosquito larvae will consequently prove to be much effective in controlling the growth of some species of anopheles or culex or other genera of mosquitoes which live and subsist on some particular species of algae at a certain period of their development in water. It is observed that *Tricho-Plankton* composed of *Potamogeton* and *Halophila* interwoven by masses of *Lyngbya aestuarii* and also spreading sheets of this alga mixed with *Cladophora crispata* and *C. calicoma* on the muddy layer of silt in the mainland and islands of the Chilka lake offer ideal food and shelter for the larvae which flourish luxuriantly among such a vegetation. Therefore the study of the life history of the mosquito larvae in relation to algal food is likely to throw light on the problem of the control of mosquitoes in different parts of the country. The importance of the studies on algal flora of India in relation to mosquito breeding cannot be overemphasised.

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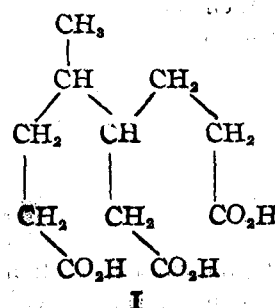
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SYNTHETICAL EXPERIMENTS IN THE ZINGIBERENE GROUP

PART I

By the oxidative degradation of dihydrozingiberene Ruzicka and Van Veen¹ obtained a tricarboxylic acid which has been ascribed the constitution I. The present note deals with the synthesis of the above acid.



Ethyl α -methyl- α -acetyl-glutarate was brominated in the cold and the resulting bromo-compound in the crude state after being condensed with ethyl sodio-malonate in benzene followed by hydrolysis of the resultant tetra-carboxylic ester with concentrated hydrochloric acid gave ethyl γ -keto- δ methyl-suberate (B.P. 160-161/7 mm.). The keto-diester was then subjected to Reformatsky's reaction with activated zinc and ethyl bromoacetate to give a lactone (B.P. 192°/6 mm.), which on being reduced with red phosphorus and hydriodic acid followed by esterification of the crude tricarboxylic acid with methyl alcohol and sulphuric acid, afforded the trimethyl ester (B.P. 182°/6 mm.; literature records 145-150°/0.3 mm.) of the required acid I.

My grateful thanks are due to Prof. P. C. Mitter, M.A., Ph.D., for his keen interest and advice during the course of this investigation.

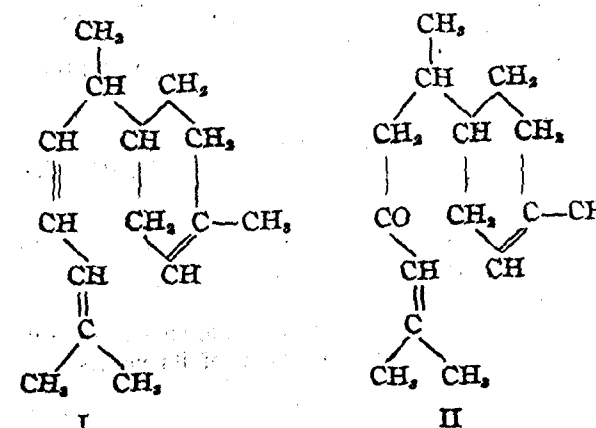
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¹ *Annalen*, 468, 143, 1929.

PART II

The pungent principle of oil of ginger from the rhizomes of *Zingiber officinale*, *Roscoe*, is the monocyclic sesquiterpene zingiberene I. We owe the determination of its structure to the ingenious experiments of Ruzicka and Van Veen.¹ The present investigations were initiated with a view to finding out a general method for synthesis in this group of sesquiterpenes.



Ethyl 6-bromo-2-methyl-cyclohexanone-2-carboxylate was prepared by the bromination of ethyl 2-methyl-cyclohexanone-2-carboxylate according to the condition of Conrad and Kreichgauer.² The above bromo-compound on treatment with quinoline or dimethyl aniline at 150-160° gave ethyl 2-methyl- Δ^2 -cyclohexanone-2-carboxylate (B.P. 112-114°/10 mm.). Condensation of the unsaturated keto-ester with ethyl malonate in presence of a trace of sodium ethoxide in alcohol proceeded smoothly.³ The malonic ester derivative (B.P. 192°/5 mm.; semicarbazone m.p. 126°) was methylated by means of sodium ethoxide in alcohol and methyl iodide. The methylated product (B.P. 188°/3 mm.) underwent smooth hydrolysis, when boiled with concentrated hydrochloric acid, to give 2-methyl-cyclohexanone-5- α -propionic acid, isolated as its ethyl ester (B.P. 131°/6.5 mm.). This keto ester was reduced by aluminium isopropoxide in isopropyl alcohol to give the corresponding hydroxy ester (B.P. 138°/7 mm.) which was dehydrated with phosphorus pentoxide in benzene to afford a mixture of ethyl α -(4-methyl- Δ^2 -cyclohexenyl)-propionate (B.P. 108°/7 mm.) and ethyl α -(4-methyl- Δ^2 -cyclohexenyl)-propionate (B.P. 95°/7 mm.).⁴ The Δ^2 -isomer after being purified through repeated fractionation was subjected to reduction with sodium and absolute alcohol to give β -(4-methyl- Δ^2 -cyclohexenyl)- n -propyl alcohol (108°/5 mm.) which was converted into the corresponding bromo compound (B.P. 106-108°/6 mm.)

with phosphorus tribromide and a little pyridine. The Grignard complex prepared from the above bromo-compound was induced to react with β -methyl-crotononitrile to give the ketone II.

It may be added that the ketone II on reduction with aluminium isopropoxide followed by dehydration is expected to yield zingiberene I.

My best thanks are due to Prof. P. C. Mitter for advice and keen interest he has taken during the progress of the work.

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¹ *Annalen*, 468, 143, 1929.

² *Ber.*, 30, 856, 1897.

³ Cf. Bartlett and Woods, *J. Am. Chem. Soc.*, 2937, 1940.

⁴ Cf. Price and Karabinos, *ibid.*, 1159, 1940.

ON THE SCATTERING OF FAST β -PARTICLES BY ATOMIC NUCLEI

The theoretical investigation of the problem of scattering of fast β -particles by atomic nuclei has already been made by Mott¹ according to whom the relative intensity of scattering by a single atomic nucleus between angles θ and $\theta + d\theta$ is given by

$$I = 2\pi \left[\frac{Ze^2}{2m_0c^2} \right]^2 \cdot \frac{1-\beta^2}{\beta^4} \cdot \left(\text{cosec}^2 \frac{\theta}{2} - \beta^2 \text{cosec}^2 \frac{\theta}{2} + \pi\beta \frac{2\pi Ze^2}{hc} \cot^2 \frac{\theta}{2} \cdot \text{cosec} \frac{\theta}{2} + \text{higher terms} \right) \times \sin \theta d\theta \quad \dots (1)$$

where $\beta = \frac{v}{c}$, Z = the atomic number and the other symbols have their usual meaning. As the experimental data is always given for finite ranges of the angle of scattering, it is necessary to integrate the above differential intensity between the limits θ_1 and θ_2 . On carrying out the integration and multiplying by Nt , one readily finds

$$I(\theta_1, \theta_2) = \pi Nt \left(\frac{Ze^2}{m_0c^2} \right)^2 \frac{1-\beta^2}{\beta^4} \left[\left(\cot^2 \frac{\theta_1}{2} - \cot^2 \frac{\theta_2}{2} \right) - 2\beta^2 \log \frac{\sin \frac{\theta_2}{2}}{\sin \frac{\theta_1}{2}} + \frac{2\pi\beta Z}{137} \left(\sin \frac{\theta_1}{2} - \sin \frac{\theta_2}{2} + \text{cosec} \frac{\theta_1}{2} - \text{cosec} \frac{\theta_2}{2} \right) \right] \quad \dots (2)$$

where N is the number of scattering nuclei per c.c. and t is the total path length of the β -particle in the gas.

In order to verify Mott formula (2), one of us² studied experimentally single scattering of β -particles of energy 2×10^5 e.v. by Xenon nuclei, over wide angular ranges for two different track lengths and obtained results in fair agreement with the values calculated from Mott Formula (Tables I and II). On closer examination, however, it becomes evident, that the experimental values for total number of scattering are somewhat less than those given by the theory. The differential distribution of the observed number of scattering shows some irregularities. This, however, is not very serious and can be readily explained if we consider that (a) the photographic method of measurement of scattering angle is liable to some error and consequently the number observed in successive angular ranges may not be quite accurate, (b) the number in each differential range being small, the magnitude of relative fluctuation is large.

TABLE I.

OBSERVATION ON 64M. OF TRACKS IN XENON AT N. T. P.

Angle of Scattering	I (Mott)	I (observed)	Mean $\cos^2 k' r_0$	$I_{\text{Mott}} \times \cos^2 k' r_0$
20°-30°	106	88	0.835	88.5
30°-40°	40	45	0.865	34.6
40°-50°	19.2	...	0.89	17.0
50°-60°	10.7	...	0.915	9.78
60°-70°	6.1	...	0.940	5.80
70°-80°	3.8	...	0.955	3.6
80°-180°	5.3	...	0.970	5.1
40°-180°	45	28	...	41.28
20°-180°	191	161	...	164.38

TABLE II.

OBSERVATION ON 172M. OF TRACKS IN XENON AT N. T. P.

Angle of Scattering	I (Mott)	I (observed)	Mean $\cos^2 k' r_0$	$I_{\text{Mott}} \times \cos^2 k' r_0$
40°-50°	50	50	0.89	44.5
50°-60°	28	16	0.915	25.2
60°-70°	18	15	0.94	15
70°-80°	10	5	0.955	9.5
80°-180°	14	15	0.97	13.7
40°-180°	118	101	...	107.9

As is apparent from tables I and II, the agreement between the theoretical and experimental values

can be appreciably improved if we argue that the β -particle can approach the scattering nucleus only up to a certain critical distance r_0 , depending on its velocity, and bring in an additional correction factor in Mott formula. As in the non-relativistic case, the wave-statistical correction³ is made by taking in (1) the additional factor $\cos^2 k' r_0$,

$$\text{where } k' = k \sin \frac{\theta}{2}, \quad k^2 = \frac{4\pi^2}{h^2 c^2} (E^2 - E_0^2), \\ E_0^2 = m_0 c^2$$

and the wave-statistical value of the critical approach (r_0) is given by,

$$r_0 = \rho \frac{Ze^2}{m_0 v^2} (1 - \beta^2)^{\frac{1}{2}} \left(\operatorname{cosec} \frac{\theta}{2} - 1 \right); \quad \rho = 1.35.$$

The Mott formula is modified into the form, $I_{\text{Mott}} (\text{modified}) = I_{\text{Mott}} \times \cos^2 k' r_0$ (3)

where the value of $\cos^2 k' r_0$ over the small range θ_1, θ_2 has been taken to be the mean of its values at θ_1 and θ_2 .

A detailed account of the work will be published elsewhere.

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¹ Mott, N. F., *Pro. Roy. Soc.*, 124, 425, 1929.² Sen Gupta, R. L., *Pro. Phy. Soc. (Lond.)*, 51, 355, 1939.³ Kar, K. C., *Phil. Mag.*, 24, 971, 1937.

A NOTE ON TWO COMBINATORIAL PROBLEMS HAVING APPLICATIONS IN THE THEORY OF DESIGN OF EXPERIMENTS

A scheme in which v objects are arranged in b sets such that (i) each set contains just k different objects (ii) each object occurs in just r sets (iii) any two objects occur together in just λ sets, is called a Balanced Incomplete Block Design. Such designs were first introduced in experimental studies by F. Yates.¹ The problem of obtaining such designs with given parameters v, b, r, k, λ has been considered by the author² where it has been shown that the construction of designs belonging to the following two series

$$v = 6t + 5, b = 2(t+1)(6t+5), r = 6t+5, k = 3, \lambda = 2 \quad (E_1) \\ v = 6t+4, b = 2(2t+1)(3t+2), r = 6t+3, k = 2, \lambda = 2 \quad (E_2)$$

can be made to depend on the solution of the following combinatorial problems.

Problem (A). Given any integer t , find $2t+1$ triplets of integers

$$(x_i, y_i, z_i), \quad i=1, 2, \dots, 2t+1$$

such that (i) either $z_i = x_i + y_i$ or $x_i + y_i + z_i = 6t+5$ (ii) among the $6t+3$ integers x_i, y_i, z_i the integers $1, 2, \dots, 3t+1$ occur exactly twice, while the integer $3t+2$ occurs just once.

Problem (B). Given any integer t , find $2t$ triplets of integers

$$(x_i, y_i, z_i), \quad i=1, 2, \dots, 2t$$

such that (i) either $z_i = x_i + y_i$ or $x_i + y_i + z_i = 6t+2$ (ii) among the $6t$ integers x_i, y_i, z_i each of the integers $1, 2, \dots, 3t$ occurs exactly twice.

Only trial solutions of these problems for $t \leq 4$ were given by the author, whence the corresponding designs were obtained. A general solution for each of the two problems was given by K. N. Bhattacharya³, in a paper read before a joint meeting of the Indian Science Congress and the Indian Statistical Conference. The object of the present note is to give much simpler solutions for both the problems, from which elegant general solutions for the designs belonging to (E_1) and (E_2) automatically follow, by using the methods of §5 (p. 378-381) of the author's paper already referred to.

Solution of the problem (A).

The problem (A) is solved by taking the $t+1$ triplets

$$(i, 2t+3-2i, 2t+3-i), \quad i=1, 2, \dots, t+1 \quad (I)$$

together with the t triplets

$$(2i, 3t+3-i, 3t+2-i), \quad i=1, 2, \dots, t \quad (II)$$

The triplets (I) satisfy the first alternative in the condition (i), while the triplets (II) satisfy the second alternative in the condition (i). Writing out (I) in full as

$$(1, 2t+1, 2t+2) \\ (2, 2t-1, 2t+1) \\ \dots \\ (t+1, 1, t+2)$$

We see that in the first and last columns all integers n satisfying the inequality

$$1 \leq n \leq 2t+2 \quad (1)$$

occur once, while in the middle column all odd integers satisfying the inequality (1) occur once.

Again writing out (II) in full as

$$(2, 3t+2, 3t+1) \\ (4, 3t+1, 3t) \\ \dots \\ (2t, 2t+3, 2t+2)$$

we see that the integers in the first column, together with the last integer of the last column, consist of all even integers (each occurring once) satisfying the inequality (1); while in the middle column together with the remaining integers of the last column, all integers satisfying the inequality

$$2t+3 \leq n \leq 3t+1 \quad (2)$$

occur twice, and the integer $3t+2$ occurs once.

Hence the triplets (I) and (II) taken together, satisfy the condition (i) of our problem.

Solution of the problem (B)

The problem (B) is solved by taking t triplets

$$(i, 2t+1-2i, 2t+1-i), \quad i=1, 2, \dots, t \quad (III)$$

together with the t triplets

$$(2i, 3t+1-i, 3t+1-i), \quad i=1, 2, \dots, t \quad (IV)$$

The triplets (III) satisfy the first alternative of the condition (i), while the triplets (IV) satisfy the second alternative of the condition (i). Writing out (III) in full, we find that in the first and last columns, all integers n satisfying the inequality

$$1 \leq n \leq 2t \quad (3)$$

occur once, while in the middle column all odd integers satisfying (3) occur once. Again writing out (IV) in full we find that in the first column all even integers satisfying (3) occur once, while in the last two columns all integers satisfying

$$2t+1 \leq n \leq 3t \quad (4)$$

occur twice. Hence the triplets (III) and (IV) taken together, satisfy the conditions of our problem.

RAJ CHANDRA BOSE

Giridih, 8-6-1942.

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PRELIMINARY REPORT ON THE OCCURRENCE OF
HIGHER FUNGI ON BAMBOOS IN AND ABOUT
CALCUTTA

Bamboo is one of the chief forest products of India, cosmopolitan in its distribution. It is one of the most useful and at the same time most neglected plant of India from the point of view of cultivation, preservation and improvement of its species. Trotter in his 'Manual of Indian Forest Utilization' observes that "over hundred species have already been identified . . . are of almost of universal utility . . . The revenue realized during the year 1928-1929 from the sale of bamboos reached a total of nearly Rs. 19,00,000".

But because of abundance, utilization, however, has never been according to plans. For the very same reason, the loss in the bamboo population, both in quality and quantity due to fungal attacks so far, it appears, has not attracted much attention of the economists and the mycologists of Bengal.

A study of the collection of fungi in Calcutta and suburbs during the last fifteen years shows that the bamboo could be the host, either in the living or in the dead condition to at least thirty one species of higher fungi.

At the time of collection, it was noticed that these fungi differed from one another in the degree of their destructive properties. The exact relation of the fungi to the host has not been determined as yet, but it is significant to note, that *Merulius similis* B. and Br. has never been found so far growing on any other host than bamboo stumps. It is hoped that investigations which are now being carried out in this laboratory may result in the establishment of the parasitic relationship of some of them. It is interesting to note in the course of our field-study that bamboo used in fencing are always harboured by *Schizophyllum commune* Fr., *Polyporus durus* Jungh., *Irpex flavus* Kl., *Guepinia spathularia* (Schw.) Fr., hexagonal form of *Daedalea flavida* Lev. and *Nectria* sp., thereby indicating their probable saprophytic nature.

It may further be mentioned here that the study of the life-histories of some of these fungi has already been undertaken with a view subsequently to find out the extent of damage caused by them in the field. A list of the Fungi is given below:—

LIST OF FUNGI

Name	Habitat	
	On living bamboo	On dead bamboo
<i>Polyporus durus</i> Jungh.	+	+
<i>Polyporus friabilis</i> Bose	+	+
<i>Polyporus rubids</i> Berk.	—	+
<i>Polyporus zonalis</i> Berk.	—	+
<i>Polyporus ostreiformis</i> Berk.	—	+
<i>Polyporus anthelminticus</i> Berk.	—	+
<i>Polyporus gilvus</i> (Schw.) Fr. forma <i>licnoides</i>	—	+
<i>Polystictus sanguineus</i> Linn. (Red & white varieties)	—	+
<i>Ganoderma lucidus</i> (Leyss.) Fr.	+	+
<i>Amauroderma rugosus</i> Nees.	+	+
<i>Trametes cubensis</i> (Mont.) Sacc.	—	+
<i>Trametes Persooni</i> Fr.	+	+
<i>Daedalea flavida</i> Lev.	—	+
Hexagonal form of <i>Daedalea-flavida</i> Lev.	—	+
<i>Merulius similis</i> B. & Br.	+	+
<i>Portia diversispora</i> B. & Br.	—	+
<i>Stereum percome</i> B. & Br.	+	+
<i>Stereum petalodes</i> Berk.	—	+
<i>Irpex flavus</i> Klotzsch.	—	+
<i>Grammothele effuso-reflexa</i> Banerjee	—	+
<i>Guepinia spathularia</i> (Schw.)	—	+
<i>Tremellodon gelatinosum</i> (Scop.) Pers.	—	+
<i>Tremella fuciformis</i> Berk.	—	+
<i>Auricularia auricula-judae</i> (L) Berk.	—	+
<i>Schizophyllum commune</i> Fr.	—	+
<i>Flammula dilepis</i> B. & Br.	—	+
<i>Lentinus subundus</i> Berk.	—	+
<i>Clathrus delicatus</i> Berk.	—	+
<i>Cyathus striatus</i> Willd.	—	+
<i>Nectria</i> sp.	—	+
<i>Xylaria</i> sp.	—	+

Department of Botany, SACHINDRANATH BANERJEE
Calcutta University, TARASANKAR GHOSH
Calcutta, 7-9-1942.

SUPPLEMENT

Indian Science News Association
PROCEEDINGS OF THE SEVENTH ANNUAL MEETING

The Seventh Annual General Meeting of the Indian Science News Association was held on Friday, September 25, 1942 at 4-30 P.M. in the hall of the Applied Chemistry Department at the University College of Science, Calcutta.

In the absence of Dr S. C. Law, President of the Association, Prof. P. N. Ghosh, Vice-President was in the chair and Dr John B. Grant, Director of the All-India Institute of Hygiene and Public Health, Calcutta was the Guest of Honour.

Before the business of the meeting began all assembled stood in silence as a mark of respect to the memory of late Mr N. C. Ray and Mr G. Chatterjee, life Members of the Association. Prof. N. C. Ray was a distinguished teacher of science and was long connected with the educational activities of the province. Rai Bahadur G. Chatterji made his mark as an efficient organiser of meteorological research having been Superintending Meteorologist of the India Meteorological Department for a long time.

The proceedings of the last Annual General Meeting were read and confirmed.

On behalf of the Secretaries, Prof. S. K. Mitra submitted the following report of the working of the Association and the audited accounts for the year 1st July, 1941 to 30th June, 1942.

ANNUAL REPORT

The Council of the Indian Science News Association have pleasure in submitting the Seventh Annual Report and the Statement of Accounts for the period July 1, 1941 to June 30, 1942.

MEMBERSHIP

It will be remembered that in 1941 we instituted a new class of members called "ordinary members". During the year under review 15 members joined us in this category as compared with 3 in the previous year. Of these, 12 were already subscribers to the journal. The number of life members at the close

of the year under review was 97 compared to 90 on the corresponding date last year showing an increase of 7.

SCIENCE AND CULTURE

The total number of copies of SCIENCE AND CULTURE despatched in June 1942 i.e., the last month of the period under review was 965 as compared with 820 in the same month in 1941. The number of subscribers in June 1942 (including members of the Association) was 759, which represents an increase of 124 since June, 1941. The actual number of subscribers enrolled however was 155. Against this 12 subscribers were transferred to ordinary members' list and 5 to life members' list. Our loss of subscribers during the period was 36. This include 24 subscribers who discontinued their subscription, 5 subscribers in Burma and 7 subscribers whose names were removed from the list on account of continuous default.

We have been much handicapped owing to the abnormal rise in the price of paper. As our funds do not permit us to hold reserves for a long period, we had to purchase from time to time paper of somewhat inferior quality to print the journal.

EXCHANGE JOURNALS

The total number of copies sent out every month in exchange and for review purposes was 70. We were compelled to stop sending copies to foreign countries owing to the war. Due to the same cause we received in exchange only 4 English, 10 American, 10 Indian and 1 Australian journal as compared to 8 English, 16 American, 7 Indian and 1 Australian journal in the previous year. We also recieved journals of 12 learned societies and publications of 4 Government Scientific Departments. Four Calcutta newspapers, viz., the *Statesman*, the *Hindusthan Standard*, the *Amrita Bazar Patrika* and the *Jugantar* supply their daily issues in exchange. We send the journals regularly to 20 Societies and Institutions on request.

ADAIR DUTT RESEARCH FUND

The well-known firm of Messrs. Adair, Dutt & Co., Ltd., donated a sum of Rs. 4,000 to the Association for creating a Research Fund to be named after the firm in order to encourage scientific work by research students in different institutions in Calcutta. The management of the Fund has been vested in a Committee consisting of Prof. M. N. Saha, Prof. S. K. Mitra, Prof. J. C. Ghosh, Prof. B. C. Guha, Dr A. C. Ukil and Mr G. Bhattacharyya, General Manager for India of Adair, Dutt & Co., Ltd. The Committee has already taken steps to give effect to the proposals of the Donor. The firm of Messrs. Adair, Dutt & Co., Ltd., deserves our sincerest congratulation on having set this example. It is indeed an encouraging sign that industrial and business firms of our country are realising the importance of scientific research.

GRANTS

We express our gratitude to the University of Calcutta, the Bengal Chemical and Pharmaceutical Works, Ltd., and the Indian Association for the Cultivation of Science for renewing their annual grants. The amounts of these grants are as follows:—

Calcutta University ...	Rs. 500/-
Bengal Chemical & Pharmaceutical Works, Ltd. ...	„ 500/-
Indian Association for the Cultivation of Science ...	„ 100/-

We also received during the year the following donations. We take this opportunity of expressing our sincerest thanks to the donors.

Sir U. N. Brahmachari ...	Rs. 450/-
Prof. S. C. Mahalanobis ...	„ 10/-
Hon'ble Mr. N. R. Sarker ...	„ 150/-
Messrs. Adair, Dutt & Co., Ltd. ...	„ 1,000/-

To the authorities of Calcutta University we are further indebted for allowing us accommodation in the buildings of the University College of Science and Technology.

ACKNOWLEDGEMENT

We owe a debt of gratitude to our subscribers and well-wishers who have rendered valuable help in securing new subscribers. We would in this connection mention the names of Mr S. C. Ray, D. P. I. Assam, and Dr K. Mitra, Officer-in-charge Nutrition Scheme, Behar. Dr N. R. Dhar, Deputy Director of Public Instruction, Government of U. P.,

like the past years was instrumental in introducing the journals to the educational institutions in U. P. We had sent an appeal to the Director of Public Instructions, Behar and we are glad to inform you that as a result of same the Behar Government has included SCIENCE AND CULTURE in the list of its approved journals.

The stock of some of our back issues having been depleted, we wanted to purchase copies of them. Prof. J. Ghosh, Indian Physical Society and the All-India Teachers Association have kindly supplied us with some of the copies free of cost.

[For statement of accounts see next page]

OFFICERS AND MEMBERS OF THE COUNCIL

The following persons were unanimously elected officers and members of the Council for the year 1st July, 1942 to 30th June, 1943.

President.

Dr S. C. Law.

Vice-Presidents.—Sir U. N. Brahmachari, Dr Baini Prashad, Prof. M. N. Saha, Dr B. C. Law, Sir S. S. Bhatnagar and Dr P. N. Ghosh.

Treasurer.—Prof. P. C. Mitter.

Secretaries.—Prof. S. K. Mitra and Prof. B. C. Guha.

Members.—Prof. S. P. Agharkar, Dr B. Ahmad, Mr H. P. Bhaumik, Dr K. Biswas, Prof. D. M. Bose, Mr Rajshekhar Bose, Dr Qudrati Khuda, Col. Sir R. N. Chopra, Mr A. T. Ganguly, Prof. J. C. Ghosh, Dr D. S. Kothari, Mr B. N. Maitra, Dr S. C. Mitra, Prof. H. K. Mookerjee, Prof. J. N. Mukherjee, Prof. B. B. Ray, Dr A. H. Pandya, Prof. P. Ray, Dr S. L. Hora and Dr A. C. Ukil.

The editorial board of the journal SCIENCE AND CULTURE for the next year was constituted with Prof. M. N. Saha, J. C. Ghosh and Dr A. C. Ukil with the two secretaries as ex-officio members.

Prof. P. N. Ghosh then delivered his welcome address at the meeting which was attended by important scientific men of the city.

Dr John B. Grant in course of his address* stressed on the deplorable lack of public education in this country. He urged that before SCIENCE AND CULTURE could achieve significant success, it was necessary that the system of education ought to be reorganised.

*Full text of the Address is expected to be published in a subsequent issue.

“SCIENCE AND CULTURE”, he said, “can continue for decades to propagate in the community without significant results unless there is a reorganization of the educational system abreast of modern international trends to provide educated citizens capable

of comprehending the background of the world-mind without whom there can not be the new social order.”

Prof. S. P. Agharkar proposed a vote of thanks to the chair.

Receipts and Payments Account for the year ended 30th June, 1942

RECEIPTS	RS.	AS.	P.	PAYMENTS	RS.	AS.	P.
To Opening Balances on 1-7-41—				By Establishment ...			2,402 6 0
(a) At Bengal Central Bank, Ltd. on Current Account as per Pass-book ...	128	8	6	„ Journal Printing ...			3,956 9 0
(b) At Bengal Central Bank, Ltd. in Savings Bank Account re: Science & Culture A/c. as per Pass-book ...	628	10	1	„ Paper ...			1,870 11 6
(c) Cash at Office ...	86	13	0	„ Postage & Receipt Stamp ...			723 1 6
„ Donation ...				„ Conveyance & Travelling ...			314 2 9
„ Grant ...				„ Telephone ...			156 1 0
„ Life-Membership Fee ...				„ Miscellaneous ...			211 11 6
„ Ordinary Membership Fee Rs. 145/8/0 ...				„ Audit Fee ...			40 0 0
„ Subscription ...				„ Bank Charges ...			29 12 0
„ Advertisement ...				„ Stationery & Printing ...			322 9 6
„ Adair, Dutt & Co., Ltd. Research Fund ...				„ Commission ...			2 8 6
„ Reprint ...				„ Binding Charges ...			10 11 0
„ Miscellaneous ...				„ Furniture ...			18 4 0
„ Bank Interest ...				Closing Balances on 30-6-42—			
				(a) At Bengal Central Bank, Ltd. on Current Account as per Pass-book ...	678	1	9
				(b) At Bengal Central Bank, Ltd. in Savings Bank Account re: Science & Culture A/c. as per Pass-book ...	715	12	3
				(c) At Bengal Central Bank, Ltd. as per Pass-book (re: Adair, Dutt & Co., Ltd. Research Fund as per Contra)* ...	4,000	0	0
				(d) At Office ...	107	13	6
							5,501 11 6
							Rs. 15,560 3 9

* Amount of Rs. 4,000/- is held in trust by the members of the Editorial Board of Science and Culture and by Mr. G. Bhattacharya of Messrs. Adair, Dutt & Co., Ltd., which is to be utilised to defray tuition expenses of a number of deserving students engaged in Scientific and Research work in different institutions in Calcutta.

AUDITOR'S REPORT TO THE MEMBERS

I have audited the above Receipts and Payments Account of Indian Science News Association (registered under Act XXI of 1860) for the year ended 30th June, 1942, with the books and vouchers and have obtained all the information and explanations I have required. I certify that the said Account is correctly stated in accordance with the books of accounts of the Association.

10, Old Post Office Street,
Calcutta, the 14th August, 1942.

Sd. S. K. MITRA,
Sd. B. C. GUHA,
Hony. Secretaries.

Sd. P. C. MITTER,
Treasurer.

Sd. A. K. GHOSH,
Government Diplomaed Accountant
Registered Accountant.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

NOVEMBER, 1942

No. 5

The Renaissance of China

THE Chinese War—or the China Incident as the Japanese call it—entered on July 7, 1942, into the sixth year of its existence. When the War started in 1937, probably very few people outside China could believe that China was capable of offering such a long and stubborn resistance. It is true that the success or rather continuance of the resistance has been in large measure due to the material assistance obtained from foreign powers, *viz.*, Soviet Russia, Britain and U. S. A., but there cannot be the least doubt that the essential factor has been the magnificent and unexpected spirit of resistance shown by the Chinese, and the leadership of the Kuomintang* party under Generalissimo Chiang Kai Shek.

CHINA AND INDIA

Let us trace briefly the history of the Chinese Renaissance, how it has been brought about and what measure of success it has achieved.

* Kuomintang is short for Chung Kuo Ke Min Tang—or the Chinese Revolutionary Party. This name was adopted by Sun Yat Sen in 1919 for his party. The party seized supreme power in China on October 10, 1928, and is now the only political party in Free China with complete political power (with the exception of the communists who are now allied with Kuomintang in their struggle against Japan). Admission to Kuomintang is not easy. Unlike ordinary political parties, admission to it is not secured by merely signing the pledge and paying the fees. The intending member has to undergo rigid tests concerning his knowledge of party principles before he is considered eligible.

China has many points in common with India. Both the countries have a great past with unbroken traditions from hoary antiquity and both have made great and enduring contributions to the progress of civilisation. Neither of the countries have, at any time, even in the days of their greatest power and glory shown a spirit of aggressiveness which has been so characteristic of European and West Asian nations. Both the countries have tried with varying degrees of success to assimilate foreign races and aggressors more by patient, peaceful methods than by violence. In the past both have frequently fallen victims to foreign aggressions, the cause being rottenness of indigenous rulers, inertia of the masses, and internal discord amongst those possessing residuary power after the collapse of the central authority. For the last two hundred years, both countries have been the scenes of imperialistic designs; and both have started their fresh experiments on nation building about the same time.

THE CHINESE AND THE INDIAN PEOPLE

But the countries have points of difference too. Like India, China has joint family system. But in China the joint family system has developed through hundreds of centuries to a degree quite unknown in this country. The result has been that even up to the nineteenth century the Chinese had his first loyalty to his family*, then to his clan, and next to

* There are instances of as many as 13 generations living under one roof. They are now mostly broken up.

his province. Absorbed in the struggle for existence for himself and his numerous family and clan members, the spirit of individual freedom, and national sense, so characteristic of the European nations was almost totally lacking. China was more like "a sheet of loose sand" than a well-knit nationalistic edifice. But in one respect, China has been more fortunate. In India "Religion" has proved to be a great disturber of human relations rendering national unity almost impossible of achievement. In China, on the other hand, religion sits very lightly on the shoulders of its people. A Chinese common man would not think it incongruous to offer his homage simultaneously to Buddha, to Laotze, and to innumerable local spirits and dragons for personal and spiritual satisfaction, while majority of the learned sceptics who ruled the country regarded all religions as worthless.* But in the organisation of society, religion is not allowed to take any liberty as in India. China has followed in this respect the wise precepts laid down by the great philosopher Confucius, a near contemporary of Buddha. This has prevented the growth of any such evil system as 'caste' with hereditary privileges and pretensions as in India; but society has been organised into classes based on profession. The highest class was composed of imperial officers, chosen by a competitive examination; they were essentially scholars and took precedence over every other class. The classes† next in rank were farmers, artisans, merchants and soldiers.

At the apex of this social pyramid was the Emperor, the "Son of Heaven". But herein lay the weakness of the Confucian system; for, the great philosopher could not ordain any practical method for the selection of the "Son of Heaven" and "Heaven" had rarely condescended to send one straight for this key-post, which had usually gone to the head of the clan or the family which could wield the "Biggest Club".

* "Religions are many, but reason is one," says a wise Chinese proverb. Would the Indians realise the wisdom of this saying!

† The farmer and the artisan ranked high, being 'producers'. The merchant ranked low being regarded as a 'profiteer'. The soldier ranked lowest being looked upon little better than a 'murderer'. Neglect of the art of fighting has been one of China's main reasons of military weakness, and has exposed her to foreign aggression a large number of times in recorded history. Conditions have, of course, changed now. A soldier is no longer looked upon as a mercenary. Those returning wounded from war are called 'Honoured Soldiers'.

The frequent changes of dynasty occurring in Chinese history do not however indicate violent changes in the social structure as in other countries. It was only the control of the State which changed hands being wrested from the ruling dynasty by some ambitious foreign or indigenous clans; the aggressor usually found it convenient to leave the Confucian structure of society and State unchanged. Unlike India, China had never the ill luck of being the victims of a very aggressive foreign civilisation* like the Islam, so her foreign conquerors underwent a gradual process of complete Sinification. The last imperial clan were the Manchus, a northern race originally from Manchuria which taking advantage of internal dissensions took possession of China in 1646. From their early days, the Manchus rulers, some of whom, it must be admitted, were men of great ability, found it convenient to maintain and encourage the Confucian system; but the clan as a whole remained distinct from the ordinary people and were not liked by the Chinese. The Manchu emperors, politically more sagacious than their Indian contemporaries, had closed the country to the foreigners till 1839, when after the 'Opium War', the veil was forcibly torn off, and the economic control of China passed to foreign hands. The Manchus did not unfortunately respond to European aggression in the way as Japan did; probably because they had ceased to produce men of genius. The Manchus would, in fact, have passed away long ago had not the Imperialistic Nations found it profitable to help them to remain on the throne for their own selfish ends.

CHINA'S STRUGGLES

When, after nearly half a century's struggle, the Chinese got rid of their Manchu rulers in 1911, their leaders, like the majority of political leaders of India today, were under the impression that the introduction of popular government on European model would enable China to emerge as a great and free modern nation. They were however completely disillusioned by the subsequent turn of events. The psychology of the North was different from that of the South and Sun Yat Sen, the leader of the

* Civilisation as opposed to barbarism, for China has been conquered by barbarians like the the Hsiung-Nu (Huns) or Mongols.

Révolution who was from the South magnanimously resigned the post of the President of the Republic to make way for Yuan Shi-Kai, the most powerful military leader of the North in the hope that this step would promote internal unity. Events, however, showed that the confidence was misplaced. The latter, an unrepentant imperialist, who had previously played the traitor and nullified measures of reform introduced by the Manchu emperor in 1896, gathered all the forces of reaction round him and tried to sabotage the Revolution. Though Yuan Shi-Kai passed away in 1916, this brought no relief. There was a period of unrest in which military governors of China's numerous provinces, backed sometimes by a spirit of provincialism but mostly from personal ambition tried to assert themselves, and China was enveloped in a welter of civil discord between forces of progress (represented by Sun Yat Sen and his party and the forces of reactionary war lords). Apparently the only parties to profit from these troubles were the various imperialistic powers, who extorted trade and commercial concessions at the expense of the Chinese, sometimes by diplomacy, but more often by following the Gunboat policy. Nor were the revolutionaries including the Sun Yat Sen party united by a common ideal. Some advocated a policy of back to the villages and to village crafts. Others advocated complete 'westernisation'. Some advocated 'communism', others different forms of democracy. China was in a whirlpool of confused slogans with no unitary direction.

SUN YAT SEN—THE FATHER OF THE REVOLUTION

This much needed direction was ultimately given by Sun Yat Sen, the founder of the Chinese Republic and the father of the Revolution just before his death.

During the years of 'internal turmoil' and heartless exploitation* from foreign imperialistic powers (1911-1924), Sun Yat Sen had a hard job in trying to keep his party together, and with his fresh experiments at government-making. But unlike other leaders, he was a great scholar and whether in China or in exile, he tried to discover by quiet study and reflection, the causes of China's political weakness and disunion. Even before 1911, while he was an exile in England,

* To use the language of Sun Yat Sen: China was the fish and meat for every imperialist and constituted their hypo-colony.

he read widely in history, economics and political philosophy. He was one among those revolutionaries to whom the reading room at the British Museum, as in the case of Marx half a century earlier came to be almost a home. In 1913 due to Yuan Shi-Kai's treachery he had again to become a political exile.

"This failure caused in him a moral or rather a spiritual collapse. It is perhaps more correct to say that the visionary, whose dreams had come to him so much apart from his own people, now awoke and saw for the first time that he had been dreaming. It is the effect of this process on the mind and soul of Sun Yat Sen which we now have to examine, bearing in mind the earlier stage of westernisation through which he passed. He had been thinking to make a republic by the inherent force of a provisional constitution and an oath of allegiance. He had expected the goodwill and the support of sister democracies even against their own interests. In a book published in England in 1918 (*Memoirs of a Chinese Revolutionary*) he ascribed his failure to the idea rooted in the Chinese mind for two thousand years that *action is difficult, but knowledge easy**, a theory which he had himself believed but which he now saw to be the most fatal of mistakes. He set himself, therefore, when nearly fifty years of age, to a detached study of the economic conditions of his country and to a more realistic comparison of China and the West. Nothing could cure him of being a visionary, but he became at last a visionary striving to found his dreams on social and political facts. In one sense he succeeded, for he came to know his own people very much better, both in their weakness and their strength. His earlier admiration of the West, however, was seriously affected. The years of his retirement coincided with the years of the Great War, and when he emerged from that retirement with his changed outlook, he came back to a world which also was radically different."†

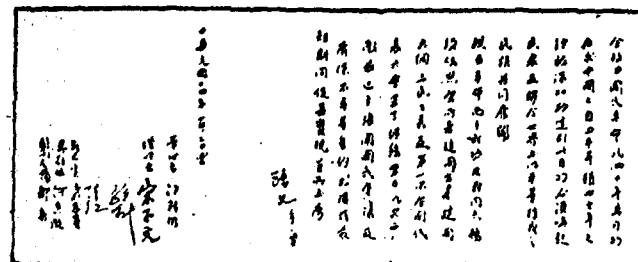
In 1925, when the whole of China was tired to death of civil wars, and foreign bullying, Sun Yat Sen was invited to Peking to try and bring all parties together. But he was a sick man and died in a Peking hospital. Just before his death he bequeathed to the Chinese Nation the product of his life-long experience and reflection: the San Min Chu I, or the Three Principles of the People, in the form of six lectures each on (1) The Principle of Nationality, (2) The Principle of Democracy, (3) The Principle of

* In San Min Chu I, Lecture 1 on the Principle of Livelihood, Sun Yat Sen says: "Here let me return to my theory that understanding is difficult, action easy. Anything in the world can be done, if it is understood." Contrast this attitude of mind of the great leader with that of Indian high officials and political leaders who consider that action is easy once you get power and office. (Footnote is ours).

† Hughes—Invasion of China by the Western World, p. 125.

Livelihood. In a Will reproduced below, he asked his countrymen to follow the Principles laid down in San Min Chu I.

Dr Sun Yat Sen's Will



中華民國二十五年二月二十日

For forty years I have devoted myself to the cause of the people's revolution with but one end in view, the elevation of China to a position of freedom and equality among the nations. My experiences during these forty years have firmly convinced me that to attain this goal we must bring about a thorough awakening of our own people and ally ourselves in a common struggle with those peoples of the world who treat us on the basis of equality.

The work of the Revolution is not yet done. Let all our comrades follow my "Plans for National Reconstruction", "Fundamentals of National Reconstruction", "Three Principles of the People", and the "Manifesto" issued by the First National Convention of our Party, and strive on earnestly for their consummation. Above all, our recent declarations in favour of the convocation of a National Convention and the abolition of unequal treaties should be carried into effect with the least possible delay. This is my heart-felt charge to you.

Written on February 20, 1925.

(Signed) SUN WEN
March 11, 1925.

Though Sun Yat Sen's great Legacy to the Chinese Nation was published nearly seventeen years ago, it does not appear to have been noticed in India, and we hope to review it in a subsequent article. The contents may be briefly stated. Sun Yat Sen stresses that members of a great political party must have spiritual union; the party must first evolve a great moral idea, to which it would be possible for the largest number of earnest minded workers to offer unstinted homage; the idea, according to the leader, would create a new Faith, and the Faith would create Power.

The first series of lectures are on the Principles of Nationality.* The leader goes deeply into the

* According to Dr Sun, the West accepts nationality as a matter of course, as being fundamental to existence, but the East has not grasped the idea. It places religion, and sometimes cosmopolitanism above nationality. Hence Dr Sun's emphasis on Nationalism.

causes of absence of a national spirit amongst the Chinese and pleads for the growth of such a spirit which would take precedence over the hitherto predominant spirit of loyalty to the family, to the clan, and to the province. It must also take precedence over religion or over any romantic cosmopolitanism. In other words, Sun Yat Sen put forward a strong case for a psychological revolution in the Chinese mind in the direction of European ideal of nationalism minus their barbaric elements.

In the second series, the Principles of Democracy, or rather government-making on the basis of sovereignty of the people are discussed. By this time, as already noticed, Sun Yat Sen had been cured of the early glamour of the superiority of European civilisation, and found that ancient Chinese ways, put in a modern garb, were better than Western methods of parliamentarianism, communism or fascism. He suggests a very well thought out and novel method of government, but it is not possible to enter into details in this short article.

Our political leaders would do well to make a serious study of Sun Yat Sen's scheme of government adopted in principle by the Kuomintang, and partially put into operation: as some of the methods advocated by him may turn out to be a radical cure for communism, mock parliamentarianism, bureaucraticism and other obsolete forms of government introduced and maintained in this country.

The third series of lectures are devoted to the Principles of Livelihood of the people, and he pleads for adoption of a programme of development of the country's industries, trade, commerce, transport and communication on the latest methods of science and technology. In fact, he completely throws overboard the cry of 'Back to the villages or to the ancient crafts', and pleads for a hundred per cent. Technological Revolution for China.

He discusses in detail the doctrine of Utopian Socialism (advocated in this country by Mahatma Gandhi, and his followers) for the amelioration of the economic condition of the people of China, and has no difficulty in disposing of its alluring but absurd claims. He also rejected, with almost prophetic vision, certain methods of Russian communism as practised between 1919-1922, but advocated for the retention in the Kuomintang programme of what he considered the essential points in communism. The Russians themselves, as a result of their

experience, have dropped those methods, thus justifying Dr Sun's wisdom.

In 1929 four years after 'San Min Chu I' was published and largely as the result of the new vista opened in the mental horizon of the Chinese, the Kuomintang party came into full political ascendancy and set up their government at Nanking. The Three Principles became the accepted policy of the country, and no effort was spared to give effect to the Leader's idea by propaganda and practice. It was taught as a text book in all schools, not to be altered in any essential particular since it had been given to the country by the sainted Leader. E. R. Hughes describes the movement in his 'Invasion of China by the Western World' in the following terms:—

"As the revolution swept the country, so everywhere schools came under the virtual control of the Nationalist Party. Whilst the main curriculum was not interfered with, new and thrilling lessons were introduced on the basis of the Three Principles of Democracy (San Min Chu I). Special teachers were added to the school staffs whose business it was to inculcate these principles; and although the scope of Dr Sun's famous lectures was very much wider than an attack on Western imperialism, yet the sections containing the attack were the spiciest in the book. These, therefore, attracted the bulk of attention, as also did the fiery speeches which characterised the weekly memorial services held in honour of the dead Leader. From a dozen different angles, with all sorts of pithy illustrations, the lesson was driven home in class-teaching that the stronger races were making colossal fortunes out of their special trade privileges. As a method of teaching history, if somewhat garbled history, nothing could have been more calculated to make an impression on the nation's youth. History became alive and full of meaning, a very grim meaning when the modern expansion of the white races was shown to have involved the extermination of weaker races like the Red Indians."

In the Chinese mind, Sun Yat Sen has taken the place of Confucius, and San Min Chu I* has become

* The San Min Chu I is, in spite of occasional Tai Hua particularly with regard to China's ancient imperialistic

the modern Chinese Nationalist's Bible†. In course of 17 years, the book has completely metamorphosed the Chinese mind, and has led to complete elimination of all other political parties (excepting the Communists) based on provincialism, religion or different forms of political creeds. The Chinese mass is no longer 'a vast sheet of loose sand', but a well-knit edifice the strength of which is vouchsafed by the fact that the imperialistic Japanese hordes have been battering against it in vain for five years. China is now 'Ein Volk', 'Ein Staat' (one people, one state), and the exigencies of the war have given her 'Ein Führer' (one leader) in Marshall Chiang Kai Shek. In accordance with Sun Yat Sen's Will, the Kuomintang started a full programme for complete and unqualified Technological Revolution,—by starting a Sinica Academica, a National Resources Planning Commission, improving communications, harnessing and training rivers, by introducing a Pai Hua (people's language) in place of the difficult classical language, and by adopting an all-round programme of industrialisation based on the latest methods of science and technology and with no mental reservation. But time was too short for China to become 'Ein Werkstatt'—a vast workshop, which was Sun Yat Sen's ideal, and which would have enabled China to face a world of open enemies and dubious friends on her own strength. Thus though the future is 'On the Knees of Gods' the Leader has exerted a greater and probably enduring influence on His people after His death than He had even been able to do so in life.

claims, a great and truly inspiring book, one of the world's classics, and should be on the table of every thinking Indian.

† Shrines have been erected all over China in honour of the Leader, and services are held weekly for communion with his spirit. The ritual is simple—a discourse from some passage in San Min Chu I, followed by three bows to the soul of Sun Yat Sen.

How China Trains Her Leaders

(Extracts from 'China after Five Years of War')

The 'Kuomintang' is now the only political party in China, corresponding to Communists in Russia or Nazis in Germany. It imparts a rigid training in principles to, and enforces a strict discipline among its members, whose numerical strength is estimated at over two millions. Unlike other countries in which party membership is acquired through paying a fee, Kuomintang membership is fairly difficult to obtain. An applicant must have the recommendation of two active members and undergo severe tests concerning his knowledge of party principles. Only after he has passed them all and taken an oath to be loyal to the Party and the Nation does he become a full-fledged member. Every month he pays his membership fee and from time to time he may be called up for further training or for various kinds of service.

In the countries and provinces there are regional party offices. Aside from directing party affairs in their own districts, they elect delegates to the Party National Congress, in which is vested the supreme authority of the Kuomintang and which, until China has a constitutional government, exercises the sovereignty on behalf of the people.

Apprenticeship to Kuomintang is given through the organisation of San Min Chu I Youth Corps. Young people between 16 and 25 years of age with

proper recommendations by two members are admitted into the Corps which aims at instilling into the nation's coming generation a strong faith in Dr Sun Yat Sen's revolutionary principles. In a short period of four years, the membership of the Youth Corps has grown from a handful to 400,000. The Youth Corps has set up branches throughout China, even in enemy occupied places, and in foreign countries. A Youth Corps member automatically becomes a full-fledged Kuomintang member upon the attainment of the necessary age requirement.

In his speech as concurrent leader of the Youth Corps at the time of its formation, Generalissimo Chiang called upon all Chinese youths to rally to the national cause under the banner of the new organization, which he said, has three objectives: first, to strengthen China's war effort and to fulfil her reconstruction programme; second, to conserve new vitality for the furtherance of the revolution and the third, to put the Three People's Principles into greater effect. When formally initiated into the Youth Corps, a member has to take an oath to practise Dr Sun's principles, to obey orders of the Leader, to observe rules of the Corps, to enforce its decisions, to live up to the tenets of the New Life Movement, not to shun difficulties but on the contrary, to be always ready to make sacrifices for China's cause.

Filial Piety in the Confucian System

(Extracts from Bertrand Russell's 'The Problem of China')

The way in which Confucian emphasis on filial piety prevented the growth of public spirit is illustrated by the following story.

One of the feudal princes was boasting to Confucius of the high level of morality which prevailed in his own State. "Among us here", he said, "you will find upright men. If a father has stolen a sheep, his son will give evidence against him".

"In my part of the country", replied Confucius, "there is a different standard from this. A father will shield his son, a son will shield his father. It is thus that uprightness will be found."

It is interesting to contrast this story with that of the elder Brutus and his sons upon which we in the West were all brought up.

Indian Physical Anthropology and Raciology

Ramaprasad Chanda's Contribution

INTRODUCTION

The death of Ramaprasad Chanda removes perhaps the most significant figure from the field of Indian Anthropology. Anthropology in India may be said to have taken quite a few strides since 1916, when he made his debut as the author of the "Indo-Aryan Races". With the help of anthropometry, osteometry and growth studies, we today possess a more complete picture of man in India than we did in 1916. But much of the present position of Indian anthropology is due to his researches and to his sense of its problems. In one respect, his demise leaves a gap which it will take long to fill up. I refer to his application of the methods of ethnology to the analytic study of ancient Indian culture as created by different races of man.

In a very definite sense, Chanda may be said to be the father of Indian Physical Anthropology. Mantegazza,* indeed, had worked on the races of India and published his researches long before his day. The official researches of the Hon'ble Mr Herbert H. Risley (afterwards Sir) with his very definite views on all problems of Indian raciology and racial history were published during the last decade of the 19th century. But by his field-work in anthropometry of the Brahmans of Bengal (1909), of the Santal settlers in Dinajpore, of a number of Hindu castes from different districts of Bengal and Behar (1910), of the Kashmiri Brahmans of Lahore and Allahabad (1921) and by his interpretation of the data collected

* Mantegazza, Paolo: (1831-1910). Mantegazza took part in the foundation of the Anthropological and Ethnological Society of Florence (1871). His multifarious researches added a just lustre to the Florentine School of Anthropology. The results of his anthropological studies made in India are embodied in his papers—'Studio sull' Etnologia dell' India' which appeared in Archivio per l'Antropologia e la Etnologia, Vols. XIII & XIV, Firenze, 1883-1884. He classified the Indian population into 8 types which are as follows: (1) Indu a tipo ariano, (2) Indu a tipo malesoide (of the Malabar Coast and South India), (3) Indu a tipo Semetico (N. India and Nilgiri), (4) Mongoli, (5) Ebrei dell' India (Black and White, of Malabar), (6) Parsi, (7) Musulmani, (8) un numero indefinito di razze selvaggi.

by himself and by Risley, Chanda liberated the young science of physical anthropology from the leading strings of officialdom and set it up as an Indian Science which may be pursued by the people of India for their own good, and for unravelling the threads of their own racial history and culture.

RISLEY ON INDIAN RACIOLOGY

As Chanda's work constituted to criticism and in many respects a refutation of that of Risley, it is not out of place here to sum up Risley's principal conclusions, which were based upon an Ethnographical Survey* of N. India (1886-88) embracing a large number of castes and tribal groups. Risley came to recognise three principal races in the Indian population. These are:—

I. *Aryan*—A leptorrhin or fine-nosed dolichocephalic or long-headed type, tall stature, light build, long narrow face, fair complexion, high facial angle. Exogamous social divisions named after Vedic saints or heroes. Following Penka, Risley recognised in this type the "descendants of Aryans of 3,000 years

* *Ethnographical Survey of India*—The first ethnographical survey of India associated with the name of Mr H. H. Risley developed as a sideline of the Indian Census operations in the closing decennium of the last century. The line of enquiry was laid down, in the official Conference on Ethnography of N. India which sat at Lahore in March 1885, with D. Ibbetson, J. C. Nesfield and H. H. Risley. The results of the enquiries regarding the sociology of Indian tribes and castes appeared in Risley's 'Tribes and Castes of Bengal', Ethnographic glossary, Vols. I & II, Calcutta 1891. Risley took the initiative regarding the Anthropometric Survey of India and anthropometric data on 89 castes and tribes of northern and eastern India being collected and published in the Companion volumes, 'Tribes and Castes of Bengal', Anthropometric data, Vols. I and II, Calcutta, 1891. See also Census of India, 1901, I, Ethnographical Appendix. In 1901, a systematic and detailed ethnographic survey of India was sanctioned by the Government of India, a Superintendent of Ethnography being appointed to each presidency or province for the work. The anthropometric data from Burma and Bombay due to this survey were published in 1906 and 1907 respectively. A detailed official account of the work done by the Government in this direction is very much to be desired.

ago, changed in hair, eyes and complexion, but retaining the more enduring characteristic of their race in the shape of their head, stature and finely cut proportions of their nose".

II. *Dravidian*.—A platyrrhin or flat-nosed, dolicho-cephalic type, low stature, thick-set made, very dark complexion,—darkbrown—charcoal like black, relatively broad face, usually low facial angle. Type most distinct in Chota Nagpur and C. P. Social organization totemistic. These are the descendants of the Vedic *Dasyus*.

III. *Mongoloid*.—A mesorrhin or medium nosed, brachy-cephalic or round or broad-headed type, low or medium stature, sturdy build, yellowish complexion, low facial angle. Type found along the northern and eastern frontiers of Bengal. The exogamous social groups bear nicknames of supposed founders.

The increasing volume of data collected by the Ethnographical Survey of India led Risley to formulate what may be called his seven type theory of the Indian population. This is summed up as follows:—

1. *Turko-Iranian*.—Baloch, Brahui and Hazara of Afghanistan etc. Brachy-cephal, stature above mean, prominent nose, abundant hair, and fair complexion.

2. *Indo-Aryan*.—Rajputs, Khatri and Jats. Type prevalent in the Punjab, Rajputana and Kashmir (*ante I*).

3. *Aryo-Dravidian or Hindusthani*.—Type found in the Agra and Oudh provinces, parts of Rajputana and Ceylon. Shorter stature, head longish, complexion variable, nasal index varying according to social status.

4. *Scytho-Dravidian*.—*Maratha* Brahmins, Kunbi and Coorgs of Western India. Brachy-cephal, moderately fine nose, medium stature, fair complexion. "Probably formed by a mixture of Scythian and Dravidian elements, the former predominating in the higher groups, the latter in the lower".

5. *Dravidian*—(*ante II*).

6. *Mongolo-Dravidian or Bengali type*.—Koch, Bagdi, Mal, Goala, Kaivartta, Sadgop, Muchi, Pod, Muhammadan, Chandal, Kayastha, Brahman, Raj-

vamsi and Magh. "Within its own habitat the type extends to the Himalayas on the north and Assam on the east, and probably includes the bulk of the population of Orissa. The western limit coincides approximately with the hilly country of Chota Nagpur and western Bengal". "Probably a blend of Dravidian and Mongoloid elements with a strain of Indo-Aryan blood in the higher groups. The head is broad, complexion dark, stature medium, nose medium with a tendency to broad."

7. *Mongoloid (ante III)*.—This type is found in the Himalayas, Nepal, Assam and Burma, and is represented by the Kanet of Lahoul and Kulu, Lepcha of Darjeeling, Limbu, Murmi, Gurung of Nepal, Bodo of Assam, and the Burmese. Stature short, complexion dark with yellowish tinge, hair on face scanty. Head broad, flat face and frequently oblique eyes.

Of the above, types 2-7 belong to India proper; they comprise either the three racial types described earlier, or arise from their mixtures, with the addition of a Scythian type of brachy-cephaly in Western India, traceable to the Scythian invasion—a mere episode in Indian history.

Even earlier than Chanda, it was pointed out by Crooke (1910), that the Scythians had never penetrated as far as Maharastra and Coorg and "it is more than probable that this [brachy-cephalic] strain reached India in prehistoric times". This "need not necessarily imply a Mongoloid invasion from Central Asia *Mongoloid Akkads* or the short headed races from Baluchistan may have made their way along the coast or by sea into Southern and Western India".

CHANDA ON INDIAN RACIOLOGY

It was about this time (1909) that Chanda began his work in Indian Physical Anthropology. His results which were first presented in a lecture delivered at Darjeeling (1913) together with some of his older writings on Indian proto-history were finally published in the 'Indo-Aryan Races' (Rajshahi, 1916). His conclusions on Indian Raciology were published in a revised form as a short paper entitled "Races of India" (*Journal of the Department of Letters, University of Calcutta*, 8, 295-312, 1922). In his memoirs on the 'Indus valley in the Vedic period' (1926) and 'Survival of the Pre-historic Civilisation of the

Indus Valley' (1929) he had occasion to revise some of his earlier conclusions on Indian proto-history. The following is a brief summary of his conclusions, as far as they concern Indian Raciology.

I. *The Arya*.—The Aryas of the R̥gveda were not a homogenous body. They had two distinct social grades (i) the *Ṛsi*, including the Atharvans, Angirases, Bhṛgu, Atri, Vasisthas, Bharadvajas, Gotamas, Kasyapas, Agastyas, Kanvas and Visvamitras, whose hereditary calling was to officiate at sacrifices and compose hymns; and (ii) the *Rajanya* or warrior class, viz., Yadus, Turvasas, Purus, Anus, Druhyus, Trtsus, Bharatas, etc.

Originally, the *Ṛsi* clans, founders of the sacrificial cult claiming to be descended from the gods were four in number; but these multiplied by budding and by adoption from the warrior clans. The Visvamitras and the Kanvas were *Ṛsis* by adoption and they originated from the Bharata and Puru clans. These *Ṛsis* by adoption were regarded with hostility by some of the original priestly clans, particularly the Vasisthas.

The two antagonistic groups of *Ṛsi* were differentiated by skin colour. The R̥gveda describes the Vasisthas as *Śvityāñch*—or white (VII, 33, 1) and the Kanva *Syāva* i.e., brown (X, 31, 11). Gopatha Br. describes the Brahman as *Sukla* or white by colour (I, 1, 223). "The tradition of the existence of a group of Brahmins with white complexion and yellow hair survived down to the time of the grammarian Patanjali (about 150 B.C.) who writes in his Mahabhasya (on Panini, V, 1, 115).—Penance, knowledge of the Veda, and birth make a Brahman. He who is without penance and knowledge of the Veda is a Brahman by birth only. White complexion (*Gaurah*), pure conduct, yellow or red hair (*piṅgalah kapila-keśa*)"

* In a discussion in which the present writer doubted whether "*piṅgalah kapila-keśa*" really signified gold blonde and not chestnut brown, Chanda drew his attention to the following verse from Manu (III, 8):—

"Nodvāhet kapilāḥ kanyāḥ nādhikāṅgīm na roṇinīm
Nālomikāḥ nātilomāḥ na vāchālāḥ na piṅgalāḥ"
Here it is forbidden to marry a girl who is *Kapila*, or six-fingered or suffers from incurable diseases, or has too little or too much body hair, or speaks too much or harshly, or has *Piṅgala* eyes. Commenting on the above Medhatithi explains: "*Yasyā kadruvarṇāḥ kanaka varṇā vā keśāḥ sā Kapilā*".—She whose hair is tawny coloured or gold coloured is *Kapila*. Also "*Akṣi roṇena māṇḍalākṣi kapila-piṅgalākṣi vā*". In the Amarakosa, Dhivarga (V, 16) where the six synonyms of *piṅgala* colour are given "*Kāḍṛaḥ Kapilāḥ Piṅgapīṣaṅgau Kadruṇḍīṅgalau*". Mahesvara comments "*Ayamatyanta gaura vālakasya keśeṣu prasiddhaḥ*".—This is well-known in the hair of the very white (fair) boy, which may be taken to imply the process of "nachdunkeln" or darkening with years, found in populations with a blonde strain.

are characteristics that constitute Brahmanhood." The dark section of the *Ṛsis*, the Kanvas and Visvamitras were kins of the Rajanyas or warrior clans, who are described as "swarthy" (*dhūmra*) of colour in the Kāthaka Samhita (XI, 6).

Skin colour and hair colour being important criteria of race, the R̥gvedic Aryas were clearly not racially homogeneous. The white-skinned and yellow-haired group, (which must have contained a strain of the *nordic* race), migrated to India from the temperate region in the far north. The dark section of the Aryas, the Rajanya, on the other hand must have come from the tropics. Two of these, the Yadus and the Turvasas had been settled in the Kathiawar peninsula, whence they spread to the north. According to certain passages in the R̥gveda these two tribes came over the Sea or *Samudra*. Chanda recognised in them Aryan-speaking immigrants from Syria and Mesopotamia like those of the Tell-el-Amarna tablets and Boghaz Kuei writings (15th century B.C.), who "must have absorbed a good deal of Semitic blood and were probably dark like the Semites". The other Rajanya tribes "may have come from the same quarters and were probably of the same physical type".

Years afterwards, when the discoveries of the Indus valley civilization had added considerably to our knowledge of Indian pre-history, Chanda thought that there was sufficient internal evidence in the R̥gveda of the contact between the *Ṛsis* with their sacrificial cults and the trading population of the Indus valley, the Chiefs of which reigned over towns and came under the influence of the Arya priests, adopting their gods. He recognised in the Yadu and Turvasa Indus Valley Rajanyas, who took part in the wars of the R̥gveda, sometimes allying themselves with the town-dwellers. The Aryas and their gods, particularly Indra among them, were hostile to the people of these towns or *Puras*. The Yadu and the Turvasa could no longer be regarded as Aryans from Mesopotamia who had absorbed Semitic blood,—although Chanda makes no specific mention of this important modification of his earlier hypothesis. One passage from the R̥gveda (VII, 5, 3) cited by Chanda runs—"The dark-skinned folk (*viśaḥ asiknīḥ*) fled away abandoning their riches when Agni rent their *Puras* (cities or castles) for the sake of the Puru King." There are certainly grounds for believing that the population of the Indus valley civilization, whether the Aryas had come in contact with it or not, was more or less dark-skinned. The skeletal

remains of Mohenjo-daro, originally evaluated by Sewell and Guha and finally diagnosed by Friederichs and Müller, show the population to have consisted of Weddoid (Proto-australoid),* Hamitic, Mongoloid and probably the Armenoid racial types. Such a mixed population, one containing particularly the Weddoid strain, would undoubtedly show a very wide range of skin colour and contain a number of very dark individuals.

II. *The Anārya: Draviḍas or Niṣādas?*—The vedic Aryas are usually held by Indologists to have stood in opposition to the *Dāsas* or *Dasyus*. Chanda departed from this view in his later writings, maintaining that at the time the earlier hymns of the *R̥gveda* were composed, "as many [wars] are waged by the Aryas against the *Dāsas*, as are waged by the Aryas against other Aryas allied to the *Dāsus*". In any case there were a people who are called *Dāsa* in the hymns, and Chanda identified them with the *Niṣādas*, who are mentioned among the '*Panchajandh*' of the later texts. Various sanskrit texts were collated by him describing the physical characters of these *Niṣādas* and their habit. The original '*Niṣāda*', according to a mythical story recorded in the *Mahabharatam* (XII, 59, 94-97) was brought into being by magic,—“a short limbed person . . . resembling a charred brand, with blood red eyes and black



FIG. 1. The *Niṣāda* Type
(From the *Transaction of the Bose Research Institute*, Vol. VIII)

hair . . . From him have sprung the *Niṣādas*, viz., those wicked tribes that have the hills and forests for their abode, as also those hundred and thousands of others called *Mlecchas*, residing on the Vindhya mountains". The *Bhagavata Purana* (VI, 14, 44) describes the *Niṣāda* as "black like crow, very low-statured,

short armed, having high cheek-bones, low-topped nose, red eyes and copper coloured hair." The Bhils and Gonds of the Vindhya hills still preserve these features. "Dark skin, short stature and broad nose indicate the physical relationship of the Bhils and the Gonds with the old *Niṣādas* on the one hand, and the hill tribes of Chota-Nagpur and Orissa and the Paniyans, the Kadirs, the Kurumbas, the Sholagas, the Irulas, the Maḷa Vedars and the Kanikars, on the other." In these pre-Dravidian peoples, extending widely beyond the frontiers of India, Chanda recognised the descendants of the ancient *Niṣāda* opponents of the Vedic Aryas. Following Pater Schmidt and Sten Konow, he presumed the *Niṣāda* race as a whole to have originally spoken the Mundari language.

In recognising the *Niṣāda*—pre-Dravidians as the opponents of (some) of the Aryas, and sometimes their allies, Chanda was in direct opposition to Risley, according to whom the Dravidians were their enemies. In the words of Chanda—"Sir Herbert Risley classifies these dark, short, and broad-nosed savage tribes of Central and Southern India together with the civilised speakers of Dravidian languages under the head 'Dravidian type'. But the first thing that suggests itself at a glance at the summary of the measurements of the castes and tribes of the so-called Dravidian type arranged in order of nasal index in Appendix IV, p. cxiii of his work; 'the People of India' (Calcutta, 1908) is that a line should be drawn between Parayan and Irula in this table. The average nasal indices will be found to vary from 69.1 to 80.0 above the line, whereas they vary from 80.9 to 95.1 below it. Mr Thurston gives 84.1 as the average nasal index of the Irula of the Nilgiris. So if we exclude the Mukkuvan of Malabar, the Moormen of Ceylon and the Dom and Kurmi of Chota Nagpur and Bengal, we are left face to face with twenty-seven broad-nosed jungle tribes with average nasal indices above 84. We are therefore hardly justified in classifying these broad-nosed tribes-men with the upper group unless it is admitted that the nose-form of the latter has been modified by the influence of environment."

The Dravidian type appeared to Chanda to be a mixed type. "May we not*** hold that the Dravidian type * * * originated in India as a result of the intermixture of aborigines of pre-Dravidian or *Niṣāda* type with immigrants of Caucasian type [like the dolichocephals of the Mediterranean type whose skulls were found by Pumpelly at Anau in

Western Turkestan] now represented by the Todas and Mala Aryans who may therefore be termed Proto-Dravidians" (1922).

INDIAN BRACHYCEPHALS AND THE INDO-ARYANS OF THE OUTER COUNTRIES

The achievement by which Chanda won for Indian Anthropology a recognised place in the world of science, was his recognition of the true nature of Indian brachy-cephaly. His study of the ancient Sanskrit texts made him conscious of the fact that the Aryas living in the northern plains between the Punjab and N. Behar bounded on the east by the Kosi river were very hostile to the peoples who lived around them. Cultural differences and consciousness of a different origin were, according to Chanda, the causes of this hostile attitude. Thus the Vratyas of Magadha or S. Behar did not practise agriculture or trade, had a different code of law and spoke some form of *Prakrit*. They had adopted the vocabulary of the Vedic religion while retaining their own faith. In common with the eastern peoples, viz., the Angas, the Pundras, the Vangas and the Kalingas, the Andhras, the inhabitants of the Deccan, the Saurastras (Kathiawar), the peoples of Anartta (Guzrat) and Sindh, the Arattas and Karaskaras of the Punjab, the Khasas of the southern slopes of the Himalayas were taboo to the Aryas. Persons visiting them were required to go through certain rites (Badhayana, I, 1, 32-33) or undergo the ceremony of initiation anew (Devala, cited by Vijnanesvara on Yagnavalka III, 292). The inhabitants of Anartta, Anga, Magadha, Saurashtra, the Deccan, Upavrit, Sindh and the Sauvirs were held to be of mixed origin, while the Vāhikas of the Aratta country were descended from two *Piśācas* or demons. According to Mbh (Karna XLV), "They [the Vāhikas] have not been created by Prajapati, therefore, being lowborn, how can they know the rules of piety prescribed in the sacred books? . . . the low Brahmans of that country, who have been living there from the time of Prajapati do not either study Veda or perform sacrifice. The gods do not eat food offered by these wicked Vratyas". Chanda concluded:—

"Baudhayana's statement that the inhabitants of Anartta, Anga, Magadha and other outer countries are of mixed origin and the statement * * * that the Vāhikas were not created by Prajapati, clearly indicate the belief of the dwellers of Vedic Aryandom that the Outer nationalities originated from ethnic

stock or stocks that were quite different from the stock or stocks from which they themselves originated and culturally the latter were Vratyas or heathens who had not yet adopted the Vedic cult."

The fundamental cultural difference between the two groups is still manifest in the social organization of their modern representatives. "In the Punjab, Rajputana, and the United Provinces, and among the countries in the Outer ring, in Gujarat and Bihar, the fourfold division of society still survives. But the social organisation of the Marāṭhā country, of Orissa, of Bengal and of other countries lying beyond, is of a different type. In these countries there are only two orders from the Brahmanic standpoint—the Brāhman and the Sūdra . . . It is, therefore, more reasonable to suppose that the fourfold division of society was not indigenous in the Outer countries, but was imported from Vedic Aryandom in an imperfect form and the Kṣatriya and Vaisya usages failed to make their way therein. This could hardly have been so if the two groups of Indo-Aryans—the Inner or the Hindusthani and the Outer group—had come of the same stock—if the Outer group had been mainly descended from immigrants from the Vedic country".

Chanda also noted the fact that the modern representatives of the two groups of peoples are differentiated in their dialects. The distribution of the Indo-Aryan dialects is thus described by Grierson:—

"There is a Midland Indo-Aryan language, occupying the Gangetic Doab and the country immediately to its north and south. Round it on three sides is a band of Mixed languages, occupying the Eastern Punjab, Gujarat, Rajputāna and Oudh, with extensions to the south in Bāghelkhand and Chattisgarh. Again, beyond these, there is a band of outer language occupying Kashmir, the Western Punjab, Sind (here it is broken by Gujarāt), the Marāṭhā country, Orissa, Bihar, Bengal and Assam". Grierson was of opinion that the people of the Vedic Midlands were the latest of the Indo-Aryans to arrive in this country and drove themselves like a wedge into the heart of the country already colonised by the people of the outer dialects. Numerical increase led them to expand and in the countries once occupied by their armies and settlers we have the Mixed languages. Chanda, on the other hand, contended that in older days the Vedic culture extended beyond the Midland. The ring of Mixed dialects—the basis of each of which is that of the Outer Band, but the body that of

* This has been recently modified by Guha and Basu (see Guha, 1935).

the Midland—is the result of political changes which began to operate from the periphery, particularly the east, which dominated the countries of Vedic Aryandom from the beginnings of 'Indian History'.

RACIOLOGY OF THE OUTER INDO-ARYANS

Turning now to physical anthropology, Chanda observes—"Not only social institutions, and language, but an important physical feature also—the shape of the skull—lends support to the testimony of the Śruti [=Vedic Texts], Smṛiti [Codes of behaviour, e.g. Baudhayan] and Purāṇa, that the Indo-Aryans of the Outer countries originally came of an ethnic stock that was different from which the Vedic Aryas originated. Long heads preponderate in all ranks of society in the provinces that now represent the ancient Vedic Aryandom, and among the Maithil Brahmins of Bihar with only 25 per cent of medium heads and 15 per cent round heads. But among the typical castes of the Outer countries there is a preponderance of medium and round heads indicating, roughly speaking, an admixture of 50 per cent round heads, with the exception of Bihar where a larger percentage of long heads as well as the survival of the fourfold division of caste, are due to the absorption of larger Midlandic elements. Other Indian peoples among whom broad or medium heads are present in as large numbers as among the Indo-Aryans of the Outer countries are the Telugu, the Kodagu- and the Canarese-speaking population of the Deccan [the strain being absent from the Tamil and Malayalam countries]. * * * so to account for the presence of round and medium headed elements in such large numbers we are constrained to assume the immigration of round headed or medium headed tribes who have commingled with the long-headed men of Niśāda, Vedic Ārya, and Tamil stocks in different proportions in different parts of the wide area inhabited by them".

In concluding that the brachycephalic Indo-Aryans of the Outer belt, i.e., the brachy-cephals of western India and those of Bengal and Orissa were traceable to the same race, Chanda relied to a certain extent upon the evidence of history, both positive and negative in character. Thus, going into the question of the Scythian origin of the west-coast brachy-cephals who are called Scytho-Dravidian by Risley, he distinguished between two phases of Indo-Scythian rule, viz., (1) the Parthian, represented by their Satraps in N. W. and W. India, their inscrip-

tions having been discovered at Taxila and Mathura and coins in the Punjab and W. Agra; and (2) the Kushans whose rule or sphere of influence extended much further east and in Central India. These may have been round-headed, argued Chanda, but from the fact that the N. Indian head form has not been changed by them, one can only conclude that they had been numerically too few. How, then, could it be assumed that the Indo-Scythians could introduce such high percentage of brachycephaly into W. India? The Satraps indeed ruled over Gujrat and parts of Malwa for over three centuries, but their dominion further south was short lived and intermittent. Konkan and N. Maharashtra were repeatedly taken back by the Andhras. "The Indo-Scythians who held only the outskirts of the Deccan for such short intervals can hardly be regarded as the ancestors of the vast broad or medium headed population of the entire tableland. We must therefore reject Risley's Indo-Scythian theory and trace their origin to brachy-cephalic hordes who migrated in large numbers in the pre-historic period and by intermingling with the Niśāda, Dravidian and Vedic Aryan elements produced the hybrid population of Gujarat, Mahārāṣṭra, Coorg, Karṇāṭ and Andhra (Telugu country)".

Nevertheless as his writings on the Mongolo-Dravidian origin of the Bengali brachycephals show, Chanda relied upon morphological evidence to an extent that constitutes a break from the traditions of Risleyan Anthropology. As he rightly observes, "The pre-Dravidian or Nishāda—Risley's Dravidian strain in the Bengali is quite prominent". There is also a slight Indo-Afghan [Risley's Indo-Aryan] strain (1922). But what of the brachycephals? Risley traces it from the Indo-Burmese brachycephaly. He says, "These facts [distribution of Cephalic Index] seem to afford some ground for the conjecture that the peculiar and characteristic type of feature which distinguishes the higher castes of Bengal proper from the corresponding ranks of society in Northern and Western India may be due to an infusion of non-Aryan blood, derived, not from the black races of Central and Southern India, but from the brachycephalic Indo-Burmese stock further east" (1890). Again in 1908 (?)—"In the Brahman seriation [of B. H. Index of the nose] the finer forms predominate, and it is open to any one to argue that notwithstanding the uncompromising breadth of the head, the noseform may in their case, be due to the remote strain of Indo-Aryan ancestry to which their

tradition bear witness". So, according to Risley, the brachycephals derived their headform from the Indo-Burmese and noseform from the Indo-Aryans! Risley does not contemplate the existence of forms allied to European brunette brachycephals with their straight profiles, the high, often convex noses in the region embraced in his survey.

Chanda however, insisted not on theoretical considerations how a stable type could arise from the juxtaposition of the head form of one race and the nose form of another, but on defining the type itself. "Headform [Cephalic Index] alone, unless accompanied by other Mongoloid characteristics cannot be accepted as a sign of considerable Mongolian strain", (1916). "Risley's theory * * * involves the assumption that Mongoloid invaders preceded in large numbers the carriers of Aryan speech and culture in Bengal and Orissa But neither the physiognomy of the bulk of the Bengali and Oriya folk nor the legends and traditions relating to their origin, support this hypothesis, while legends and traditions bearing testimony to Mongoloid affinities are well known relating to the Nepalese and Assamese among whom men with Mongoloid physiognomy still predominate" (1916). "As regards the strong round headed elements among the Bengali, Risley was led on to trace a Mongolian origin for these by mistaking the Koch of N. Bengal as typical Bengalis and by assuming that round-head was a monopoly of the Mongolians" (1922). The mongoloid tribes on the Bengal frontiers are not autochthones, but immigrants. Mongoloid invaders from Kamboja or Tibet conquered part of N. Bengal in the 10th century and gave a king to Gauda in 966 A.D. The historian Minhaj who visited N. Bengal in 1240 A.D. writes in the Tabakat-i-Nasiri (Bibl. Ind. I, p. 560).

"In the different parts of those mountains which lie between Tibbat and the country of Lakhanawati [near Gaud] are three races of people, one called the Kunch [Koch], the second Mej [Mech] and the third Tiharu [? Tharu]; and all have Turk countenances [Mongolian features]. They have a different idiom, too, between the language of Hind and Turk" [Tibeto-Burman].

The northern Mongoloids were known to Chanda from his extensive travels in N. Bengal, while on exploration work for the Varendra Research Society. "In Northern Bengal we come across a group of allied castes called Koch, Paliya and Rajvansi. The

further north we go, such Mongoloid features as scanty beard, flat face, yellowish brown complexion, become more and more prominent, and so one is led to consider these Koch as a cross between the Bengalis and the Mongoloids" (1922).

Chanda concluded, "To account for the linguistic, social and physical differences between the Hindusthanis on the one hand and the Indo-Aryans of the Outer countries on the other we have to assume the immigration of round and medium-headed invaders of Aryan speech in the prehistoric period". He traced these immigrants to a similar strain disclosed by Joyce's analysis of Stein's data from the Pamirs and Chinese Turkestan, which is described as follows:—

"A white-rosy race, very brachycephalic, stature above the average, with thin prominent nose, varying from aquiline to straight, long, oval face, hair brown, usually dark, always abundant and wavy (* * * this should now be altered to curly), eyes medium in the main. This is Lapouge's *Homo Alpinus* (1912)."

Chanda continues, "In the North-Western Frontier Province and Baluchistan this *Homo Alpinus* type has been modified into medium-headed Indo-Afghan by contact with the longheaded Vedic Ārya and the Avestic Ārya on the one hand, and the Dravidian, whose language, the Brahui, still survives in Baluchistan, on the other. In India the same type has been turned into the mesaticephalic [average] Indo-Aryan of the Outland by Niśāda, Vedic Ārya, and Dravida admixture." "When immigrants of the *Homo Alpinus* type entered India they [probably] found the middle portion of the Gangetic plain in possession of the Vedic Āryas, and therefore the first batch found their way to the lower Gangetic plain (Bihar) across the table-land of Central India. Other bands after whom Mahārāṣṭra and Saurāṣṭra are named, wandered into the Kathiawar Peninsula and the Deccan". Later waves were represented by the Vahikas of the Punjab and speakers of the modern Piśāṇa dialects.

OUTER INDO-ARYANS—PAMIRIANS

In 1922 Chanda came forward with certain details regarding the morphology of these brachycephals from different parts of India and proposed a new name for them,—all of which are of the greatest

importance for estimating the value of his work. He writes :

"On the North-Western borderland, in Baluchistan, Sind, Guzrat, the Deccan, Orissa and Bengal is found a strong ethnic element characterised by broad head, plentiful hair on the face, prominent nose, and above mean stature. * * * so in connection with the Bengali origins the difficulty lies in tracing that element which is found in considerable number in the upper ranks of the society and particularly among some sections of the Brahmans, and



FIG. 2. The Pamir Type

that is characterised by variable complexion, mean stature, round head, prominent nose, and plenty of hair on the body. In most of these cases the round or broad head may be discerned without measurement by looking at the back of the head which is

usually almost flat.* I have elsewhere suggested that such elements among the Bengalis and among the population of the Deccan,—Western India, and the North-Western borderland should be traced to a common source, that source being represented in its purest form by the Galchas or hill Tajiks of the Pamirs, by the Tajiks of Turkestan, Khurasan and Afghanistan, and by the scattered remnants of a population of the same type that once occupied the oases of the Taklamakan desert, and whose bodily remains dating from the beginning of the Christian era have been unearthed by Stein in the eastern border of that desert. This type seems to be akin to the Armenoid race of Western Asia and the Alpine race of Europe and may be termed the Pamirian race".

Chanda, then, had made it sufficiently clear in 1922 that the brachycephaly of the Outer Indo-Aryan belt was of the "plan-occipital" type, associated with prominent nose, a type with distinctly Armenoid affinities. In affiliating the Armenoids with the Alpines he was simply following the practice still prevailing among Anglo-Saxon anthropologists, e.g., Haddon.

(To be continued).

* Thurston, E., noticed this trait in South India and illustrated it by the photograph of a Linga Banajiga from the Canarese country, of amenoid habitus, without associating it with Brachycephaly or any particular race.—Caste and Tribes of S. India, I, Madras, 1909, p. xlvii.

Oxalic Acid in Feeding Stuffs and its Significance in Calcium Assimilation

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IT is now generally known that calcium is poorly utilised by rats and human beings from leafy materials, such as spinach, which contain a fairly large amount of oxalic acid. This appears to be due to the precipitation of calcium oxalate in the intestine. Fairbanks and Mitchell (1938) have shown that practically no absorption of calcium takes place when calcium oxalate is fed to rats. Kohman (1939) has shown that in the case of rats, if spinach is given as a supplement to a basal diet low in calcium, not only this vegetable does not supply any available calcium but it also renders unavailable considerable amount of the calcium of the basal diet. A part of the ingested oxalate appears in the urine and much more in the faeces as calcium oxalate. It is thus clear that vegetables cannot always be used as a good source of calcium for humans unless they are found to contain a negligible amount of this calcium precipitating substance.

So far, observations on oxalic acid in affecting calcium utilisation have been confined to one-stomached animals and no reference is available in the literature where studies have been made on this aspect with cattle. For the herbivora, the problem may have a special significance because traces of oxalic acid have been found in large number of plant materials and vegetables (Kohman, *loc. cit.*, Nelson and Mottern, 1931, Widmark and Ahldin, 1933, Majumdar and De, 1938, Rau and Murty, 1940).

In so far as analytical data are available, there is practically no information in regard to the oxalic acid content in feeding stuffs such as straws, hays and other forage crops. A few data on some varieties of rice straw are given by Chatterjee (1940-41).

In view of the obvious importance of the subject as affecting the mineral metabolism in ruminants, detailed investigation has been carried out in this laboratory for the past 2½ years and some interesting data have been collected.

NEW METHOD OF ESTIMATING OXALIC ACID IN BIOLOGICAL MATERIALS

The lack of a satisfactory method for the estimation of oxalic acid was keenly felt at the very beginning of the investigation. The method used by Kohman (*loc. cit.*) Arbenz (1917), Nelson and Mottern (*loc. cit.*), and its modifications by Majumdar and De, (*loc. cit.*) have not given satisfactory results. The only method which gave reproducible values, namely that of Pucher *et al* (1934), was found unworkable during the summer, as it mainly depended on an efficient extraction of oxalic acid by specially prepared sulphuric ether. In any case, when an acid is used for the preliminary treatment of biological material as has been done in the existing methods, only the total oxalic acid

can be estimated, whereas, from consideration which will be stated later, our intention was to estimate both the soluble and the insoluble fraction of oxalates present in a sample. It was therefore, necessary for us to devise a new method of estimating oxalic acid and this briefly is as follows:—

A. Determination of total oxalic acid.

(1) Two to five grams of the oven-dried and finely ground biological samples like dry and green fodders are first boiled in water for $\frac{1}{2}$ hour; while still hot, a sufficient quantity of 20 per cent. solution of sodium carbonate is added to give a final concentration 4 per cent. The thoroughly mixed alkaline mass is then again boiled for another $\frac{1}{2}$ hour. During these cooking processes, first with water and then with dilute alkali solution, tissue cells are disintegrated, releasing completely salts of oxalic acid. The boiling with sodium carbonate solution, moreover, quantitatively converts by a process of metathesis all insoluble salts of oxalic acid originally present in the sample into sodium oxalate. The hot alkaline extract is then filtered through a disc of cloth fitted to a 7 c.m. Buchner funnel and the residue is well washed with hot water. The combined filtrate and washings are then concentrated to about 150 c.c., cooled and sufficient hydrochloric acid (1:1) is added to make the final acid concentration about 1 per cent. At this stage, a voluminous precipitate of extraneous organic matter appears which is allowed to flocculate and then filtered off. In an aliquot of the clear filtrate, oxalic acid is precipitated in the cold by first adjusting the pH to 4.5 with ammonia and acetic acid and then by adding a 10 per cent. solution of calcium chloride. As in some samples the fine precipitate of calcium oxalate drags with it some colouring matter, it is advisable to reprecipitate after dissolving the first precipitate in hydrochloric acid. From the final precipitate of calcium oxalate, oxalic acid is determined by the usual permanganate titration.

The accuracy of the method has been thoroughly tested out. It has been found that (a) the percentage error in individual estimations, from the mean of twelve independent analyses, varies from +0.4 to -0.9 and (b) the percentage recovery of the added oxalic acid in a biological sample lies between 98 to 102. The proposed method has also been compared with the method of Pucher *et al*

(*loc. cit.*), and in eight independent analyses of paddy straw, the results of anhydrous oxalic acid estimated are as follows:—

	The method of Pucher <i>et al</i>	The proposed method
Mean value of all analyses ..	1.184	1.235
Standard deviation ..	0.0169	0.0095
Standard error ..	0.0171	0.0095

It is evident from the above results that, compared to the method of Pucher *et al*, more oxalic acid is recovered by the present method and that the standard error in the estimation is significantly lower.

(2) In the case of biological samples like oil-bearing cakes, seeds, grains and bran, the first cooking should preferably be done in 1 per cent. caustic soda solution instead of water, so as to saponify the fat.

(3) A further modification, other than that mentioned for oil-bearing samples, has to be adopted for estimating oxalic acid in faeces. The alkaline extract and washings are concentrated to about 50 c.c. and when cold, sufficient hydrochloric acid is added to make the final acid concentration 1 per cent. The precipitate which appears at this stage as well as the original liquid are then quantitatively transferred to a 100 c.c. volumetric flask and made up to the mark with water. After thorough shaking, the flask is allowed to stand, when the flocculated precipitate settles at the bottom. The supernatant liquid is then carefully filtered out. An aliquot of the filtrate is then made just ammoniacal (ammonia 1:1) when a precipitate of silica appears which is filtered off. In the final filtrate oxalic acid is determined in the usual way.

(4) The analysis of urine of cattle has been done by a comparatively simpler method. 100 c.c. urine are boiled with 10 c.c. concentrated hydrochloric acid, allowed to cool and the precipitate which is formed (mainly hippuric acid) is filtered off. An aliquot of the clear filtrate is neutralised with ammonia, and the pH is then adjusted to 4.5 by the addition of acetic acid. The oxalic acid is then precipitated in the usual way by adding

calcium chloride and estimated by permanganate titration.

B. Determination of "soluble" oxalic acid.

During the present investigation, it was found that oxalic acid in the form of calcium oxalate is not absorbable in the animal body. It was therefore, considered necessary to estimate the amount of "insoluble" oxalic acid in feeding stuffs. This is done by subtracting from the value of total oxalic acid, the value of "soluble" oxalic acid which is separately estimated according to the following modification of the original method.

The extraction of soluble oxalates is carried out by boiling a sample in a solution of ammonia (1:10) for one hour under a suitable condensing arrangement. The obvious use of water for the extraction purpose is precluded by the fact that free organic acids are liberated from the plant material when cooking is carried out with water alone. The liberated acids act with some salts of calcium and magnesium and the kations thus set free combine with soluble oxalates in the extract to form insoluble salts. Ammoniacal solution is therefore used to neutralise the liberated acids which otherwise may vitiate the true estimation of "soluble" oxalic acid. The ammoniacal extract is boiled from 15 to 20 minutes, allowed to cool, diluted to a definite volume and then filtered through a quantitative filter paper to rule out the presence of any fine crystals of calcium oxalate which may mechanically separate out from the sample during the extraction process. To estimate the 'soluble' oxalic acid, an aliquot of the filtrate is treated in the same way as the alkaline extract in the total oxalic acid estimation.

OXALATES IN PLANT MATERIALS

A large number of feeding stuffs have been examined for their oxalic acid content and results varying from nil to fairly high values have been obtained. It has been observed that in paddy plant, napier (*Pennisetum purpureum*) and guinea grass (*Panicum maximum*), the oxalic acid content is high at the early stage of growth and gradually decreases as the plants mature. In table 1, are given the data of total oxalic acid, "soluble" and "insoluble" oxalic acid, calcium, magnesium, potassium and sodium contents of the above mentioned fodders which have proved conspicuous by their high oxalic acid content.

It may be noted from the data, that (a) oxalic acid in these plant materials can combine with two to three times the calcium present in the plant to form insoluble calcium oxalate, (b) the major portion of the total oxalic acid is present in the soluble form (except in the case of ripe guinea grass) and (c) the distribution of bases suggests that the soluble oxalates are mainly in the form of potassium oxalate and that the insoluble fraction can be accounted for mainly as calcium oxalate, with a little amount of magnesium oxalate. Some of the other plant materials examined for oxalic acid content are wheat straw, juar hay (*Andropogon sorghum*), Anjan grass (*Pennisetum annulatus*), Dub grass (*Cynodon dactylon*), Golden crown grass (*Paspalum dilatatum*), Sudan grass (*Andropogon sorghum var. sudanensis*), Rhodes grass (*Chloris gayana*), Jirga grass (*Pennisetum cenchroides*), Beiseem (*Trifolium alexandrinum*), Guar (*Cyamopsis psoraloides*) and Lobia (*Dolichos lablab*). In some of these fodders oxalic acid

TABLE I.
OXALIC ACID CONTENT OF SOME FODDERS
(Composition expressed on dry basis)

No.	Name of the sample	% anhydrous oxalic acid			% calcium	% magnesium	% potassium	% sodium
		Total	Soluble	Insoluble				
1.	Paddy straw No. 1 ..	1.46	1.25	0.21	0.307	—	—	—
2.	Paddy straw No. 2 ..	1.60	1.35	0.25	0.280	0.220	2.50	0.07
3.	Napier grass (early cut) ..	3.05	2.04	1.01	0.812	0.510	2.91	0.11
4.	Napier grass (dead ripe) ..	0.65	0.40	0.25	0.174	0.200	1.83	0.07
5.	Guinea grass (early cut) ..	2.00	1.10	0.90	0.655	0.481	2.66	0.17
6.	Guinea grass (dead ripe) ..	0.80	0.25	0.55	0.436	0.352	1.16	0.10

has been found in small quantities and in other cases, mere traces only could be recorded.

A sample of spinach was also examined in this connection and it was found that the oxalic acid content in this material was 11.25 per cent. (on dry basis). Of the total oxalic acid present, about 13.3 per cent. was found to be in the insoluble form and 86.7 per cent. in the form of soluble oxalic acid.

EFFECT OF FEEDING OXALATE-RICH PADDY STRAW ON THE ABSORPTION OF CALCIUM

In view of the finding that paddy straw contains a fairly high amount of oxalic acid and that a large quantity of this is ingested when cattle are kept on a paddy straw diet, it was considered desirable to carry out a metabolism test in order to determine the effect of oxalic acid on calcium absorption. A significant fact in this connection is the observation that when paddy straw is used as a roughage, a high level of calcium has to be fed to obtain positive balance for this mineral.

Four young heifers were fed continuously for 30 days a ration consisting of rape cake and paddy straw. During the last 10 days, calcium excretion and balance were determined. The results are given in table 2.

acid, and considering the high amount of this acid ingested from the straw, it was probable that calcium in the faeces might be entirely in combination as calcium oxalate. But when the oxalic acid content of the faeces was determined, it was found that the average oxalic acid present in the faeces could only combine with 3.88 gms. of calcium. The rest of 15.18 gms. of faecal calcium was apparently in combination other than as oxalate.

The amount of oxalic acid present in the paddy straw consumed could actually combine with 29.30 gms. of calcium and the amount of insoluble oxalic acid could combine with 4.27 gm. of calcium. Considering the closeness of the two values, namely Ca-equivalent of oxalic acid in faeces and Ca-equivalent of insoluble oxalic acid in the straw consumed, it seemed that about 90 per cent. of the latter in food was simply excreted in faeces without entering into any metabolic reaction during its passage through the alimentary tract. Apart from the insoluble portion, which by itself was unavailable, soluble oxalic acid in the paddy straw seemed to have no effect on the absorption of calcium and hence, the reason for its large excretion in faeces and the negative balance must be sought elsewhere. Separate experiments conducted by us tend to show that the large ingestion of potassium resulting from heavy feeding of paddy

present investigation, only a small quantity of oxalic acid could be detected in the urine of cattle when the animals were ingesting such a heavy dose as 65.90 gms. of the acid per animal per day. This small urinary excretion appears to be of metabolic origin.

It is, therefore, of interest to determine the fate of the ingested large quantity of "soluble" oxalic acid. Considering the fact that the rumen is inhabited by a varied type of micro-flora and that soluble oxalates are known to be destroyed by microbial attack, the suggestion occurs that the site of destruction of ingested soluble oxalates in cattle is probably the fore-stomach. This view has been tested by us, and we have found in a number of preliminary experiments that when a dilute solution of a soluble oxalate is incubated with freshly collected rumen content, fairly rapid destruction of oxalic acid takes place.

CONCLUSION

The results so far available tend to show that unlike the case with one-stomached animals, the

soluble oxalate in food has no deleterious influence on the absorption of calcium in the ruminants. If, however, a high amount of potassium is also ingested along with the soluble oxalates, as is usually the case with feeding stuffs such as paddy straw, this will have an adverse effect on the calcium absorption. Almost the whole of calcium, in the form of calcium oxalate in the food, however, is not available either to rats, human beings or ruminants.

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TABLE 2.

INTAKE AND EXCRETION OF CALCIUM UNDER PADDY STRAW FEEDING

Animals.	Intake of calcium. gm.	Excretion of calcium in faeces. gm.	Excretion of calcium in urine. gm.	Balance.	Ca-equivalent of total oxalic acid ingested.	Ca-equivalent of insoluble oxalic acid ingested.	Ca-equivalent of oxalic acid excreted in faeces.
Heifer 1	18.93	20.95	0.12	-2.14	31.8	4.55	4.10
2	15.87	17.31	0.35	-1.79	27.0	3.86	3.49
3	18.81	21.00	0.07	-2.26	30.8	4.71	4.40
4	16.07	16.98	0.08	-0.99	27.7	3.96	3.54
Average :	17.42	19.06	0.16	-1.80	29.3	4.27	3.88

It may be seen from the above table that average intake of calcium per animal per day was 17.42 gms. and the excretion in faeces and urine were 19.06 gms. and 0.16 gms. respectively. The animals were thus running on a deficit balance of 1.80 gms. per day. From the amount of faecal excretion, it seemed that the animals failed to absorb any of the dietary calcium. If this lack of absorption was due to oxalic

straw had an adverse effect on the absorption of calcium.

THE FATE OF INGESTED SOLUBLE OXALATES

Kohman (*loc. cit.*) has shown that in rats, a part of ingested oxalate is assimilated and then excreted as calcium oxalate in the urine. In the

POWDER METALLURGY DEFINED

In view of the growing industrial importance of powder metallurgy, from both the scientific and commercial points of view the American Society for Metals has issued a glossary of some hundred terms used in connection with powdered metals. "Powdered Metallurgy" is defined as "the art of producing metal powders and shaped objects from individual, mixed or alloyed metal powders, with or without the inclusion of non-metallic constituents, by pressing or forming objects which are simultaneously or subsequently heated to produce a coalesced, sintered, alloyed, brazed or welded mass, characterised by the absence of fusion, or the fusion of a minor component only.

—Chemical Age.

Brother and Sister in Marathi Folksong

IRAWATI KARVE

THE following description is based on only one particular kind of folksong prevalent in the Maratha country. These are really not songs but couplets, each independent and complete in itself. These are sung exclusively by women and are heard throughout the length and breadth of the Marathi speaking provinces. The contents and the similes are the same, the only difference being that of dialects. The couplets whose translations appear below (the originals in Marathi are given in Roman script in the footnotes numbered serially) are a selection from a collection of a thousand or more songlets collected in the Ahmadnagar district by Miss Balubai Saptarshi.

The following few songlets depict the brother-sister relationship as it is found in the Maratha country. Brothers and sisters are born in the same house and are playmates, but the sister's marriage separates these two. Even after her marriage the sister is fetched by the brother at the Divali Festival and presents are showered on her but the brother becomes gradually a stranger to the sister when he brings home his bride. The relations between brother and sister are strained but a happy ending to the drama is provided by the custom by which the brother's daughter weds the sister's son, and the brother's wife, who could never tolerate the sister's presence in the home, has to bow before her as she becomes her daughter's mother-in-law.

1. The rains of Rohini come before those of Mr̥ga, the sister's cradle rocks before the brother's. (The girl should be born before the boy because she takes care of her younger brother).

2. Did any one notice the faint fragrance of Jasmine? The overpowering fragrance of Ketaki has

1. pāusa paḍato mṛgā ādhī rohinīcā |
pāṇā hālato bhāvā ādhī bahinīcā ||
2. jāicyā phulācā vāsa koṭhe ālā |
uddāma kevaḍā vidi daravajata gelā ||

filled the whole street. (The girl is soft and modest in her ways. Her existence is barely noticed, while the boy makes himself felt in the whole alley. The word kevada used for ketaki is masculine in Marathi.)

3. Do not wash your hair on the full moon day, on the new moon day and on Monday, you have brothers who are younger than you.

4. While sowing the first handful of corn, do it in your sister's name, 'my brother, you are blessed, fill your granary'. (Cādē is the upper part of the sowing apparatus in which handfuls of corn are poured. The name of the sister brings luck to the brother.)

5. The corn is ripe. It is my brother's wheat; Laxmi (the goddess of plenty) is asking, 'by which footpath in the fields may I come to your house?'

6. We two sisters are the wells in the two villages; our darling brother is the green corn in the middle. (Just as the green field is watered by the two wells at each end, so the brother bathes and prospers in the love of his two sisters.)

7. My brother's heart beats for me, I am sure he will never forget me.

8. The brother heard that the sister was ill-treated at her husband's house, the water was taken

3. āvasa paurṇimā nako nḥā somavārī |
bāi mājhe pāṭhi bhān āheta kaivārī ||
4. cāḍyāvārī mūṭha dhari bahinīcyā nāḥvā |
bhāi rājā mājhyā bhāgyavanta bharā pevā ||
5. pika ga pikālā mājhyā bhāi yāce gahūm |
lakṣmī mhaṇate koṇyā bāndhānā ga yetū ||
6. āmhi doghi bahinī donhi gāḥvācyā bāravā |
bhāi rājā mājhyā madhē jōdhaḷā hiravā ||
7. bhān mājhyā phār mapalyā jivācā |
jivālā bharāvasā nāḥim aṁtara dyāyācā ||
8. bahinīlā sāsuravāsa bhāḍvācyā kānī gelā |
upaṣilā jharā tethe pāṇi nāḥim pyālā ||

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BROTHER AND SISTER IN MARATHI FOLKSONG

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out from the spring but he did not take a drink (when he heard the news he was on the point of drinking water at the well, but he started to go to her immediately without stopping to take the drink.)

9. A sister should have a brother even though he be poor or simple, because then she secures a 'choli' (blouse) even though it be of an indifferent cloth and shelter even though it be for one night.

10. Divali (the festival of lamps), you are long in coming. My brother has already brought the 'sari' for me. (Divali is a great festival, when the sister is brought home and all members of a household gather together, give presents and eat sweet things for days as at Christmas.)

11. My darling brother asks the wife, 'on which day is the Divali festival?' He is sewing his sister's blouse on the door steps.

12. This is the Divali festival. I am constantly coming to the front door and going back again to my work. Today is the brother's day and I am waiting for my brother.

13. Its evening. I see something in the bush, it is my brother. I recognise him by his walk.

14. My stupid heart was perturbed for no reason. After seeing you it is calm again.

15. You have given me a 'choli' (blouse) for Divali and a golden ornament for 'bhaibij' day. You do love me indeed.

16. You have twelve bullocks. I don't claim any share in them; but my brother open your cowpen, in these I have a share (a cow is given to the sister after her first child is born).

9. veḍā bāgaḍā bhān bahinīlā asāvā |
bāḥḍī bhuraki coḷī ekā rātrīcā visāvā ||
10. dipāvāḷibāi tvā ga dirāga lāvalā |
bhāi rājārāne śelā (?) gheṭna thevalā ||
11. sakḥā pusā tilā divālī koṇyā vārī |
bahinīcā bhān dārim ubhārīta coḷī ||
12. divāḷicā sapā bāhera yete jātte |
āja bhāibīja bhāvāci vāta pāḥāte ||
13. jhālyā tinhisāmājā jhāḍī madhye camakalā |
bhāirājā mājhyā cālimadhe valakhata ||
14. veḍā mājhyā jīva ugāva veḍāvalā |
bhāirājāsā re tulā pāḥūna thirāvalā ||
15. divāḷici coḷī bhāubījācā kekata |
bhāi rājā mājhyāvārī āhe re tujhī prita ||
16. bārā baila tujhe tyāṭa nāḥim vātā |
bhāi rājā mājhyā ughaḍā gāicyā re goṭhā ||

17. Listen to the quarrels of the brother and the sister. The darling brother is not giving any share in cows to the sister.

18. You did not take the sister home for Christmas. The loving brother had taken a Christmas vacation ticket and forgot you. (This song is from a Christian women who has substituted Christmas for the usual Divali.)

19. The brothers are ours. Their wives are unknown strangers. By the side of the amulet I also string other golden plaques (when one puts silver amulets round the neck one strings other beads, etc. also side by side. It is the amulet which is of importance. So is my behaviour to my brother's wives).

20. The brothers are mine. Their wives are strangers, but to please my brothers I try to please their wives also.

21. O brother's wife, I have come to bow down to your feet. Do not forbid me for your husband is my life.

22. A 'choli' for Divali, a sweet sesame ball for Sankrant festival. Only this much we want. O sweet brother's wife, do not disappoint us.

23. My brother's wife is wiser than the brother. She has sent to me a comb folded in a piece of cloth for my 'choli'.

24. My brother's wife is even more good hearted than my brother. My father chose the daughter of a gentleman as his daughter-in-law.

25. This choli-cloth costs Rupees two. The tailor asks, who is the lucky wearer of such of a costly choli. I tell you, she is my younger sister.

17. bahīṇa bhāvāci bhāḥḍane aika bāi |
gāicyā goṭhyānt sakḥā vāṁṭā deta nāḥim ||
18. nāḥālcā sapā tulā gharīm nāḥim jhālā |
prīcā bamdhu pāsā gājavāya gelā ||
19. bhān te āpale bhāvajayā tyā kuṭhūnī |
tāitā śejārī ghetē putalyā gāṭhūnī ||
20. bhān te āpale bhāvajayā parakyācyā |
bhāvāsāṭhīm manadharāṇī doghācyā ||
21. pāyā paḍā āle nakā karūm anamāna |
sāṁgate bhāvajayilā tujhā kāṭha mājhyā prāṇa ||
22. divāḷilā coḷī saṁkrāntilā tilā lāḍā |
gori bhāvajaya āśā āmacī nako modū ||
23. bhāvāparīs mājhyā bhāvajaya āhe śāḥāṇī |
aśī tinē pāṭhavilī khaṇācā poṭṭi phāṇī ||
24. bhāvāparīs mājhyā bhāvajaya bhāi |
bāpājī rāyānī koṇā aṣṭilāci keli ||
25. bhāṭṭī coḷī rupayē dile dona |
pusato śūṇpīdādā aśī lehaṇārica koṇa |
sāṁgato dādā tulā mājhyā pāṭhīci bahīṇa ||

26. After saying good bye to the sister, the brother rests by the way side and asks every traveller, 'how far has my sister gone?' (Have you seen her while you came this way?)

27. The brother tells his wife, 'fill my sister's lap with corn and cocoanut'. The brother's wife says, 'the mice have stolen all the cocoanut in the house'.

28. The brother says, 'sisters come on a visit'. The brother's wife says, 'here come the husband's sisters to rob my house'.

29. After the death of the parents my 'maher' (parents' house) is lost to me, for the brother's wife says, 'outside the town there is a traveller's rest house' (you should rest there and not come to stay with us).

30. My home is filled with sacks of sorrow and sacks of happiness. Brother dear, can't you come even once? (I must tell my joys and sorrows and empty the sacks before you).

31. By constantly watching for his arrival my eyes have become red like *kumkum*. My mother's child's heart has become like that of a stranger.

32. The neighbour asks, 'why is you face so sad?' My friend, brothers have not come to fetch me.

33. In this age a brother does not care for his sister (he does not belong to the sister) with a 'choli' (blouse) in his pocket, he is asking for the house of his wife's sister. (The present to be given to own sister is being given to the wife's sister).

26. bahiṇilā ghālavuṇi bhāu base vātevari |
ālyā gelyā vicārito bahiṇa geli kuṭhavari ||
27. bhāu mhaṇato bahiṇi bhara oṭi |
bhāvaja sāṅgate undarāṇe neli vāṭi ||
28. bhāu to mhaṇato yāga bahiṇi bhetāyālā |
bhāujayi bhaṇate ālyā naṇadā luṭāyālā ||
29. ātibāpāṁ māhāri māherāci jhālī rāja |
bhāvajaua sāṅgāti gāṁvābāhera dharmaśāla ||
30. duḥkhasukhācyā re mājhyā bharalyāta gonyā |
sāṅgate baṁdhūji ēka khepa karavanā ||
31. cāta pāhūṁ pāhūṁ ḍole jhāle kumkā vāṇi |
bayacyā bāḷānā mana kelā lokā vāṇi ||
32. vicāri śējāriṇa tujhe mukha kām komele |
sāṅgate sakhe ga mājhe bhāu nāḍiṁ āle ||
33. ātācyā yogāṁta bhāu nāḍiṁ bahiṇicā |
khiśāmādi coḷi vāḍā pusā mevhaṇicā ||

34. My mother has taught me that I should never make a third when two are talking (said by a sister to her brother and his wife).

35. The rains fell and subsided. My brother has daughters and has forgotten his sister. (The rains are the rains of love, which poured over the sister's head).

36. He gives a dozen excuses for not going to his sister's village and loosens the bullocks from the plough when he has to go to his daughter's village. (Even when agricultural work is at its highest he does not mind releasing the bullocks to take his cart to his daughter's village).

37. Cream is sweeter than milk—my brother's child I love more than brother.

38. I have nearly finished mealing the corn only five handfuls remain—God has given me nephews (brother's sons) like ornaments to my *kumkum* box. (The reference to corn mill is made because all these songs are sung at the time of daily mealing of corn).

39. The mare is straining at the reigns and the seat below the Pipal tree becomes full of noise. My friends are calling me. It is not the brother but it is his son who has arrived. (The brother has ceased to come but his son visits the aunt).

40. Why be envious of pots full of gold? My brother is proud in the possession of many children.

41. My infant baby is calling, 'māmā, māmā' (mother's brother). The office of 'māmā' (uncle) suits my brother very well.

34. malā śikavila māya bāi tusaḍiṇe |
ubhā rāhūṁ naye doghā tithe tisaryāne ||
35. pāusa padlā padūni osaralā |
bhāvalā jhālyā leki bahiṇilā visaralā ||
36. bahiṇicyā gāṁvā jāyā sāṅgato bārāvadhī |
lekicyā gāṁvā jāyā dhurece nadim soḍi ||
37. dudhāparisa dudhāci sāya goḍa |
bhāvāparisa malā bhācyāci āvaḍa ||
38. dalaṇa saralā uralā pāca pase |
devājine dile bhāce mājhyā karamḍdayālā ṭhase ||
39. śiṅgīnā hisakalā pipalapāra daṇāṇalā |
bolāvatī sayā bhāu navhe bhāsā ālā ||
40. kāya karāyācā dhanasampatticā hādā |
bhāirājasānā mājhyā saṁtatīcā jhēḍā ||
41. māmā mhaṇe hāḱā māri mājhā tānhā |
mājhyā baṁdhayātā sājatā māmepaṇa ||

42. The house of the goldsmith is full of sparks. My 'bhāchi' (brother's daughter) has become my daughter-in-law and I have ordered gold ornaments for her hands, feet and neck.

43. I have finished mealing the corn by these golden hands of mine. The mill belongs to the lucky person, my daughter-in-law's father, i.e., my brother.

42. sonārācyā gharīm ṭhinagyācā bhaḍimāra |
bhāśi kelī sūna goṭha ṭoḍe caṁdrahāra ||
43. dalaṇa saralā mājhyā sonyācyā hātāna |
vyāhi rāgasācyā bhāgyavāntācyā jātyānā ||

44. This is the season of marriage. Cloth has become dear. The sister is the important personage, i.e., the bridegroom's mother. The marriage of the nephew is being performed. (The brother gives his daughter in marriage to his sister's son).

45. Come, aunt, let us go to the mother's house. To fetch us, is come my father, who is also your brother.

44. lāgīna sarāi kāpaḍālā mola jhālā |
bahiṇa varamāi bhāśāca lagna jhālā ||
45. calā ātyābāi māherālā jāṁi |
mūla gheūniyā ālā mājhā bāpa tumacā bhāu ||

INTERNATIONAL ROLE OF SCIENCE

If we are to have a durable peace after the war, if out of the wreckage of the present a new kind of co-operative life is to be built on a global scale, the part that science and advancing knowledge will play must not be overlooked. For although wars and economic rivalries may for longer or shorter periods isolate nations and split them up into separate units, the process is never complete because the intellectual life of the world, as far as science and learning are concerned, is definitely internationalized, and whether we wish it or not an indelible pattern of unity has been woven into the society of mankind.

There is not an area of activity in which this cannot be illustrated. An American soldier wounded on a battlefield in the Far East owes his life to the Japanese scientist, Kitasato, who isolated the bacillus of tetanus. A Russian soldier saved by a blood transfusion is indebted to Landsteiner, an Austrian. A German soldier is shielded from typhoid fever with the help of a Russian, Metchnikoff. A Dutch marine in the East Indies is protected from malaria because of the experiments of an Italian, Grassi; while a British aviator in North Africa escapes death from surgical infection because a Frenchman, Pasteur, and a German, Koch, elaborated a new technique.

In peace as in war we are all of us the beneficiaries of contributions to knowledge made by every nation in the world. Our children are guarded from diphtheria by what a Japanese and a German did; they are protected from smallpox by an Englishman's work; they are saved from rabies because of a Frenchman; they are cured of pellagra through the researches of an Austrian. From birth to death they are surrounded by an invisible host—the spirits of men who never thought in terms of flags or boundary lines and who never served a lesser loyalty than the welfare of mankind. The best that every individual or group has produced anywhere in the world has always been available to serve the race of men, regardless of nation or colour.

Notes and News

COLLECTIVE FARMING IN U. S. S. R.

THE successful issue of collective farming in Russia is a unique triumph of the Soviet regime. The traditional agricultural policy with all its inherent drawbacks, followed through ages, could not be so easily changed, and it required several years before the Soviet Government could show some measure of success in collectivising farming in Russia. Much of the success witnessed in Soviet agriculture today with great improvement in the economic condition of the agricultural population is largely due to a steadfast pursuance of the policy of collective farming. In the course of a short note in *Nature* on the recent trends of the Soviet agricultural policy, Mr E. J. Roberts has placed before us the views of Sir John Russell, whose intensive study of Russian agriculture and occasional visits to that country have made him an authority on this subject. From the very outset the supreme importance of collectivisation in farming with the fullest possible use of modern machinery to tillage and of scientific methods of livestock improvement and disease control was realised, and State farms were developed after the Revolution. Collective farming did not at first receive a ready response from the people with their strong prejudice for individual ownership. Besides the idea of restarting from the same level as the backward and poor peasants with hardly any agricultural implements or livestock was particularly repugnant to comparatively prosperous peasants who offered strong opposition to collectivisation. But the opposition gradually melted away before the decided advantages of the tractor in large-scale farming and the favourable action of the State in securing land to the collective farms permanently. By 1939 area under collective farms was eleven times than that under State farms.

Planning in agricultural production is the most significant feature of collective farming. Production is planned for a period of five years, each district having beforehand its quota of production according to the local soil and climatic conditions. This has necessitated an extensive soil survey in which the most modern scientific methods are being increasingly

utilised. Science is also playing a vital part in making agriculture possible in the face of scarcity of rain from which the southern regions seriously suffer. Rotations have been carefully studied and developed to keep as large an area as possible under cultivation during most of the seasons with the result that the area of fallow land has now reduced from 35 to 20—25 per cent. It should be remembered, however, that despite these gigantic strides the Russian farm workers have hardly yet attained a standard of living comparable to that of England. But compared to the condition of agriculture and agriculturists in the Tsarist Russia Soviet achievement in the direction of agrarian improvement is indeed phenomenal.

EXCAVATIONS AT NALANDA

THE recent excavations at Nalanda, once the site of a famous Buddhist University, have brought to light some seals of office of rural and urban dignitaries of ancient India and inscriptions on stone and on copper plates which bear testimony to the contact the great Buddhist centre maintained with Java, Sumatra and other countries. The Archaeological Survey of India has published a memoir (No. 66) containing the results of excavations carried on for over two decades, which includes a series of remarkable 'stupas' and monastic buildings. The clay seals reveal how far civic administration advanced in India 1,100 years ago. A stone inscription of the 8th century refers to a warden of the northern marches, probably of Tartar origin as his title, 'Tikin', suggests, who had made a religious offering at Nalanda. According to another record of over eleven centuries ago, unearthed in those excavations, a ruler of the Sailendra dynasty, whose dominions included Sumatra and Java, made a request to the Pala King Devapala to provide for the maintenance of a monastery which the Indonesian ruler had erected at Nalanda.

'F. M.' TRANSMISSION

'F. M.', the abbreviated form of Frequency Modulation, is a new system of transmission gradually coming into use, notably in U. S. A. where

new broadcasting stations utilising this system have recently been established. Theoretical possibilities of transmission based on frequency modulation were calculated mathematically as long ago as 1922 by J. R. Carson. But it was only in 1937 that Edwin H. Armstrong could definitely show the practical advantages of this type of transmission. Since then United States of America has shown an increasing interest in the new system which has also aroused lively interest in other countries as well.

The system of transmission, now generally followed in radio telephony, is based on the modulation of amplitude; that is, the amplitude or intensity of the radiation is varied according to the sound to be transmitted. The receiver used in such a set should necessarily be sensitive to amplitude variation. In the new system the amplitude is allowed to remain constant throughout, while the frequency of the carrier wave is decreased or increased with the nature of the sound, producing a frequency modulated signal. This, however, requires a receiver of special design, sensitive to changes of frequency and not to those of amplitude. F. M. transmission which must use ultra-short waves such as are used in television is, therefore, suitable for local services only. Curiously enough the new system enjoys considerable freedom from undesirable interference effects and works with a much weaker signal. For instance, in the present amplitude modulation system the signal from one broadcasting station should be hundred times stronger than that from a second one operating on the same wavelength before it could be clearly received without any interference effect. F. M. signal, however, ensures a good reception when the signal is only twice as strong, and as such, it is possible to operate many more stations in a particular area. This 'radio freedom' is the characteristic feature of F. M. transmission.

ROCKEFELLER FOUNDATION REVIEW FOR 1941

THE manifold activities of the Rockefeller Foundation in 1941, as the review of work in that year reveals as usual centered round six major fields, namely, public health, medical sciences, natural sciences, social sciences, humanities and programme in China. The appropriations of the year under review, amounting to \$9,313,964 were less than the previous year's amount and were distributed for works in the six major fields mentioned. The foreign lands where the activities of the Foundation in that year were radically affected owing to the spread of war in those regions include Shanghai, Manila, Peking and others. The work of the Foundation in Europe is now completely stopped as there are now no Foundation representatives in the continent. But in

spite of these various difficulties imposed by the war time emergency the Foundation has steadily pursued its programme of work and put in greater efforts to solve problems having a vital bearing on the war. In view of the increased demand for yellow fever vaccine developed in 1936 in the International Health Division of the Foundation, the laboratory space and the number of technicians had to be doubled, and the Foundation furnished the vaccine free of cost to the U. S. Army and Navy to Panama Canal Zone, Virgin Islands, Africa, India, Brazil and Singapore, amounting to 4,260,680 doses in total. Besides, substantial progress has been made in the war time diseases like malaria, typhus and influenza. At the request of the Army and Navy and on the invitation of the Government of Trinidad the Foundation has assigned a malariologist and an entomologist to study the factor causing malaria in Trinidad and make intelligent plans for controlling the disease. The International Health Division of the Foundation undertook laboratory research in typhus in January 1941, and carried on field work in Spain where it breaks out in epidemic form. The discovery of the Eastern Cotton rat which has proved to be better than guinea pig as the experimental animal for typhus research has greatly facilitated the study of chemotherapy in typhus.

The Foundation continued to show its interest in the development of natural sciences and came forward with its usual generous grants to promote basic researches in biochemistry, biophysics and various other branches of natural science. A grant was placed with the University of Oxford to bring to the United States Professor H. W. Florey and Dr N. C. Heatley, noted for their work on 'penicillin', a chemical substance with extraordinary antibacterial activity, to carry on their research in the United States which country offers better research facilities than England. Grants were made to Stanford University for research in genetics under the direction of Dr C. W. Beadle, to the Cornell University Medical College for research on biotin, supposed to be essential for plant and animal life and responsible to a certain measure for some kind of cancer and to the California Institute of Technology to assist Professor Linus Pauling and his associates to study the structure and formation of chemical substances called 'antibodies' whose presence or absence in the blood makes people immune or susceptible to infectious diseases.

In the year under review the Foundation appropriated \$104,000 to carry out its programme of rural reconstruction in China, which it has been maintaining for over six years and extended its support to the National Council for Rural Reconstruction and

the Mass Education Movement with headquarters in Chungking, and to the Department of Agricultural Economics of the University of Nanking, now at Chengten.

A handsome fund has been appropriated by the Foundation in the hope of preserving valuable and irreplaceable historical, literary and architectural records of England, which have so far escaped destruction by aerial bombing. A fund of \$170,000 has been placed with the American Council of Learned Societies which has arranged for the micro-filming of irreplaceable books and documents in the British Museum, the Public Record office, the libraries of Oxford and Cambridge and in other localities where material of great historical importance is housed. The scheme of the preservation of architectural records includes (1) preparation of lists of the large number of buildings of interest, with some guiding note as to their individual character, (2) the collection in a central index of particulars of existing records (drawings and photographs) in public and private hands, (3) the production of accurate records of buildings that have hitherto received insufficient documentation, and (4) the careful examination of and noting of structures which through the injuries received, disclose points of growth of construction valuable to the student.

In view of the growing American need of cultivating an intimate acquaintance with the languages of the East the Rockefeller Foundation freely contributed several hundred thousand dollars in 1941 to the American Council of Learned Societies and a number of other universities and institutions to stimulate special courses in Chinese, Japanese, Russian, Hindusthani, Turkish, Arabic, Persian, Malayan, Tibetan, Siamese and other languages. Attempts are being made to prepare primers, grammars, dictionaries, glossaries of technical terms to facilitate the mastery of these Eastern languages.

In its review for 1941, the Rockefeller Foundation has reaffirmed its undiminished belief in the ultimate power of reason and expressed its unshakable belief in the complete internationalisation of the intellectual life of the world, so far as science and learning is concerned, which has already taken place in certain measure and is weaving slowly but surely an indelible pattern of unity into the society of mankind in spite of the present political strife and dissensions.

A NEW SCIENTIFIC QUARTERLY

ENDEAVOUR is a new quarterly scientific review published by the Imperial Chemical Industries,

London. The publication of this journal, as is made clear in the editorial of the first issue, has been inspired by the honest desire to record the progress of the sciences in the service of mankind and keep the world informed about current scientific thoughts and developments. We are pleased to note its honesty of purpose in the acknowledgment of the international aspect of science which is the result of concerted efforts of the scientific men of all countries of the world, but a bit perplexed to find an unexpected parade of British scientists and scientific achievements, with really a long list of brilliant scientists. The journal has called upon British men of science to report on the progressive scientific thought and work with particular reference to British achievements. The editor himself seems to be fully conscious of this parade as is evident from his concluding remarks:

"We do not apologise if these pages lay emphasis on British scientific work. That is our particular pride. But that they will not be marked by any narrow insularity is, we are confident, sufficiently guaranteed by the contents of this inaugural number." It is with a feeling of reluctance that the contribution of other countries like Greece, Egypt, Babylon and Arabia have been mentioned, and British pride has refused to travel further East and mention the name of India and China whose original contribution to Astronomy, Chemistry, Medicine, Mathematics, Philology is an undisputed historical truism. We doubt whether this conscious manifestation of a national outlook in the field of scientific journalism at a time when internationalism in science in all its aspects is vehemently advocated from all platforms will serve the purpose which is supposed to have inspired its publication.

SIZE OF EXTRA-GALACTIC NEBULA BY PHOTO-ELECTRIC MEASUREMENT

THE great space of the universe is studded with a large number of star cities or the nebulae, of which our galactic system is one. Although our galaxy and the extra-galactic nebulae have been known to be identical in nature, and rank in the same class in the universe structure, it remained a crux as to why our galaxy is so large compared to other nebulae. Measurements showed that the spread of our galactic system of stars is about 300,000 and 60,000 light years along its major and minor axis respectively, while the most conspicuous extra-galactic nebula seen through the constellation of Andromeda, is only $3^{\circ} \times 1^{\circ}$ as measured on photographic plates, and means only $50,000 \times 17,000$ light years in linear dimensions.

Recent observations have been that the photographic plates do not take the impression of the full extent of the nebulae; the extreme contours are, in fact, nor recorded on it. The extent of the Great Nebula in Andromeda has recently been traced by photoelectric method. The photoelectric measurement of the isophot contour (i.e., the lines of equal intensity of light) of the image of the nebula, formed in the telescope, shows that its angular size is $6.7^{\circ} \times 2.2^{\circ}$ instead of $3^{\circ} \times 1^{\circ}$ as previously estimated by photographic methods.

This observation has reduced the difference between the nebula and our own galaxy, as regards size. The measurements have further shown fainter elongation of the nebula along the major axis and it is slightly curved in the anticlockwise direction.

DR J. HENG LIU

A DISTINGUISHED visitor at the Annual Meeting of the Indian Science News Association held at the University College of Science last September was Dr J. Heng Liu, M.D., Dr P. H., former Minister of Health in the Chinese National Government. Earlier in the day, Dr Liu visited the Biochemical Laboratories of Prof. B. C. Guha and took notes on the problem of the jute retting. Later Prof. M. N. Saha explained to him the construction of the cyclotron which is being installed at the University College of Science. Dr Liu was passing through Calcutta en route to Washington, where he will be stationed for sometime as 'Adviser to Lend-Lease for China' with respect to medical supplies.

Dr Liu had his education and medical training at Harvard. As surgery was poorly developed in China in his student days, he took post-graduate work in America and returned to China as a surgical

specialist. As Associate Professor of Surgery in the Peiping Union Medical College, one of the foremost medical institutions in Asia, he soon made his mark and successively became the Superintendent of the Hospital and the Director of the College. With the establishment of the National Government at Nanking, Dr Liu was invited to organise the medical and public health activities of the Government and it was under his leadership that the splendid organization known as 'Wei-Sheng-Shu' sprang up. Dr Liu initiated the Government's policy of 'State Medicine', and unbiassed observers admit that his achievement in this direction was well worthy of high commendation. The writer had the opportunity of meeting Dr Liu in 1934 during the Far Eastern Association for Tropical Medicine Congress at Nanking when more than 1,000 distinguished delegates from all parts of the world assembled there. All delegates present testified to the splendid organization he created from almost nothing and were highly impressed with his foresight and attention to minute details. A man of pleasing manners and unassuming behaviour, Dr Liu must be given the credit for slowly but surely building China's National Health Administration which is functioning actively and efficiently to-day at Chungking, though many of the hospitals, buildings, and equipment originally belonging to the Nanking centre had to be abandoned as the result of Japanese occupation.

Dr Liu was in Hongkong when the island capitulated to the Japanese and he had a miraculous escape through the help of Chinese fishermen who rowed him day and night through various rivers and creeks until he reached a safer zone from where he walked 300 miles before he could come to friendly territories known to him.

B. M.

SCIENCE IN INDUSTRY

X-RAY IN INDUSTRY

X-RAY methods of analysis have received considerable importance in recent years in deciding industrial problems of a scientific nature. Mr H. B. Rooksby of Research Laboratories of the General Electric Company Ltd. reported in *Nature* some specific industrial applications of radiography and X-ray crystal analysis of which the following may be mentioned.

Radiography has found its most important application in the field of metal castings. Defects such as porosity, inclusions and cracks in metal casting, which render regions in which they occur less absorbing of X-rays can be easily revealed by the negative which is marked by darkened areas corresponding to these defective regions. The method is so sensitive that an inhomogeneity arising from a variation of thickness by 1 per cent. in a steel piece of about 2 inches thick can be easily detected. Radiography has been useful in the air-craft industry in examining the faults of the light aluminium and magnesium alloys; but owing to the smaller mass absorption coefficient of these light metals the sensitivity is not as great.

Another important application of radiography, yet very insufficiently developed, consists in the testing of the parts of an assembly. The radiographic examination of the opaque metal parts with a view to detect possible deteriorations and deformation during operation often leads to useful suggestions as to improved designs in future construction. So far the method has been most successfully applied in the testing of the inner parts of the different forms of radio valves. The little clearances between the various parts in the small valves are critical, and, owing to the opaque metal covering, can only be delineated on the photographic plate with X-rays, when an examination of these inner parts, such as the tungsten and molybdenum electrodes in water- and air-cooled transmitting valves, is desired.

Powder photography has proved to be a valuable technique in distinguishing between the structures of different chemical compounds and substances of industrial importance. Silica bricks are now widely used as refractories in glass and steel furnaces. It exists in the three polymorphic forms, namely quartz, cristobalite and tridymite, stable at the ordinary temperatures, of which the last two polymorphic forms are suitable for making bricks. Quartz is the naturally occurring substance and must be fired at high temperatures to effect the conversion of quartz to cristobalite and tridymite. The similarity in the chemical composition of all the three polymorphic forms of silica makes X-ray crystal analysis absolutely necessary to ascertain this conversion.

The method has proved equally successful in determining the formations of mixed crystal and the changes of the composition of a continuous series of solid solutions with isomorphous end members. The necessity for such determination arises for instance, in the case of barium and strontium carbonates used in the preparation of the alkaline earth oxide-coated cathodes for thermionic purposes, where the method has been applied.

The use of powder photography in powder metallurgy deserves more than a passing notice. Considerable lattice distortion is introduced in the process of obtaining metal filings and grounding a powder. Such strain or distortion can be removed by subjecting the filings to a process of heat treatment. The examination of the back-reflection region of the X-ray pattern alone can reveal the presence or absence of such distortion. Thus in various types of magnetic loading and radio cores alloys of nickel and iron in the powdered form are necessary. Such metal powders naturally suffer from high degrees of lattice distortion with considerable loss of magnetic properties and require heat treatment. The necessity of X-ray analysis to ascertain whether the powder has become strain free is therefore obvious.

CELLULOSE FODDER

ACUTE shortage of fodder has of late resulted in the increased slaughtering of cattle in many countries. The difficulties have been particularly severe in countries, like Sweden, which depend upon foreign countries for their supply of feeding stuffs. Recently some Swedish institutions undertook research work and succeeded in developing what is known as cellulose fodder which can be produced by the chemical pulp mills and used as an important substitute for natural fodder. The marked deficiency of albumen and salts in cellulose which is almost pure carbohydrate constitutes the principal weakness of cellulose for use as a fodder. Some other substances, preferably products of the pulp mills if possible, require to be added to the fodder cellulose to make good this deficiency. Addition of fodder yeast from pulp mills has been found to produce the desired result. Spirit is recovered from waste liquor, which yields yeast as a by-product. Its albumen content is as high as about 50 per cent and it is also rich in vitamins, particularly B₂. Richness in vitamin content is particularly favourable for animal growth and hence guarantees good nourishment in the young stage. Results of research also point out that for fermenting sugar in the sulphite lye some salts containing nitrogen and phosphoric acid must be added as food for the fungi. These salts further add to the fodder value of yeast.

Formerly this product used to be allowed to run to waste along with the liquor. It has now proved to be an important substitute for fodder. At present production takes place at one factory, belonging to the Swedish Pulp Company. Production on a large scale is, however, soon expected.

SYNTHETIC FIBRE FROM SOYABEAN

It seems, as it were, that there is no end to the list of uses in which soyabean can be used. Here is the news of a synthetic fibre, similar to sheep's wool, produced from soyabeans, which is coming into use in upholstery in ever increasing quantity. The pioneering lead was given by the Ford Motor Company which now operates a 'pilot' mill capable of spinning more than thousand pounds of synthetic fibre a day. The fibre is spun from a molasses-like substance containing soyabean protein as its chief ingredient. The process involves the extraction of oil from soyabean and the subsequent removal of protein from oil-free meal. Protein, thus extracted, is dissolved to produce a viscous substance which is forced through a spinneret containing 500 holes to emerge in the form of filaments. The filaments are then passed through acid baths and later on immersed in formaldehyde baths to set the fibres.

The fibres are cut according to required lengths and subjected to a process of drying under controlled conditions of temperature and humidity. Some other minor operations are necessary before the fibres are finally made ready for spinning. The product is merited with a natural crimp and a high degree of resiliency. The research chemists are of opinion that the synthetic product can be best used in combination with sheep's wool, and it is in this form that soyabean fibre is now-a-days used in American upholstery mills.

FOUNDATIONS IN CLAY STRATUM

THE Progress Reports of Special Committee of American Society of Civil Engineers define clay as the material resulting from the decomposition and consequent hydration of the feldspathic rocks, especially granite and gneiss, and of the crystalline rocks in general. Clay is also defined as a mixture of minerals of which the representative members are silicates of aluminium, iron, the alkalis or the alkaline soils. In general, any mineral can be present in clay, which is responsible for modifying its properties to a certain extent.

The peculiar structure of clay, and its great affinity for water, react in so large a variety of complicated ways that the definite causes of its instability are generally not traceable and the accurate determination of its shearing resistance becomes extremely difficult. The most important recent contribution regarding the shearing resistance of typical clays was made by M. J. Hvorslev, in "Über die Festigkeit seigenschaften gestörter bindiger Boden", Ingenieurwissenschaften, 1939, Nr. 45.

Clay in its undisturbed state has a complex cellular microstructure. It has large silt grains which are separated by smaller flocculated colloidal particles, the actual diameter of clay particles varying from 10^{-4} cms. to 10^{-6} cms. According to Clement C. Williams of Lehigh University, the influence of colloidal content is reflected in its effect upon the permeability and the extent to which the entrained water is held as capillary moisture, which controls the rapidity with which the water and air can be expelled under pressure. The decrease of porosity as the stress over it increases results in a continuous increase of time rate to expel the bound water before complete consolidation is reached.

The Void Ratio of clay, that is, the ratio of the volume of voids to the volume of solids, varies from 0.33 in hard clays to 2.5 in soft and liquid clays. Upon the resistance which clay offers in expelling water and air from its voids depends its compressi-

bility. Its bearing capacity then varies from 1 ton per sq. foot to 5 tons per sq. foot, depending on its specific weight, which increases from 100 lbs. for dry residual clay to 140 lbs. for dense consolidated clay.

According to R. R. Minikan, clay loses a considerable amount of what stable properties it possesses when it is disturbed or exposed to weather from its original condition or position. It is then very

difficult to apply any mathematical treatment to such a disturbed clay, or even when it is in a "cut" or "fill". Research has shown that clay has no definite angle of repose, and that a clay stratum at a depth equal to one and a half times the width of a building is considerably affected by the weight of the building, and in many cases the effects are observed at the ground surface by settlement.

S. K. G.

Artificial Rubber—Its Prospects*

M. GOSWAMI

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ARTIFICIAL rubber has been of widespread interest during the last Great War and in this total war. Its necessity was felt by Germany which was entirely cut off from the supplies of natural rubber during the years 1914-18. Its necessity is now being felt heavily by the Allied powers on account of Japan's aggression in the principal rubber growing countries. Synthetic rubber, like synthetic dyestuffs, synthetic petrol and synthetic ammonia is one of the greatest triumphs of modern science. But this triumph has been won with great difficulty. From Faraday's pioneer work in 1826 to Perkin's patent application in 1910 for the production of synthetic rubber in England, the path of the chemists and industrialists has been beset with ups and downs of hopes and failures. Still it was not a success. After about 20 years and between the years 1931-1935 announcements of successful preparation of synthetic rubber, both from the point of view of quality and strength comparable to natural rubber, were made in U. S. A. and Germany. Perfection was reached to such a state that in 1938 the German army rolled into Austria on tyres made entirely of synthetic rubber—after about 200 years from the time rubber became known to the civilised world.

The milky fluid (latex) obtained by incision of rubber trees gives spongy mass called rubber by coagulation—a process resembling the separation of casein from ordinary milk. The first attack of

chemists was on the inner composition of rubber. It was a riddle. It was composed of only carbon and hydrogen like so many hydrocarbons of natural petroleum. The usual destructive and constructive experiments were done. In the series of destructive experiments rubber yielded on heating a liquid—also consisting of carbon and hydrogen. This liquid was investigated threadbare. On long keeping it gave a viscous mass and further experiments with other chemical reagents showed that it was capable of giving rubber-like stuff. It thus appeared from these results that the liquid—which was named Isoprene—was the ultimate product of decomposition of rubber and that isoprene could be metamorphosed into rubber by chemical reagents. This latter constructive side gave enormous troubles.

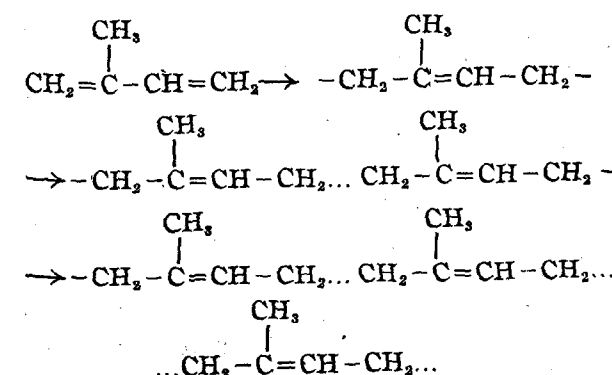
To understand these we must know the complex nature of natural rubber. Unlike natural indigo and other substances like camphor, cocaine which have been successfully synthesised it is what is called a polymerised product formed by duplication and reduplication of a single unit i.e., a molecule of



Isoprene $\text{CH}_2=\text{C}(\text{CH}_3)-\text{CH}=\text{CH}_2$. This process of duplication and reduplication which is called poly-

* From a lecture delivered at the Calcutta Rotary Club on 11th August, 1942.

merisation has been repeated 1000-1400 times and the result has been rubber:—



To make this point clear we may consider a brick structure of which the unit is one brick. Without taking into account the cementing factor as the unit of rubber has the inherent cementing quality—let us consider the ups and downs of such a structure with its terraces and stores built by duplication and reduplication i.e., superimposition of bricks. This superimposition is not the same in every part of the building. In some places the number is greater and in some places it is less. But on the average we can say that there have been so many superimpositions. In the case of rubber too although researches have shown that it is the result of superimposition of the unit isoprene, and that its average number varies from 1000-1400, nevertheless this number is not uniform throughout the rubber edifice. In contradistinction to this complex nature of rubber, indigo, camphor and cocaine are definite units without any superimposition or polymerisation. Once the unit was synthesised (say indigo) it was identical with the natural product in all respects. The unit of rubber i.e., isoprene was successfully synthetically prepared from various raw materials long before but the process of superimposition or polymerisation of this liquid (isoprene is a volatile liquid much more volatile than ether or alcohol) to the elastic, buoyant complex rubber presented insuperable difficulties. Numerous processes became known by which this liquid isoprene could be converted into rubberlike stuff but none gave a product identical in properties with the natural one. Apart from this difficulty there arose another one of a very serious nature in the process of vulcanisation of the resultant product. Natural rubber is elastic and sticky; it becomes plastic in heat and crumbles to powder in cold. For industrial uses these defects are removed by mixing with sulphur and by heating—a process called vulcanisation. The first patents for vulcanisation were taken simultaneously in England and America about the year 1830. Since that time innumerable patents on

vulcanisation have been taken and gradual improvements to the present perfected stage made. The strength of a product (say motor tyre) manufactured from rubber depends on vulcanisation. Before the last great war the life of a motor tyre was never guaranteed more than 2000 miles, now this figure has risen to 40,000 miles indicating how improvement in the process has been made. The synthetic rubber prepared from isoprene on vulcanisation gave useless products from industrial point of view. This was the position in the years 1910-1911 when the production of natural rubber (93,000 tons) could not cope with the demand in the market and its price rose to \$3 a lb. Feverish attempts were made to produce synthetic rubber and pioneer attempts for its manufacture began to be made by Synthetic Rubber Co., in England and by F. Bayer & Co., and I. G. Farbenindustrie in Germany. From the very start the British Government did not view with favour such synthetic works as it was feared that these attempts would hit their rubber plantation in Malaya and Ceylon.* In 1914 when the last war broke out Germany could not get any natural rubber due to the blockade. She had some reserve and she established one factory which produced during the war some 150 tons per month of synthetic stuff of inferior quality. After the war the production of natural rubber increased enormously with the result that the price fell down to 1s. per lb. The impetus to produce synthetic rubber thus vanished. Only du Pont factory in U. S. A. and I. G. Farbenindustrie stuck to their guns. Although the restriction scheme introduced by the British Government in 1925 helped to augment the price of natural rubber, the production in Dutch East Indies nullified the effect and the price tumbled down in 1935 to less than 4d. per lb. It would be of interest here to know world's actual production of natural rubber in 1940. It was 1,389,695 tons out of which the shares of Malaya, Dutch East Indies, Borneo, Thailand, Indo-China, Philippine islands and Burma were as follows:—

Malaya	...	...	540,417 tons
D. E. I.	...	...	536,740 "
Indo-China	...	...	64,437 "
Thailand	...	...	43,940 "
Borneo	...	...	52,789 "
Burma	...	...	9,668 "
Philippines	...	...	2,257 "
			1,250,248 tons

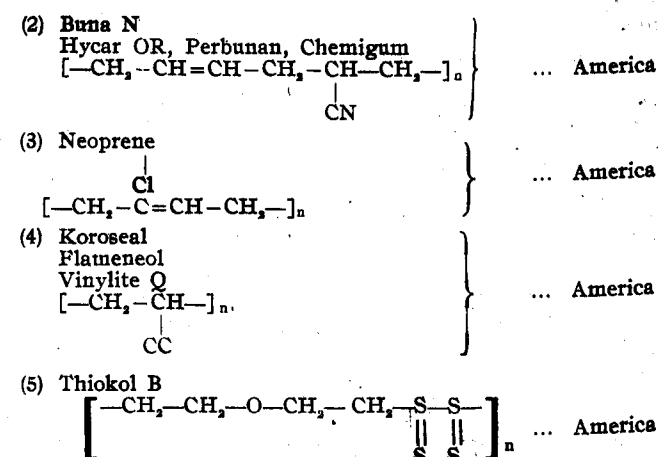
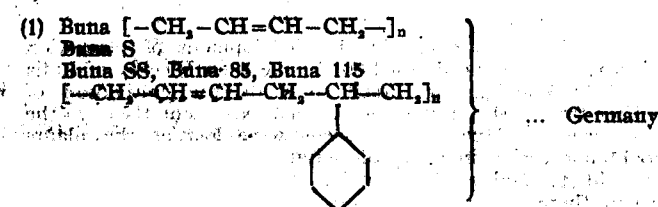
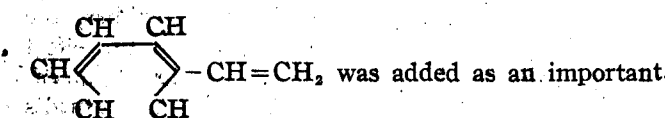
* India has a share in the development of plantation rubber. In 1875 Lord Northbrook, the then Viceroy of India sent Mr Wickham to Brazil to study the cultivation of rubber trees. He brought some seeds and sent these to the Kew gardens. Much of the seeds were lost as the plants could not thrive in that cold climate. The remainder was brought to Malaya and Ceylon and successful plantation began there.

Of the remainder i.e., 139,447 tons, 135,331 tons were distributed as follows:—

Ceylon	...	88,894 tons
India	...	11,510 "
South America	...	17,601 "
Africa	...	17,326 "
		135,331 tons

As numerous processes were evolved for the preparation of synthetic rubber from isoprene so also numerous patents were taken for the preparation of isoprene itself. It was successfully prepared from turpentine, petroleum, starchy materials and even from coaltar. Isoprene was also exhaustively studied, and the cause for its polymerisation was also examined thoroughly. When chemists found that they could not imitate natural rubber starting from isoprene they abandoned their orthodox method. The goal was then to produce rubberlike stuff from units which have the peculiar property of cementing among themselves or polymerising like isoprene to give elastic buoyant products. Two substances Butadiene $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$ and Dimethyl Buta-

diene $\text{CH}_3-\text{CH}=\text{C}(\text{CH}_3)-\text{CH}=\text{CH}_2$, immediately attracted their attention. The accumulated experience of the methods for the preparation of isoprene and the methods for the polymerisation and vulcanisation were applied. Newer methods were patented and, newer units were gradually added. Styrene



The production of synthetic rubber in different countries before 1942 was as follows:—

Year	Country	Production
1941	U.S.A.	17,000 tons plan for production of 80,000 tons under way.
1936	U.S.S.R.	40,000 tons
1938	Germany	25,000 tons

It has been held that the production figures of Germany and Russia have been suppressed and that in reality they are much higher. Great Britain has had no contemplation of producing synthetic rubber. Formerly the reason was her enormous production of natural rubber in the colonies. The present reason is perhaps an agreement with U. S. A. which country will alone produce synthetic rubber for the Allies as Mr Oliver Littleton, the Minister for Production has lately hinted on such an arrangement in the House of Commons. Attention is thus focussed on U. S. A.—on her consumption of natural rubber in the pre-Jap-aggression period and her capacity to meet the demand of the Allies by way of reclamation of used rubber and of producing synthetic rubber. Rubber, like petroleum, is of vital necessity not only in our civil life but also in war. For foot wears, waterproof fabrics, medical outfits, gas masks, tyres, tubes, insulation and shock-proof pads in tanks and aeroplanes rubber has become irreplaceable. We can, therefore, understand why strenuous attempts are being made by U. S. A. to meet the rubber situation.

She has already taken the following steps:—

- Conservation of 600,000 tons of natural rubber.
- Curtailment of civil supplies.
- Reclamation of used rubber.
- Erection of huge plants for the production of synthetic rubber.

Her normal requirement was 60,000 tons per month. It rose to about 80,000 tons in 1941 and if she is to supply all other members of the United Nations we may at least add another 20,000 tons. To meet the possible emergency U. S. A. Government in May, 1941, decided to build four Government owned synthetic rubber plants each with a capacity for producing 10,000 tons per year—to be operated under lease agreement by the four major rubber companies—the B. F. Goodrich Company, the Goodyear Tyre & Rubber Company, the Firestone Tyre & Rubber Company and the United States Rubber Company. This presumably refers to Buna type. Other concerns have also increased their production of synthetic rubber. The du Pont Factory has increased their output from 6,000 tons to 9,000 tons and is now building a new plant of 10,000 tons capacity. The Thiokol Corporation has increased their production to 1,750 tons. The B. F. Goodrich Company has expanded their Koroseal plant and by 1942 they will be able to produce about 18,000 tons. We have thus the following position regarding the production of various kinds of synthetic rubber in U. S. A.

Rubber	July, 1941 Production per annum	January 1942 Production per annum	January 1943 Production per annum
Buna type	5,000 tons	10,750 tons	70,000 tons
Neoprene	6,500 "	9,000 "	19,000 "
Thiokol	1,750 "	1,750 "	2,650 "
Koroseal	5,000 "	6,000 "	18,000 "
Total	18,250 tons	27,500 tons	109,650 tons
% of Normal require- ment in U. S. A.	3%	4.6%	18.2%

If we add 135,331 tons of natural rubber at present available to the United Nations, and for the matter of that to U. S. A. the total quantity of synthetic and natural rubber at her disposal will be 244,981 tons. This will barely meet the demands for two months and a half.

Reclamation of used rubber is being done in U. S. A. for a long time. The figure now stands at

245,000 tons per year (as announced by Jessie Jones on January 12, 1942). It is expected that this figure will be increased to 300,000 tons. Although reclaimed rubber cannot be used for many purposes like the manufacture of tyres, still this figure may be added to 244,981 tons—the total available synthetic and natural rubber—and may be regarded as covering another 3 months. Of the reserve of 600,000 tons which accumulated up to the end of 1941, about half has been spent and the available half with the cut in civil supplies will carry U. S. A. up to the end of this year so that there will be actually a void of 64 per cent in 1943. To meet this situation gigantic plants at the cost of £100,000,000 are contemplated to be built to give 600,000 tons of synthetic rubber and at the same time civilian supplies will be more drastically retrenched. The raw material will be butadiene obtained from natural petroleum and natural gas from petroleum well of which the supply in U. S. A. is inexhaustible.

But what about India? What will be her position as regards this essential commodity as the war gravitates towards this country? What steps have been taken in the possible eventuality of her being cut off wholly or partly from external supplies? She can count upon the supply from Ceylon for some time; the production of this country may come up to 100,000 tons. India's own production may be increased to 20,000 tons. So that total available supply of crude rubber is expected to be about 120,000 tons. Her normal consumption is about 8,000 tons and she imports rubber goods worth about Rupees two crores, all of which must be manufactured here. With war coming in our midst, her war production of rubber goods not to speak of enormous inevitable replacements will certainly far outweigh the combined production of Ceylon and India. As it is, we are quite unprepared for meeting such a serious situation. A rubber production Board should at once be set up by the Government which will take stock of the entire situation regarding our reserve, production and possible requirements. The Board should at once marshal the help of the eminent chemists of the land to take up the production of synthetic rubber from raw materials available here.

MEDICINE & PUBLIC HEALTH

NATIONAL INSTITUTE FOR MEDICAL RESEARCH, LONDON

ANNOUNCEMENT has been made that Dr C. R. Harington, Professor of Chemical Pathology in the University of London has been appointed Director of the National Institute for Medical Research, London, in place of Sir Henry H. Dale, retired. It is symptomatic of the increasing recognition of the importance of the basic sciences in the progress of medicine that the premier medical research institution of Britain has got Dr Harington as Director, who is a chemist and biochemist of international repute but has no medical degree. A non-medical man (in the conventional sense) at the head of a medical research institution in this country would be unthinkable. Such heterodoxy would produce a pretty little tempest in the medical world, here, particularly in the official medical circles, who adhere to a wooden system.

VITAMIN PRODUCTION IN THE SOVIET UNION

The Soviet Union has been one of the first countries to produce vitamins in a mass scale and distribute them to the people. During the present war, the production of vitamin concentrates has been greatly stimulated. It is now reported from Frunze that a vitamin C factory has been constructed there, the output of which is expected to be twice as big as the whole Soviet output of vitamin C concentrates before the war. The concentrate is produced from green walnuts, which are available in inexhaustible quantities in Kirghizia's rich forests.

CONTROL OF VENEREAL DISEASES IN GERMANY

Anticipating that the incidence of venereal diseases was likely to increase as a result of the war, the German Reich has, by a decree dated the 27th February, 1940, introduced improved regulations for their control.

When a person, suspected of suffering from venereal disease, and of disseminating it, does not

comply with an order to furnish a medical certificate on his state of health or to be examined, the local police authority issues a summons immediately. The tracing of the source of infection is made compulsory; and the information obtained is sent on a special form to the Health Offices. If the name of the person who caused the infection cannot be obtained, a detailed description is sought, so that the Health Office may make an immediate inquiry. When persons with venereal disease interrupt their treatment or when, because of the trade or profession followed, they constitute a source of infection, stern legal measures are adopted to bring the patients under treatment.

The notorious places are kept under observation by the personnel of the Health Offices, with the support of the police if required. Persons from those places are required to present themselves for examination once weekly, or more often according to the case, by a doctor allocated for the purpose. If for a person domiciliary treatment is no longer authorized, "hospitalization" is immediately enforced, if necessary with the assistance of the police.

Under the law of 1927, treatment of syphilis by arsenical preparations, mercury or bismuth was possible only with the consent of the patient. Since this law is in abeyance, these methods of treatment will henceforth be imposed; the consent of the patient is required only for lumbar puncture, cystoscopy, ureteral catheterization and urethral dilatation. An order of the Council for the Defence of the Reich, of the 21st October, 1940, further modified the law of 1927 by providing free treatment for those unable to pay for it.

By a decision of the 28th March, 1940, the Minister of the Interior ordered that a census of new cases of syphilis, gonorrhoea and soft chancre should be made during the month of June, 1940. Doctors had to inscribe on a postcard to be provided by the Medical Chamber and returned by the 1st July, all

new infections treated during this period; the cards were to be centralized at the Reich Medical Chamber. The Medical Chambers had also to indicate the number of sources of infection which had been notified to them during the period in question. The

army, the other military organizations, the labour services and the police had also to undertake this census through their own doctors. The results of the census have not been published, so far as is known.

Dental Education and Practice in China

ASHLEY W. LINDSAY

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IN the field of medicine the Chinese people developed long ago a vast empirical knowledge in the use of herbs and minerals for the purpose of curing pain and disease, but no group of medical specialists arose out of Chinese medicine to take the place of the dentist of the Western world. There will not be found, in Chinese tombs of the wealthy of ancient days, gold-capped teeth or artificial substitutes for lost teeth. There does not seem to be any evidence to show that the Chinese had any artisan or craftsman interested in restorative dentistry before the coming to China, during the nineteenth century, of foreigners to treaty ports.

Ancient Chinese medicine accounted for all diseases and pains of the teeth and the body by supposing them to arise as a result of an unbalanced condition of heat and cold within the body. All therapeutic measures were designed to harmonize these two states; cooling or heating remedies were the only remedies given to combat toothache or other inflammatory conditions of the mouth. That all too prevalent phenomenon, "tooth decay," did not receive the slightest attention because it did not fit into the "yin-yang" philosophy of disease. Thus the field of dental care was left to the workers of magic and to quacks. The magician's curative methods were based on attempts to remove dental pain by exercising an evil spirit which had made its home in the aching tooth. The quack insisted that the tooth ached because worms were gnawing at its vitals.

Now-a-days modern or so-called Western dentistry is finding its place in China. There is a growing

demand for a body of trained dental personnel capable of providing for the scientific and technical care of the mouth with its most important structures, the teeth. Progress is being made in the training of such men and women, but as yet their numbers are few. A brief survey of the groups practising some type of dentistry in war-time China will picture the steps of progress that are leading towards the establishment of a modern dental profession.

In the interior provinces, and probably everywhere in China, one may yet find women who make a living by removing "tooth-worms". By neat sleight-of-hand work the "worm remover" takes from her client's aching tooth a worm or worms, according to a fee agreed upon. The gnawing ache of the tooth is usually, or at least temporarily, relieved by the placing of a lime-cement within the tooth-cavity, ostensibly to prevent the entrance of more worms. Many times the power of suggestion is the real therapy that produces a temporary cure.

There is still found in most parts of China the old-styled "tooth-extractor". He removes such teeth as have been loosened by chronic or acute inflammatory conditions. Frequently he is seen in busy market-places, or in the company of the "out-of-doors" herb-sellers, phrenologists, fortune-tellers and the like. You may recognize his stand by his piles or strings of removed teeth. These attest his skill as a successful extractor.

The group to which this extractor belongs is being replaced by the young man who follows very much his methods of practice, but has added to his

equipment one or more pairs of western-styled tooth-forceps. Also he may rub on the gums about the tooth to be extracted, some modern anaesthetic preparation, usually cocaine. No estimate can be made of the numbers of these "tooth-pullers", but it is large.

There is also an itinerating group made up of "tooth-cleaners" and "tooth-pullers". These men attend country fairs and their charge for teeth cleaning and extraction is very small. The tooth cleaning technique is rapid and seemingly quite effective, for the teeth become clean and white after the treatment. The cleansing mixture is composed of an acid which dissolves away the stain and the outer enamel surface. This treatment leaves the enamel surface rough and more ready to hold anything that stains the enamel such as tobacco and food debris, but the consequent discoloration is not blamed on the method. The "tooth-puller" adopts all the schemes of approach and suggestion that are characteristic of the mountebanks of all times and countries.

Another dental group, housed in rooms with opening directly on to the busy street and displaying signs, announces itself as "tooth-fitters". They offer to restore lost teeth by full or partial artificial dentures and to cover decayed teeth with a more or less too-shaped cap of gold, brass, silver or their alloys. Also they cater to the human desire for adornment, by gold-capping perfectly good anterior teeth. Some even attempt the filling of cavities with cement, gutta-percha, or with a locally made silver-alloy. No attention is paid to an anatomically formed restoration, or to any functional use. The equipment and drugs employed by these men are most meagre; they do not take into account the existence of a bacterial kingdom. To ply their practice, they require no formal education or licence; self-instruction or apprenticeship for a short time in another "tooth-fitter's" shop is all the training considered necessary. This group is very large and as yet no complete survey has been made of their activities. It has been estimated, however, that throughout China, they number at least five thousand.

In the larger and more up-to-date cities, such as Chengtu, Nanking, Shanghai, Peiping, Canton, there is to be found a body of men in practice who have served as chair and laboratory-assistants to Japanese, European or American dentists. These offer a slightly better grade of dental care than those of the previously mentioned group, but, because their treatments are all based on unreasoned observations, they can do no more than produce faulty mechanical results without any pretense to biological requirements. Many times they prove very dangerous to

the public welfare. They have a large clientele who believe that they can receive "something just as good for less money."

In a number of the larger cities of China there may be found European and American dentists. These men confine their practice largely to the well-to-do patients among the Chinese and their own nationals. They have done little or nothing for the advancement of dental practice in China, nor have they made any contribution to dental educational development. The same criticism is true of those Chinese dentists who have received their training abroad.

China owes to Christian missions the most valuable contribution towards the development of dental practice and dental education. The most notable and successful of these has been that of the College of Medicine and Dentistry of the West China Union University, located in Chengtu, the capital of Szechwan. This college, registered with the National Government, offers a university-grade dental education and its graduates are to be found all over China. Since 1920 it has provided a course of seven years following high-school graduation: two years of general college work, four years of medical and dental didactic and laboratory education and a final year of clinical internship. Biological and medical sciences are taught in common to both medical and dental students, in the same class-rooms and laboratories and by the same staff. It is the hope of this college that its graduates shall be of service in meeting the wide demand for dental practitioners, but more particularly that they shall become leaders of dental education in China.

As has been implied, until a very few years before the war, the national and provincial governments and the leaders of modern scientific Chinese medicine paid little or no attention to modern dental education or dental practice. At present, the public health programmes of some of the provincial governments demand a preventive dental service in schools, and in municipal health clinics of which there are an ever increasing number. The Peiping municipality, in conjunction with the Peking Union Medical College and the Peiping National University, formerly had dentists in two of their health-centres. The Nanking municipality up till the time of evacuation had a dental service in its main health centre and in one of its school health clinics.

Many of the larger general hospitals *viz.*, the Peking Union Medical College, the Peking Methodist Hospital, the Changsha Hunan-Yale Hospital, the Central Hospital in Nanking, the Central Hospital of

Wuchang, the Kwangsi Provincial Medical College Hospital, the Chungking United Church of Canada Mission Hospital, the Chengtu Dental Hospital and several others have dental departments with qualified dentists in attendance. Unfortunately the war has been closing many of these institutions and their staffs are for the present widely scattered far from their homes.

In the year 1935, the National Government of China promulgated a regulation requiring all practising dental workers to register within a certain limited time. Following this announcement, standards of practice were set up and the Board of Examiners met twice to examine and admit applicants for licenses. Then came the war. During the succeeding years this board has not been convened. Dental practitioners now desiring to register apply directly to the National Health Administration.

In the same year, the National Central University of Nanking opened a Technical School of Dentistry. This was the first dental educational institution to be organized directly under the National Government's educational system. It was started as a three-year school, but in 1936 it extended its courses and became a full six year school, as a department of the National Central Medical College. At the fall of Nanking in 1939 this School had to flee from the place and was received on the campus of the West China Union University at Chengtu. Here it was helped to carry on by the teachers of dentistry in the College of Medicine and Dentistry. It now has its own buildings, but still receives teaching assistance.

The Ministry of Education required the reinstatement of the three-year school in 1940 so that today the two grades of dental school are being carried on by the National Central University.

This article will not attempt further to give details of many and worthy local dental clinics, all of which are helping to build up or to meet the demand for better dentistry. The mention of one new venture will be sufficient—that of the Army Medical College of Anshun, situated in Kweichow province. This college has three faculties—medicine, dentistry and pharmacy, providing a four-year course of technical training. The graduates are intended for army service. This College hopes to increase the length of training to a full six-year course after the war.

Dental graduates along with medical and pharmacy graduates are under national conscription for one year immediately following graduation.

These men and women serve in the army, the air force, the Red Cross and the public health clinics. The stories of the service of some of these men and women indicate the great need for better and more equipment and more drug supplies. China is now forced to improvise or do without much of what is an absolute minimum according to our Western requirements.

In March 1937, the first meeting of the National Commission of Dental Education was convoked at Nanking. This Commission arrived at important and fundamental decisions and further meetings were arranged. If the war had not broken out that summer many of the vital and urgent reforms advocated would have long since come into effect.

The following are some of the more important decisions reached at that gathering:

1. Dental practice shall become an integral part of the national programme for State Medicine.
2. The period of education for dentists shall be six years.
3. There shall be a grade of dental technician, with fewer years of training, who shall serve in dental clinics under the direct control and supervision of the dentist.
4. The Committee on the Training of Nurses is requested to enlarge its programme to include the training of dental nurses.
5. Unqualified dental practitioners shall be required to take a period of training and to pass a certain qualifying test.
6. Medical colleges shall be requested to add dental courses to their curricula.
7. The Minister of Education is requested to establish colleges of dentistry in Shanghai, Nanchang, and Canton.

Unfortunately the occupation of Nanking by the Japanese necessitated the withdrawal of the National Government to West China. The wartime urgencies and demands on the Government, together with the appointment of a new Minister of Education and a new Director of the National Health Administration, neither of whom had been in contact with dental education and practice development, kept the proposed dental legislation from receiving its due attention.

On March, 1939, certain proposals emphasizing some of the more urgent findings of the meeting

of the 1937 National Commission of Dental Education were presented to the Minister of Education. These proposals were made because evidence was accumulating to show that forces were at work undermining the desire of dental leaders that high dental standards be set up in China. It had been learned that steps were being taken to reduce the dentist to the status of low-grade dental practitioner in order to meet an immediate and specific need for large numbers of dental practitioners for the army. This was felt to be a short-sighted policy, likely to do irreparable harm to the practice of dentistry in a state-health programme and to the building-up of a group-practice personnel.

Also, the proposals sought to point out that in the process of organizing China's wartime and post-war educational and health programmes, dental education and dental practice should not be overlooked; that before any principles could be accepted deciding the pattern of the future dental educational system it was necessary that the whole question as to the best type of dental service for China's need should be thoroughly taken into consideration.

It was pointed out that dentistry in Western countries had developed through pragmatic methods, resulting in many ventures up blind alleys with a divergence from the main path of medical progress, resulting in too great a dependence on the mechanics of dental restorations. The hope was urged that no further steps be taken which might prove prejudicial to the development of a worthy national dental profession, or might bring about the repetition of the historically deplorable errors which have led Western dentistry into commercialism or lead to a separation of dentistry and medicine or to an over-emphasis on mechanical dentistry. Imitation is a sincere form of flattery; but, if what is imitated has passed its age of usefulness or has been outmoded by the progress of science, no good can accrue to the imitator. Present-day socialization of the luxuries of yesterday requires that dentistry should be organized to meet the health needs of the masses of the people. China should not import from abroad a system of dental education and dental practice which cannot answer the demands of a social programme based on the "Three People's Principles".

It was also pointed out that the people of China, both the educated and the unlettered, dread dental disease too little. They have not recognized the positive value of a disease-free mouth and of its necessity in the maintaining of a healthy body. For the good of the country, and in spite of themselves, the citizen's health must be protected. Emphasis

must be placed upon preventive dentistry and dental health education must be emphasised.

The 1937 National Commission of Dental Education recommended that dentistry should join with medicine in a national health service and that dental education should have as its objective the training of dental personnel to operate "group" dental service.

In order to promote the development of dental education and practice in China, the following personnel was suggested as necessary:

- (1) dental research workers
- (2) dental administrators
- (3) dental teachers
- (4) dental clinicians
- (5) dental technicians
- (6) dental nurses
- (7) dental dressers.

This dental personnel will enable dentistry to develop institutional clinics, and thus to care for both the rich and the poor.

These proposals made to the Ministry of Education provide the basis for a hoped-for increasing recognition of the aims and needs of an adequate dental programme for China.

Today a new stage in the progress of dental education seems to be coming. This is evidenced by the approach of the National Health Administration to the College of Medicine and Dentistry of the West China Union University and the Technical School of Dentistry of the National Central University asking them to co-operate in the education of the dental personnel necessary to establish group practice in dentistry.

It is hoped that this programme can be put into immediate effect with the generous assistance of the American Bureau for Medical Aid to China.

To be able to bring to fruition a plan for the educating of a complete dental personnel before the end of the war will definitely assure to China rapid development in dental education and practice and insure to her an adequate national, socialized dental health programme. Such service plans and aims to provide dental care for all classes of the people rather than the development of a luxury dental service available only to the rich. This is assuredly a vital requirement in this age, and for China. Progress is being made, but much more is yet to be accomplished, before the lineaments of the full pattern can be discerned.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

ON THE OBSERVED MAXIMA IN NUMBER AND FIELD-STRENGTH OF DISTANT ATMOSPHERICS DURING SUNRISE AND SUNSET PERIODS

It was known for a long time that there was some peculiarity observed in the number of atmospherics and in their field-strength values during the sunrise and the sunset periods. Eccles¹ observed a sunset minimum and other workers too at the time confirmed these observations. In his work on high frequency atmospherics, Potter² observed maxima both during the sunrise and the sunset periods. The preliminary investigations on distant atmospherics carried out on medium frequencies by Kameswar Rao³ and Ray⁴ in this laboratory showed an unmistakable maximum during the sunset period. A rapid fall in the field of the atmospherics was also observed immediately after the ground sunrise. Later observations, on very high radio frequencies by Innas Ali⁵ and on medium frequencies by Basak⁵ revealed in many cases maxima in the region of the ground sunrise and sunset times. Usually one maximum (and sometimes two maxima) was observed, some minutes before the ground sunrise time. One maximum was also observed some minutes after the ground sunset time. Occasionally another maximum appeared at the time of the ground sunset.*

The object of the present note is to give briefly a general explanation of the observed maxima in number and field-strength of the distant atmospherics before the ground sunrise and after the ground sunset in terms of the changes in the ionospheric conditions during the transition time from day to night or vice versa. For very long waves Namba⁶ suggested an explanation of the sunset and

sunrise phenomena. According to his view, the reflection at the ionized layer is *metallic* before sunset and *dielectric* after sunset and the sunrise and sunset effects are due to the change in the reflection characteristics of the layer. For high frequency channels this explanation cannot be valid. Potter also had attempted an explanation which is also not tenable in view of the present knowledge of the ionosphere. We offer here an explanation in the light of our experimental results:—

It is now well known that the E-layer ionization gradually falls during the night and attains a minimum value in the small hours of the morning. The ionization then begins to increase and the increase is rather rapid during the sunrise period. Before the ionization minimum is attained, it is evident there is a gradual decrease in attenuation due to gradually diminishing collision-frequency in the layer, causing thereby a gradual increase in the intensity of the downcoming waves, till there is a peak when the E-layer ionization is minimum. After the ionization minimum, the ionization rapidly increases during the sunrise period. This would cause a large fall in the intensity of the downcoming waves due to two causes, viz., (1) higher attenuation due to larger collision frequency in the layer and (2) larger deviation of the rays due to higher electron density. A maximum is therefore expected during the sunrise period. Before the sunset time, too, it is known that there is a gradual decrease in the E-layer ionization. Thus there would be a gradual rise in the intensity of the downcoming waves due to a continuous fall in ionospheric absorption or attenuation. At the sunset time when the ionizing solar rays are suddenly withdrawn, there would be a sudden and a perceptible decrease in electron density of the layer, so that the downcoming waves originally coming from the distant source of atmospherics would be much less deviated and would necessarily fail to reach the receiving point. At this point of the withdrawal of the ionizing solar rays, the intensity would therefore fall in spite of small attenua-

* Venkata Rao Telang (*Proc. Ind. Sci. Cong.*, Benares, 1931, Paper No. 20) reported recently about (i) a sharp needle-shaped peak, (ii) a sudden collapse of the field, (iii) a collapse followed by a partial recovery, (iv) a sharp run to negative with equally sudden recovery, in his records of the atmospheric electric field during the sunset period. He explained the instability as due to sudden changes in electrical conductivity, humidity, temperature, etc., of the atmosphere during the transition period from day to night.

tion. Subsequently, however, the gradually decreasing attenuation would assert itself and the intensity would increase. This explains the sunset maximum.

The work on the early morning increase of the E-layer ionization by Mitra and his associates⁷ has definitely shown that the ionization begins to increase *not* when the early morning solar rays strike the E-layer by grazing the surface of the earth *but* when the rays strike the layer by grazing the top of the ozonosphere at a height of 35 km. from the earth's surface. The sun's rays in order to produce ionization in the E-layer should evidently pass over the ozone region so as not to have its shorter wavelengths absorbed by ozone. Let the source of the atmospheric disturbance and the receiving point be represented in the East-West plane by S and R respectively both being on the surface of the earth. Then the damped electromagnetic pulse of the

would be earlier or later than the ground sunrise at R, according as $\phi >$ or $< \theta/2$. It can also be shown that the difference between the instant of ground sunrise at the receiving point and the instant when the ionization begins to increase in the region A would be given by—

$$\Delta T = 4(\phi \mp \theta/2) = (4\phi \mp 2\theta) \text{ minutes} \dots (1)$$

The signs of the difference and summation refer respectively to the cases when the receiving point R is to the east and to the west of the noise source S.

From these considerations it can thus be said that maximum in the strength of the distant atmospherics would appear $(4\phi \mp 2\theta)$ minutes *before* the ground sunrise provided $\phi > \theta/2$. When, however, $\phi < \theta/2$, the maximum would appear $(2\theta \mp 4\phi)$ minutes *after* the ground sunrise.

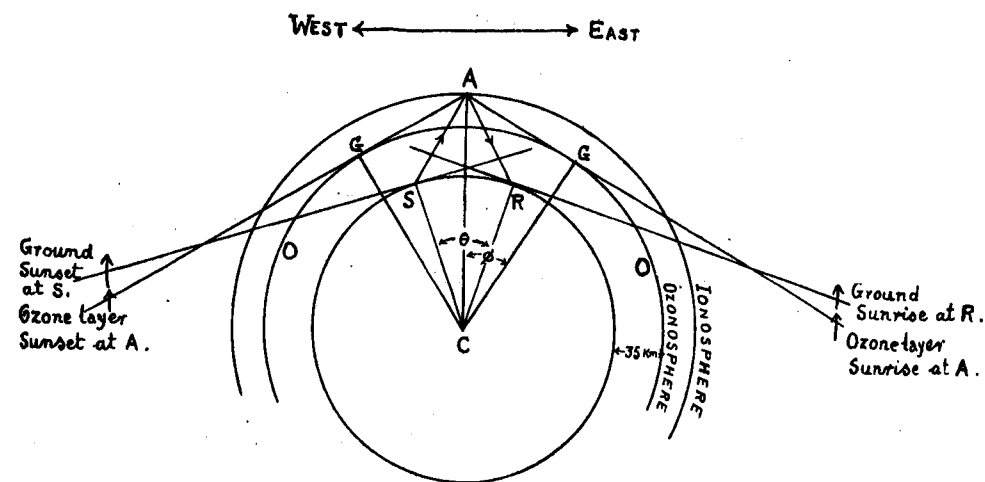


FIG. 1.

atmospherics which contains all the frequencies of the Fourier series would reach the receiving point after reflection at A (Fig. 1) in the ionospheric layer. It is evident from the diagram that the ionization in the region A would begin to increase only when the sun's rays would pass over the tangent from A to the top of the ozone layer represented by OO. The ground sunrise or sunset at the receiving point is of course easily determined by drawing a tangent plane to the earth's surface at the receiving site R. From A where the ionospheric reflection takes place, let us now draw a tangent AG touching the ozone layer at G. Denoting the angular distance between the noise source and the receiving point by θ and the angle ACG by ϕ , it can be easily seen that the instant when the sun's rays would begin to produce ionization in the region A by grazing the top of the ozone layer

Similar arguments would apply to the case of the sunset. It should be noted that the sunset maximum would appear *after* the ground sunset, provided $\phi > \theta/2$, whereas under the same condition the sunrise maximum would appear *before* the ground sunrise.

The double sunrise maxima which were observed at times can be explained in terms of the two layers E and F. The location of the source of atmospherics can also be indicated according to this view. The detailed explanation with an examination of all our experimental results on the subject will be published elsewhere.

The maximum which was occasionally observed at the time of the ground sunset is to be attributed to the sudden fall in temperature and electrical

conductivity of the atmosphere and to the rise in humidity and changes in the other meteorological conditions during the sunset period.

S. R. KHASTGIR

Physics Department,
Dacca University,
Dacca, 16-8-1942.

- ¹ Eccles, Handbook of Wireless Telegraphy and Telephony, 176, 1918.
² Potter, Proc. I. R. E., 19, 1731, 1931.
³ Khastgir and Rao, Proc. I. R. E., 28, 511, 1940.
⁴ Khastgir and Ray, SCIENCE AND CULTURE, 5, 772, 1940.
⁵ Khastgir & Innas Ali and Khastgir and Basak (Communicated for publication) Vide abstracts in Proc. Ind. Sci. Cong., 1941, papers Nos. 14 and 15.
⁶ Namba, Proc. I. R. E., 21, 238, 1933.
⁷ Mitra, SCIENCE AND CULTURE, 3, 496, 1938.

ON THE SIGNAL MAXIMUM DURING THE SUNSET PERIOD

The maxima in number and field strength of the distant atmospherics observed *before* the ground sunrise and *after* the ground sunset have been explained by one of us as due to the changes in the ionospheric conditions during the transition period, in early morning and late evening. Following up the conclusion of Mitra¹ from his work on the early morning increase of the E-layer ionization, it can be said that the change in the ionospheric conditions begins to take place when the ionizing solar rays in early morning just strike the E-layer by grazing the top of the ozonosphere which is at a height of 35 Km. from the earth's surface. Similar statement could also be made for the sunset time;—the change begins when the solar rays just begin to pass into the ozone layer and the shorter wavelengths responsible for ionization are absorbed. Supposing the disturbance from a source of atmospherics on or near the earth's surface reaches the distant receiving point after reflection from the ionosphere, it has already been shown that the difference between the instant of ground sunrise or sunset and the instant when the noise maximum is observed is given by

$\Delta T = (4\phi \mp 2\theta)$ minutes . . (1), where the angular distance between the noise-source and the receiving point with reference to the centre of the earth is denoted by θ and the angle contained between the two tangents on either side of the ozonosphere drawn from the point where the ionospheric reflection takes place is given by $(180^\circ - 2\phi)$. The source of atmos-

pherics, the receiving point and the point where ionospheric reflection takes place are here supposed in the East-West plane. The upper difference sign in (1) is to be used when the receiving point is to the east of the noise source and the lower positive sign, when the receiving point is to the west. According to this idea, when $\phi > \theta/2$, the sunrise and the sunset maxima are expected $(4 \mp 2\theta)$ mins. before and after the ground sunrise and sunset respectively at the receiving point. When however $\phi < \theta/2$, i.e., when the noise source is *very* distant, the sunrise and the sunset maxima should appear $(2\theta \pm 4\phi)$ mins. after the ground sunrise and before the ground sunset respectively.

If this view of the cause of the sunrise and the sunset maxima is correct, we would expect similar effects in the signal strength observations of a distant transmitter at the time of ground sunrise and sunset at the receiving site. We accordingly chose the Calcutta short wave station (4840 Kc., $\lambda = 61.98$ m.) and continuous observations of the signal current in the anode circuit of the detector valve of a three-valve receiver were taken for some days during the evening hours, well covering the sunset period. In Fig. 1 are shown typical curves for three different days showing galvanometer deflections due to the signal at short-time intervals of Dacca time during the sunset period. A distinct maximum is evident in each of the three curves. In Table I are given the times of occurrence of the signal maximum *after* the ground sunset for the three days:—

Table I

No.	Dates of observations	Times of occurrence of signal maximum after ground sunset	Ground Sunset times
1	3-2-41	20 min. 27 sec.	17 hr. 43' 33"
2	4-2-41	21 min. 32 sec.	17 hr. 44' 13"
3	17-3-41	23 min. 19 sec.	18 hr. 5' 11"

The time of occurrence of the sunset maximum can also be computed according to (1). The computation has been made from the following data:

Radius of the earth = 6371 Km.

Reflection height in the E-layer = 80 Km.
from the surface of the earth

Top of the ozone layer = 35 Km.
from the earth's surface

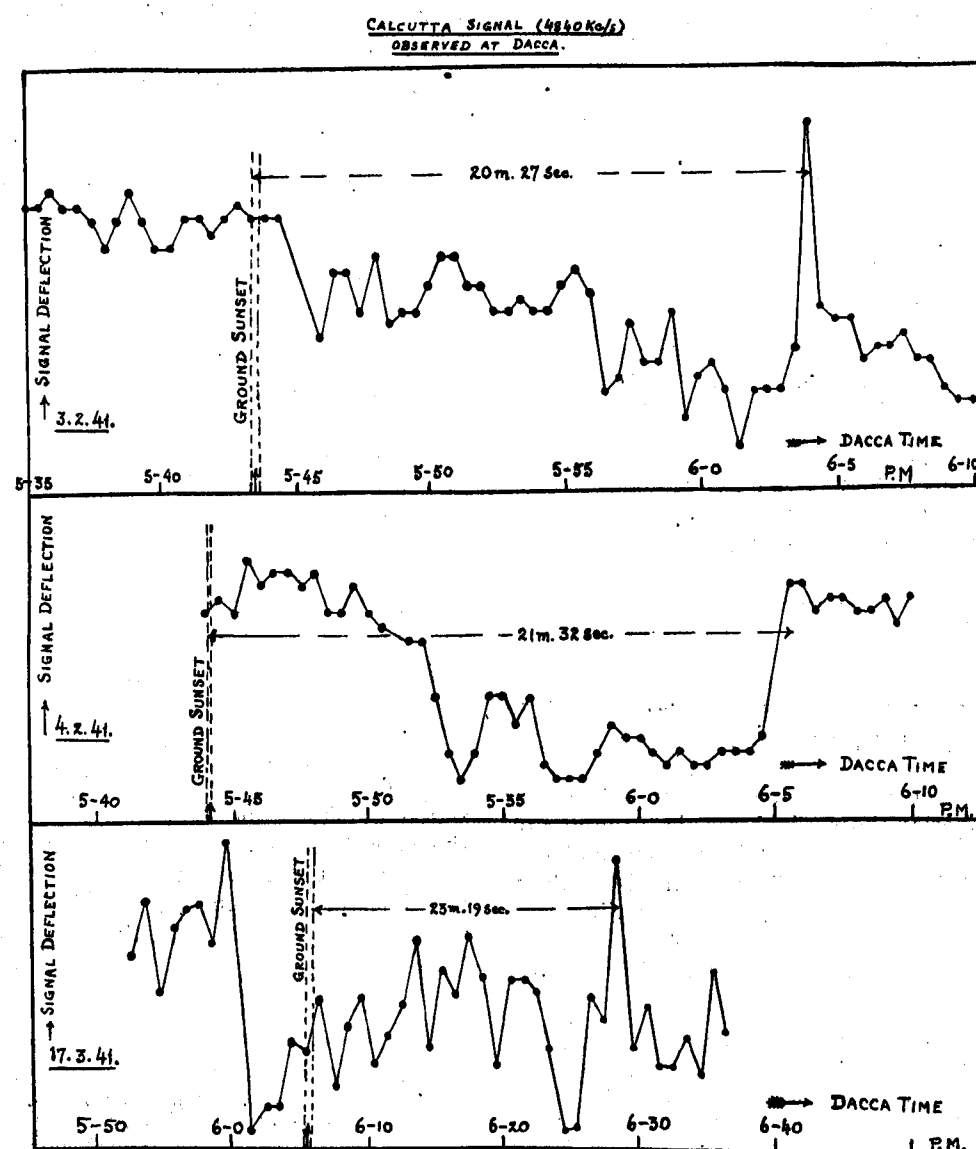


FIG. 1

With these values, ϕ comes out to be $60^\circ 9'$. Now since the difference between Calcutta and Dacca times is 8 mins., the angular distance θ between Calcutta and Dacca is $2^\circ 0'$. The signal maximum is therefore expected at $(4\phi - 2\theta)$ min. i.e., 23 min. 36 sec. after the ground sunset. The computed time is thus in good agreement with the observed time of occurrence of the signal maximum after the ground sunset.

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Dacca University,
Dacca, 18-8-1942.

S. R. KHASTGIR
S. N. MAZUMDAR

¹ Mitra, SCIENCE AND CULTURE, 3, 498, 1938.

ON BIVARIATE CORRELATION SURFACES

Correlation as conceived in Statistics is a measure which determines the importance of common causes effecting two characters. The Product moment correlation, as defined by K. Pearson has a special significance in the case where the regressions are linear. Consistent with the above idea, if we define the characters X and Y as

$$X = f(x_1, x_2, \dots, x_k, y_1, y_2, \dots, y_l) \\ Y = \phi(x_1, x_2, \dots, x_k, \eta_1, \eta_2, \dots, \eta_m)$$

where the variables, $x_1, x_2, \dots, x_k$ correspond to the common causes producing X , Y , by certain opera-

tional procedures. Then, by knowing the distribution of—

x 's, y 's and η 's.

we can obtain, the distribution of X and Y , which in general gives a correlated bivariate surface.

The general bivariate Gaussian surface is got when the distribution of the variates is taken as the univariate normal distribution.

In a bivariate binomial distribution the Probability of N_1 successes of one kind and N_2 successes of another kind is given by the coefficient of $x^{N_1} y^{N_2}$ in

$$(q + px)^k (q + px)^l (q + py)^m.$$

The Marginal distributions are binomial.

In a bivariate Poisson distribution, the marginal distributions are Poisson, and the Probability of N_1 successes of one kind and N_2 successes of another kind is given by the coefficient $x^{N_1} y^{N_2}$ in

$$e^{-p(k+l+m)} e^{p(lx+kxy+my)}.$$

In a similar manner several other distributions have been found. If $\phi(t)$ is the moment generating function of any one of the variables either of the conditions of homoscedasticity or equality of coefficient of variation demands

$$a\phi'^2 + b\phi'\phi'' + c\phi^2 = 0$$

where a, b, c are suitable constants. Some of the solutions of this obtained under certain conditions have been used to find out some bivariate surfaces.

A more general system of surfaces satisfying the conditions of Linear regression and either equality of coefficient of variation or homoscedasticity has been obtained by an alternative procedure.

Reserving the mathematical set up for an elaborate paper, some of the results obtained are given below.

If the marginal distributions are $G(x)$ and $F(y)$ then the general bivariate surface, in which the lines of regressions are linear is given by

$$\text{const} \cdot G(x) F(y) \{1 \pm \rho H_1(x) H_1(y)\} + I_2(x, y) \\ \text{where } H_i(t) \text{ is the } i\text{th Hermite Polynomial}$$

$$I_k(x, y) = \left(\frac{1}{2\pi}\right)^2 \iint e^{-it_1x - it_2y} \\ [\sum_{r>k} \sum_{s>k} a_{rs} t_1^r t_2^s] dt_1 dt_2$$

and ρ is the correlation between x and y .

The further conditions for homoscedasticity or common coefficient of variation under the assumptions made require that the marginal distributions should be symmetrical.

If $G(x)$ and $F(y)$ are the marginal distributions then the general bivariate surface in which linearity of regression and homoscedasticity are satisfied is given by

$$\text{Const } G(x) F(y) \{1 \pm \rho H_1(x) H_1(y) + \frac{\rho^2}{a_4 - 1} \\ H_2(x) H_2(y)\} + I_2(xy)$$

where a_4 is the common 4th moment for marginal distributions.

If we replace the condition of homoscedasticity by the condition of equal coefficient of variation the general bivariate surface takes the form

$$\text{Const } G(x) F(y) \{1 + \rho H_1(x) H_1(y) + \\ H_2(x) H_2(y)\} + I_2(xy)$$

In all the given surfaces the variation of any marginal distribution is taken as unity and the mean at the origin.

The bivariate normal surface when deduced from the above comes out in the form given by Mehler¹.

$$\frac{1}{2\pi} \exp\{-\frac{1}{2}(x^2 + y^2)\} [1 + \frac{\rho}{1!} H_1(x) H_1(y) + \frac{\rho^2}{2!} \\ H_2(x) H_2(y) + \dots]$$

In this the marginal distributions are normal, and the regressions are linear and homoscedasticity is satisfied if $a = \rho$ and equality of coefficient of variation if $a = 1$.

The results obtained above are capable of easy generalisation to any number of variables and it is hoped to give a systematic treatment in an elaborate paper.

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Calcutta, 5-9-1942.

¹ Mehler, G., Jour. fur. Math., 66, 174, 1866.

ISOLATION OF CHOLINE-ESTERASE FROM COBRA VENOM (NAJA TRIPUDIANS)

The existence of the enzyme choline-esterase was first predicted by Dale,¹ Loewi² as well as Loewi and Navratil³ while working with isolated frog's heart, demonstrated experimentally the existence of an agent, likely to be an enzyme which destroyed the effect of a substance possibly acetylcholine formed or liberated during the stimulation of the vagus. Stedman *et al.*⁴ confirmed the findings of these previous workers to the effect that the aforesaid agent, found also to be present in the various body fluids of animal, is enzymic in character, an esterase which, specifically, hydrolyses the esters of choline and accordingly he, for the first time, christened it as choline-esterase. Stedman *et al.*⁵ then tried to purify it from normal horse serum and succeeded in obtaining a product which is purer than the original to some extent. Chopra and Iyenger⁷ simultaneously with Ghosh, Dutt and Chaudhuri⁸ detected the presence of choline-esterase in considerable amount in the venoms of the colubridae types of snakes. Chopra *et al.* suggested that it might be identical with the neurotoxin present in the crude venoms, but Ghosh *et al.* conclusively proved that the enzyme is absolutely different in nature and properties from those of the neurotoxin. Attempts made to isolate this enzyme in a pure form are given below.

2 gms. of cobra venom are dissolved in 100 c.c. of water adjusted at pH 6.0 and to it is added 22.0 gms. of solid Na_2SO_4 (anhydrous). The mixture is maintained at 35°C for 15 minutes. The precipitate is filtered and dissolved in 100 c.c. of water. After adjusting at pH 6.0, it is again precipitated with 22.0 gms. of solid Na_2SO_4 and then kept at 35°C for 15 minutes. The precipitate is dissolved again in 100 c.c. of water, pH being maintained at 6.0 and is precipitated once more with 22.0 gms. of solid Na_2SO_4 at 35°C. The precipitate which contains most of the choline-esterase is dissolved in 40 c.c. of water adjusted at pH 6.0, treated with 60 c.c. of saturated $(\text{NH}_4)_2\text{SO}_4$ solution and kept at 0°C for 30 minutes. The precipitate is filtered, dissolved in 40 c.c. of water adjusted at pH 4.0 and treated with 26 c.c. of saturated $(\text{NH}_4)_2\text{SO}_4$ solution and kept at 0°C for 30 minutes. It is filtered and the filtrate containing the greater part of the choline-esterase is treated with 34 c.c. of saturated $(\text{NH}_4)_2\text{SO}_4$ solution and kept at 0°C for 30 minutes. The precipitate is again dissolved in 10 c.c. of water adjusted at pH 6.0, cooled to 0°C and is mixed gradually with 5 c.c. of saturated $(\text{NH}_4)_2\text{SO}_4$ solution when a slight permanent turbidity appears. It is kept for 4 hours at 0°C and then the precipitate centrifuged off. The precipitate contains 24 per cent of the choline-esterase activity with a protein content of 1.11 per cent with respect to crude

venom. The iso-electric point of this pure enzyme is determined and found to be in the neighbourhood of pH 5.9. Though it is not obtained in a homogeneous crystalline form, nevertheless it is completely free from the other active principles present in crude cobra venom.

My grateful thanks are due to Dr B. N. Ghosh, D.Sc. for helpful suggestions and for facilities offered to carry out the work. I would also thank the authorities of the Bengal Immunity Company for granting a research scholarship.

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¹ Dale—*J. Pharm. Exptl. Ther.*, 6, 147, 1914-15.

² Loewi—*Pfluger's Arch.*, 189, 230, 1921.

³ Loewi and Navratil—*Pfluger's Arch.*, 214, 678, 1926.

⁴ Stedman *et al.*, *Biochem. J.*, 26, 2056, 1932.

⁵ ————*J. Physiol.*, 89, 37, 19337.

⁶ ————*Biochem. J.*, 29, 2563, 1935.

⁷ Chopra and Iyenger—*Current Science*, 7, 53, 1938.

⁸ Ghosh, Dutt and Chaudhuri—*J. Ind. Chem. Soc.*, 16, 75, 1939.

OBJECTIVE MEASUREMENTS OF SPECTRAL INTENSITIES

Photographic photometry has so far remained the only accurate method of estimating the intensities

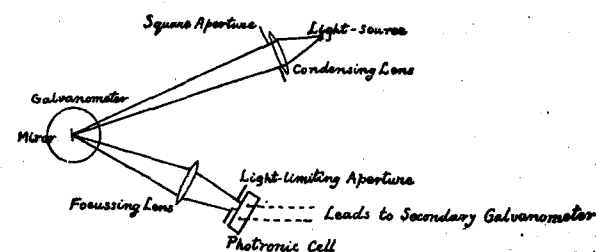


FIG. 1 (a) The original Barnes-Matossi Amplifier.

of spectral lines on a relative scale. It is with the object of verifying these results that we thought of setting up an apparatus for the objective measurements of spectral intensities. In these attempts, we have evolved an arrangement incorporating the

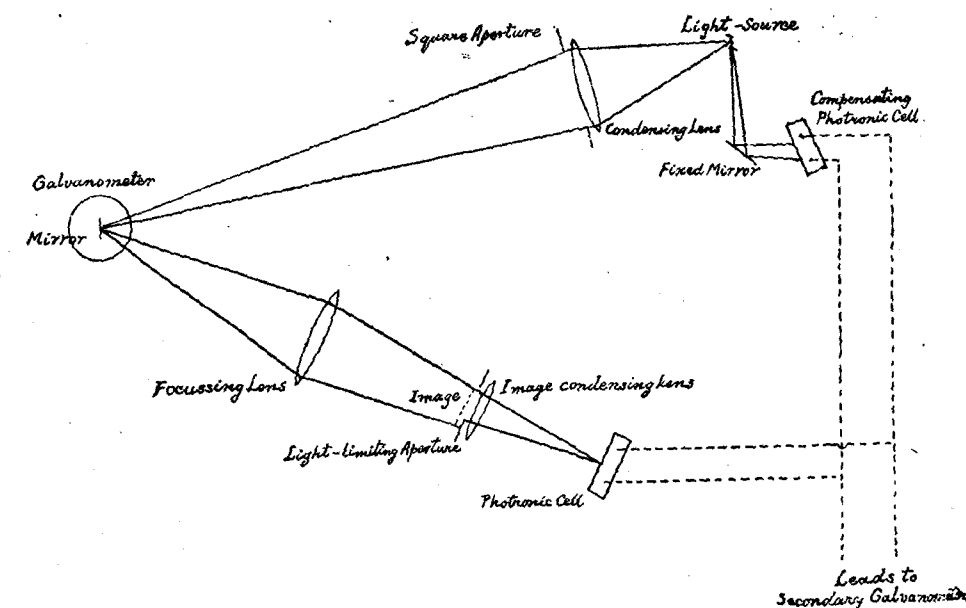


FIG. 1 (b) The Improved Arrangement.

Barnes-Matossi (1932) type photoelectric amplifier, the receiver being a Weston photonic cell. This type of amplifier has been used by Bergmann¹, Matossi², Barnes and Matossi³ and Gerschowitz and Wilson⁴. With certain improvements it has been found suitable for our purpose also. The improvements consist of (1) the avoidance of the movement of the light image on the photocell surface, to eliminate errors due to areal variations of sensitivity over the surface, and (2) the connection of an extra photocell in parallel-opposition to the excited photocell, in order to compensate for momentary fluctuations of the exciter-lamp intensity. In the diagram, the original arrangement of Barnes and Matossi has been shown in the upper part (Fig. 1a), while the improvements incorporated in the arrangement have been shown in the lower part (Fig. 1b). Amplifying factors up to 1700 have been possible by this method, but so far factors of 500 and 80 have only been used due to the difficulty of making the system vibration-free. A detailed account of the direct measurements, by this arrangement, of spectral intensity distributions, will be published elsewhere.

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¹ Bergmann, *Physik. Zeit.*, 32, 688, 1931.

² Matossi, *Physik. Zeit.*, 32, 690, 1931.

³ Barnes and Matossi, *Zeit. f. Phys.*, 76, 24, 1932.

⁴ Gerschowitz and Wilson, *Jour. Chem. Phys.*, 6, 197, 1938.

METALLIC DROPS

Much work¹ has already been done on the Liquid Drops floating on the same liquid surface by the author and others in the past. But little has been done on the metallic drops floating on the surface of the same metal, for metals are not available in the form of liquid at ordinary temperatures except mercury. When the metals are heated to the liquid form in the furnaces they do also tend to exhibit the same phenomenon under favourable conditions though the life of the drops so formed is very small due to their heavy weight. But mercury—the only metal being liquid at room temperatures—exhibits this phenomenon very well under suitable conditions.

Ordinarily as already stated in one² of the previous papers, mercury, solutions of inorganic salts in water, inorganic acids, and their water solutions, glycerine, saturated sugar solutions, form neither the primary³ nor the secondary⁴ drops. But recently it has been observed by the author that the secondary drops of mercury (metallic drops) can be easily formed on the surface of mercury having average life of about 5–6 seconds and diameter about 1–2 mms. when the medium surrounding the drops is some light liquid. Sometimes bigger drops are formed by coalescence of the tiny ones and last for fairly long time, even up to five minutes. But no such drops can be formed when the medium surrounding the drops is air or any other gas.

This phenomenon is very well observed when the surrounding medium for the mercury drops is acidulated water and is often noticed when purifying commercial mercury with dilute nitric acid solution with a separating funnel. The best results are obtained when the height of fall is about 15 cms. and mother liquid has a layer of dilute nitric acid about 5 cms. thick above it in a flat and shallow vessel.

These observations are in accordance with the mathematical theory⁵ of the author regarding the phenomenon of the liquid drops floating on the same liquid surface.

The author begs to acknowledge his best thanks to His Highness' Government, Patiala, for giving all facilities to carry out the investigation.

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Mahendra College, Patiala, 7-8-1942. L. D. MAHAJAN

- ¹ L. D. Mahajan, "Liquid Drops", *Phil. Mag.*, 7, 1929; *Nature*, 126, 761, 1930; 127, 70, 1931; *Phil. Mag.*, 10, 383-386, 1930; *Current Science*, 1, 100, 1932; 1, 128, 1932; 1, 162, 1932; *Zeitschrift für Physik*, Berlin, 81, 605-610, 1933; 79, 389-393, 1932; 90, 663-666, 1934; 84, 676, 1933; *Kolloid-Zeitschrift*, Leipzig, 69, 16-21, 1934; 66, 22-23, 1934; 65, 20-23, 1933; *Ind. J. Physics*, 13, 299-304, 1939.
- ² L. D. Mahajan, J. B. Seth, C. Anand, "Liquid Drops on the same Liquid Surface", *Phil. Mag.*, London, 7, 247-253, 1929.
- ³ *Ibid.*
- ⁴ *Ibid.*
- ⁵ L. D. Mahajan, "Liquid Drops". *Ind. J. Phys.*, 13, 299-304, 1939.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

DECEMBER, 1942

No. 6

Science and Scientists During the War and After

THE supreme role which science and scientists are playing in this total war and are destined to play in connection with the much talked-of post war reconstruction has during recent months formed an important subject of discussion by eminent scientists on either side of the Atlantic. Demand has been made on all branches of science—physics, chemistry, biology, mathematics, and psychology in ever increasing intensity. In course of presenting the first Richtmyer Memorial Lecture* before the American Association of Physics Teachers and the American Physical Society at Princeton, Prof. A. H. Compton, a distinguished physicist said, "I believe the statement that in this war a hundred physicists are worth a million soldiers". In fact, physicists have now come to be reckoned as a vital factor and a potential source of power in this total War, whose training should be undertaken with that precision and planning which mark the training of the personnel of air force or of the panzer divisions. Perhaps what Prof. Compton said about physics is equally true of other branches of science.

The need for planned efforts in training and turning out the right type of scientists is increasingly

becoming obvious. Any progressive country, as the recent trends of facts unmistakably indicate, can henceforward hardly afford to follow the insufficient and wasteful policy of *laissez faire* in producing scientists and allow the scientists to indulge in monastic seclusion in their pursuit of pure research and new knowledge. This must not lead any one to think that, in so saying, we wish to minimise the supreme value of pure research. During the last Great War when the need for technological research was most keenly felt in England, Sir Joseph Thomson, doyen of the British Scientists urged at the deputation to the Lord President that

"Pure science is the seed of applied science, and . . . to neglect pure science in a thing of this kind would be like spending a very large amount on manuring and ploughing the land and then to omit the sowing of any seed".

Commenting on this fitting analogy the report of the Advisory Council remarks,

"We accept the analogy, and we trust that the absence of extended reference to pure science in this report will not be taken as indicating our lack of appreciation of its importance."†

† Report of the Advisory Council of the Board of Education, 1916-17.

* SCIENCE AND CULTURE, Vol. VIII, No. 3.

It need hardly be said that this is precisely also our view. It will be far from the object of such planned efforts to encroach in any way upon the freedom of scientists engaged in pure research and in long-term research activities promising results of a far-reaching character. But there is an undisputed need of co-ordinating scientific work in a particular branch and revising thoroughly the old methods of teaching to secure the best utilisation of the country's wealth of scientists in the service of the State during the war and in the period of reconstruction likely to follow the war. The universities and similar other training centres are incapable, by themselves, of fulfilling this need which can only be met by proper State intervention and a thorough change of outlook. We propose to illustrate our point of view by taking a single branch of science *viz.*, Physics.

The problem as to how best a steady flow of the right type of physicists can be maintained and utilised in the services of the State during and after the war formed the subject of a lecture delivered by Sir Lawrence Bragg, Cavendish Professor of Physics at Cambridge at the Royal Institute. Sir Lawrence seems hardly satisfied with the state of affairs that obtains in Britain today with regard to the teaching and utilisation of physicists, though there may be impression in this country that Great Britain is making the best use of science and the scientists in formulating plans for victory and reconstruction after the war. The existence of such bodies as the Advisory Council of the Department of Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council and the Aeronautical Research Committee, created before the war, and the Civil Defence Research Committee and the Council for Scientific Research and Technical Development, created as war-time emergencies has helped to engender this feeling of complacency. But Bragg points out that these bodies are not always truly representative of the scientific men and have therefore lost much of their utility and significance through the interference of undesirable non-scientific elements. That is why recently a deputation from the Parliamentary and Scientific Committee*, including Sir Lawrence Bragg among other representative scientists, laid emphasis on the creation of a full-time Scientific and Technical Joint Board to secure the fullest strategic utilisation of scientific man-power and resources.

In course of his discourse Sir Lawrence took stock of the existing practices in the teaching of physics, conducting fundamental research, appointing physicists and making the knowledge of physics available to industry and for the service of the State pointing out their insufficiency and drawbacks and the direction in which the remedies should be sought. He naturally depended in his criticisms and suggestions mainly on his experiences gathered through his long and fruitful connection with universities though he did not infrequently refer to problems not directly concerning the universities. There is a certain amount of similarity in the nature of the problems of our Universities and Research Institutions with those of Britain. Though at first it may come as a surprise to many, the reason is not far to seek. This is due to our closely following Britain in matters of scientific education and research. The situation is however much worse in this country as the scientists have hardly been given any real responsibility. None the less the views of Sir Lawrence Bragg may help us to see our own problems.

A CENSUS OF PHYSICISTS

Any attempt at co-ordination and planned efforts in making the best use of scientists in general and of physicists in particular must reckon the supreme necessity of having a census of scientists. Even in Great Britain there was no move in this direction till the outbreak of the present war when the pressure of events and the growing feeling about the importance of the technique of science for the war made such a census inevitable. The Central Register initiated by the Royal Society now keeps a record, more or less complete and up-to-date, of the names of all scientists in Great Britain with careers, qualifications and experience. The definition of the term 'scientist' is supposed to include "all who have received higher scientific education, have taken up a post in industry, government service or the universities, and other educational institutions and have continued to use their scientific knowledge for research or administration", as Sir Bragg puts it.* The Register reveals that Britain started with a total force of 12,000 scientists, of whom 1,200 were physicists, when the present war broke out. For Great Britain with a population of 45 millions and an average working life of thirty years the rate of

production of physicists is approximately one per million population in a year *i.e.* about 40 per year.

UNIVERSITIES VS. RESEARCH INSTITUTES

The last Great War led to the establishment of a number of industrial research associations and laboratories all over the world, partially or wholly supported by the respective governments, which have today come to play a very significant part in the national economy of a country. We refer, for instance, to the Department of Scientific and Industrial Research, the Agricultural Research Council and similar other associations in England, and to the Board of Scientific and Industrial Research (B. S. I. R.) created in India much after its British prototype, the D. S. I. R. These bodies are interested in the problems of particular industries which they have set themselves to develop and therefore have a rather limited range of research activities. The research programme of these associations differs radically from that of the universities in the fact that, unlike the universities, these industrial research associations do not act from an incentive and urge for adding to the total store of human knowledge, but function under the great responsibility of developing a new process or making a fresh industrial application of pure science, calculated to be of economic value. The merit of these associations is that they are new instances of organised scientific activities in the services of the State. They are still in the experimental state but have achieved considerable success.

Fundamental research in all branches of science in Great Britain and in most other countries is generally conducted in the universities and in the research institutes, either under private or government management, and in certain scientific services. Research Institutes are, however, of comparatively recent development, and in certain quarters it is thought that such institutes offer better facilities for certain types of research, *viz.*, those relating to standardisation, large-scale industrial application, national service (*e.g.*, radio and meteorology) and sometimes even some fundamental researches involving expenditure which are beyond the resources of a university laboratory. And yet these very research institutes have in recent years come to be severely criticised in view of their tendency towards fossilisation. In fact, many older institutes with a good

record of work to their credit have succumbed to this process. Sir Lawrence attributed such fossilisation to, (1) the complete divorce of teaching from these research institutes and, (2) the permanency of the tenure of service of the staff of research workers employed in such institutes. They lack the healthy flow of young freshers endowed with the enthusiasm of youth and equipped with up-to-date modes of thinking which impart a dynamic character to researches conducted in a first class university. This is further enhanced by constant contact with and exchange of ideas among men engaged in widely different fields of research. Said Prof. Bragg:—

"Fossilisation is seen at its worst in the laboratories where there is no such flow, where members of the research staff enter as young men and continue to do work of much the same character throughout their lives, and where advancement is rather by seniority than merit."

Accumulation of tradition and perfection of a particular technique appear to be the most important and distinctive features of such institutes which, in the opinion of Sir Lawrence, can best serve their purpose "as a place open to all for short periods of intense work", with "its main population a changing one". Unlike England, the problem of research institutes has not yet become a very pressing one in this country where the number of such institutes is insignificantly small and where research activities were not undertaken in right earnest till the beginning of the present century. Still we may do well to take a note of warning in the remark of Prof. Bragg as, we are afraid that some of the new research institutes have been brought into existence fully laden with germs of fossilisation.

PHYSICS IN INDUSTRY

The necessity of a happy marriage of physics with industry was not realised in Britain till the last World War, and has only been partially achieved through the pressing needs of the time. In our country we have only recently begun to understand in a dim way the significance of such a happy blending. Even in those countries where the relation between physics and industry has been established, for instance in Great Britain, university teaching is increasingly tending to be too academic and is failing to breed the right type of physicists who can take their place in an industry without feeling foreign. Sir Lawrence thinks that the incentive of scholar-

* Vide Notes and News section of the current issue.

* Italics are ours.—Ed.

ships and the absence of any definite programme of maintaining a close connection of the teaching staff and the students with the technologists coupled with the general impression that a handsome university degree in science should by itself guarantee a safe job with immediate returns have been mainly responsible for this unfortunate state of affairs. He has the following suggestions to make, which are expected to generate an industrial outlook and enable the universities to function as effective breeding centres of future physicists in whose hands industrial and technological advancement will make rapid strides:—

(a) The transition from the schools to the universities should be interrupted by a period of practical training, covering six months or more, in an industrial concern. The general excellence of American students in practical science is largely due to their utilisation of long summer vacation for practical training.

(b) The example of medical schools and colleges where an important part of teaching is conducted by practising physicians and surgeons with specialised knowledge, in addition to general teaching by the permanent staff, should be followed. The leading technologists should be invited to deliver courses of lectures to acquaint the teachers and the students with principal industrial developments. Similar arrangements of special lectures should be made in the universities to present before the industrialists and technologists a short review of recent advances in pure and fundamental research to help them maintain a stimulating breadth of vision.

(c) The recent tendency of industrial research being partly conducted in the universities should be further encouraged as it offers an excellent opportunity of bridging the gap between pure and technological research and helps to ventilate the purely academic atmosphere of the university. As far as possible such research should be consistent with the more important fundamental research of the universities. The spirit of enquiry and search after truth and new knowledge embodied in fundamental research should be, however, given full freedom and scope and under no circumstances interfered with.

ADMINISTRATION IN RESEARCH

The importance of the right type of administration in research has been emphasised from time to

time in our editorial columns.* The preponderance of red-tapism and Civil Service mentality in the matter of administration in research have made things bad beyond conception. This view is now widely held by the leading scientific men of Great Britain and elsewhere, and is reflected in the following passage:—

"Some change in the methods by which Government scientific research is administered and financed appears to be very desirable. * * * * An apparatus which is well designed for the administration and financial control of other classes of activity is inappropriate when it is applied to scientific research and development".

Sir Lawrence believes that under the present circumstances the constitution of the universities is such as to favour most such research activities. He insists on a research unit of six to twelve scientists capable of independent research with a few assistants. Such a unit should be provided with all the facilities of a first-class workshop and considerable freedom of expenditure. It is his experience that research progresses very smoothly under these conditions and promises best results.

While we endorse many of the views and suggestions put forward by Professor Bragg in the hope of a better organisation of scientific research and utilisation of scientists in the service of the community these are by no means the last words on this extremely difficult and important problem. Like a typical Englishman he has accepted the existing structure of administration in scientific teaching and research in Great Britain and proposed some improvements upon it with a view to making the present system function more efficiently. He has avoided any fundamental enquiry into the possibilities of an alternative structure more suited to the needs of the times. So long as the political philosophy of any country is based on capitalism and exploitation in some form or other, or imperialism in the case of dependencies, any reorganisation of science without profoundly altering the set structure must be directly or indirectly under the influence of the vested interests of the ruling class, no matter how fine and noble the declared wishes of official spokesmen might superficially appear. The social benefits of science will not materialise to the fullest degree and science will be compelled to look after vested interests rather than freely serve the human society as a whole.

* Science and War Effort in Great Britain and India—Vol. VIII, No. 3.

It is pre-eminently science and technology which largely determine the nature of social relations. Scientists and technologists should not be at the back and call of unprogressive politicians but should assume responsibility themselves. Administration by men trained in ancient and modern history, literature, rhetoric and economics, who are not supposed to require any training in science is characteristic of a theory of Government developed and successfully

translated into practice in a pre-technological era. Transition from a pre-technological to a technological era without any corresponding change in governmental philosophy has led to anomalies and discrepancies which cannot be removed by piecemeal methods or by any policy of reconciliation. The future of civilisation seems to depend on the extent to which the conservative human mind today is prepared to accept such revolutionary changes.

THE VALUES OF SCIENCES TO HUMANITY

The consistent object of pure scientific research is to establish a coherent body of objective knowledge and explanatory theory over the whole range of natural phenomena. In the course of this work new phenomena come to light, often by chance, and some of these can be exploited industrially. At the same time new principles are established which give rational direction and lead to crucial improvements in industrial processes that had hitherto been purely empirical. It is naturally physics and chemistry that have had the most extensive use in the field of technology, because industrial processes deal mainly with dead material. But biology has made important contributions to the two great practical arts of medicine and agriculture, and we are now on the verge of far-reaching social developments in which the applications of biological and psychological knowledge will play a commanding part.

We must not underrate the scientific importance of the enormous amount of work that is now done in technological laboratories attached to industrial firms, instituted or assisted by Government, and sometimes attached to universities. Not only is it necessary to improve and perfect established industrial processes and to learn how to exploit new scientific discoveries on an industrial scale, but also in the course of such work new scientific problems emerge which have to be solved if further advances are to be made. Some of these problems can be tackled in the technological laboratory itself, others are remitted to laboratories of pure science. Some technical laboratories, indeed, though founded solely for work in applied science, do in fact spend part of their time in pure scientific research on problems chosen from the particular field. Thus pure science and technology act and interact to the advantage of both, and so it must always be. While insisting on the essential distinction between them, we must not forget that the two are in one sense parts of a whole—a whole which has a fundamental unity given by the consistent application of the scientific method to every sort of problem, whatever the material and whatever the object. But the immediate object, which carries with it the specific motive, does determine the nature and scope of the results.

—Herbert Spencer Lecture delivered by Prof. A. G. Tansley, F.R.S. in the University of Oxford.

Planned Transport During the War

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THE Japanese aggression has given rise to many serious problems in India. One of these is transport and communication. The problem has further become complicated through (i) curtailment of normal railway services to meet military needs and save materials on account of wear and tear, (ii) closing up of lines and transfer of locomotives and trucks to meet the demands of new railway projects overseas for strategic reasons and (iii) rationing of petrol. In the interest of the people, therefore, alternative forms of transport should be explored.

It may be argued that the existing scope of alternative forms of transport is only very limited and would scarcely serve any effective purpose when compared with the needs. But it may be remembered that the relaxation of the petrol rationing or even the total abolition of rationing—even if that could be possible in the present circumstances, will never meet the demands caused by the curtailment of railway transport for civilian needs inasmuch as the capacity of the road transport to carry traffic is only 2% of that of the Railways*. It, therefore, follows that any increase, however small, in the capacity of other forms of transport would be of great value. With this end in view it has been attempted here to chalk out a scheme of transport organisation in the following sections.

Section I—Available means of Transport.

Section II—Details of different forms of Transport.

Section III—The Scheme of Transport.

Section IV—Expected Results.

Section V—Conclusions.

* Sir Andrew Clow's reply to debate on Railway Budget, 1942-43 in Central Assembly.

SECTION I—AVAILABLE MEANS OF TRANSPORT

With the exception of railway transport and road transport through petrol engines the following means of transport are within our reach:—

1. Transport by trucks hauled by steam engines.
2. Transport by trucks hauled by kerosene engines.
3. Transport by carts hauled by bullocks, buffaloes or mules.
4. Transport by animals, e.g., mule, ass, ox etc.
5. Transport by human power, e.g., palanquin, on shoulder or on head, "bunks."
6. Transport by inland navigation in country boats and "dingis".

The task now remains to carry out a systematic organisation of the above forms of transport. The organisation has to be on a collective basis under a Central Authority which would direct the various units of Organisation. Below we briefly discuss each form of transport to achieve proper co-ordination among the different units of small organisation to yield maximum result.

SECTION II—DETAILS OF DIFFERENT FORMS OF TRANSPORT

Transport by truck hauled by Steam Engines:— Coal fuel has not so far been found wanting. Wheeled steam engines may well substitute petrol

engines. Wooden or bamboo-made trucks, both open and close type, will form the transport carrier. Both passenger and goods may be hauled through these means. On non-metalled roads only comparatively lighter engines will have to be brought into use. Where the existing roadways are not good enough to bear even the burden of lighter steam engines and improvement in the roads cannot be undertaken at the present moment a different mode of transport has to be resorted to. Transshipment may also be conveniently taken recourse to between metalled and non-metalled roads. The scope of this system will entail considerable expenditure towards the purchase of steam engines. The transport will be slow, and there will be difficulty in procuring engines at this time. It appears to be practical that the application of this mode of transport may profitably be limited to carrying heavy goods on principal metalled roads.

*Transport by trucks hauled by Kerosene Engines:—*For the same power-rating kerosene oil engines are lighter than steam driven engines. The use of wheeled kerosene oil engines may, therefore, be adopted on a wider field of use than the steam engines, provided kerosene oil may be available in sufficient quantity.

*Transport by carts hauled by bullocks, buffaloes and mules etc.:—*The potential source of transport by animal drawn carts has been known to us from ages. Nevertheless in the present emergency the value of this method of transport cannot be too strongly emphasised. The forms of carts may easily be improved. Open and covered trucks of wood may be introduced. Even seating arrangements may be made in properly built roofed trucks. The sizes and capacity will only be smaller than railways or buses and traffic slow. They will be animal drawn taxicabs. The motive power will be bullocks, buffaloes and mules or other painstaking animal available. Even in military sphere there are animal drawn carriages, and Animal Transport Company is a regular feature in the Army Establishment.

*Transport by Animals:—*While carts and carriages or trucks can be hauled by animals the latter can alone be employed to carry goods on their back. Animals such as bullocks, horses, mules and asses, are the commonest that can be employed for the purpose.

*Transport by Human Power:—*Transport by human power is a common feature in rural areas. "Palkis" and "Dulis" carry passengers, while "Bunks" (बाँक—बाँक) are used for carrying milk, water, vegetables etc. The Santhals using "bunks" बाँक—बाँक for carrying earth is a common feature where Santhal labour is employed for excavation or road works: coolies carrying loads on their heads or backs is too common a feature to be mentioned.

*Transport by inland navigation through country Boats and "Dingis" etc.:—*The first four means of transport are road transport. The success of the fifth item, that is, transport by human power is also greatly dependant upon road facilities. An altogether alternative means is transport by navigation in rivers, tributaries, canals etc. The country made boats and dingis are carriers of cargo and passengers. The success of this form of transport largely depends on (i) the extent to which the existing water passages can be utilised, (ii) the number of boats and dingis that can be employed, and (iii) opening up of new waterways. The inland navigation, if it can be applied to practice successfully, will not only solve the present acute transport problems and thereby save economic isolation between the different parts of the country, but also will greatly contribute towards the improvement in the public health. Malaria, the greatest scourge, and other epidemics will certainly inflict lesser harm to the population through improved drainage which will naturally result if an organised plan for inland navigation be adopted.

SECTION III—THE SCHEME OF TRANSPORT

In order that transport through the means detailed above may prove a success the following requirements must be met:—

1. Proper organisation of different forms of Transport.
2. Co-Ordination between them.
3. Supervision and Management.
4. Direction and Control.
5. Transport Advisory Committee.

Proper Organisation of different forms of transport.

(a) *Collection of Statistics:—*An area will be chosen and its various existing sources of roadways

and navigable waterways will be surveyed. The approximate population of the area will be ascertained. The approximate quantity of surplus produce of the area that can possibly be sent outside and the quantity of principal commodities that have to be brought within the area have to be found out. This is a difficult task but very necessary without which pre-arranged plans cannot be adopted. If this is not possible a start will have to be made on purely guess work and subsequent experience to be followed as guide. From the census of population it may not be difficult to find out an average volume of passenger traffic.

(b) *Improvement in the Roads and Waterways*:—While collecting the existing sources of serviceable roads and waterways a comprehensive survey must be made of deteriorated roads and silt-laden or drying up or weeded waterways and every effort must be directed to improving these communications so as to put them into service. This will be real exploration. New road and waterways projects are costly and close examination should be made before embarking upon them.

(c) *Unit Area, Classification of Ways and Carriers*:—The area chosen as per (a) above will be the smallest unit of the transport organisation. It may be a locality resided by 100 or 200 persons or a village or a group of villages or a small town. After the volume of traffic is ascertained, both passenger and goods, and sources of communication from the collected statistics as per (a) and (b) above, the required number of transport carriers may be determined. This includes all types of mechanised, animal and human carriers.

The next thing is the classification of the carriers and the routes. Good metalled roads may be used with benefit for the heavier class of carriers i.e., the steam and kerosene Oil Engines. The unmetalled roads can be used by the animal drawn vehicles while the narrow pathways by individual animal and human carriers. This classification may be relaxed where necessary. Essentially the aim of classification should be (i) cheaper cost and (ii) quicker speed of transport.

(d) *Designation and Jurisdiction of Transport Organisations*:—The transport organisation in each unit area will be termed "Unit Transport Organisation". Five or six such adjoining units will be termed "Zonal Transport Organisation". Several such Zonal Organisations will form a "Sub-divisional

Transport Organisation" while several Sub-divisions will form the "Divisional Transport Organisation". In this way the whole of the province may be organised.

The designations of the organisations may profitably be converted to equivalent or other convenient terms in vernacular. This will be appealing to the vast rural population which will lead to easier working of the organisations.

(e) *Workshops*:—Each "Zonal Transport Organisation" will have a small repair workshop for carrying out minor repairs to trucks, carts and boats. Smithy carpentry and a small fitting shop will constitute the workshop. Several "Divisional Transport Organisations" will have a manufacturing workshop for trucks, carts, wheels, boats, baskets etc. and heavy repairs also may be carried out in these workshops. Trucks, boats and carts etc. may also be hired or purchased.

Mechanics in the "Zonal Workshop" will be drawn from village blacksmiths and carpenters as far as possible. Mechanics in the manufacturing workshops will be primarily constituted of the village mechanics though skilled men will have to be imported from outside for handling the repairs of steam and kerosene Oil Engines.

Raw materials such as bamboo, wood, canes, coir-ropes etc. are to be obtained from local supplies as far as practicable. Boys of village people belonging to agricultural and mechanic class may be trained to the needs in the workshops after their primary education.

(f) *Animal Stables*:—Animals may be purchased or hired. Stables will be built in each unit area for accommodating the animals owned by the organisation. Veterinary Surgeons will be required and one or two surgeons per zonal area may suffice.

Co-Ordination.

The classification of routes and carriers described in (c) will naturally cause transshipment of goods from one class of carrier to another. There will be transshipment stations where change of carrier will take place. The same merchandise may have to be transhipped more than once. From a large boat on the river to a smaller boat in the canal; from the

canal boat to trucks, from trucks to carts and thence by animal or human carrier alone. Transshipment will necessitate (i) co-ordination between the different means of transport in each unit area and also (ii) between different adjoining units.

In co-ordinating as above a limitation will have to be imposed on the journeys of human and animal or animal drawn carriers. A certain merchandise may have to be carried through the jurisdictions of many Divisional Transport Organisations, but the carrier may not cross over more than one or two units to avoid fatigue and exhaustion and consequent disruption in the regular flow and sequence of transport. In such cases the change in the bearer or the animal drawing the vehicle or carrying the merchandise would be the best course. Horsedrawn tram car in the streets of Calcutta before the advent of electricity is a bright illustration of this method.

Supervision and Management.

Each Unit Transport Organisation will be placed under the supervision of a "Supervisor". The transshipment stations, the repair workshops, and all staff of the Unit Transport Organisation will be placed under him.

Each of the transshipment stations and stations where the change-over of carrier or animals takes place, will be placed under a "Station Master" and the workshop under a "Head-Man" to supervise the repairs.

The office of the Supervisor will be located close to Repair Workshop which should preferably be situated near a river or canal "ghat".

All records of the office of the Supervisor, of the workshop and stations will be kept in vernacular so as to enable the local village people having vernacular education to take these responsibilities. This will enable the cost of organisation cheap and administration simpler.

Zonal and Sub-Divisional Organisations will be supervised by touring officers attached to the office of the Divisional Organisations. They will be required to settle matters on the spot in course of their tours. Divisional Officers will have a very small and compact office and just sufficient to cope with the correspondence with the superior or the Central Authority. Divisional Officers will have to

take comprehensive tours so that direct touch with the smallest Unit of Organisation is maintained.

Heavy Repair and Manufacturing Workshops will be under separate officers under direct control of Central Authority. Divisional Officers will report on the developments and changes necessary in the designs, etc. to the Central Authority who would examine them and issue necessary orders to the Manufacturing Workshop establishments.

Divisional Officers will be persons of common sense with a knowledge of the country and the people.

Direction and Control.

The entire field of transport organisation will be directed by a Central Provincial Transport Authority attached to the Government Headquarters. This will be placed under a Chief Transport Officer who will be both a technical expert and a person knowing the needs of the country. He will be assisted by an office comprising the following sections:—

(a) Traffic, (b) Engineering, (c) Statistics, (d) Animal, (e) Medical, (f) Research, (g) Training, (h) General, (i) Advisory.

(a) This branch will deal with matters of passenger and goods traffic, the rates of fares, etc.

(b) This branch will deal with all engineering matters.

(c) Collections and compilation of statistics will be its chief work.

(d) This section will be responsible for all affairs connected with animals for hauling trucks and vehicles.

(e) This section will look after all medical and veterinary affairs.

(f) The work of this section will be to investigate into the possibility of improvements, developments and economy, etc. of all aspects of the transport organisation.

(g) The duty of this section will be to fix up curriculum of training of artisans and skilled workers

of all branches, their remuneration and period of training, etc.

(h) General works such as replying to queries from the public, attending to their complaints, publicity, etc. will be carried out by this section.

(i) This section will act as the connecting link between the Advisory Committee and the Transport Administration.

The Chief Transport Officer will be required to keep strong watch that paper work be kept to the minimum in his own office as well as in subordinate offices. All officers of his department must be painstaking persons capable to undertake tours and decide matters on the spot. Though the Government will control the entire transport organisation non-governmental enterprises should be allowed to carry on their work. The Government will have powers to exercise control and fix up maximum rates of fares of passenger and goods traffic. Suitable terms of agreement will be arrived at between the parties before any such enterprise may be allowed to commence work.

Transport Advisory Committee.

The Transport Advisory Committee will be formed chiefly of non-officials with Government representatives. There will be experts and nominees of representative public bodies in the Committee. The Universities, the Institution of Engineers (India), the various representative scientific bodies such as the National Institute of Sciences, representative Medical Associations, the various Chambers of Commerce must be invited by the Government to send their nominees to serve on the Committee. In short the Advisory Committee will constitute the intelligentsia, the leaders and the able persons of the country.

The task of the Advisory Committee will be to advise the Government on all matters of transport. The Committee will convey the wishes of the people and make recommendations on their needs to the Government.

SECTION IV. EXPECTED RESULTS

The results expected through a properly organised transport system as indicated in the above lines will be as follows:—

1. Provision of alternative sources of transport during the present emergency when railway transport facility is reduced and petrol is rationed.

2. Prevention of economic isolation threatened owing to reduction of normal transport facilities.

3. A stable transport organisation will be in existence even after the war is over.

4. Permanent economic advantage will be achieved through the medium of the 3 above.

5. Employment of people having vernacular education as distinct from English education.

6. Impetus to vernacular education amongst village people.

7. Impetus to new projects of roads and waterways and improvement of existing roads, pathways, and all kinds of waterways.

8. Improvement in public health as a result of item 7 above.

9. Improvement in agricultural production. The agricultural population will be able to devote more time and energy through improved health.

10. Finally, closer contact of the machinery of Government with the people of the country.

SECTION V—CONCLUSIONS

The organisation may be set up on an experimental basis in a selected area. The experience gained through the experiment may be applied to subsequent extensions of the scheme.

It is a happy sign that the Central Transport Organisation has been set up by the Government of India and the Inter-Provincial Transport Board has also been formed.

The labours of those bodies will eagerly be awaited by all interested in the country's welfare. Meanwhile individual attempts to solve the problems confronting the task may not be unwelcome.

Indian Physical Anthropology and Raciology

Ramaprasād Chanda's Contribution

(Continued from the last issue)

The preceeding account of Chanda's contribution to Indian Anthropology will have made it sufficiently clear that his interest in this young science arose mainly from his historical studies. To him history was pre-eminently a study of civilisation,—civilization as created by different races of man, by their respective social and mental habits, thoughts and superstitions. This habit of considering man as a whole, led Chanda to glean and make use of data from various fields, e.g., sociology, religion, funeral customs, language and material culture. For a just estimation of his work, therefore, it is necessary to review it from the standpoints of various disciplines. The following is an attempt to consider it from the point of view of Indian Physical Anthropology and Raciology, and the problems that face it today.

RISLEY AND CHANDA

With Chanda as with Risley, the pivot on which the racial history of India turned was the Aryan question. There was, however, a fundamental difference in the outlook of the two. Unlike Risley, Chanda could not unreservedly accept Prof. Sayce's dictum of "the Aryan race as an established ethnic aggregate". He rejected Penka and Risley's "assumption that the so-called Aryans or the people among whom the Aryan speech and culture originated were long-headed" (1922). Unlike Risley he was not religiously committed to the view that the immigration of the Aryans into India, their struggles with the darkskinned and snubnosed aborigines and their ultimate bastardization with the same element, together with some minor episodes as the importation of Scythian brachycephals to west-coast and the silent Mongolian admixture in Eastern India, comprised the "be all and end all" of Indian Racial History! (Did not the Vedic Aryas come across other populations in the Indus Valley and in the East, who could not be classified in the same cate-

gory as the darkskinned Niśādas?). Nevertheless, owing to the nature of most of the data he handled, he envisaged the raciology of India as a contemporary of king Sudāsa or one of the Vedic Ṛsis may have envisaged it, dwelling on the racial contrast among the Vedic Aryas, their probable contact with the Indus Valley civilization, their relations with the darker aborigines, and the cultural and racial differentiation between the midlandic Aryas and the Aryas of the outer belt.

I. The Arya:

Chanda's theory of racial difference in Ṛg Vedic Arya society rests upon a delicate structure of evidence gleaned from words from the texts, which sometimes leave us in doubts as to the idea they were originally intended to convey. I refer, above all, to his interpretation of *Svityāñch*—, which can signify "fair", "shining", "festively decorated", etc. The most important evidence cited by Chanda for the existence of a blonde strain in India is Patanjali's statement that "*Gaurah * * piṅgalah kapila-keśa*" are among the intrinsic or indispensable attributes of Brahmanhood. Here "*kapila-keśa*" is a *saṁāsa* or compound of the *Bahuvrīhi* class, but "*piṅgalah*" with its *ḥ* ending (as has been pointed out to me by my esteemed friend Dr Bata Krishna Ghosh) cannot at the same time be an attribute of "*keśa*". True, Mahesvara in commenting on the synonyms of *piṅgalah* in the *Amarakośa* associates it with the hair of the very fair boy. But if it be legitimate to take the help of Medhatithi's commentary on *Manu* III, 8, in interpreting the *Mahabhasya*, which is much earlier in origin, "*piṅgalah*" (which the commentator associates with *kapila*) should refer to eye colour (when a particular type of deformity of the eye is not contemplated), while "*kapilah*" refers to the colour of the hair. As an illustration of circumstances in which Panini's aphorism (V, 1, 115) explaining the use of the suffix "*-vat*" is excluded, Patanjali

gives "*Putreṇa tulya piṅgalah*", or "(a fat 31) *piṅgalah* like (his) son," which should refer to eye-colour as in the earlier passage. One notes that while "*Kanaka-varṇa*" (gold coloured) hair may be characteristic of the Nordic race or the Teutons, the usual significance of *piṅgalah* does not imply "*blue eyes*", but may indicate light brown eyes. Chanda's reference to "*abhinila-netto*" or intensely blue eyes as one of the thirty-two marks of the *mahāpurusha* mentioned in the Lakkhana Sūta of the Dīgha Nikāya is more to the point (1922).

Fortunately there is some evidence of the existence of a blonde strain on the north-western frontiers of India, which suggest that Patanjali's reference to "*kapila-keśa*" should be considered in this light. The early mediaeval wall-paintings of Turfan, revealed by the German excavations of 1902-14 portray Tocharians, blonde-haired, light eyed, even blue eyed, partly also with narrow faces and narrow noses, and we are told that many of them in European dress would pass unnoticed in European cities. These Tocharians are identified with the Yüe-tshi of the Chinese writers, whose language has proved to be an Indo-Germanic idiom, with greater affinity to its European branch than to the Irano-Indian. A Nordic strain among them would not by itself prove the existence of a similar strain among the Indians.

The most welcome light on this problem has been thrown by the investigations of B. S. Guha and A. Herrlich among the Hindukush Kafirs. Herrlich's detailed work covered the Katis, Aschkuns, Paruns, Waigelis, Wamas and a group of slaves. He found among 258 Kafirs 7.5% light eyes, 34.2% medium-coloured eyes and the rest dark eyes. Of 32 Aschkuns 15.6% were light eyed and 37.5% medium eyed. Among 25 Paruns 24% were light eyed and 60% medium eyed. Among 243 Kafirs, however, there was only one instance of the light blonde type of hair of the colour-value 1, b., another of red, while 10.2% had medium hair-colour, M-T (the colour-scheme of Fischer-Saller being referred to). The Katis who showed 5.8% light eyes in a population of 121, exhibited 14.5% medium colour-tones of hair in a total of 108 cases. The Aschkuns and the Paruns were mostly dark-haired. The population is undoubtedly mixed, containing several darker strains. By his analysis, which depended upon a comparison of types of head and nose-profile, soft parts of the eye region, lips and chin, Herrlich succeeded in identifying among the Kafirs, "An

element C, which exhibits characteristic features of the Nordic and Dinaric races and is presumably one of the racial components, which succeeded in maintaining itself in this hilly country from the time of the early Aryan Indiam." The type is represented by people of high stature, dolichocephals, with straight or slightly arched noses, moderately depressed at root, narrow at tip, lips medium-thick to thin, chin straight, furrow of the chin deep or medium high, having 27% medium-light hair colour, 47% light and medium-light eye-colour. "We may . . . presume", says Herrlich, "that the said invading host of conquerors [Indo-Germans] did not reach the land of the Five Rivers as a group of men purely of the Nordic race, but had already long mixed with other racial elements. Probably the type C gives us an idea as to the elements of which we could presume this mixture to have taken place". Guha and Herrlich fully corroborate each other about the existence of this blonde strain on the N. W. frontier, and it has been traced by the former into the plains of N. India, though changed in skin-colour etc.

The question of Aryan, or more correctly speaking, a Nordic or mixed Nordic immigration into India, however, will always remain an open one till we have more direct and definite evidence. Unfortunately, the tendency so far for anthropologists as well as archaeologists has been to remain satisfied with whatever crumbs Indology could offer them from its table, and not to seek for material evidence of the immigration in skeletal remains and in objects of material culture, e.g., pottery, tools, weapons and ornaments, in the soil of the Vedic *Madhyadeśa*. This aspect of the Indo-Aryan question has been entirely overlooked by the Archaeological Survey of India, and the honour of giving us a lead in this matter is due to Robert, Baron von Heine Geldern (Vienna), who read a paper on the archaeological traces of the Vedic Aryas ("Archäologische Spuren der vedischen Arier") in the Congrès International des Sciences Anthropologiques et Ethnologiques, London, 1934. The traces comprised copper implements, viz., (1) a hand axe (*Ärmchenbeil*) from the village Shalozan in the Kurram valley, Waziristan*, of a type which has so far been found only in Europe, Caucasus and Troy, having developed from older oriental forms during 1400-1200 B.C. It could not have reached India

* For this specimen, see Annual Report of the Archaeological Survey of India, 1913-14.

earlier than 1300 B.C., and not later than 900 B.C., when it seems to disappear in the west. (2) A shouldered double-axe (*Schafthalsdoppelaxt mit Kreuzständigen Schneiden*) of bronze found in 1927-28 in the uppermost stratum of Mohenjodaro belonging, in a broad sense, to a class of similar implements from Hungary, Bulgaria, Crete, Troy etc.; yet so distinct from the latter that a direct connexion is not to be thought of. On the other hand it is extraordinarily similar to eight small bronze models discovered in the foundations of the Anu-Adad temple at Assur erected by Salmanassar II (860-824 B.C.). The appearance of two distinct types of axe having Caucasian and Assyrian affinities in N. W. India at about the same period (1300-900 B.C.), considered together with the fact that during the fifteenth and fourteenth centuries Indians [Indo-Aryans] had been living in N. Mesopotamia (Mitanni) and some neighbouring countries suggests that these axes are probably traces of the Vedic Aryas from the time of their immigration into India. Heine Geldern also discusses the long swords of copper from the Gunga-Jumna Doab, which are dateable 1300-800 B.C., and suggests that though of a distinct type, the swords may have been brought into India by the Arya immigrants.

Chanda, however, was fully alive to the necessity of testing the hypothesis of Aryan immigration into India by archaeological evidence. In his analysis of the different modes of disposal of the dead prevalent in the prehistoric cities of Harappa and Mohenjodaro, while concurring with Sir John Marshall in the view that cremation was the general practice and the few fractional burials in cinerary urns are due to the presence of foreign elements coming from the west, he attached special significance to the cemetery in area H, at Harappa, evidently belonging to the last batch of immigrants. This cemetery is later in date than the latest stratum of the city of Harappa and according to Mr M. S. Vats who excavated it consisted of two strata. "In the upper stratum selected bones of the dead are put in jars and buried; in the lower stratum either the entire body or a part of it [in its western section] is laid on the earth and buried". The two strata are not separated by any structural remains and are more or less contemporary. The cemetery at Sohr Damb, near Nal in the Jhalawan district, Baluchistan excavated by Hargreaves also showed the contemporaneous practice of the same modes of

disposal of the dead. There were complete burials, some of them within walls of sun-dried bricks and fractional burials where a few selected bones were laid in the earth or deposited in jars. There is, according to Chanda, a wide ideological difference between the preservation of the whole body by burying it, and exposing the body till only a few bones remain to be buried in the earth or inside a jar.

"Do these latest settlers of Harappa bring us nearer to the Vedic Aryans than their predecessors in point of culture?" Here Chanda refers to some paintings on the burial jars of Harappa and Sohr Damb which Mr Vats endeavours to explain in the light of Hindu belief in life after death as defined in the Hindu sacred books. He observes: "But it seems to me safer to trace the inspiration of these paintings on the burial jars of the Harappa cemetery on the one hand, and those on the funeral pottery of Sohr Damb (Nal) and other similar sites of Baluchistan to a common source".

Chanda then passes under review the various ways in which the Vedic Aryans disposed of their dead. The *R̥gveda*, (X, 15, 14) distinguishes between fathers who are '*agnidagdadhāḥ*'—cremated, and others who are '*anagnidagdadhāḥ*'—not cremated. The latter may refer to those who could not be cremated by accident (Macdonell). The *R̥gveda* (X, 18, 10-13) is supposed by some to refer to the burial of the uncremated body. According to Asvalayana-grihyasūtra (4, 5, 7-10), the reference is to the burial in a cinerary urn of the bone relics of a body that has already been cremated. This text presupposes the preservation of a considerable number of bones after cremation for burial in an urn, including the skull. The students of the different Vedas evidently followed different methods of post-cremation burial of calcined bones. According to the *Satapatha Br.*, the custom of the westerners or Indus valley people was to pour the charred bones from the jar on ploughed land, to rearrange them in the form of a skeleton over which were placed thirteen bricks, each a foot square, a mound of earth being erected on the bricks. The easterners and others covered the entire site with bricks and placed the bones and erected a mound on them. The *Pitrimehasūtra* of Hiranyakesin prescribes jar burial for a woman or a man who has not established the sacred fire, depositing on the earth for one who has performed the offering of rice cakes and butter, re-cremation

for one who has performed the *soma* sacrifice, and the collection of bone relics for the builder of the fire altar. Chanda concludes "These diverse methods of disposal of the calcined bones could not all have originated among the Vedic Aryans whose poets composed the hymns of the *Rigveda*, and the permanent jar burial was probably a survival from the pre-Aryan chalcolithic culture of the Indus valley". (1941)

II. The Nišāda:

The Nišāda question has resolved itself into a controversy about the appropriateness of the appellation as denoting a certain racial type corresponding to the descriptions of the texts, frequently represented among the Indian aborigines. There is, however, a tendency among workers in India to use the term in preference to others which have been proposed. To quote Guha:

"Various names have been given to this race such as 'Pre-Dravidian', 'Proto-Australoid', and 'Veddoid', but none of them seems to be as appropriate as 'Nišādic', the generic name given to them by the Vedic Aryans and resuscitated by Mr Chanda and which should henceforth be used to designate the non-Negritoid Indian aborigines".

The unfortunate result of this controversy has been that the real and far more important points at issue have been overlooked. These are:—

(1) Were the Nišādas truly the Dāsas and Dasyus as maintained by Chanda and others?

(2) Did the Vedic Aryas come in contact with the Nišādas?

(3) What are the racial affiliations of the Nišādas?

As regards (1), no evidence, either for or against this assumption has as yet been brought forward which would enable us to form an opinion. Regarding (2), Chanda has proved his case on the basis of internal evidence from texts, though not from the *Rgveda*. It would not, therefore, be unjustified to conclude that such contact, friendly or inimical began comparatively late in the history of Indo-Aryan society, though for reasons to be presently stated, earlier contact is not ruled out.

According to Chanda, Nišādas are first named as such in the Rudradhyaya of the Yajurveda

together with the Vrātyas (nomads) and a number of occupational groups. "In the Pañcaviṃśa Brāhmaṇa (XVI, 6, 7) the performer of the Viśvajit sacrifice is required to live for three days among the Nišādas. In the Śrauta Sūtra of Kātyāyana (I, 12) and in the Mimāṃsā Sūtra of Jaimini (VI, 1, 51-52), Vedic texts are referred to, which provided that Brāhman priests should make chiefs, who were Nišādas by descent, offer certain sacrifices".

Such a racial contact is rendered highly probable by the existence of Nišāda villages, referred to in Latyāyana Śrauta Sūtra (VIII, 2, 8), which must have lain sufficiently close to the Arya colonies. In fact, crania of the particular racial type implied by the texts seem to have been found among the prehistoric ruins of Makran in Baluchistan, of Harappa and Mohenjodaro. The first identification of this type of skull at Mohenjodaro, as already mentioned, was due to Sewell and Guha, who have been corroborated by Friederichs and Müller (1933). From their analysis of this type of skull, the latter conclude:

"It follows . . . that the skull No. 11 appears to belong to the same racial type as the Wedda, Drawida, Australians and Melanesians, which has been defined as Proto-Australoid (Sewell and Guha), Proto-Dravidian (Thurston), Drawidoid (v. Eickstedt) Australoid (Guha and Basu) and Weddoid (v. Eickstedt)".

The authors also mention that the latest excavations in Kish and Ur have led to the discovery of skulls which exhibit Weddoid characters and close affinities with similar types from Mohenjodaro. While describing further discoveries of the same type of skulls from Mohenjodaro in 1939, Guha and Basu again emphasized their Australoid affinities, viz., the stout supraorbital ridges, the low forehead and the broad nasal aperture. But from an examination of the al-'Ubaid and Kish crania as well as the Long Barrow skulls of England made by Guha, they expressed themselves satisfied with Keith's conclusion regarding the Sumerian and Caucasian affinities of this type of Mohenjodaro skulls. "The presence of a well-developed glabella and strong supra-orbital ridges in these skulls, which are in other respects and also closely allied to the Mohenjodaro A [formerly classified as proto-Australoid] skulls, has convinced us of the soundness of Keith's contention. In spite, therefore, of the marked prominence of the supra-orbital ridges, these skulls must really be designated

as *Caucasic*, to use Keith's none too happy expression" (Guha and Basu). As Guha is expected to give us further details about the affinities of this type of skulls with the Long Barrow type in his forthcoming work on the Harappa crania, final judgment regarding this problem should for the present be suspended. While the greatest weight will be attached to the observations of so experienced an investigator as Guha, it may, however, be pointed out that mere affinity or resemblance in respect of certain cranioscopic characters as is claimed to subsist between the Long Barrow skulls on the one hand and the Ur, Kish and Mohenjodaro skulls on the other would not constitute a proof of the racial identity of types so widely separated in space and time. Friederichs and Müller (1933) and Müller (1935) speak of the existence of a very ancient strain with Weddoid affinities in Elam, Azerbaizan, Luristan, Farsistan, S. Persia, Schat-el-Arab in Mesopotamia, S. Baluchistan and Afghanistan, on the basis of some archaeological evidence and the studies and observations of various investigators, among them Lebzelter and v. Eickstedt. The hair of this type is long and "teils lockig, teils locker kraus, kaum je dicht kraus" (Gabriel). The crossing of this strain with one of the dolichocephal europid types present in this area from very ancient times should be theoretically capable enough of producing *crania* with a varying degree of seeming affinity to the Long Barrow type, though the living owners of either types of skulls could be distinguished at sight. Some weight is certainly to be attached to the evidence of the bronze figurine of a *danseuse* discovered at Mohenjodaro, which (as Friederichs and Müller point out) shows a Weddoid profile; its limb proportions are not unusual among the Weddoids. Unless we have very positive evidence, however, the Weddoid or Australoid type in its purity is not to be expected in the prehistoric population of the Indus Valley, which contained other racial elements in much greater numerical strength. At any rate, the possibility of the existence of a Weddoid or Australoid strain in however mixed a form, must be reckoned with, while finally determining the true racial affiliations of the Mohenjodaro A type of skulls.

There is some evidence to show that the Weddoid type or characteristics are represented in the modern population of the Punjab and the neighbouring regions, though the strain may not be very strong in the Land of the Five Rivers. A type with Weddoid affinities, having relatively broad nose,

small head, overhanging occiput and prominent superciliary arches was recognized among the Sikhs by v. Eickstedt (1920) and among the Chuhra and Chamar castes by Guha (1935), though according to the latter it is not appreciably present among other peoples of the Punjab. Four skulls in the Senckenberg Museum collected by the brothers Schlagintweit during 1854-58, Nos. 1274 and 1287 from Narsinghpur and Jablpur in Central India and 1275-1276 from Nepal described as Rajputs have been recognised as having Weddoid affinities. The plains between Rajputana and Nepal could hardly have been free from this strain. According to Risley, in the North-Western Province (Agra and Oudh), dolichocephaly may be a mark of Aryan or non-Aryan descent, according to the social status of the individual. The presence of this type or its characteristics among the so-called outcaste groups of the Punjab, among the Sikhs who are of heterogenous origin, as well as in the lower stratum of the Agra and Oudh Provinces suggests that this strain is of ancient date; so that it is not improbable that it represents the Nišāda elements mentioned in later Vedic literature.

The third point at issue, concerning the racial affiliations of the Nišāda or Weddoid type, must not be mixed up with the question of nomenclature. From the standpoint of racial anatomy etc., the type extends far beyond the limits of the Indian subcontinent, being represented among the well known 'Weddas' or 'Veddas' (=Skr. Vyādha). To quote Prof. Kleiweg De Zwaan about its distribution: "The Sarasins thought they had found in Celebes a population which in many respects resembles the Vedda of Ceylon. The Senoi and Sakai of the Malay peninsula, studied by Rudolf Martin, also possess more or less this Vedda type. But it is not settled yet, whether or to what extent the Vedda element has contributed to the building up of the inland population in other regions of the Indian Archipelago. I presume this has really been the case. To obtain more certain information about the spreading and significance of the Vedda element in the East Indian Archipelago I have carefully studied a great number of photographs representing natives from various regions of the Archipelago. I recognize this type clearly in photographs of different tribes of Sumatra (Miyangkabau, Malay, Karo-Batak, Toba-Batak, Kaebal and Loebae); in photographs from the islands situated on the west coast of Sumatra (Nias, Mentaive); in photographs of natives of the islands of Java, Ceram, Boeroe, Madoera, Boeton, Morotai,

Tenibar, Babar, and Alor ; and also in photographs of natives of Borneo, New Guinea and the Philippines". Its presence in Hinter India is also indicated.

The relationship of the Nišāda or Weddoid type to the Australians has caused much *Kopf-zerbrechen* among anthropologists. Sir William Turner, who was the first to make a systematic study of a large number of Indian aboriginal crania, including those of Gonds, Bhuiyas, Mundas, Oraons and Kols, and from his detailed analysis confirmed Risley's conclusion that there is no difference between the Dravidian- and Kolarian-speaking tribes, found that when Dravidian (Ris'ey) and Australian skulls are compared together, they show agreement in general form and proportions, both groups being dolichocephalic ; in the proportions of the nose and in the microseme orbit usual in the males. On the other hand the Australian skull is heavier, with smaller cranial capacity, greater absolute length which is partly due to the prominence of the glabella, much more receding forehead, prominent supra-orbital ridges, greater depression of the root of the nose, heavier and prognathous jaws, dolichuranic palato-alveolar arch, outer table of cranium coarser and rougher, sagittal region frequently ridged etc. So Turner concluded : "The comparative study of the characters of the two series of crania has not led me to the conclusion that they can be adduced in support of the theory of the unity of the two people" (1905). Martin in his study of the Senoi skulls also points out that the crania of the Senoi, the Wedda and many of the Anterior Indian hill and jungle tribes, in common with the Andamanese etc. either owing to their common descent or similar ways of living do not create the same wild impression as the Australian crania with their heavier weight, thick calotte, the stronger relief of their muscular impressions and bony projections. The projecting bony ridges and the configuration of muscular impressions are deficient in the

former, which are smooth in surface. The presence of the latter characteristics, partly Neanderthaloid in appearance, has led to the opinion that the Australians are more primitive than the Nišāda—pre-Dravidians and is perhaps responsible for the view that the latter are Proto-Australoid. Thus, according to Guha : "A more primitive form of this type [Nišādic] is seen among the aborigines of Australia among whom some of its traits are found in an intensified form". The Proto-Australoids, therefore, possess "the chief somatic characters of this racial family in a less developed form" On the other hand these cranioscopic differences may be due to the infantile character of the Weddoid skulls, which has been emphasized by Müller. According to the latter "the Weddoid small skulls, to go by their general form, compare with the crania of the taller Australians and Melanesians as do skulls of infants with those of adults ; this infantile character of the former is particularly manifest in the facial skeleton, above all in the relative largeness of the orbita and the nose ; the dolichocephalic Weddoid small skulls and hence the Weddoids themselves are according to Müller to be regarded as a morphologically infantile form of a pre-melanoid—australoid race, whose childlike habitus became fixed for some reason or other and thus appears as a secondary differentiation in growth having independent racial character". Also, according to v. Eickstedt : "The (living) Weddoids are characterised above all by the infantile nature of the racial features, by the smooth, round, childlike face with steep forehead, the child-like snub-nose with the wide nostrils, the soft full and childlike mouth curved downwards, the small retreating chin and the delicate, childlike somewhat stocky (thick-set) body, with the small hands and feet".

(To be concluded)

Notes and News

DRUGS TECHNICAL ADVISORY BOARD

THE Drugs Technical Advisory Board, created in connection with the Drugs Act, 1940, "to advise the Central Government and the Provincial Governments on technical matters arising out of the administration of the Act and to carry out the other functions assigned to it by the Act," recently had its first meeting held in New Delhi. Sir Gordon Jolly, Director-General of the Indian Medical Service and Chairman of the Board made some suggestions about the use of various authoritative pharmacopoeias other than the British Pharmacopoeia and the draft rules formulated by the Government. The Director-General referred to a letter from the Government of India requesting the Board to advise on the question of what other pharmacopoeias in addition to the British Pharmacopoeia should be prescribed for the purposes of standards of identity, purity and strength of drugs other than sera, vaccines, vitamins and similar products. The suggestions put forward included the recognition of the standards of all authoritative pharmacopoeias, subject to the condition that the label of the container must explicitly mention the name of the pharmacopoeia should its standard differ from that laid down in the B. P. The letter further requested the Board to offer suggestions, if any, for the modification of the draft rules drawn in connection with the proposed Central Drugs Laboratory. Sir Gordon stressed on the need to obtain a set of rules which will be acceptable not only to the Government of India but to the Provincial Governments responsible for administering the Act within their boundaries.

The establishment of the proposed Central Drugs Control Laboratory, as the Director-General has himself said, is a primary injunction of the Drugs Act, 1940. It is noteworthy that the Government of India has at last felt the necessity of formulating the rules laying down the functions of the Drugs Central Laboratory which, it is understood, will come into being on an agreement being arrived at on these rules. The Director-General, as is wont with such high officials, has found an excuse in the present abnormal conditions of the war for such delay in the fulfilment of a primary injunction which is likely to invite adverse criticism. Unfortunately

such a weak excuse has hardly impressed us. The report of the Drugs Enquiry Committee, be it remembered, was submitted in 1931, and it took full nine years to convince the Government as to the recommendations of the report when there was no war, so far as we are aware, to divert the attention of the Government. In all other countries the war has expedited the adoption of measures calculated to further national interest whenever such problems come up before the Government for consideration. It is only in India that war has come to stand in the way of prompt adoption of measures in connection with problems which vitally concern national interest.

DIAMOND-POLISHING INDUSTRY IN BRITAIN

FOR a long time the diamond polishing industry has almost been a monopoly of the people of the Netherlands, who largely developed and perfected this extremely exacting process of polishing diamond. Thanks to the war, the industry has now crossed the channel and found a footing in England. During the Nazi invasion of Holland and Belgium towards the beginning of the present war a number of skilled diamond polishers and owners of diamond polishing factories fled to England and succeeded, after consultation with the British and their own Governments, in establishing the industry in that country. The establishment of such a new industry involving the manufacture and installation of numerous complicated and precision instruments was hardly an easy affair. A small start was, however, given through the setting up of a little factory in the south, containing only four benches, which rapidly developed into a valuable new industry in course of a year and a half. The factory equipments now include 84 polishing benches, 69 sawing heads, and 8 cutting machines. The absence of tradition on the part of Englishmen rendered the training of the personnel of diamond polishers difficult to a certain extent. But the difficulty has been overcome, and the English polishers, it is reported, are beginning to show sufficient skill in the difficult art of diamond-polishing.

ORIGIN OF THE SOLAR SYSTEM

THERE has been much discussion as to the origin of the solar system by distinguished astronomers and

mathematicians. And yet the controversy hardly appears to have come to an end. Difference of opinion exists as to the size of the sun when the planetary system was being evolved. Recent workers on the problem start from the assumption that the sun had then almost its present size instead of one comparable with the present planetary orbits. The latter view constitutes the basis of the tidal theory of the origin of the solar system proposed by Sir James H. Jeans in 1916. In a letter published in *Nature*, June 20, 1942, the author of the tidal theory has put forward further arguments in support of his assumption as to the size of the sun being comparable with the planetary orbits and showed that the supposition of the recent workers not only reduces the probability of planets being born, but involves serious dynamical difficulties. On any theory of stellar evolution, Jeans argues, it is reasonable to suppose that the sun must have at one stage of its life history in the past extended to thousand times its present radius. From very simple considerations and assuming the validity of Lane's law he obtained an expression for the total chance of planets being born as a result of a tidal encounter of the type contemplated in his theory when the sun and the stars all precisely had "n" times their present radii. For a value of "n" equal to about 5,000 which corresponds to a sun big enough to include the orbit of Uranus the total chance becomes as 1 in 6, whereas the probability of planets being born of a sun of the present size in 2,000 million years is only about 1 in 2,500,000,000. The sun of this size must have then existed in a semi-nebulous state; and yet it was not too diffuse to hang together dynamically. It may be doubted whether the application of Lane's law in the case of a star of this size can give correct results. But these adjustments, as Jeans remarks, will on the contrary strengthen his results. Finally he concludes that the planetary system came into existence when the sun was in a semi-nebulous state several hundred, perhaps thousand times greater than its present size—a supposition which avoids most—perhaps all—of the dynamical objections produced against the tidal theory. A large proportion of the stars, indeed far greater than we can think, must be associated with planets which were formed when their respective suns were in a semi-nebulous state. This had led him to think of an abundance of life in the Universe on a scale hitherto inconceivable.

THE NEW DUDELL MEDALLIST

We note with great satisfaction the award of the eighteenth Duddell Medal of the Physical Society to Dr William David Coolidge well known among physicists and radiologists for the invention and development of the X-ray electron tube and for his researches

in the production of ductile tungsten. The hot-cathode high-vacuum X-ray tube which bears his name was a great improvement on the older cold-cathode gas-filled type and largely responsible for great progress in radiology and theoretical research. During the last Great War he designed complete X-ray field installations to study scientific problems in connection with the war. He developed self-contained oil immersed outfits which have been found useful in dental therapy and in many industrial laboratories. Recently for deep X-ray therapy involving the use of extremely penetrating radiation he has successfully constructed a million-volt tube in which the final maximum voltage is attained in successive stages of acceleration.

Dr Coolidge was born in 1873, and graduated in 1896 from the Massachusetts Institute of Technology. He joined the staff of the Research Laboratory of the G. E. C., Schenectady, N. Y., gradually filled higher posts and finally became the director of research and vice president of the Company in 1940. He was the recipient of many honorary degrees and medals from distinguished societies and associations at home and abroad. He received the Hughes Medal of the Royal Society in 1927 and the Faraday Medal of the Institution of Electrical Engineers in 1939.

MILK FROM VIRGIN GOATS

UNDER the caption 'Milk from Virgins' the July issue of *Monthly Science News* publishes a note how Dr S. J. Folley and his colleagues at the National Institute for Research in Dairying at Shinfield have recently succeeded in making virgin goats produce milk and demonstrated the superfluity of the usual process of mating. This somewhat peculiar result is reported to have been achieved by treating virgin animal with diethylstilbaestrol and hexoestrol—synthetic alternatives to sex hormones, first prepared by Prof. E. C. Dodds. The basis of such treatment is the knowledge gained recently through researches that hormones from two glands, the ovaries and the anterior pituitary glands, are mainly responsible for the development of the mammary glands of the animals and the production of milk. It has been found that the hormones from the latter gland are indispensable for starting and maintaining the flow of milk. A definite knowledge as to whether sex hormones act directly on the mammary glands, or simply stimulate the anterior pituitary glands, to generate other hormones which are directly responsible for the development of udders is, however, yet lacking. Dr Folley has further observed that the quality of milk from cows depends on the strength of the doses of sex hormones or the synthetic preparations administered. Strong doses may even altogether stop the production of milk. Weak doses,

on the other hand, have been found to increase the proportion of fats and other solid matter in milk which demonstrates that a proper selection of strength can improve the quality of milk. Further research in this direction is in progress, and these new results are destined to be of considerable economic importance.

BRITISH THERMAL UNIT

Nature has recently published a number of letters devoted to the history and definition of the British Thermal Unit to which our attention has been focussed. Though this unit has come to play an important part in modern physical and engineering measurements involving the problem of heat and work, the way in which the unit was first defined and introduced into our sciences seems shrouded in mystery. The letters of R. W. Powell of the Physics Department, National Physical Laboratory, Teddington and of G. Woledge of the Queen's University, Belfast have thrown much light on the subject. According to Dr R. W. Powell, it appears that Joule, Thomson, Rankin and others whose work on the equivalence of heat and work subsequently led to B. T. U. did not refer to it as such though they talked of a 'heat unit'. The first mention of the term British thermal unit occurs in "Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum, 1876". But nothing in the nature of a definition of the unit was available till 1884 when William Anderson in his Howard lecture on "The Conversion of Heat into Useful Work" defined it as "the quantity of heat or energy of molecular vibration which raises one pound of water 1°F" and called it "the British unit of heat". In the contemporary scientific literature like Lardner and Loewy's 'Heat' (1877), Cotterell's 'The Steam Engine considered as a Heat Engine' (1878) and Prof. Everett's 'Unit and Physical Constants' (1879) there is, however, no mention of the term British thermal unit, which leads Dr Powell to conclude that its mention in Catalogue of the Special Loan Collection of Scientific Apparatus was rather casual. It appears sufficiently clear that the B. T. U. received a precise definition and recognition by 1895. The definition found in Prof. Jamieson's Text Book of Steam and Steam Engines, 10th Edition (1895), and Prof. Callendar's statement in the British Association Report (1896) that 'for steam engine work undoubtedly one of the most important units at present in use is the British thermal unit, or pound degree Fahrenheit', clearly bear this out.

The precise temperature at which the rise of 1°F is to be achieved, as Dr Powell would have us suppose, does not appear to be clearly specified until recently. The Gas Regulation Act, 1920, however, mentions 60°F as this temperature. The subsequent

literature on this subject has taken care to mention this temperature though there has been some divergence of opinion as to what the correct figure should be. The definition of the British thermal unit proposed by the British Standards Institution has preferred 60°F as the temperature from which the rise of 1°F should be reckoned.

The earliest date of the phrase 'British thermal unit', as suggested by Powell, has, however, been questioned by G. Woledge of the Queen's University who claims for the unit a much earlier date. He has discovered the phrase in W. J. M. Rankin's 'Manual of the Steam Engine' published in 1859 which means that the phrase is some fifteen years older than what Dr Powell could tell. According to him, it occurs as a technical unit in 1885 in 'Thermodynamics', 3rd edition (New York), by De V. Wood. He further thinks that the word 'British' before the thermal unit was first incorporated in America whence it crossed the ocean as a technical term and became known to the British physicists through British engineers.

DEPUTATION FROM THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

THE need for the establishment of a full-time Scientific and Technical Joint Board was emphasised in a deputation of the leading scientific men recently arranged by the Parliamentary and Scientific Committee. The aim of such a Joint Board, as laid down in the deputation, was to secure the fullest strategic utilisation of scientific man-power and resources and the proper organisation and exchange of scientific and technical information relating to the war effort. For sometime past the leading scientific men of Britain came to doubt the efficiency of the existing arrangement and organisation to draw fully on the scientific man-power and resources of the country and seriously felt the need for some central scientific direction. In course of the deputation Capt. L. Plugge pointed to the importance of improving the scientific and technical approach to war problems which is at present lacking to a certain measure. The deputation included Sir Lawrence Bragg, Mr Hugh Linstead, M.P., Mr C. S. Garland (British Association of Chemists), Prof. W. Makower (Institute of Physics), Prof. J. D. Bernal (Association of Scientific Workers) and Mr Richard B. Pilcher (Institute of Chemistry) and representatives of various other scientific institutes.

A CORRECTION

In the editorial entitled 'The Renaissance of China' appearing in the last November issue unfortunately a mistake has crept in. On page 198, in the middle of the second column (line 27 from the top) read communalism for communism.

SCIENCE IN INDUSTRY

LOW-GRADE CHROMIUM ORE

THE growing importance of chromium in the metallurgical field of alloys and in the construction of furnaces necessitated the development of metallurgical processes to work out low-grade chromium ores in which Montana and other Western States of America highly abound. A vast deposit of $2\frac{1}{2}$ million tons in Montana alone, if properly developed, will, it is believed, supply 900,000 tons of chromite of a grade suitable for making ferro-chrome. The Bureau of Mines under the directorship of Dr R. S. Dean, the chief of the Metallurgical Division, showed interest in the problem of utilising low-grade chromite ores for a number of years and succeeded in effecting a concentration of the chromium content of the ore which in the natural state of occurrence is excessively rich in iron.

The roasting and leaching process developed by Dr Dean consists in mixing the chromium ore concentrate from mining and concentration plants with coke and treating it in rotary kilns specially designed in his metallurgical laboratories for this purpose. The material is then cooled and the removal of iron is effected partly by gravity concentrations or magnetic methods and partly by leaching the reduced iron with sulphuric acid or sulphur dioxide. According to the Bureau's research, the residue having a 3:1 chromium/iron ratio can be reduced directly by electric furnace to produce standard ferro-chrome containing 70 per cent chromium. But the production of a residue with a 5:1 chromium/iron ratio has been found economical which can be afterwards mixed with raw concentrates to make the ratio 3:1.

Another method of enriching low-grade chromium ore involving the use of a combined chlorine and carbon monoxide gassing treatment has been developed by A. J. Gaiby, of Niagara Falls according to U. S. P. 2,277,200. The ore is first crushed and properly sized and then subjected to a temperature of above 600°C in a reaction tower. Carbon monoxide and chlorine are allowed to percolate through the crushed materials in the reaction tower. Chlorine combines with iron oxide producing ferric chloride

which is volatile at the reaction temperature and easily removable. It does not, however, attack the chromium oxide which is non-volatile at the reaction temperature and therefore remains behind, leaving the residue enriched in chromium content.

CHEMISTRY OF PORCELAIN INSULATORS

THE difference in the designs and manufacturing processes of electrical insulators depending upon the choice of plastics of ceramic or organic origin is well-known to the manufacturers. Dr E. Rosenthal has discussed in the *Electrical Review* of June 12, 1942, the real causes of such differences which may be traced to the peculiar molecular arrangement and the presence or absence of the molecules of water in the two varieties of plastics mentioned. Ceramic plastic materials contain as a rule water of crystallisation. Besides absorption takes place at the surface of the Kaolinite crystals forming the China and ball clays. The forces of attraction responsible for the layers of water molecules surrounding the clay molecule are electrical in nature. These absorbed molecules of water often impart to it the characteristics of colloidal gels, and are really responsible for the plasticity of such ceramic materials. This explains why the ceramic articles can be given any designed shape. But the insulating and other physical and mechanical properties have their origin in the new crystal patterns and the glass matrix formed in the process of heating. The temperature required for such transformation to take place usually lies between $1,300^{\circ}\text{C}$ and $1,400^{\circ}\text{C}$.

Organic plastics, unlike ceramic plastics, owe their plasticity to long chains of carbon atoms or molecules containing carbon arranged in various forms, such as long bundles or micelles, and not to molecules of water. The process of heating involved in the manufacture disturbs this arrangement of carbon atoms and brings about a new structural arrangement of the molecules with consequent loss of plasticity and gain of important mechanical and electrical properties. The conversion from the plastic to the non-plastic state occurs at about 180°C . Organic

plastics suffer little or no volume change and therefore promise a greater accuracy in certain shapes.

ORGANIC INSECTICIDES

BORDEAUX mixture and other copper sprays have received almost universal application as insecticides. The toxicity of these preparations experienced by certain fruit trees like peach, plum, cherry, apple, etc. necessitated the development of alternative fungicides with varying degrees of success. So far as inorganic fungicides are concerned lime-sulphur solution and elemental sulphur have only partially been able to replace copper sprays and Bordeaux mixture which are still reckoned as essential insecticides. Failure to find out suitable inorganic substitutes, however, has in recent years led to a comparatively successful development of synthetic organic compounds to be used as effective insecticides. The U. S. Department of Agriculture has so far prepared and studied some 2000 organic compounds to develop new organic insecticides which will have all the virtues of the present varieties in use, but none of their vices.

Phenothiazine appears to be the most promising agent first prepared in 1932. It is reported to have controlled various plant diseases, and offered them protection against insect activity. Its toxicity, so far as laboratory tests indicate, exceeds that of rotenone with regard to mosquito larvae. It satisfactorily controls cooling moth larvae and proves toxic to several insects of economic importance, such as tent caterpillar, the Mexican bean beetle, the grape berry moth, the European corn borer, the screw worm etc. It suffers from a lack of adherence which can be improved by finer grinding. Proper development of phenothiazine bids fair to replace lead arsenate as an effective insecticide. It is also expected to be available at a reasonable price.

β Pyridyl- α -piperidine (Neonicotine) is another compound developed by Smith, Richardson and Shepard, which is a good contact insecticide. The

product has subsequently been found to be present in a certain type of weed of the sugar beet family in the optically active form. Other organic insecticides on which tests have been performed with varying degrees of success are thiuram disulphides, diphenylamine derivatives, thiocarbamates, dinitro-compounds etc. These compounds have, however, no general applicability, but offer good control to certain specific plant injuries and fungus activities.

DEHYDRATED FOODS IN BRITAIN

PREVIOUSLY we have reported in these columns the progress of U. S. A. in the direction of the dehydration of food-stuffs. The demand for dried food, principally arising from a shortage of shipping space has led the Ministry of Food in Britain to encourage dehydration of raw meat, vegetables and other food-stuffs on a large scale. The extent of the demand is clearly exemplified in the fact that recently some 20,000 tons of hydrated butter have been ordered by the British Government from New Zealand. A large dehydration plant for drying and packing vegetables has been installed in London to meet this growing demand of dried foods.

Various dehydration methods are now in operation. The method followed by H. J. Heinz & Co., Ltd., in co-operation with the Ministry of Food, is capable of turning out 9 tons of dried potatoes from 80 tons of the same every week without any loss of nutritious value. The process consists in peeling off the skin of the potatoes with a machine lined with carborundum. The eyes are then extracted and the stuff cut into strips before they are subjected to boiling. The necessity of boiling is to inhibit the action of the enzymes and ensure good preservation. Drying is secured either by passing hot air over trays of potato strips, or by allowing the stuff to travel on a moving belt with hot air blowing through it, when the strips come out in the form of crisps and flakes. The temperature should be between 65°C to 88°C . The tins in which dried foods are to be packed should preferably contain nitrogen instead of air as they keep better in the atmosphere of inert nitrogen.

Food Preservation at Low Temperatures and under Controlled Atmosphere

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INTRODUCTION

BEFORE the advent of successful refrigerating machines, preservation of food usually meant cooking, canning and sometimes adding preservative chemicals too. Even today cooked and tinned food, condensed and dried milk, dehydrated potatoes, salted fish and meat, etc., are widely available, and they mean a good proportion in the world trade. But these processes of preservation make the articles widely different in taste and flavour as compared with those of fresh ones. It is the proper storage in cold alone that can keep the foodstuff in the natural fresh conditions provided they are stored at adequately regulated low temperatures, moisture and other atmospheric conditions.

ICE AND REFRIGERATING MACHINE FOR PRESERVATION

The preservative effect of cold on foodstuff is known from early times when the people harvested natural ice and stored them up in caves and in desert sands for the same purpose. In later dates the use of ice became more and more widespread through the improvements in the methods of its harvesting, storing and distribution. The first commercial shipment of natural ice was exported from Boston to West Indies in 1805. Even in these days of ice manufacture the use of natural ice is not altogether dispensed with. America has more than seven thousand ice factories, producing sixty million tons of ice each year. In addition, the natural ice supply is about seven and a half million tons, which means about eleven per cent of the total supply.

Commonly speaking, ice is a potent source of coldness. It can be carried from one place to another and used as a refrigerating agent in an ice box where foodstuffs can be kept for preservation. But ice is not a very convenient material as it melts, and is to be packed afresh. Further, ice does not leave

room for controlling the temperatures, so that ice boxes have been replaced by refrigerating machines. Such a machine, primarily for the manufacture of ice, was invented by the French scientist F. Carré in 1858 working with ammonia gas. The original Carré machine was subsequently improved upon by Mignon and Ronart in France, Vaso and Littman in Germany, Reece, Mort and others in England and Austria, and these improvements marked a new era in the modern technique of mechanical refrigeration. In these machines gases like ammonia, sulphur dioxide, methyl chloride, or freon, etc., are liquefied by suitable pressure through an electrically driven compressor. The liquefied gas is then evaporated at low pressure in copper pipes where intense cold or refrigeration effect is produced.

STORAGE TEMPERATURES

The reason why cold prevents decay will be understood if we look into the cause of rotting of a food article or of souring of milk. All of them—fruits, vegetables, fish, meat, milk, etc. contain micro-organisms, enzymes, bacteria, and their life's process continue under favourable conditions. These conditions include warmth, moisture, oxygen supply, initial bacterial content, etc. Under the ordinary conditions of temperature, moisture and atmosphere these processes go on briskly and make the articles stale and finally rot. The actual number on breeding and multiplying of the bacteria may be observed with interest in connexion with milk storage. The activities of enzymes, yeast, bacteria—which are all living organisms, are greatly retarded at lower temperatures.

Although the metabolic processes are retarded at lower and lower temperatures we cannot go too far down. Too much chilling of fruits and vegetables would cause internal breakdown and would depart

far from freshness to affect taste and flavour to a great extent. Thus too much refrigeration is detrimental, nor all the varieties keep at the same temperature. It has been found that different varieties of foodstuffs would keep at different coldness. The storage temperatures have been carefully determined for each of them. In the table below the storage temperatures for some of the food articles are given.

TABLE I
STORAGE TEMPERATURES FOR VARIOUS FOOD ARTICLES

Food Articles	Temperature	Food Articles	Temperature
Cabbage, Lettuce, ...	45°F.	Banana (ripe) ...	50°F.
Cucumber ...	35°	Banana (danger of chilling) below	49°
Cauliflower ...	36—40°	Mango ...	45—52°
Potato ...	55—60°	Milk ...	40—45°
Potato (Sweet) ...	50°	Butter ...	45—50°
Lemon, Orange ...	38—40°	Fish ...	30—35°
Apple ...	40—45°	Egg ...	38—45°
Melon, dried fruits ...	60—62°	Meat ...	38—42°
Banana for slow ripening ...			

HUMIDITY

Next to temperature, the condition of moisture in the storage chamber is also important for maintaining freshness of the commodities. Green vegetables and fruits are better kept at higher moisture conditions of about 80 to 90 per cent relative humidity, while meat, egg, confectionaries prefer comparatively dry atmosphere of 50—60 per cent humidity. For fruits and vegetables dry atmosphere would lead to more evaporation of water causing shrinkage. Attempts have been made to prevent the evaporation loss from fruits and vegetables by covering them with waxed papers, green leaves or moist linen inside the cold storage. Recently a method of coating fruit surfaces with some form of colloidal wax has proved useful.

Preservation of milk :—We have discussed the storage temperatures of various kinds of foodstuffs, but milk, meat and fish require special attention for obvious reasons. Milk is the only food for infants whose constitutions are delicate and susceptible, while it is also the best food for bacteria which can multiply in it at the ordinary conditions of storage. Milk is thus a very delicate article of food and should be handled very carefully.

Souring and curdling of milk is due to the growth of lactic acid producing bacteria which turns the milk-sugar into lactic acid. But this is not the

only type which increases rapidly in milk. Many diseases such as scarlet fever, cholera, diphtheria, septic sore throat, typhoid fever, tuberculosis and others have been traced definitely to contaminated milk.

The original bacterial content of milk depends upon various factors including health condition of the animal, hygienic way of milching, etc. The receptacle should be sterilized in steam or in the ultraviolet light. The method of pasteurization is now-a-days widely adopted in hygienic dairy farms. This is the method of killing most of the germs by holding the milk at a temperature 140°F or 60°C, for half an hour, then quickly chilling down to 40°F or 5°C. The chilling of the milk is brought about by allowing the hot milk to flow down over a series of zigzag tubings through which cold brine circulates from a refrigerator machine. The cold milk is then received in sterilized bottles or cans, and stored in a refrigerator at 40—45°F.

TABLE II
THE BACTERIAL GROWTH IN MILK AT DIFFERENT STORAGE TEMPERATURES

Condition of Milk	Bacteria per cubic centimetre.		
	At 40°F	At 50°F	At 60°F
Fresh ...	4,295	4,295	4,295
After 24 hours	4,138	13,961	1,587,333 (sour)
" 48 "	4,566	127,727	35,011,111 (")
" 72 "	8,247	5,725,277 (sour)	326,500,000 (")
" 96 "	19,693	39,490,625 (")	962,785,714 (")

According to the health authorities, milk containing more than 10,000 bacteria per cubic centimetre is injurious to an infant's health.

In a tropical country like India, the danger of contaminated milk is a serious matter. But the mothers do not hesitate to feed their babies with milk kept in cupboard for 10—12 hours. Their test for spoiled milk is to see if it curdles. The souring, as already mentioned, is due to one type of bacteria, the lactic acid forming ones, but there is absolutely no guarantee that other dangerous bacteria have not developed beyond tolerable limit before the milk has actually curdled.

Preservation of fish :—Fish is another commodity which stales down readily. From the table of storage

temperatures mentioned previously, it will be found that fish keeps well at ice temperature. Fish is generally exported in wooden boxes, packed together with broken ice, and can thus be sold within 12 or 18 hours of fishing. The quality of iced fish is however not so good. There are various reasons behind it. One is due to the fact that the fishes are badly hurled into boxes where they remain under their own weight and the weight of ice. Further, water from melting ice always soaks them. So, in spite of temperature control, the iced fish loses its quality and texture. This defect can be remedied through well designed cold storage and cold transport vans where the fish can be kept on properly spaced shelves. Closer chemical examination of iced fish has revealed that the protein in fish begins to lose its solubility at the ice temperature, and the tastelessness of iced fish is ascribed to this change. The solubility of the fish protein can be kept unaffected by suddenly chilling down to about -20°C (-4°F) and then holding them between -20 and -30°C (-4 and -22°F). Such low temperatures cannot be reached by ice, so that specially designed refrigerator is necessary for this purpose.

Preservation of Meat:—Meat, however, rots more slowly, but once rot it becomes dangerously poisonous. Meat keeps best between $38-42^{\circ}\text{F}$, but before storing, the pieces should be exposed to dry atmosphere, so that a dry crust may be formed over them. The crust provides a good protecting shield against contamination of bacteria seeking access into the meat.

GAS STORAGE OR STORAGE UNDER CONTROLLED ATMOSPHERE

Temperature and humidity are not the only things in food storage. It has already been pointed out that the metabolic processes which are responsible for bringing out the changes with time, can be retarded by controlling temperature, moisture and supply of oxygen and other gases. The micro-organisms need oxygen just the same as we need. Modern gas storage usually means lowering the oxygen content of the storage chamber by putting in some amount of carbon dioxide gas.

For keeping meat, about 10 per cent. carbon dioxide is quite suitable, while for vegetables it may vary from 20 to 30 per cent. The first commercial gas storage employing the combined control of temperature, oxygen and carbon dioxide of the enclosure was installed in Kent in 1928. The first shipment of gas-stored chilled beef and bacon was brought from

New Zealand to England in 1933. It is also interesting to note that the cubical space for gas storage of apples in England in 1928 was about 25 thousand cubic feet which rose to one million cubic feet in course of the first five years.

Carbon dioxide not only controls the decay but also retards the critical change of state in fruits preceding ripening—the state in which they begin to develop their characteristic odour and flavour. This 'climacteric change', as it is technically called, can be enhanced, on the contrary, by the introduction of ethylene vapour in the storage atmosphere. This is particularly useful when a large quantity of fruits are to be uniformly brought to the optimum stage of ripeness for good keeping.

Traces of ozone in the storage helps in removing strong odours of the ripening fruits. The odour laden atmosphere from one kind is harmful to themselves as well for other varieties kept in the same compartment. Small amount of ozone removes this difficulty. But in any case, banana should be stored in a separate compartment owing to its strong odour and fairly higher storage temperature.

Ammonia is a good disinfectant. It retards the germination of spores in the decay organisms which are invariably present on the surface of fruits and other things. The surface disinfection by the mildly ammoniated atmosphere prevents internal contamination and thus improves the keeping quality and time.

KEEPING TIME UNDER COLD STORAGE

The aim of refrigerated storage is to keep the articles in their natural state, unlike those of the cooled and tinned foods. The underlying principle, as already explained, is to retard the metabolic and bacterial progress at the low temperatures and under partially inactive atmosphere. The bacterial and metabolic activities can only be retarded by such control but cannot be stopped altogether. By cooking (as in tinned meat, fish, fruits, jam, etc.) or mixing preservatives (as sugar added to fruit crushes or skimmed condensed milk, etc.), the articles can be preserved, though not in their natural state, for a longer time. The keeping time under cold and gas storage can be lengthened ten times or more of its natural storage time, under ordinary conditions. For example, milk can be used with perfect safety even after three days if properly kept at -40°F . Mangoes can be stored for 25 to 45 days. Potatoes in tropics are much wasted in storing and transit. This can be saved by the

method of cold storage. There are varieties of lemons in this country. Lemon and orange crushes saved under cold storage would make a very profitable business. Thirty to fifty per cent of these fruits are wasted before they reach the customers.

DOMESTIC REFRIGERATORS FOR THE PREVENTION OF WASTAGE

A refrigerator for domestic use is considered here more as a luxury than necessity. It is true that the average people of India cannot afford to buy a refrigerator. But there are people who can. But they do not buy this machine simply because they have never paid attention to its usefulness. A little thought will show them its utility in avoiding the danger of stale food and milk. The machine will curtail a good proportion of daily wastage of food with which the housewives are often too much worried.

Small refrigerators of the domestic type are well suited for medical dispensaries in keeping vaccines, sera and some other medicines which are easily spoiled under the ordinary warmth.

LARGE INSTALLATIONS OF COLD STORAGE AND COLD TRANSPORT

Large installation of cold storage can be undertaken by businessmen, industrialists and the government, for profit and minimizing wastage of food products of the country. Growing more food is not helpful if it cannot be preserved till the time of consumption. In the stringent times of war it is of utmost importance to minimise wastage and to organise food storage and adequate means of distribution. This was why the Department of Scientific and Industrial Research Formed a Food Investigation Board during the last war to study these problems.

All mercantile vessels have cold storage for worldwide trading in fruits, fish, meat and other perishable commodities. It is also necessary for inland trade to set on cold transport systems, including railway and motor vans, particularly in a tropical country like India where she is so much gifted with the bounties of Nature with all her blossoms, fruits and greens. It is also a very great problem as to the transport of fish. Until cold vans are planned up the huge wastage will continue in its accustomed way.

PLASTICS FROM BAGASSE

Bagasse, the fibrous portion of the sugar cane, is a waste product in sugar mills. It is usually burnt in Indian Sugar Mills to raise steam for the generation of power. With a high ash content, it is scarcely an ideal fuel; lumps of gas-like materials are formed during combustion. Bagasse is now employed for making wall boards known as 'celotex', in Louisiana and Hawaii. But the quantity available is so large that a new use has recently been discovered for it.

Thermosetting moulding powders from synthetic plastics usually contain a filler to the extent of about 50%. Vegetable waste materials like cornstalks, sawdust, oat or wheat straw, etc. in finely powdered form are generally used as the filling materials. Bagasse has been found quite suitable for a wide range of plastics products of low cost. Valentine sugars of Lockport, La are now manufacturing plastics moulding powder of bagasse. For this purpose, the bagasse from the sugar mills is baled, dried and ground into a fine powder, and treated with appropriate chemicals. It is fine enough to pass through a No. 16 mesh sieve. It is moulded at high temperature and under high pressure. Coal-black plastics, non-combustible and with a very high tensile strength (about 13,000 lbs. per sq. in.) are thus produced.

U. S. Department of Agriculture points out that sugar cane grows more fibre to the acre (about 20 tons per acre) than cornstalks, oat straw, wheat straw, hay, etc. (between 1,000 to 3,000 lbs. only per acre). It is therefore more economic to use bagasse.

An acceptable grade of alpha-cellulose may be obtained from bagasse. It was reported from Japan some time back that cellulose from bagasse is quite suitable for the manufacture of viscose silk.

MEDICINE & PUBLIC HEALTH

TRAINING OF MEDICAL AND AUXILIARY PERSONNEL IN GERMANY DURING THE WAR

By a decree of the 8th April, 1940, Hitler granted an amnesty to doctors, dentists, veterinary officers and pharmacists who had been convicted for certain professional offences committed before the 1st September, 1939. For doctors, the amnesty rescinded the temporary or permanent prohibition of practice, except in cases where the doctor had been found "unworthy of exercising the healing art". The order of the Minister of the Interior of the 17th July 1939, on the requirements for a medical diploma, reduced the course of medical studies from 11 to 10 semesters and suppressed the compulsory period of a year in a hospital service at the end of the course. It introduced, on the other hand:—

(a) A period of six months as a nurse-attendant in a recognized hospital. Persons liable to military service can fulfil this stage in a sanitary unit of the Army.

(b) A period of six weeks in a rural or factory Medical Service;

(c) A compulsory period of six months, or preferably two periods of three months, as an "apprentice" (famulus) in a Medical, Surgical, or Obstetric Department of a recognized hospital.

This stage must take place during the holiday period. Each apprentice will be allotted at least 30 beds and it is desirable that he should be lodged and fed at the hospital.

From the 1st October, 1939, it seemed necessary, in order to speed up the syllabus, to replace the system of six-monthly terms by that of three-monthly terms in secondary teaching establishments. This is only a temporary measure. It follows from this that the practical stages (as hospital attendant or apprentice) can no longer be done during the vacations, and definite three months must be allotted to them (the second trimester in 1940).

By the circular of the Minister of Science and Popular Education of the 20th October, 1939, theses required to obtain the title of the Doctor of Medicine must thenceforth be submitted to a Commission of the Party if they deal with subjects related to the direction, history or organization of the National Socialist movement. A reminder is also given that *Jewish authors may be quoted only if that is absolutely necessary for scientific exactitude; in such cases the fact that non-Aryans are quoted must always be specified and their works must be placed in a special category in the index of authors cited.* A circular of the 18th March, 1940, of the Minister of the Interior authorized, in cases of necessity, administrative authorities to transfer doctors temporarily, with the agreement of the local Medical Chamber, to allow them to give medical care to the civil population of other areas. They may be employed either in a hospital service, in private practice or in insurance work. Their removal expenses will be repaid and the doctor's family may receive an allowance.

A circular of the 6th September, 1939, states that the need for hospital beds cannot fail to increase and that, in consequence, the number of maternity cases treated in hospitals must be reduced as far as possible, except as regards teaching hospitals. It is better that the confinement should be carried out at home under the care of a midwife than that it should take place in a hospital filled with miscellaneous cases.

CENSUS OF MEDICAL PERSONNEL IN GERMANY

A circular of the 14th March, 1940, orders a census of all medical and auxiliary personnel to be carried out, in the following way:—

In the card index of the population of the Reich, the individual cards of doctors, dentists, veterinary officers (whether in practice or not), male and female nurses of every kind, midwives, masseurs, laboratory assistants, disinfectors and "visiteurs des morts" will be marked with a distinctive sign. The names of such persons will be given to the Health Office of the

area of residence, and every change of address must be notified.

The profession of children's nurse was codified for the whole Reich by the Order of the 15th November, 1939. Training for a period of 18 months is given in special schools recognized by the State. To obtain admission, the student must prove that he has spent a year in household duties, including cooking, in a family or institution. After the State examination, the candidate must spend a period of six months in a children's hospital, and be attached for a further six months to a child welfare service before being able to practise her profession, which is subject to the obligation of professional secrecy. These new regulations devoting particular care to children have been introduced with the special object of preventing the present war from having the serious repercussions on the future of the nation that were caused by the last War.

The order of the 17th February, 1940, created two classes of laboratory assistant,—sub-assistant and assistant medical technician. The course of studies

is a year for sub-assistants, with a State examination including the following subjects:—radiography, physiological chemistry, anatomy and physiology, physio-therapy, general and racial hygiene, shorthand-typing and administration. For assistant technicians, the course of studies lasts for two years and the State examination includes, in addition to the subjects mentioned above, the application of radium, bacteriology, serology, haematology, histology and chemistry.

Under an order of the 25th September, 1939, the student-pharmacist must spend, after or before his final examination, a period of 4 months in a dispensary with no other assistant. Pharmacists will give board and lodging to the pupil but will not pay him any salary. This apprenticeship may be divided into periods of at least one month; it must be performed during the vacations. The Ministry of the Interior will draw up the list of pharmacies where such periods of work may be performed, and the distribution of the pupils will be made by the Reich Chamber of Pharmacists.—(From the *Bulletin of War Medicine*, Vol. II, No. 1, 1941, Medical Research Council, England.)

Medicinal Importance of Ergot and Need for its Cultivation in India

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HISTORICAL AND GENERAL

ERGOT is the compact mycelium of the fungus, *Claviceps purpurea* (Fig. 1) which develops in the ovary of the rye (*Secale cereale*, N.O. Gramineae). Its action on the human uterus came to be recognised nearly four centuries ago through widespread epidemics of disease called 'ergotism' which resulted from eating bread made of rye infected with the fungus. Frequent abortions occurred in women sufferers during

these outbreaks and this naturally attracted pointed attention to the possible role which this fungus might play in bringing about uterine stimulation. The earliest authentic reference to the medicinal use of ergot was made by Adam Lonicer (Clark, 1927) who stated that ergot powder was very efficient in bringing on 'labour pains'. In the seventeenth century, ergot was used extensively for the purpose of criminal abortion and as a consequence its use was forbidden by many authorities. It was however reintroduced in

the eighteenth century, and gradually found a recognized application in obstetrical practice. Its entry into British official medicine dates from a brief re-



FIG. 1. *Claviceps purpurea* on Rye grass. This yields Ergot, a valuable medicine.

ference by Parmentier (Barger, 1931) and more particularly from a detailed paper by Desgranges, an obstetrician of Lyons in France. Papers on the pro-

perties of ergot by Stearns (Barger, 1931) and by Prescott (Barger, 1931) of America were also responsible for giving an impetus to its adoption in the British Pharmacopoeia.

It is interesting to note that though many other medicinal herbs and drugs of various kinds were used all over the world for their oxytocic properties in labour and the puerperium, most of them are lost to-day, with the exception of ergot which is still serving mankind.

CHEMISTRY OF ERGOT

The ergot fungus has the peculiar property of developing in the ovary of the rye a large number of chemical substances. In fact, ergot may be said to be a veritable storehouse of active principles, as will be seen from Table I.

Amongst the substances referred to in the table the two chief groups of substances which have been considered responsible for the characteristic action of ergot are (1) the amines and (2) the alkaloids. Though the amines are almost always found associated with ergot preparations, they are not specific for the drug and are seldom found in freshly collected specimens. These amines are really produced as a result of putrefaction in extracts of both animal and plant origin. *Histamine* and *tyramine* are the most important amines of the group and it has been shown fairly conclusively that both of them are effective only when injected subcutaneously, intramuscularly or intravenously but are destroyed either in the gastrointestinal tract or in the liver when introduced though the oral route. Even when administered hypodermically, histamine produces only a very tran-

TABLE I.
CONSTITUENTS OF ERGOT

(A) Amines			(B) Alkaloids	(C) Other simple bases		(D) Sterols	(E) Inert extractives	
(1) Isoamylamine (2) Tyramine (3) Histamine (4) Cadaverine (5) Agmatine (6) Guanidobutylamine	Decarboxylation products of	←Leucine	(1) Ergotoxine ⇌ Ergotinine	Choline	Decomposition products of	←Lecithin of rye ovary ←Thiohistidine	Ergosterol Fungisterol	(1) Fixed oil (10 to 35%).
←Tyrosine		(2) Ergotamine ⇌ Ergotaminine	Acetylcholine	(2) Colouring principle (sclerorhythrin)				
←Histidine		(3) Ergometrine ⇌ Ergometrinine	Ergothioneine	(3) Inorganic salts.				
←Lysine		(4) Ergosine ⇌ Ergosinine	Uracil	(4) Complex proteinogenous substances.				
←Arginine		(5) Ergocristine ⇌ Ergocristinine	Guanosine					
		(Pharmacologically active members) (Pharmacologically inactive isomers)						

sitory effect upon the uterus of experimental animals, and it is believed that the doses required as a parturient would be so large as to be dangerous on account of the depressant effect of histamine on blood pressure. As ergot preparations are definitely proved to be active by the oral route, it is clear that this activity does not lie in its amine content. *The amines, therefore, cannot be the clinically useful constituents of ergot.*

It is now generally agreed that ergot, like many other substances of natural origin, owes its characteristic effects to the presence of the *alkaloids*. A number of these alkaloids had been isolated from it at wide intervals over a period of 60 years from 1875-1935, but the exact relationships of these alkaloids to each other and to the activity of the drug as a whole were not clearly understood. The rapid and remarkable advances in our knowledge of ergot alkaloids within recent years through the researches of Jacobs and Craig (1934-36) in America, Barger (1937), Smith and Timmis (1936) in England, and Stoll and Burckhardt (1935, 1937) in Switzerland have however clarified the problem a good deal. It is now possible to state that ergot contains five pairs of interconvertible isomerides [Table I, (B)] which differ from each other in chemical composition and physical properties. All these alkaloids are soluble in organic solvents, except petroleum ether. Most of them again are insoluble in water with the exception of two alkaloids, ergometrine—ergometrinine which are soluble. All the five pairs of isomeric alkaloids are particularly well characterised, are now available in crystalline form and their molecular formulae have been established and confirmed by hydrolysis. Each pair consists of a laevo-rotatory alkaloid having a powerful pharmacological action and a strongly dextro-rotatory one with but little pharmacological activity. The inert alkaloids are sparingly soluble in organic solvents and crystallize readily without the solvent of crystallization. The chemical constitution of the various pairs has also been successfully investigated by Smith and Timmis in England and Jacobs and Craig in America and it has been established that they are all derivatives of *lysergic acid*, $C_{18}H_{19}O_2N_2$. Although lysergic acid can be obtained in relatively large quantities in pure, crystalline form from any or all of the individual alkaloids, the determination of its structure has not been easy, and consequently successful synthesis of the important ergot alkaloids has not yet been achieved.

MEDICINAL USE OF ERGOT

Each of the alkaloids of ergot has actions that differ slightly from each other. It is the combined

action that is usually utilized in ergot preparations. Edmunds and Gunn (1934) point out that the purified alkaloids may have certain beneficial effects but that the extracts are perhaps the best of all, since they give a combined action. Mukerji (1938) has also shown that standardised powdered drug is preferable to isolated and purified constituents, particularly as far as its use in India is concerned. *The most important action of ergot is, of course, on the uterus.* It causes powerful contractions of the uterus, which last for a short time and is followed by slow relaxation of the organ. This relaxation is interrupted by new contractions, which create a rather lasting contracted effect on the organ. If the uterus is at rest, doses of ergot will cause it to undergo rhythmic contractions. (See Graphs, Figs. 2 and 3). It is also valuable in the late stages of labour.

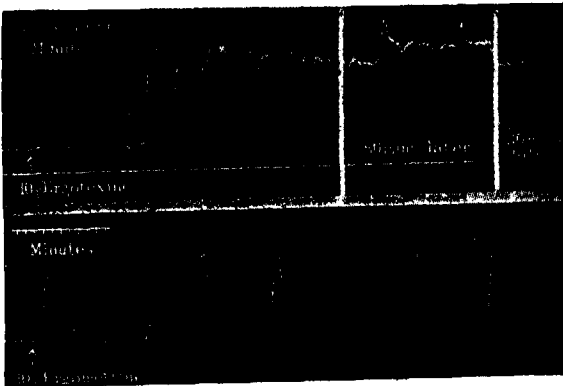


FIG. 2. Records of uteri *in situ* of two guinea-pigs about 12 hours *post-partum*. Upper, 10 ergotoxine intravenously. Lower, 10 ergometrine intravenously. (Note the different types of uterine stimulation produced by ergotoxine and ergometrine.)

It is in the prevention and control of post-partum haemorrhage, that ergot plays a vital role. After delivery of the placenta, the administration of ergot in fairly large doses keeps the uterus contracted and the blood vessels closed. Indeed, it is the oxytocic *par excellence*, as it is the only effective drug which can be given by the mouth. Even midwives can use it with impunity to stop fatal post-partum haemorrhage in outlying places where medical aid is either not available or not easily forthcoming.

Ergot also acts on other types of haemorrhage, in which the bleeding point cannot be reached. Bleeding of the stomach, intestines, kidneys and lungs, are often treated by means of ergot. It is believed that the drug contracts the ends of blood vessels and arterioles, and thus arrests the blood flow.

One of the ergot salts that has received wide attention for its valuable clinical applications is ergotamine tartrate. This salt has been found particularly useful in the treatment of periodic sick headache known as 'migraine'.

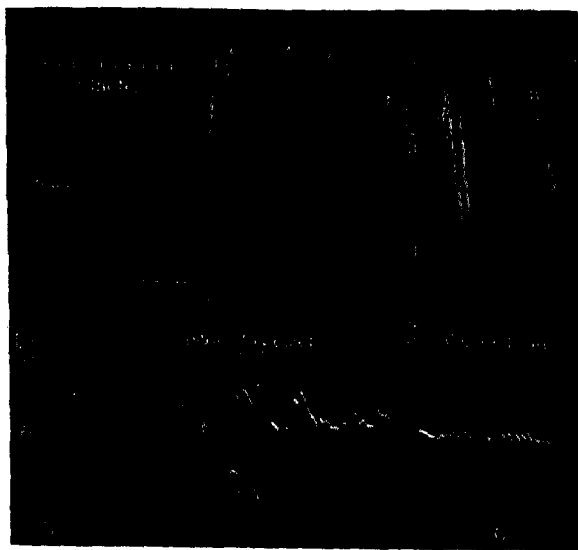


FIG. 3. Decerebrate Cat. 3 kg. 24 hours *post-partum*. Record of uterus *in situ* and blood pressure A, uterus pinched. B, 0.5 ergometrine i.v. C, 35 minutes later. (Note the increase in amplitude and in frequency of the uterine contractions after ergometrine in parturient cat uterus. The effect remains apparently unaltered at the end of 35 minutes.)

SOURCES OF ERGOT

The original home of ergot is Spain. By systematic research, Portugal, Hungary and Russia have been able to produce it on a commercial scale. Until recently, these countries were deriving considerable revenue from the export of ergot to all other parts of the world. The occurrence of ergot on some of its hosts has been reported from time to time from Great Britain, Germany, New Zealand and America but until recently, no systematic efforts appear to have been made to promote its cultivation in these areas.

Ergot is not indigenous to India, though one or two varieties with very small-sized sclerotia have recently been reported (Pushkar Nath and Padwick, 1941). Like many other countries, India is entirely dependent on foreign supplies. Thousands of pounds of ergot were used to be imported into India during the pre-war days and it always fetched a fancy price. Due to shipping difficulties, imports are almost restricted now and the prices have reached almost astronomical figures. For such an essential drug as ergot, *no satisfactory substitute which can be given*

by the mouth has yet been discovered. Posterior Pituitary Extract, which has many of the properties and uses of ergot, is often used by medical practitioners but this has to be injected parenterally, and there is considerable danger in allowing such a potent preparation to be employed by comparatively illiterate midwives in rural areas.

ARTIFICIAL PRODUCTION OF ERGOT

Several strains of ergot fungus have been identified. It is most common on rye, and only rarely of economic importance on grasses, wheat, oats, and barley. Ergot does not seem to have so general a prevalence as some of the other cereal diseases, e.g., rust, smut, etc., but shows a more local occurrence. Wild ryes are more susceptible than cultivated ones, because in their case glumes remain open. Mycologists have experience that cereals with closed glumes are generally very resistant as the principal seat of infection is the point of insertion of ovary and not the stigmas or the free wall of the ovary. Under these circumstances if the inoculated plots of rye are carefully segregated off at a safe distance, i.e., if plots are carefully selected, there is very little chance of infection spreading to the staple crops. Ergot disease in Russia and Siberia has been reported to be localised in sheltered valleys. It is therefore quite safe to undertake its artificial production in any country with suitable climatic conditions.

A proposal for the production of ergot in England has been enthusiastically taken up last year (*Nature*, 1941). Large quantities of ergot are imported and consumed by the British drug manufacturing concerns and the closure of the Spanish market has affected British trade in pharmaceuticals considerably. Already plans have been carefully laid for its experimental cultivation in Wales and certain districts in the West coast of England, and research workers are devoting particular attention to the selection of the species and the strain of the fungus for this purpose. The alkaloidal content depends largely on the *strain* of ergot selected for cultivation and commercial success of any undertaking would naturally depend on this important factor. Micro-methods of evaluating the alkaloidal content (both water-insoluble, ergotoxine group and water-soluble, ergometrine group) of individual sclerotia have been devised and cultivation experiments are being controlled on this basis.

Recently successful attempts are reported to have been made in Australia for growing ergot on a large scale. Following representations from the British Government for supplies of ergot during the

war period, steps were taken by the Department of Agriculture, New South Wales, for the artificial production of ergot and this effort has succeeded partially (Hynes, 1941).

An outline of the experiment may be included here with advantage. Cultures were made from conidia of the ergot. The best fungus growth occurred on rye to which 300 mls of water had been added prior to sterilisation. Almost as good growth was obtained rye + oats to which 300 mls of water were added. In general, after three weeks the fungus completely penetrated the rye medium, and microscopic examination showed that sporulation was abundant. These cultures were kept in quart bottles and despatched in cardboard cartons. A set of directions was issued with each carton containing the culture. As many as 28 growers from various localities of the State co-operated in this project, using cultures provided *gratis* by the Department of Agriculture, New South Wales. The total acreage inoculated was 200, averaging about 7 acres per grower. Ergots developed in most instances—even in the driest area sown to rye. Most probably dry seasonal conditions were responsible for the low production of ergots in the dry areas compared to the more wet areas. From a large series of experiments, it was concluded that inoculation during the early flowering period of rye was the most satisfactory. These inoculations were successfully carried out by means of spraying water containing conidia in enormous quantity. On analysis, the alkaloidal content of the ergots so formed was found to be well above the minimum strength of the British Pharmacopoeia, 1932. The conclusions reached from the above investigation are worthy of record here. "It is apparent that ergots of high quality can be produced artificially in New South Wales, but the chief limiting factor to success on a commercial scale is the uncertainty of the weather conditions when the rye comes into flower. Only in cooler and moister localities can the project be considered. Attention ought to be paid particularly to quantity of inoculum and double applications of spray."

As an alternative to the spray technique, the injection-inoculation method of Bekesy (1938, 1939) is worthy of a trial. It is probable that direct injection of spores into the young ears before the glumes open would give more uniform infection under varying climatic conditions.

ARTIFICIAL PRODUCTION OF ERGOT IN THE LABORATORY

Bonns (1922) demonstrated the development of the conidial stage directly from the sclerotium without

germination and without formation of ascospores. Several workers have been able to produce sclerotia-like structures in artificial cultures, and according to McCrea (1931), "It has been proved for the first time that this fungus develops in saprophytic culture, the active principles which are characteristic of extracts made from the natural sclerotia, viz., ergotoxine, histamine and tyramine." In 1935, Jaretsky (1935) reported the results of growing ergot on agar. Recently a patent was granted (U. S. Pat. No. 2,056,360) on methods and several media for artificial growing and collecting the ergot fungus. Methods for defatting, extracting and testing are the same as those in use for the naturally grown parasite.

POSSIBILITY OF ERGOT CULTIVATION IN INDIA

It is possible to utilize the experiences of Australian growers and cultivate ergot on a large scale in India, provided certain amount of research is first conducted. Of course, there are several steps in such an attempt. These are mainly, (1) preparation of culture of the fungus (*Claviceps purpurea* (Fr) Tul.), (2) cultivation of rye, oats, wheat and barley, (3) inoculation-experiments on these host plants, (4) chemical and pharmacological experiments on the ergots obtained.

The conidial stage of ergot (termed *sphacelia*) can be cultured on synthetic media and stored at low temperatures (Melvil'e, 1941). When the glumes of rye open and the anthers are exerted out, they can be infected with the conidiospores. Infection can also be secured by means of ascospores. A sclerotium on germination gives rise to stalked stromata. Inside these stromata are formed asci containing ascospores.

A field near Shillong can be selected for trial experiments. It enjoys a temperate climate, and heavy rainfall. The physical features and some of the meteorological conditions of Shillong bear comparison with those of New South Wales in Australia. This region has a warm temperate climate, with a rainfall record varying between 20-40 inches per year. Tall Eucalyptus trees adorn its landscape. Wheat, maize and sugarcane are the principal crops grown in these areas. Nearly the same type of landscape, vegetation, and meteorological conditions are reported to prevail in Shillong, and therefore field trials can be taken up here with reasonable promise of success.

It is necessary at the outset to carry on certain amount of research in the laboratory before undertaking field trials on a comprehensive scale. Already work has been started at the Botanical Laboratory of

the Carmichael Medical College, under Prof. S. R. Bose. In a few cases, stalked stromata have been found to grow out of ergot sclerotia in culture. Further experiments to secure regular germination of ergot under controlled conditions are in progress.

CONCLUSION

The medicinal and economic importance of ergot justifies attempts at its production in India where it is not *indigenous* in the conventional sense of the word. In view of the fact that successful production have been possible in certain European countries which were not the original homes of ergot and in view of the fact that partial success in its artificial production has already been obtained in Australia, there seems good ground to feel that similar attempts would also succeed in India, if proper precautions are taken and already known difficulties in its cultivation are recognised and adequately faced. Reports of ergot damaging crop plants are few and there need be no apprehension in this regard. Artificial cultivation in the laboratory has also been reported and this is well worth further investigation in India. Though the chief breakdown product of ergot (lysergic acid) is now known, successful synthesis of ergot alkaloids has not yet been achieved. It is enjoined that organizations such as the Imperial Council of Agricultural Research, etc., should look into this problem and institute proper investigations for the production of ergot in India, if possible. This will not only prevent a heavy drain of the country's financial

resources but will also confer lasting benefit on the suffering motherhood of India.*

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* The authors are grateful to Prof. S. R. Bose, D.Sc., F.R.S.E., F.N.I., etc., Head of the Department of Botany, Carmichael Medical College, Calcutta, for advice, suggestions and criticisms.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

ON ALEURITIC ACID

Ethyl 16-methoxy- Δ^9 -hexadecenoate¹ B.P. 205°/7mm, was demethoxylated by heating with concentrated HCl in presence of glacial acetic acid in a sealed tube at 160°-180° for six hours. The resulting 16-chloro- Δ^9 -hexadecenoic acid was extracted with ether washed with water, dried and freed from the solvent by heating on the water-bath. The residue was thoroughly dried in a vacuum.

The chloro-acid was esterified by refluxing on the water-bath with absolute alcohol and concentrated sulphuric acid for 24 hours. The ester was extracted with ether, washed with dilute sodium bicarbonate solution and then with water, dried and then the solvent was removed on the water-bath. The chloro-ester distilled at 184°/5mm.

It was next converted into the corresponding acetoxy-derivative by gently refluxing with a glacial acetic acid solution of fused potassium acetate for forty hours. The product was poured into ice water, extracted several times with ether, washed successively with sodium bicarbonate solution and water, dried and the residue distilled after removing the solvent. B.P. 185-190°/3 mm.

Ethyl-16-acetoxy- Δ^9 -hexadecenoate was oxidised in glacial acetic acid solution with 30% H₂O₂ in the following way:—

The solution of H₂O₂ and glacial acetic acid (distilled over CrO₃) was heated on the water-bath at a temperature of 80° for one hour. The solution was then cooled to about 30° and the acetoxy-ester added. The starting of the reaction was indicated by a rise in the temperature of the solution. The mixture was allowed to stand over-night and then freed from acetic acid by steam distillation. The product was extracted with ether and the extract washed and dried. Ethyl-16-acetoxy-9,10-dihydroxy hexadecenoate was obtained as a pale yellow semi-solid mass.

It was subjected to hydrolysis with alcoholic potash and the yellow coloured product obtained on acidification was purified by crystallisation from ethyl acetate (charcoal). The product melted at 125°C. Aleuritic acid from natural sources melts at 100-101. Mixed M.P. with the natural product is 101° C.

Found C, 63.28; H, 10.45. C₁₈H₃₂O₅ requires C, 63.15; H, 10.52.

The synthetic product is very probably a geometrical isomer of the natural product.

Our thanks are due to Mr N. Ghosh, M.Sc. for the micro-analyses of some of the compounds.

P. C. MITTER

A. BOSE

M. SEN GUPTA

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University College of Science,
Calcutta, 2-11-1942.

¹ Mitter and Mukherji, *J. I. C. S.*, 19, 303, 1942.

A GYMNOSPERMOUS FOSSIL WOOD FROM BURMA

In 1925 the Geological Survey of India presented a set of specimens to the Geology Department, Presidency College, Calcutta. The collection included a fossil wood (Fig. 1) from Burma, which has been handed over to the writer for investigation and report. The definite locality of the fossil wood is not known except that it was collected from somewhere in Upper Burma.

The specimen is barely 6" long with a diameter of 2". It is completely silicified. The preservation is perfect so much so that it permits a detailed ana-

tomical study. The important anatomical features of the wood are given below:—

Growth ring is distinct. The autumn wood is darker in colour than the spring wood. Tracheids with resins present. Tracheids adjacent to the



FIG. 1. Transverse section showing the general structure of the wood. $\times 30$.

medullary rays are always broader than other. Pits on the radial walls show much variation in their arrangements. Pores, large, circular and elliptical. Bordered pits present. Medullary rays are generally uniseriate with biseriate in the middle.

The above anatomical features of the wood agrees with those of the coniferalis (*Aurocarioxylon*). Detail anatomical description of the fossil wood will be published elsewhere later on.

Thanks are due to Prof. Agharkar of the Calcutta University and Dr M. Chatterjee of the Geology Department, Presidency College, Calcutta, for facilities given to me to work in their respective laboratories. I am also indebted to Mr A. K. Ghosh of the Botany Department, Calcutta University for his helpful criticism.

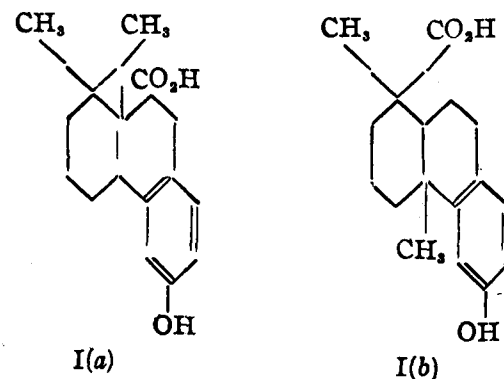
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Calcutta, 28-10-42.

SYNTHETICAL INVESTIGATION ON PODOCARPIC ACID

Podocarpic acid was first isolated in 1873 by Oudemann¹ from the resin of *Podocarpus Cupressinus*. Sherwood and Short² studied the compound and suggested the formula I(a) as the probable structure, on the basis of the evidence that 6-hydroxy-1-methylphenanthrene is obtained in good yield by dehydrogenation of podocarpic acid and that the carboxyl

group of it is much more highly hindered than that of the other resin acids. It was only, recently however, Campbell and Todd³ have conclusively proved that podocarpic acid is correctly represented by the formula I (b).



Following work has been undertaken with a view to synthesising podocarpic acid along the line adopted by Howarth and Baker⁴ for the synthesis of dehydroabietic acid.

The Grignard complex obtained from β -(p-methoxyphenyl)-ethyl-chloride was allowed to react on ethyl-2, 6-dimethyl-cyclohexanone-6-carboxylate when a mixture of unsaturated and hydroxy compounds b.p. 180-200°/3 m.m. was obtained in poor yield. The mixture was dehydrated with potassium-hydrogen-sulphate at 180° for 2 hours and I-(β -p-methoxyphenyl-ethyl)-2, 6-dimethyl-6-carbomethoxy- Δ^1 -cyclohexene was obtained boiling at 180°/3.5 mm. ($[n]_D^{25}$ 1.5266). The above unsaturated ester on refluxing with a mixture of acetic acid and sulphuric acid for 1 hour and subsequent treatment with 20 per cent methyl-alcoholic potash yielded the I, 12-dimethyl-6-methoxy-1, 2, 3, 4, 9, 10, 11, 12-octahydro-phenanthrene-1-carboxylic acid m.p. 193°-194°. The ethyl ester of the acid was boiled at 170°/3 mm. ($[n]_D^{25}$ 1.5120). The resolution of the de-methylated racemic acid is in progress.

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 B. Bishui, M.Sc. of the Palit Laboratory of Physics for determining the refractive indices.

BIDYUT KAMAL BHATTACHARYYA

Palit Laboratory of Chemistry,
University College of Science,
Calcutta, 6-11-1942.

¹ Ber., 6, 1122, 1873; Ann., 170, 214, 1873.
² J. C. S., 1006, 1938.
³ J. A. C. S., 64, 928, 1942.
⁴ J. C. S., 1299, 1939.

MAGNETIC SUSCEPTIBILITY OF ANTIMONY CRYSTAL

The magnetic susceptibility of antimony crystal has been measured by McLean and Cohen¹, de Haas and Van Alphen², Shoenberg and Zaki Uddin³, Zaki Uddin⁴, John⁵ and Brown and Lane⁶.

We give below the results obtained by various investigators:—

AUTHORS	M & C ⁽¹⁾		H & A ⁽²⁾		S & Z ⁽³⁾		Z ⁽⁴⁾		J ⁽⁵⁾		B & L ⁽⁶⁾	
	290°K	90°K	290°K	90°K	290°K	90°K	290°K	90°K	573°K 303°K		290°K	90°K
$\chi_1 \times 10^6$	-0.63	-0.63	-0.66	-0.65	-0.55	-0.55	-0.55	-0.55	Susceptibility $\perp$ trigonal axis remains constant over whole range of temp. Susceptibility along axis which is larger than the former by about 1.00×10^{-6} per gm. at room temp., decreases numerically with temp., almost linearly at the rate of 1.42×10^{-9} per 1°C.		-0.51	...
$\chi_2 \times 10^6$	-1.13	-1.13	...	..	-1.42	-1.72	-1.42	-1.72			-0.51	...

While working at the Royal Society Mond Laboratory of the University of Cambridge, I prepared another crystal of antimony and measured its susceptibility at 288°K, using a modified Sucksmith Balance and Faraday Method. The method of preparing the crystal and measurement of susceptibility was the same as described in (3) and (4).⁷ This particular sample of antimony was supplied by Adam Hilger Ltd., London and did not contain impurities.

The values of χ_1 and χ_2 at 288°K was found to be -0.52×10^{-6} and -1.40×10^{-6} , respectively.

M. ZAKI UDDIN

Physical Laboratory,
Aligarh, 15-10-1942.

¹ McLennan & Cohen, *Trans. Roy. Soc., Can.*, 23, 159, 1929.
² de Haas and Van Alphen, *Leiden Comm.* No. 225 b, 1933.
³ D. Shoenberg and M. Zaki Uddin, *Camb. Phil. Soc. Proc.*, 32, 499, 1936.
⁴ M. Zaki Uddin, *Cambridge Dissertation*, 1938.
⁵ W. J. John, *Physics Abstracts, Proc. Indian Sci. Cong.*, p. 30, 1940.
⁶ S. A. Browne and C. T. Lane, *Phys. Rev.*, 59, 939, 1941; 60, 895, 1941.
⁷ D. Shoenberg and M. Zaki Uddin, *Proc. Roy. Soc. (A)*, 156, 687, 1936.

"ECONOMIC USES OF FUNGI"—A COMMENT

I have read with keen interest the article on the "Economic uses of Fungi" by S. P. Ray Chaudhuri in the June issue of your journal Vol. VII, pp. 594-596, 1941-42. In the article Ray Chaudhuri has stated "The fixation of nitrogen in the soil which is accomplished by some of the fungi is an important factor in modern agriculture".

It seems that the author has overlooked many points in this much debated and complicated problem and is rather bold in suggesting that nitrogen fixation by fungi is an important factor in modern agriculture.

Recently in a paper on "Fixation of atmospheric nitrogen in living forms", Bhaskaran, T. R. and Pillai, S. C.¹ have reviewed exhaustively the work on Nitrogen fixation by Bacteria, and the higher forms e.g., algae yeasts, fungi, actinomycetes and other higher plants.

Lipman (1910) showed that certain species of yeasts and pseudo-yeasts have the power of nitrogen fixation in tap water solution containing dextrose. Fulmer (1923) also showed that *saccharomyces cerevisiae* will grow in an apparently good state of nutrition using atmospheric nitrogen as the sole source of nitrogen. Other workers however have failed to observe any fixation by yeast at all, e.g., nitrogen fixation by yeast was found to be negative by Kossowicz². In respect of yeasts therefore there seems to exist a good deal of controversy.

In other cases of fungi Froenlich (1907) found that several strains of fungi fixed from 1.1-4.5 mg. of nitrogen, the amount of nitrogen fixed per gram of dextrose being 2.5-8.9. Stabel (1911) has reported that 9 out of 54 strains showed fixation of nitrogen.

Schober (1930) found that all six strains of *Aspergillus* fixed up to 4 mg. of nitrogen in 100 c.c. medium contained 5 per cent. sugar. On the other hand Kadelbach (1931) and Schroder (1931) have failed to confirm this observation. Chambers (1916) has adduced evidence to show that no nitrogen is fixed by the free-living fungi, *Aspergillus niger* and *Penicillium glaucum*. Waterman (1913), Goddard (1913) and Duggar and Davis (1916) have also obtained negative evidence in regard to nitrogen fixation by free-living fungi. More recently, Allison *et al* (1934) have concluded that free-living fungi and actinomyces do not fix nitrogen. It may be stated in Russel's³ own words "while fungi can assimilate ammonia and change it into protein they have no power of converting it into nitrite or nitrate, nor has it been proved that any of them can fix gaseous nitrogen excepting, perhaps, *Phoma radialis*, the mycorrhiza associated with the *Ericaceae*".

According to Waksman⁴ "various claims have been put forth, at different times, that fungi are able to assimilate atmospheric nitrogen. In most cases the quantities fixed were very small, amounting to a few milligrams, so that doubt might arise whether this was not due merely to experimental errors. In some cases the mere fact that fungi grew on agar free from nitrogen compounds was taken as an index of positive nitrogen-fixation, the fact being overlooked thereby that some of these organisms can readily assimilate traces of ammonia present in the atmosphere and that various chemicals may contain, as impurities, small amounts of nitrogen. The more careful studies of recent investigators have definitely established the fact that common soil fungi are unable to fix atmospheric nitrogen".

More evidence is necessary to overthrow the observations of such eminent workers and attribute to the fungi an important role in modern agriculture as nitrogen fixers.

So far as present knowledge goes the function of fungi in agriculture in the formation of humus is in keeping the decomposition processes going when the conditions are unfavourable for actinomyces and bacteria to act effectively. The decomposition of cellulose and the assimilation of ammonia and nitrate, so long as it involves no competition with crop plants, are certainly beneficial for the soil fertility.

In modern agriculture certainly factors for nitrogen fixation are many and varied but that by

fungi has not yet been considered to be an important one.

T. C. Roy

Dept. of Agriculture, Bengal,
Tezgaon, Dacca, 28-7-1942.

¹ Bhaskaran, T. R. and Pillai, S. C., *Ind. Jour. Agric. Sci.*, Vol. XIII, Pt. I, 1942.

² Kossowicz, A., *Biochem. Ztschr.*, 64, 82, 1914.

³ Russel, E. J., "Soil conditions and plant growth", pp. 426, 1937.

⁴ Waksman, S. A., "Principles of Soil Microbiology", pp. 252, 1932.

"ECONOMIC USES OF FUNGI"—A NOTE ON THE COMMENT

I am thankful to Mr T. C. Roy for his criticisms. I would like to bring the following points to his notice.

The fixation of nitrogen by mycorrhizal fungi has been recorded for every group of chlorophyll-bearing plant except the algae. Many cultivated cereals are also directly benefitted by these fungi which remain associated with their roots in the soil.

Ternetz¹ carried out some experiments on the nitrogen-fixing powers of *Phoma*, and definitely proved that this fungus was able to fix free nitrogen from the atmosphere. Rayner² isolated certain strains of *Phoma* from the roots of ericaceous plants and clearly demonstrated that they utilize atmospheric nitrogen. He further showed that seedlings of *Caluna vulgaris* in pure culture thrive in rooting media deprived of nitrogen.

In the sixth paragraph of his comments Roy has quoted a few lines from Waksman's 'Principles of Soil Microbiology'. In the same paragraph on Pp. 252-253 Waksman³ has stated that positive nitrogen-fixation has been demonstrated in the case of *Phoma betae* and *P. radialis*. Evidently my critic has overlooked this particular line. Hence it appears that the mycorrhizal fungi inhabiting the roots of forest trees and cultivated cereals are undoubtedly capable of fixing atmospheric nitrogen.

As regards the free-living fungi, whether they are capable of fixing atmospheric nitrogen or not is a question of dispute. Roy has rightly pointed out that Bhaskaran and Pillai⁴ in their review have mentioned that several workers have experimentally proved positive nitrogen-fixation by free-living fungi in the soil, whereas some others were unable to confirm it. Fulmer and Christensen⁵ carried out an interest-

ing experiment with a type of yeast. They found that the fixation of nitrogen by the yeast at 30°C. is a function of pH, there being two optimal concentrations, the one at pH 6.0 and the other at 7.9, the latter being more potent. They further state that the failure to observe any fixation in micro-organisms by several workers is due to the time element and the presence of ring nitrogen compounds which are converted in the early stages into forms not determined by the Kjeldahl method. Christensen⁶ in a later publication has mentioned that there is probably more fixation of nitrogen in pure cultures of *Saccharomyces cerevisiae* than what any available method of determination indicates.

In many cases it has been noticed that several investigators establish some facts by experimental evidences, whereas many others fail to confirm the same. In this particular case, since a large group of fungi, *i.e.* the mycorrhizal fungi, can undoubtedly fix atmospheric nitrogen, I would feel inclined to believe that they are certainly responsible for supplying nitrogen to the plants, the roots of which they inhabit.

S. P. ROYCHOUDHURI

Biological Laboratory,
Dacca University,
Dacca, 1-10-1942.

¹ Ternetz, C., *Jahrb. wiss. Bot.*, 44, 353, 1907.

² Rayner, M. C., *Bot. Gaz.*, 73, 226, 1922.

³ Waksman, S. A., *Principles of Soil Microbiology*, Bailliere, Tindall & Cox, London, 1932.

⁴ Bhaskaran, T. R. and S. C. Pillai, *Ind. Jour. agri. Sci.*, 12, 1942.

⁵ Fulmer, E. I. and L. M. Christensen, *J. Phys. Chem.*, 20, 1415, 1925.

⁶ Christensen, L. M., *Iowa State Coll. Plant Physiol.* 3, 61, 1928.

ANOMALOUS DISTRIBUTION OF INTENSITY IN LYMAN SERIES AND THE EXTINCTION OF L_4 ($\lambda 949.7\text{A}$)

The anomalous distribution of intensities in the Lyman Series of hydrogen was first observed by Hopfield¹. Later Rao and Badami² observed the phenomenon in their investigation of the spectra of arsenic and explained this in terms of the collisions of the second kind between excited arsenic atoms and atomic hydrogen. Takamine³ recorded a complete disappearance of L_3 ($\lambda 972.5\text{A}$) line and considerable weakening of L_6 , L_8 and L_{13} , and attributed this to absorption by molecular oxygen. While investigating the absorption spectra of elements in the vacuum region, the writer has frequently observed the absence of certain lines of the Lyman Series,

while the members on the lower as well as the higher wave length side are fully developed. The chief argument which Takamine advanced in favour of his view, that the absorption was due to oxygen, was the correspondence which he observed between the missing lines and the important bands of oxygen occurring in this region. The following table gives the wavelength of the Lyman Series lines and the corresponding bands of oxygen.

	Lyman Series lines	Absorption bands of Oxygen.
L_1 ...	1215.7	...
L_2 ...	1025.7	...
L_3 ...	972.5	972.6
L_4 ...	949.7	...
L_5 ...	937.8	...
L_6 ...	930.8	930.6

Some of the plates taken by the author with a one metre normal incidence vacuum grating spectrograph, however, show also the complete disappearance of L_4 line.

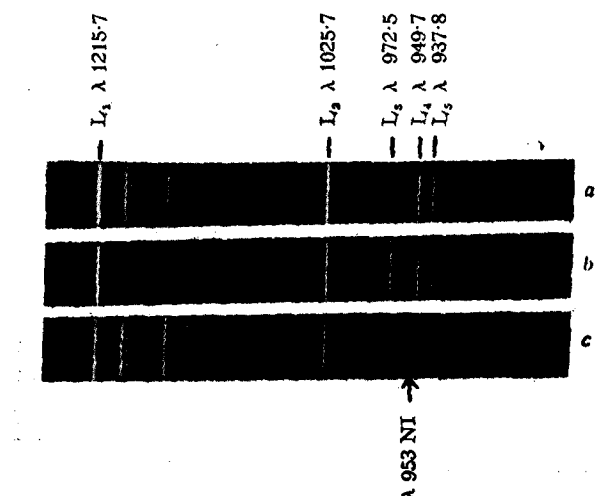


FIG. 1. a. Lyman series with L_3 missing. b. Lyman series. c. Lyman series with L_4 missing.

None of the previous investigators including Takamine, have so far, reported this disappearance or the weakening of L_4 and has been observed here for the first time. This observation is rather striking for there is no corresponding oxygen band at the position and therefore does not support the hypothesis advanced by Takamine. Indeed several of our plates showing the absence of L_3 at $\lambda 972.5\text{A}$ give no trace of any oxygen line in emission, which we should have expected if oxygen was present as an impurity.

The author therefore wishes to propose that this phenomenon may be due to the collisions between excited hydrogen atoms and nitrogen atoms and the following facts are put forward in support of the view.

On several plates showing the absence of L_3 (λ 972.5A) oxygen spectrum is absent as an impurity but nitrogen lines are strong. On the other hand the spectrum of oxygen is prominently present in plates where L_3 is present but L_4 is absent. The plates in which L_4 (λ 949.7A) is missing, show λ 953A° of nitrogen with relatively enhanced intensity. This observation may therefore be interpreted as indicating the existence of collision of hydrogen atoms excited to the quantum state 5 and giving up their energy to the nitrogen atoms whereby λ 953 increases in intensity. The difference of energy in this case corresponds to .03 e.v. The possibility of such quenching collisions is not excluded when the difference of energy is of this order, as has been shown by several authors.

B. M. ANAND

Physics Laboratory,
Government College,
Lahore, 30-9-1942.

- ¹ Hopfield, J. J., *Phys. Rev.*, 35, 1133, 1930.
² Rao and Badami, *Proc. Roy. Soc.*, 138, 540, 1932.
³ Takamine, T. and Suga, T., *Ins. Phys. and Chem. Research*, Tokyo, Sci. Papers, No. 640, 213, 1936.

BANDS FORMING RYDBERG SERIES AND IONIZATION POTENTIAL OF CARBON MONOXIDE

The first ionization potential of CO molecule has been measured by the electron impact method by a large number of investigators, giving values which range between 13.9 and 15.1 volts. The latest measurements have been carried out by Hagstrum and Tate¹ leading to a value of $14.1 \pm .1$ volts.

A number of attempts have been made to obtain a Rydberg series of electronic bands of normal CO molecule converging to the first ionization limit, but so far, no such band system has been reported, either in absorption or emission. Thus the direct spectroscopic evidence for the confirmation of the electron impact experiments has been lacking.

While engaged with the development of helium continuum between λ 600 A° and λ 900 A° for certain absorption experiments, the writer observed a faint trace of emission bands in the continuum background, which appeared to form a Rydberg series and succeeded in obtaining them with enormously

improved intensity. These appeared in a weak oscillatory discharge in helium containing a trace of CO as impurity and showed a beautifully developed Rydberg series of six headless bands.

The following table gives the mean result of the measurements taken on two different plates:—

λ in A°	ν in Cm^{-1}	$\Delta\nu$	Quantum assignments
906.2	110350		
886.3	112830	2480	3.99 5 4.99
875.7	114190	1360	4.97 5 5.97
869.4	115020	830	5.94 5 6.94
865.3	115570	550	6.89 5 7.89
862.5	115940	370	7.92 5 8.92

$$\nu = 117290 - \frac{R}{(m + .94)^2}$$

where $m=3, 4, 5, 6, 7$ and 8 .

The limit of the series at 117290 Cm^{-1} corresponds to 14.5 volts.

If these bands are interpreted as electronic bands due to CO, this result will afford the first spectroscopic value of I.P. of carbon monoxide.

It may be mentioned, that the presence of CO in the discharge tube gives rise to the first negative carbon bands due to ionized carbon monoxide. The bands at λ 2299.6 (o, 1), λ 2189.8 (o, o) and λ 2112.4 (1, o) appear strongly on the plates. A large number of absorption bands occurring within the Hopfield continuum and attributed by Henning² to CO are also present. The conditions were therefore very favourable for the appearance of electronic bands of CO. Another group of bands of CO forming a Rydberg sequence and occurring in absorption runs closely to the emission bands and converges to the same limit as the above. The following table gives these bands:

λ in A°	ν in Cm^{-1}	$\Delta\nu$	Quantum assignment
897.7	111400		
880.7	113550	2150	4.21 5 5.21
871.6	114730	1180	5.24 5 6.24
866.5	115410	680	6.38 5 7.38

$$\nu = 11750 - \frac{R}{(m + .27)^2}, m=4, 5, 6 \text{ and } 7.$$

Limit of the series at $117500 \text{ Cm}^{-1} = 14.5$ volts. The sequence could not be traced beyond four members

but even these provide a sufficiently exact data for the calculation of I.P. of CO.

Full details of the experiment will be published elsewhere.

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Physics Laboratory,
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Lahore, 30-9-1942.

- ¹ Hagstrum, H. G. and J. T. Tate, *Phys. Rev.*, 59, 354, 1941.
² Henning, H. G., *Ann. d. Physik.*, 13, 599, 1932.

DETECTION OF HORMONE CONCENTRATION IN PLANTS INDUCED BY THE ACTION OF HIGH CONCENTRATION AUXIN BY COLEOPTILE CURVATURE METHOD

In order to test the validity of our previous conclusion^{1,2,3} that high concentration auxin attracts the internal hormones from other regions to the region of its application in plants, the present investigation was undertaken to determine whether actual withdrawal takes place in the untreated region of the treated plant by directly measuring the hormone concentration of that region. The experiments were conducted with Avena coleoptile. After twenty-four

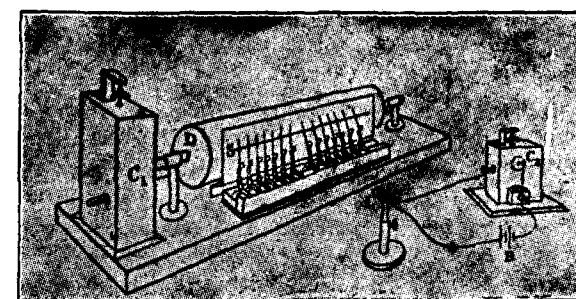


FIG. 1. Photo-kymograph for automatically recording curvature of Avena coleoptiles due to unilateral application of auxin. The Drum D, covered with photographic paper is rotated by the clock-work C. The series of decapitated Avena coleoptiles with grass peduncles inserted in them, are placed in front of the slit S. By covering the apparatus with a lid (not shown in the figure) another slit comes in front of the peduncles. An intermittent beam of light produced by the lamp L, battery B and clock-work C, passes through the two slits and strikes the drum.

hours of basal application of 1% indole acetic acid the hormone concentration of the tip was measured by coleoptile curvature method and compared to that

of the normal coleoptile tip. Coleoptile curvatures produced by the tips of the treated and control plants were recorded for 90 minutes by a specially made photo-kymograph shown in fig. 1. The records were taken by direct application of the tips and also of their extracts in agar blocks. A typical record obtained by the application of the tips of the treated and control plants is given in fig. 2. The position of each plant in the figure is indicated as a white mark in the black lines caused by a beam of light focussed on the grass peduncle projected from the test coleoptile, at intervals of three minutes. The curvature has been expressed as the actual displacement in mm. from the original vertical position of the test coleoptile. It has been found that the negative displacement produced by the unilateral application of the tip from

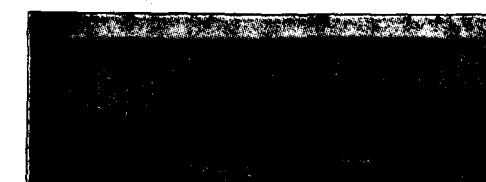


FIG. 2. A typical record from the photo-kymograph. Curvature of the coleoptiles is shown by the white marks in the black lines in the successive records produced at intervals of 3 minutes. Left six showing curvatures due to unilateral application of the tips of basally treated plants, and right six, those due to the tips of control plants.

the basally treated plant, as obtained from the average of 71 plants, was 1.05 mm. in 90 minutes and that of the tip of the control plant was 6.3 mm. The corresponding figures of displacements by extracts in agar blocks have been 0.55 mm. and 2.53 mm. respectively. From comparison of the values of displacement made by the tips of basally treated plant and that of the control plant it will be quite evident that withdrawal of hormone has taken place from the tip of the basally treated plant. The full text of the paper will be published in the *Transactions of the Bose Research Institute*.

A. GUHA THAKURTA
B. K. DUTT

Bose Research Institute,
Calcutta, 1-10-42.

- ¹ Guha Thakurta, A. and Dutt, B. K., *Trans. Bose Res. Inst.*, 13, 215, 1937-38.
² Dutt, B. K. and Guha Thakurta, A., *Trans. Bose Res. Inst.*, 14, 73, 1939-41.
³ Dutt, B. K. and Guha Thakurta, A., *Current Science*, 11(9), 366, 1942.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

JANUARY, 1943

No. 7

FIGHTING FOR WHAT ?

THE question at the head of this article is the title of a book which has recently appeared in England and is from the pen of Sir John Orr, F.R.S., Director of the Rowett Research Institute at Aberdeen, and a distinguished scientific authority on the question of nutrition. This question has been made the theme of this article, as none else is today a more burning question in the minds of millions of men and women throughout the world. And no question has been more badly answered yet. The New Year brings new hopes and new fears for mankind—hopes that a free, happy and just world-order might emerge after the tide of this holocaust has receded, fears that the forces of reaction might smother the forces of progress and leave us and our posterity to fight another cycle of cruel and devastating wars.

For, what has come to pass? Why should millions of men in the flower of their youth be hurled to death and destruction when modern science has brought the dream of universal plenty within the range of practical possibility? Why should billions worth of goods—products of human labour and human brain—be sent to the bottom of the sea or be burnt to ashes? Such are the questions which surge in the breast of the common man. For this is no mere political question. It concerns every one of us, as Sir John Orr recognises, not the least the scientist. More and more, the common man everywhere is realising that while politicians may *make* the war, the common man has to *fight* it. He feels that he should no longer be made the victim of circumstances which vested interests and their servants and exponents—the politicians—have brought about; and that every one of us must hereafter take part in the shaping of the new world, from which fear is excluded, on a plan which must be made here and now.

THE URGENCY OF THE PROBLEM

This question of planning for a post-war world brooks no delay. It has to be done within the

hearing of thundering guns. *It has to be accepted in advance by all the Governments concerned.* This urgency has to be emphasised, as some people in authority among the United Nations, including Mr Churchill, have publicly declared their preference not to be bound down in advance to a post-war scheme except in the broadest generalities. They like, they say, to devote all their energies at the moment to the conduct of the war. They fear that raising of controversial issues might produce divisions and chill the ardour for the prosecution of this war. But they forget or pretend to forget that the maximum ardour for fighting to a finish is roused *only* by a man's knowing what he is fighting for and being in complete sympathy with it as in Russia. This enthusiasm cannot be kindled to a white heat by merely returning a negative answer, by simply saying that the fighting is for the destruction of certain evil Powers, which challenge the world supremacy of the older, well-entrenched, imperialist Powers. People going to die want to know more. They are anxious to see the official acceptance of a positive plan, which would ensure, first, that a new world would emerge out of this war, in which they or their children will not have to fight such wars again and again and secondly, that this new world would provide them with opportunities for their fullest existence and self-expression.

THE FOUR FREEDOMS AND THE ATLANTIC CHARTER

To such urgent questions the answer so far supplied by those in power are only in the form of the vaguest generalities. Mr Roosevelt has enunciated the four freedoms—freedom of speech, freedom of religion, freedom from want and freedom from fear—as the aim of the United Nations. He and Mr Churchill have found the solution of the problem of human freedom in the Atlantic Charter, which seeks, in the main, to restore the territorial integrity of the European nations. Self-satisfied Pundits like H. G. Wells have found the panacea in a new

"Declaration of the Rights of Man". Sir Stafford Cripps, an ex-democrat, speaks of building in future "homes fit for heroes". And there is a plethora of similar general phrases from all ranks of officialdom and "frogs-in-wells", who think their vision sweeps the full horizon. Such declarations have an uncannily familiar ring. Variants of these were heard in profusion during the last Great War. According to the then American President that was a war to end war and to make the world safe for Democracy, to establish the principle of self-determination for all and to unite all the nations into a League, which would gradually build into a human family. After that war, slums must go and houses must be built "fit for heroes to live in".

The slogans raised by the present rulers of so-called Democracies (Plutocratic democracies) are sometimes word for word the same, or are merely slight paraphrases. To subject nations, they have a very ominous ring, as the British Prime Minister has definitely said that the Atlantic Charter does not apply to four hundred millions of Indians. Can there be a World Order, or Universal Peace in a system where the psychology and needs of one-fifth of the human race, proud in their traditions of the oldest surviving civilisation of the world, are left out?

If such declarations proved to be a mirage and have led to a far more devastating catastrophe than the World War of 1914, why should the present pronouncements lead to a different result in future? People in 1919 spoke of and formed a League of Nations. People in 1942 speak of a World Federation. Perhaps even worse things are in the offing. Speaking of the present global War, Sir John Orr realises, "it is a world civil war in which the victors will gain control of the whole world". And it is clearly hinted in such books as 'Union Now' that the vast colonial empires of the old imperialist Powers might, after victory, be put into a common pool under the Federation of Chosen White Nations. That it might mean the world hegemony of Anglo-American Imperialism cannot be excluded (*vide* an article entitled 'Oil and Invisible Imperialism' in the October number of 'SCIENCE AND CULTURE'). Such apprehensions are not likely to be allayed by vague platitudes of British intellectuals and are accentuated by recent pronouncements like that of Lord Hailey, head of the Delegation of British Colonial and Eastern Affairs in Toronto. "We would", he says, "institute Regional Councils consisting not only of colonial powers but other nations interested in them. There might be, for instance, such councils for the Pacific, the West Indies, and the African areas. Their function would be to make periodic review of the progress

made by these dependencies towards self-government".

In the spring of 1939, Hitler, it may be remembered, was asked by Roosevelt to give a guarantee regarding the independence of certain States (European). Hitler retorted by saying that the whole of Africa and nearly the whole of Asia was under foreign yoke and that yoke did not carry the inscription "Made in Germany". In the eyes of the people of Asia, the mother of all ancient cultures, and of which the present European culture is merely a descendant and continuation, the present struggle would be raised to higher moral levels, if there were an immediate declaration of the emancipation of the colonial peoples, and the bottom was taken out of such Hitlerian taunts. This has been done by the Soviet Government, which voluntarily liquidated the old Czarist Empire and has thereby obtained the enthusiastic comradeship of the ex-colonies, *viz.*, Ukraine, Caucasia, Turkestan, etc., in the present struggle. The categorical exclusion of Asia from the provisions of the Atlantic Charter and the recent declaration of Mr Churchill saying that "he had not become the King's first minister in order to preside over the liquidation of the British Empire" appears to indicate a contrary direction. British statesmen have openly declared their resolution to re-absorb Hong Kong in the British Empire, which Britain annexed from China a century ago. The Empire idea is being extolled even more vociferously than before. The slogan of world freedom ill accords with this trend to the maintenance of the *status quo*. Some far-seeing persons in America are profoundly disturbed. Mr Wendell Willkie is one of them and he has repeatedly said that opinion is disturbed in all the important countries of the East as also in Russia. Pearl Buck, who has had long and intimate contact both with the East and the West has again stated her conviction that "the present war is no longer a fight for human freedom, but only to save European civilisation". This is particularly tragic, for the continuation of the *status quo* or any slight variant of it is bound to carry within it the seeds of imperial rivalries and of future wars, as the faults and folds within the earth lead to periodic earth convulsions. Future generations would then have to ask the same seemingly eternal question again, "Fighting for What?"

ROOTS OF THE EVIL AND SIR JOHN ORR'S PLAN

Sir John Orr in his discussion of the roots of the present evil system and remedial measures, has come near enough but has not been able to hit the bull's eye of truth. We would first examine the lines in which he has some constructive suggestions to offer and then examine his fallacies.

He realises that "the economic system is more important than the political system", that capitalism has developed into monopolistic capitalism, which operates in its own interest as distinguished from that of the community. He also realises that these big business concerns have great influence over Governments. In their supposed interest, the monopolists would limit production or even destroy goods in order to keep up prices while millions would go without these goods, which may be essential.

With reference, for instance, to the commodity of food, on which Sir John speaks with considerable authority, his words may be quoted at some length:

"The defects of the system were most glaring in the case of food. While many millions of people in the world did not have sufficient food for their needs an International Wheat Committee devised measures to reduce the production of wheat. These measures were approved by Government. They were approved by the British Government at a time when, in India and in other parts of the Empire, people for whose welfare the Government was responsible were suffering from lack of food. In Great Britain, the object of the Agricultural Marketing Boards was to limit production plus imports to what could be sold at a profit. The intention was to adjust supply to the economic demand, even though it was well known that millions of the population were suffering in health from the lack of the foods which these measures prevented being produced or imported in greater amounts.

But we were forced to adopt even more drastic measures in the case of food than we were in the case of some other commodities. Raw rubber and copper and many other commodities cannot be used by the people until they have been manufactured. Food, however, can be used direct. Hungry people, to whom theories of adjusting supply to economic demand brought little satisfaction, would have eaten the food had they got their hands on it. So we had to resort to the further measures of destroying wheat had they got their hands on it. We treated wheat with chemicals to make 'surplus' food. We treated wheat with chemicals to make it unfit for human consumption. If people had used it, they would have spoiled the market either for wheat or for some other food which could be used in place of wheat. Separated milk was poured down the drains because, if people had bought this cheap milk, they might have purchased less whole milk and so narrowed the market for the whole-milk trade.

People were for a time bamboozled and bewildered by the economic and political arguments put forward in support of these schemes of restriction. But the common sense of the people began to assert itself. Men saw within their reach potential wealth sufficient to provide the necessities of life for everybody, but they found themselves under a spell which prevented them from putting their hands forward to take it. Everywhere men were asking why poverty should exist in the midst of potential plenty. None of the political parties had an intelligible answer. There was a growing feeling of frustration and resentment on the part of those lacking the necessities of life and denied a job which would have enabled them to earn and buy what they wanted. Among the wealthier sections of the community there was an uneasy feeling of impending collapse of the whole economic and social system. And, indeed, there was whole economic and social system. And, indeed, there was reason for fear. The U. S. S. R. had broken away from the old system and established Communism, which, whatever its faults, did remove the frustration of unemployment and held out hopes of running machines at full capacity to provide the things people need. When unemployment was at its worst after the world economic crisis Germany was at its worst after the Nazi system which used the most insidious propaganda to point out the evils of the old system and undermine it. The United States adopted the

'New Deal' which big business condemned and resisted as incompatible with the existence of the old system. Great Britain, with the toughest political constitution of any country in the world and with a long history of gradual evolution by consent, resisted changes more successfully than any of the other great nations. The Government followed the democratic policy of gradually giving way in the face of public demands. Unemployment insurance and other social services and charities took the edge off poverty. When discontent began to assume dangerous proportions, it was appeased by another shilling or two on the dole, a few more free meals for hungry children, cheap milk for school children and an extension of charities.

The stability of Great Britain in a rapidly changing world may be an actual danger. Britain cannot remain unchanged, retaining an outworn system which other nations are changing, unless we are content to suffer the fate of Rome, of Spain and all the other great empires which settled down to live on their fat. A ruling class living on dividends, masses of the people on the dole and a Government trying merely to maintain an uneasy status quo is a picture which fills thinking men with despair. The dole and the cinemas in Britain were too reminiscent of the bread and circuses in Rome when that great empire began to decline."* (Italics are ours).

Sir John, therefore, suggests the suppression of monopolistic capitalism, but not of capitalism itself. And the policy which, he suggests, should be adopted immediately by the Government to answer the question "Fighting for What?" is a policy for food, a house and a job. Even in a wealthy country like England, where the average wealth is more than in the rest of the world, there is such maldistribution of food that one-third of the total population is mal-nourished. Thousands live in slums, where even ordinary hygienic amenities are utterly inadequate. A job, Sir John considers to be a "psychological necessity", apart from its being the medium through which a man serves the community which serves him.

Recent nutritional researches have indicated the lines on which a food-policy can be based in order to ensure optimum nutrition on a health standard. Sir John outlines a scheme, by which, such nutrition may be afforded to everybody in Great Britain within the frame-work of capitalism. He suggests the statutory formation of a National Food Board, under which there will be a number of Commodity

* We would remind Sir John Orr and other British intellectuals that Rome was far more generous to her colonials than Britain, for by the edict of Emperor Caracalla (213 A.D.), Roman citizenship was bestowed on all free inhabitants of the Empire. The result was a longer life for the Roman Empire, a far longer life for the Roman system. When the Roman ruling class died out or became enfeebled, due to luxury and causes mentioned by Orr, the vigour of the Government was successively maintained by freed foreign-born Romans (the Antonines), then by freed colonials (Diocletian and Constantine who were Albanians), and finally by people of Balkan, Anatolian, and German extractions. No colonial (including, of course, the Indians) in the British Empire has yet succeeded to the rank of Ambassador, a Diplomat, General or Admiral, and even in purely scientific and intellectual matters, no colonial has been given real, independent authority, over empire matters, even when they have proved themselves as fit as any Britisher.—Ed.

Boards for different classes of food-stuffs. This organisation, to which money will be voted by Parliament, would buy the necessary supplies of food-stuffs for the nation (both indigenous and imported) and would fix wholesale prices such that an adequate diet would fall within the purchasing power of every family. This organisation would also be responsible for the preservation and processing of food-stuffs and for the maintenance of prices to the customer at a constant level throughout the year, even though it may have to pay the producer a higher price in some seasons than in others. The plan seeks, in the main, to remove the present almost exclusive control of the interests of the food-trade (both growers and sellers) over the nutrition of the nation and to reconcile their interests with those of the consumers by making the National Exchequer a shock-absorber, so to speak.

Regarding housing, Sir John advocates a temporary plan so that the removal of people from slums may be as quick as possible, pending the construction of houses on a long-term plan. He feels that this in itself would require so much labour and materials, that this plan coupled with a plan of indigenous food production would give employment to millions of people after the war.

Regarding the security of a job, Sir John recommends the formation of a compulsory "National Service Corps", in which "all men would serve for a period of at least a year before they are twenty-one years old". They may leave this Corps when they get suitable jobs but, if not, they should be compelled to remain in the Corps and earn their living by useful work. The unemployment dôle would thus go. The work may be of a municipal nature such as road-making, scavenging, etc., or any other unskilled or semi-skilled work. Temporarily unemployed people must also return to this Corps.

Sir John Orr does not waste many words on the food-position of the colonial countries. He knows that in the colonial countries including India, "the standard of diet is so low that gross malnutrition is prevalent. A recent dietary survey of Ceylon, one of the most prosperous of British Crown Colonies, showed that a third of the population do not have enough to eat". His remedy for such a situation is not the abolition of Imperialism but something like a Lease-Lend Act, whereby the richer nations would "help" the poorer nations. A scientific note does not appear to be sounded here, but the usual hypocritical note of Empire intellectuals which is usually sugar-coated with a veneer of Christianity.

Sir John Orr feels that an international economic system must be built up, which must ensure decent living conditions to all men, and on this alone can an international political structure be built. If the

people knew", he says, "that the United Nations had agreed to apply this policy to the common people of all lands, they would know they were really crusaders in a war to liberate their comrades in all lands not only from the tyranny of Nazism but also from the tyranny of economic slavery". "Although some of the members of the Government have given expression to vague phrases about a better world", he says, "there has been no clear-cut declaration from the Government".

THE FALLACY

There is, however, a fundamental fallacy in Sir John Orr's line of thought, when he tries to envisage a world order in the way he does. This fallacy lies in his failure to recognise the reciprocal relations of the economic to the political system in both national and international spheres. It is true that political as well as social systems have largely been conditioned by economic forces, by the methods of production in a particular epoch, so that the political system can be looked upon as a superstructure on the economic system. But, once this political system has been built up, it has its own repercussions on the economic order. In fact, the class which gains control over the political apparatus can and does use the forces of the State to subvert the economic interests of that particular class. It is this dynamic reciprocal relation between the political and economic systems which any planner, who is other than amateurish, must take cognizance of.

Sir John Orr does not want complex and revolutionary plans for a change-over to a new world order. He wishes that Government should pay attention *first* to his plan of supplying *food, house and a job* to all men of the world. His main slogan is freedom from want. Can he not see that there can be no freedom from want until the whole political system along with the vested interests it caters for is removed lock, stock and barrel? How can there be real and permanent freedom from want when production is run on the principle of profit? Monopolistic capitalism may be worse than capitalism. Super-profits may be worse than profits. But there is no suggestion by Sir John Orr that the profit motive should be replaced entirely by the motive of the good of the community. This alone can ensure the effective operation of a plan not only for freeing a community from want but also for raising its economic and cultural level to undreamt-of heights. The inexorable law of business is to develop into big business and that, alas!, has the power to smash up all half-way houses and golden means. The fate of Mr Roosevelt's "New Deal" at the hands of such groups is an example. Sir Richard Acland

has given expression to his sense of frustration in Parliament. He said that the British were not willing to break with a system, which has broken down, that while it was in the interests of the nation that good coal seams should be worked now, it was in the interests of the owners that they should be worked for better profit in the post-war period. The latest information is that 50 per cent. of the wire manufactured by a certain American Company and sent to Russia was defective. Instances like these could be greatly multiplied. It is noteworthy that even the possibility of such malpractices is excluded by the political and socio-economic system of the U. S. S. R. Sir John Orr's detailed plan about a food policy for Britain is surely worthy of consideration. But we fear, that without the back-ground of a socio-political change, it would find its way to a pigeon-hole in post-war Britain.

And we in India can rightly ask the question "Are Sir John Orr's theories only for internal consumption, or for export to colonies and dependencies?" Like most British intellectuals he prefers not to dilate on the point, and herein lies the particular weakness of Sir John's thesis. It should be clear that there can be no stability in the world unless there be freedom from want *for every body in the world* and not for the citizens of British Isles alone, and this cannot take place so long as the Imperial system survives. The Imperial system *requires* that the colonial countries should remain industrially undeveloped, so that they might for ever be the markets for the finished products of the Imperial powers and suppliers of raw materials. Sir John is blind if he cannot see that the grimmest poverty, squalor and illiteracy of hundreds of millions of people in Asia and Africa, for whom the slums of Britain against which he complains are luxuries, is the direct result of the working of the Imperial system. Further, the Imperial system breeds Imperialist rivalries, which constitute one of the main causes of recurrent wars. And if wars have to be fought in defence of Capitalism and

Imperialism, how can men and resources be diverted to the production of food and houses from the making of guns and tanks? If British scientists are not prepared to break finally and irrevocably with the Imperial system, they cannot be planners for world peace and prosperity. They can only delude themselves.

There are three fundamental conditions for the effectiveness of a plan for freeing the world from want and for establishing world peace. They are, first, that the motive of profit or greed shall be removed and all production shall be carried out for the community; secondly, complete political sovereignty shall be restored to all subject nations of the world; thirdly, that all nations without exception shall live in co-operative freedom according to a world economic plan which would ensure universal freedom from want and continued social and economic progress.

THE TASK OF SCIENTISTS

It is a healthy sign that scientists in most countries are beginning to think in terms of a better world. Along with Sir John Orr, there have been others in Britain and in America who have been engaged on this problem. There are the National Planning Association of America and also the Beveridge Plan concerning the social services of post-war Britain (a note on this will be found elsewhere in this issue). But the major lacuna in almost all these plans is the same. It is the unwillingness to break with the old Imperialist and Capitalist system. The fact is that most of these planners have so far largely benefited from this system and this benefit unconsciously colours their plans. But if these scientists are able to rid themselves of preconceived notions and apply their scientific and unbiased mind to the post-war political and socio-economic organisation of the world, they might help the emergence of a really better world out of the present welter. So far we hardly see any signs of this amongst the British or American intellectuals.

A SCIENTIST'S MUSINGS ON CHRISTMAS EVE

THE majority of Christians all over the world celebrate the Winter Solstice Night (the date on which the sun rises farthest south on the horizon) as the Night of the Nativity (Birth) of Jesus Christ, Who gave to the world the gospel of world-peace and universal brotherhood of man. How different is the Christmas of 1942, when Christian Nations of Europe and America have been divided into two warring camps, and are slaughtering each other mercilessly, and also involving the peace-loving non-Christians of Asia in the general holocaust!

This reminds us of the origin of the Christmas festival. Probably it will surprise many of our readers to know that "Christmas was not among the earliest festivals of the Church, and before the 5th century A.D., there was no consensus of opinion as to when it should come on the calendar" (Encyclopaedia Britannica, 14th edition, see article on Christmas). In other words, early Christians had no knowledge of the date and year of birth of Jesus, and the custom of celebrating the birth of Christ on the Winter Solstice Night is a later concoction.

The reason is not far to seek. None of the gospels mentions anything about the date and year of the birth of Christ, and the earliest and most reliable of them with respect to the incidents of Christ's life, *viz.*, the gospel of Mark tells us that He was the son of a poor carpenter of the village of Nazareth in the province of Galilee (Mark 6, 3), and at the age of 30, He began to preach His Gospel. (Mark 1, 9). The total period covered by His preachings probably did not cover more than 17 months; these preachings gave offence to the orthodox Jews, and He was arrested by the orders of the High Priest two days before the Jewish festival of Passover,* which Jesus had come to celebrate along with his disciples in Jerusalem. The High Priest handed Him over to the Roman governor, by whose orders He was crucified the next day, and His body was interred in a cave through the intercession of a rich sympathiser of His teachings. When His disciples went to visit the Sepulchre on the *first day of the week*, they found that the body had disappeared. The mention of the Passover festival gives us a point *d'appui* regarding the date and season of His Crucifixion, and Christians have from the earliest times celebrated these incidents in the festivals of Good Friday (Day of Crucifixion), and Easter day (Sunday following) as the day of Resurrection, though there are strong reasons to believe that the Jewish week, mentioned in the gospels is not the present seven-day week, but the original lunar week, and the Passover took place on the fourteenth day after the New Moon. The seven-day week was then not yet in vogue, and no mystical importance had then been attached to the so-called Lord's Day (Sunday). This was due to astrological influences on the growth of Christianity.

When Christianity became the State religion of the Roman Empire in 321 A.D., the Christian fathers felt the necessity of co-ordinating the then prevalent pagan festivals,—some of which in spite of Christianity were very popular with the incidents of Christ's Life. It was a clever move, for it killed two birds with one stone. The most important ones were the Winter Solstice Festivals. Under different names, they have been celebrated from times immemorial all over the world, and by all nations. The reason is not far to seek. All residents of the north temperate zone, which contains the cradles of early civilisation, have to suffer from the rigours of the winter. During these times, they found the sun rising everyday farther to the south, and the winter intensifying. On the Winter Solstice Day, the sun after reaching farthest south, begins to turn north, and this heralded the impending passing away of unpleasant winter. Amongst many nations the day was taken as the

* This festival is supposed to commemorate the exodus of the Jews from Egypt.

birthday of the Sun, and was the occasion of wide-spread festivities. The earliest Vedic Hindus started on this day their cycle of sacrifices. The ancient Persians regarded it as the birthday of Mithra (the God of Light, probably an anthropometric form of the Sun). In China, Huang Ti, the Yellow Emperor, who is said to have established the calendar about 2300 B.C., ordained that on the Winter Solstice Day, the Son of Heaven (*i.e.*, the Emperor) should offer homage on behalf of the people to the ancestors of the Nation. China retained this festival up to Manchu times in spite of all subsequent movements—Confucianism, Buddhism and Taoism and even the Teutonic barbarians of the North had similar festivals, remains of which can still be traced.

It is now well known that when Imperial Rome began to get weary of her pagan gods, she oscillated for a long time between the cults of Mithra, and of Christ. The Mithra cult with its rich ritualism made a strong appeal to the military Roman mind. On the Winter Solstice Day, it was supposed on one version that Mithra, God of Light and Righteousness, was born, fully clad and armed as a young warrior, chased a bull (symbolic of ignorance and lust), slaughtered it with a flashing knife, indicating the triumph of Light and Righteousness over Darkness and Lust. The festival was celebrated not only in Persia, but also all over the Roman Empire and was extremely popular.

About 320 A.D., the cult of Christ found favour with the State, because the Emperor Constantine was under the impression that the god of Christians had given him victory over his rivals. The support of the State gave the Christian fathers a great advantage over their rivals, the exponents of Mithraism. They began further to improve their position by absorbing the rich rituals of Mithraism, including the birthday festival of Mithra which became henceforth the feast of Nativity of Christ. About this time also, the Christian era began to replace the older era of foundation of Rome, but the Christian fathers made here a serious miscalculation for some time ago, a contemporary inscription was discovered at Ankara, which recorded that King Herod, the puppet King of Judaea under the Romans, who ordered the slaughter of innocents when Christ was supposed to have been born, had died in 4 B.C. So Christ must have been born previous to that date, say about 6 or 8 B.C. Thus both the date, and year of birth of Christ, as accepted now, are seen to be later artificial creations and not based on facts.

It appears that Mithra, whose cult was so forcibly suppressed and absorbed into Christianity, has been taking his revenge by infecting the Christian Nations periodically with his cult of War! But let us all hope that before the next Christmas returns, the gospel of Christ will prevail and the warring nations will find themselves in brotherly embrace!

IS LIFE ON MARS DECAYING?

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OUR knowledge regarding life on planets is yet mostly speculative. These speculations are, however, based upon certain facts gathered over years. As a result of careful observation upon planets and the light they send to us, much has been known about the conditions of their surface, atmosphere, and temperature. Human mind has always been curious to search for life outside the earth and this innate curiosity has led to interesting speculations about life on other planets. Perhaps, no planet had the honour of being more thoroughly investigated upon from the point of view of habitability than our nearest neighbour in the sky, Mars, on which evidences for existence of life are worth investigating. The evidences have, however, not yet proved decisive. A certain section of observers seem to favour the view that on Mars life is now in a continuously decaying state, having passed its mature days long ago probably during the pre-Cambrian days (500 million years ago) when life was probably only dawning on earth. But let us first examine the well-established facts, then we shall examine the speculations.

A view of Mars through a moderate-sized telescope shows the planet as a red disc mottled with dark markings and covered with whitish spots at the poles. With more powerful instruments, under ideal seeing conditions, more details are visible and some of them can be photographed. For the study of the delicate markings, visual observations are superior to the photographic records. In spite of numerous difficulties involved in such a study, whether photographic or visual, owing to fluctuations of air currents in our atmosphere and irregularities in following the planet with the telescope, the Martian surface has been studied in considerable detail and the mysterious nature of the finer-markings first observed visually by Schiaparelli in 1877 and now popularly known as 'Canals' has been unravelled to some extent. Some observers report them as of sensible width, others as extremely fine, hair-like lines, while still others record canals corresponding to both descriptions. Schiaparelli, himself stressed the rectilinear character of these canals and in this observation he was strongly supported by the astronomer Lowell and his followers. Deviations from rectilinearity have, however, been reported by other astronomers of great skill and experience. Schiaparelli reported a gemination, or 'doubling of certain of the canals at stated Martian seasons'. He has been strongly supported in this observation by Lowell and his pupils. On the other hand, Barnard and Pickering despite their long-continued and careful scrutiny of the planet failed to

observe such conditions. There is as yet no unanimity amongst the observers regarding the nature of Martian canals but it is hoped that with improved experimental technique and using greater skill, more positive evidence will be forthcoming in near future. The latest photographic observation of Mars' polar caps at the 1939 opposition by the veteran observer E. C. Slipher of the Lowell Observatory, Arizona, U. S. A. presents some interesting phenomena. He applied on this occasion the method of infra-red photography, which enables us to see details of the surface and comparing the infra-red photographs with the ordinary or violet light ones the presence of a cloudy or hazy atmosphere was confirmed. Mr Slipher interprets the polar cap as a cloud of ice crystals. It was spring on Mars' southern hemisphere corresponding to April or May in the northern hemisphere of the earth. The Southern Polar cap began melting, or disappearing and displaying the same rifts and markings as had been seen for many years. Various surface markings, visible best through red-filters, showed rhythmic colour changes with season. 'Some of the canals showed more prominently than in previous studies, others dimmer'. This interesting observation has stimulated far-reaching speculations about the planet's habitability.

The atmosphere of Mars is relatively clear. It consists of minute quantities of oxygen and water

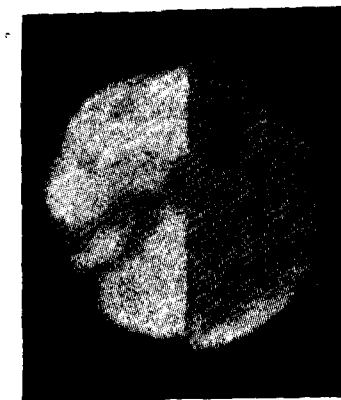


FIG. 1. A composite picture of Mars in infrared (left) and ultraviolet light, taken at the Lick Observatory. Note that the planet appears larger in the right half—the atmosphere has not been penetrated.

—With acknowledgment to *Sky and Telescope*.

vapour, and the possibility of a tenuous layer of CO_2 is not altogether ruled out. The presence of free

oxygen on Martian atmosphere is doubtful. The ruddy colour of Mars may indicate oxygen combined in the rocks as Fe_2O_3 —fossil oxygen, as Russell puts it. Perhaps, surface has imprisoned the free oxygen as oxides, similar to our familiar red iron ore, a process which is also occurring on the earth, and may, hundreds of millions of years hence, lead to the disappearance of oxygen from our own atmosphere. Water vapour may form the clouds that are seen on Mars but it is doubtful that there is any open sheet of water. Spectroscopic results is negative on this point.

The temperatures have been found to be very low. In the tropical zones on Mars the temperature rises above the freezing point, perhaps to 50°F or higher. The polar regions in winter drop to about 125°F below zero, while in summer may rise above zero. With sunset in the Martian sky, the temperature throughout falls rapidly, as the atmosphere is very thin.

These are the facts about Mars that have been gathered over years and on them we must base our

dioxide and water-vapour in the atmosphere and a temperature climate is *sine qua non* for the existence of life like that existing on the earth in any place. On Martian atmosphere, we know, these substances do not exist in appreciable amounts, and the temperature on the planet is extremely low. Does this necessarily mean that no life can exist on Mars and our neighbour is barren? The thin atmosphere might not exclude life, for we know that on the earth people can become adapted to life in high altitude, where the air is rare. The Tibetans can live at heights of 16,000 ft. where the air is thinned down to half and the high mountain climbers begin to use oxygen at heights of 22,000 ft. The low oxygen content is, of course, a handicap, but again adaptation might well make it possible to live with far less oxygen than on earth. There seems to be a fair indication of the presence of water-vapour on Mars. Such atmospheric conditions might well sustain animal life and certainly plant life might flourish there. The extremely low temperature on the ruddy planet may not seem to be favourable for the exis-

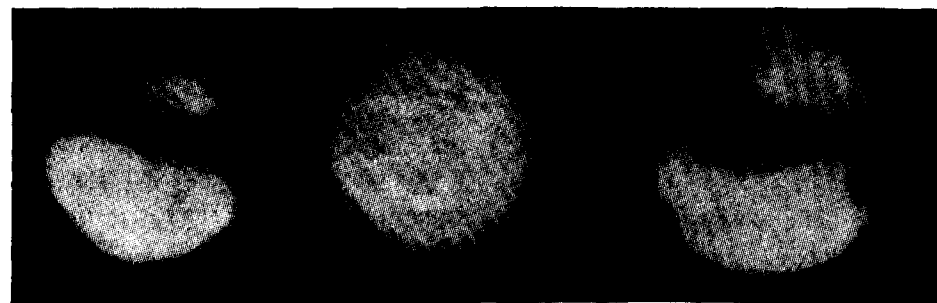


FIG. 2. Mars—July 21, 1939.

In orange light 8m. U.T., 229° In blue light 12m. U.T. In orange light 10m. U.T., 235°
These pictures were taken by Latimer J. Wilson, Nashville, Tenn., with his home-made 12-inch reflector, of 96 inches focal length using 1-inch achromatic eye piece arranged in the form of a rapid rectilinear lens.
—With acknowledgment to *Sky and Telescope*.

speculations regarding probability of existence of life on this planet. Naturally, by life we mean life familiar to us on earth and this may include any form from the simplest algae and fungi to fully developed plants and animals. What form of life do we expect to find on Mars? Should we be content with the lower forms or do we insist on plants and animals, and even intelligent beings?

Experience on earth tells us that life can thrive only under certain conditions. Do such conditions exist on Mars? This is a question which has engaged the attention of astronomers since the early days of astronomy and has been at least partially answered by them. The presence of free oxygen, carbon

tence of life. But again, here on the earth we find animal life living under the most drastic circumstances. How far our organisms can be forced to meet environments we dare not say, but we can assume that conditions may be quite elastic.

The seasonal changes on the dark areas of the Martian surface with simultaneous changes in the breadth of the canals have been interestingly interpreted. Pickering and his school seem to regard the dark areas as tracts of vegetation through which the canals make their way. When with the advent of summer in one hemisphere the polar cap melts, water flows along the canals towards the equator, with darkening first appearing near the pole. In

winter the opposite happens, the polar cap in the same hemisphere growing in size and the canals getting thinner. The vegetation theory of Pickering and Schiaparelli's observations on the gemination of canals has led many astronomers to believe that Mars is inhabited by intelligent beings possessing great engineering skill and the Martians, as suggested by the complex network of canal system all over the planets' surface, have already established a world-federation which we on earth have so far failed to achieve. But the phenomenon can, as explained just now, be regarded as merely the working of Mars' Nature, unspoiled by the hand of any intelligent being.

What would the Martians be like and how is their life now? They would necessarily have large lungs and hearts to adapt themselves to low supply of oxygen. To conserve moisture their skins would breathe very slowly. Martians would be larger than we are to accommodate the enlarged breathing apparatus, but they would not feel that as a handicap. On account of low surface gravity on Mars, they might be more massive than we are.

This sketchy picture is all that we can draw at present about Martian life and it is only speculation.

It presents the Martians, if they exist, as fighting a losing game in the struggle for existence. The planet may be a dying world—oxygen fixed in the surface. The trace of oxygen that is detected now by means of spectroscopy is probably the remnant of what once formed part of a well-balanced Martian atmosphere. The rarity of atmosphere, the scarcity of water, and low temperature all seem to suggest that the Martians are probably fighting for their lives. Generally we have on our earth the rule of 'the survival of the fittest'. Have we a parallel case for the Martians? We may probably assume that the lower animals have been exterminated by some kind of Homo Sapiens, but what about the Martian Homo Sapiens themselves? Are they fighting amongst themselves, like their counterparts on the earth, to extinction for the possession of indispensable raw materials, and freedom of exploitation of the weaker, or have they achieved some kind of world-federation? But at whatever stage they may be, Destiny is working inexorably against them. A time is sure to come when even the fittest will vanish from the Martian surface owing to unbearable conditions, but Terrestrials would not know that fellow beings have disappeared from their nearest neighbour.

THE STUDY OF EARTH IN RELATION TO MAN

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WHILE we realise that religion is, so to say, endemic in man and while we believe in God we prefer to accept quite simply that "The earth is the Lord's, and the fulness thereof; the world, and they that dwell therein." (Ps. 24.1). And although we are tempted to consider this earth as the centre of the universe, because we live in it, nevertheless it is not possible to forget that we are on a planet which rotates on its axis and circles the sun with several other larger planets. The astronomer tells us that our sun is only one of thousands of similar suns which constitute a galaxy whose presence may be traced in the Milky Way, and that this galaxy of stars, like a huge catherine wheel, is also rotating and moving forward. They tell us that there are also hundreds of star galaxies similar to the one to which our sun belongs, and that our sun is nowhere near the hub of the galaxy to which it belongs. They tell us of no other sun or star which has a solar system like that to which our planet belongs, and, while they search Mars for sign of life, there is no proof that man exists on any other planet than our own. Thus in a way the earth as the abode of man is unique, and for this

reason, the use we make of our time on this earth, with the materials and opportunities open to us, is of the utmost importance. It is of the greatest importance, when we appreciate that it is only at our disposal and does not really belong to us, that we should do the best we can with what it provides.

The true scope of geography is the study of the earth in relation to man, and this is the attitude adopted by the universities when they have introduced geography as an important subject in their syllabus. Besides physical geography, which is an essential part of the study of the earth in relation to man, there are many other aspects which are also included in the general subject of geography. These may include the distribution of the races of mankind, climates, etc., also political and religious considerations, social and economic questions, trade and commercial problems, technical industrial development and the strategy of military operations.

A fundamental aspect of geography is personal observation and investigation, both by travel and the study of maps and related data. It is essential to have good maps, and for this reason

surveys and maps are matters for Government to have conducted and prepared as a State duty. The Survey of India with its Map Office in Calcutta besides being one of the oldest establishments of its kind holds a front rank position both for its efficiency in surveying and also for the excellence and accuracy of its maps. The subject of map making is well-known for its difficulties because we have flat sheets which should fit on a curved surface.

It is interesting to notice that it was from Indian survey observations that the discovery was made that mountain masses appeared to have corresponding protuberances below, or to be compensated, and thus the idea of mountains floating on a plastic substratum arose. Similarly the repeated observation of drowned buildings or submerged forests along the coast on the one hand, and the occurrence of raised sea beaches or strata with marine animal remains on the other, have provided evidence in support of the subsidence or elevation of the land (or a transgression or regression of the sea) in recent times. Our investigations of coal seams with terrestrial plant remains in older formations hundreds of feet below the sea show that subsidence must have been in progress for a long time.

The expeditions which visited Everest and the country round have shown that the peak and dip slopes are of marble-like rocks. These are the metamorphic equivalents of certain fossiliferous limestones which were laid down in the sea at the time the coal seams of the Raniganj coalfield were being accumulated in wide fresh water lakes. This sea lay between India and Siberia, and the Himalayas represent the buckled up sediments, hardened and altered, which once lay in the bottom of this sea, which extended far to the west and of which the Mediterranean of to-day is but a remnant.

The belief is that the land masses of Siberia and India have approached each other exceedingly slowly from opposite Polar regions, and in doing so squeezed up the sediments in the intervening sea floor into the greatest mountains of the world. Support for the belief in continent drift was long ago available, when work in India, South Africa, South America, Australia and Antarctica revealed evidences of an ancient glaciation followed by the appearance of a curious *Glossopteris* flora (about 200 million years ago). There seemed no question but that these continental masses were parts of one great Southern Continent which was referred to as Gondwanaland. The evidence for a plastic subcrustal zone provided a means for the earth's crust to slip over its core and thus gave a clue to the break up of Gondwanaland by continental drift.

It is thought that the sea over the Himalayan region still existed 60 million years ago. If so the Indian portion of the Gondwana continent would

have to travel from Antarctica to its present position—say 6,000 miles in 60 million years. This is roughly one mile in 10,000 years, or say 6 inches a year, a movement which could not be detected by the most accurate observations of latitude. It is certain from other observations that this drift towards the equator would have a component to the west, but it is thought that a change in longitude of 50 feet in 100 years would not be beyond the limits of instrumental error. Thus although there is no absolute proof of the drift of continents the supporting evidence is good and strong.

That the sub-crustal region is subject to periodic melting is established by the vast outpourings of lava in India and other countries during the last 100 million years. The Deccan of Peninsular India is still covered to an extent of 200,000 square miles with basaltic lava flows which must have covered the country in successive eruptions to an average depth of 2,000 to 3,000 feet. The cavity below would be obliterated by movements at the surface and these would affect the configuration of the earth's surface in the Indian region and surrounding areas. Thus mountain chains and island festoons, so evident around the Pacific and in Southern Asia, were formed and influenced the distribution of land and sea, and affected the peoples who ultimately occupied and used them.

It is interesting to know that the currents from the North Pole convey driftwood from the Siberian forests and strand it on Spitzbergen and elsewhere in the North Atlantic; that rivers and rain which disappear on the land often re-appear as great springs in the sea from which, as in the Persian Gulf, ships can secure fresh water in the sea; that prevailing winds produce convection currents in the sea which, by the undertow produced, may cause erosion in the sea floor such as the Swatch of No Ground; that moisture laden winds driving up deep valleys and rising around exposed areas may produce the heavy rainfall associated with places like Cherrapunji.

All these regional as well as local phenomena affect the people who inhabit the lands or use the seas. It is partly to these causes that the population of some areas is small and in others great, but the fertility of the soil has an influence on this aspect of human affairs. Another factor, more characteristic of modern times, is the mineral wealth of the land, but none of these is as great as a drive in industrial development with proper technical skill and ability. The greatest industrial enterprises are in the lands bordering the North Atlantic and in the North-Western Pacific. Grouped about these regions are the great navy concentrations and armies of the world.

By comparison with the Atlantic the Indian Ocean, although smaller, has been a quiet sea for coast to coast trade, while the Pacific, which is twice as large as the Atlantic, had shown a marked increase in shipping for some years. Similarly the technical progress and industrial activity in Germany and in Japan has been conspicuous for many years whereas India appears to have stirred to develop its mineral resources and industries quite recently. Germany is not a remarkably rich mineral country and lacks many important substances—bauxite, chromite, manganese ore, mica, oil, etc. Japan is poorly endowed with mineral resources, and yet these countries had a world wide trade in goods which were largely made from imported raw materials. The mineral wealth of India is far greater than that of Japan and in many respects richer than that of Germany.

In a talk on 'A Geologist in Russia' it was sketched that there existed (see *SCIENCE AND CULTURE*, 4, 218, 1938-39) a vast plain stretching from Berlin to the Urals with no natural defensible features, but having fine navigable rivers and filled with a serious people wholly absorbed in industrial development. And while religions seemed absent there was a great unity of purpose and the Soviet Government were embarked on immense projects—electrical power stations, metallurgical works and other technical industries—which involved the fullest utilisation of all the available mineral wealth of the U. S. S. R. The country was being searched from end to end by geologists.

There was a great pride in achievement evident everywhere and an intense desire to go forward so that the country was in the front rank of world producers, that all could earn good wages and live without fear of want and poverty, and, above all, that they were able to live in peace by having sufficient armed protection against Germany and Japan. The peoples—Uzbeks, Kazaks, Tartars, Cossacks and Russians—were knit together by this great spirit of enterprise, and the discord of conflicting religions was gone. But material prospects alone did not unite the various peoples of the Soviet Union as they included Mongols, Muslims and believers of the Greek Church.

We have all in recent months witnessed the miracle of Russia's defence against the craft of a prepared Nazi attack, and Germany, with no respect for religious freedom, has miscalculated the strength of the Soviet Union. It is clear to every one now that the Russian masses had been transformed from ignorant superstitious peasants into intelligent technicians by the drive for industrial development boldly embarked upon by the Soviet Government 25 years ago. Perhaps an important clue to this transforma-

tion and the unity which binds these Socialistic Soviet Republics in the Union is the influence of their womenfolk. None are more earnest or hard-working for better conditions of living and for progress than the women of Soviet Russia.

Here then is one of the greatest lessons in Geography or the study of the earth in relation to man. A government with immense courage embarked upon the fullest exploitation of its mineral and other resources and established industries in the face of every kind of foreign criticism. When other countries may have 100 geologists the Soviet had 10,000 and the whole land was searched and all mineral occurrences re-examined. New discoveries were made but a vast amount of information already existed although it was not previously followed up. By confidence in its technological personnel and courage and enterprise the Soviet Government already in 1937 astonished all those scientists, geologists (among whom the writer was one) and engineers who visited Russia.

And now at this moment of her destiny at the very door of her opportunity India appears hesitant. There is an implacable enterprising enemy on the eastern frontier and the greatest battles in history are being fought near the western borders of Asia. Is it not possible to learn from the heroic example of Soviet Russia how strength lies in unity and unity comes from a common desire for progress and requires unselfishness and sacrifice? It is clear that the Union of the Socialistic Soviet Republics was not obtained through religion but by the courage and enterprise of a Government to utilise its mineral and other resources to the fullest for the benefit of the people.

Already in India the Government has encouraged mineral exploration and exploitation by the establishment of an Utilisation Branch which is to show the way to successful industrial development. All that is needed is efficient and hardworking colleagues and these are coming together both as official and non-official geologists and mining engineers to work together. The Indian States have been the earliest to come forward in this re-examination of the mineral occurrences of all India with a view to their utilisation for industrial purposes.

Geography is the study of the earth in relation to man. We agree that "the earth is the Lord's and they that dwell therein", and this is the fundamental aspect of our lives. There is no room for creeds and dogmas, and it contains the fundamentals of all aspects of geography, and geography is the basis of geological investigation. It seems evident that our happiness, our prosperity and our security lies in the strength we will have by unity in this great effort of industrialisation which in no way affects

our beliefs if they are simple and sincere. We must ourselves belong as the earth does, and have a duty to perform.

There would seem to be no reason why unity cannot be quickly secured in this urgent opportunity when mineral exploitation, industrial development, technical training and military employment are both

urgently necessary and welcomed by Government. And it would also appear that such an immediate objective as the Federation of the Provinces and Indian States is too limited and the way lies open through an Union of the Allied Nations to a Confederation of All Nations. This is the logical conclusion of geography and the common belief of mankind.

INDIAN PHYSICAL ANTHROPOLOGY AND RACIOLOGY

Ramaprasad Chanda's Contribution

(Continued from the last issue)

A side-issue from the standpoint of nomenclature but an important problem of raciology is whether the term *Niṣāda* should be confined strictly to the Weddoid type of aboriginals to the exclusion of Negritos as proposed by Guha. While it must always remain doubtful whether the fair-skinned Vedic *Ṛsis* could have distinguished at sight between the Weddoids and the Negritos, the historical approach to this question involves two bigger issues, *viz.*, was the Negrito strain at all present in Northern India in ancient times, and are there real Negritos in India today? Müller indeed speaks of a brachykran skull with strong Negritic characteristics from Nepal collected by the Schlagintweits and now in the Anthropological Institute of Frankfurt on Main. As no details are published it is impossible to judge if the association of brachycephaly with the other Negritic characteristics (not specified) is due to extraneous causes, *e.g.*, the crossing of a primitive type with Mongoloid brachycephaly, or not. Naturally if rightly diagnosed, the Negritoid skull from Nepal must be considered together with the presence of the same strain in Upper Burma (v. Eickstedt), Siam, Annam and the Malakka peninsula. Hutton also speaks of the Negrito strain in Assam. To be mentioned in this connection is the case of a Bagdi boy of fourteen, pronouncedly brachycephal (C.I. 85.5), with skin colour corresponding to 33 of V. Luschka's scale, whose hair showed "short spirals of a distinctly wooly type", reported from the Rajmahal hills, Santal Parganas (Sarkar).^{*} The investigation of the boy's pedigree is expected to show interesting results. E. v. Eickstedt assumes the existence of an ancient interpluvial Indo-Negrid (proto-Negritid) race, a link between western (African) and eastern (Melanesian) Negrids, who today survive in contact groups, *viz.*, the Melanids and the Malids. The Northern variety of the Melanids are the Kolids, who are represented by

the Hos and Santals in their purest form. They possess extremely dark brown—black skin, full lips and strongly-marked mesorrhiny which suggest Negrid influence, but in other respects have europid features. The theory of v. Eickstedt at least may be said to have been tested by the work of Rosa Koller on four Santal crania in the Natural History Museum of Vienna, as a result of which Koller recognised in the Santals the unmistakable presence (though not predominant) of a primitive racial element which shows many characters, weakly impressed, of the Austro-Melanesian race of P. Sarasin, or of the Australiform racial circle in the sense of G. Sergi, P. Rivet, V. Lebzelter and others. At the same time the influence of the E. Mediterranean or Indid (v. Eickstedt) race is distinct (particularly on one of the male skulls), which would explain the europid features noticed by v. Eickstedt among the Santals.

The Malids on the other hand, are regarded by v. Eickstedt as a harmonised product of Proto-Negritid—Weddoid contact and are characterised by primitive features in comparison with the Negritos. Such are the Kurumbar, Kadar etc. During 1928-29 Guha found among the Kadar five males and one female with spirally winding and undoubtedly frizzly hair (in 1935 he mentions 14 such cases). Five individuals measured by him gave an average Cephalic Index of 75.0; two were mesocephal and the rest dolichocephal. From the two mesocephals (C.I. 77.3 and 79.3) Guha concludes that "the basis of this Negrito type was probably brachycephalic or at least meso-, as in the Semangs (mean C.I. 79), but large admixture with a primitive dolichocephalic race had affected the general shape of the "head". Of 23 Kadars measured by Thurston with an average C.I. of 72.9 varying from 69.0 to 80.0 only one reached 80. 19 Kadar males measured by Cipriani yielded an average C.I. of 72.6 and ranged between 69.6 and 76.7; also 12 females measured by the same investigator with an average C.I. of 73.2 varied between 69.0—77.6. Thus in a total of 59 cases there

is no segregation of brachycephaly. Guha also noticed unmistakably frizzly hair in one Pulayan and presumes the same sort of mixture in this tribe as in the Kadars. It is interesting to note that 24 Pulayans measured by Thurston gave an average C.I. of 76.3, the maximum and minimum being 83 (brachycephaly!) and 72.3 respectively. In any case brachycephaly among the Kadars and Pulayans is not appreciable or significant. It is therefore interesting to turn to the researches of Lapicque (1906) who found in India no true Negrito population like the Andamanese. Nevertheless he found well marked Negro type of physiognomy with frizzly hair among a mixed population, half Paria and half savage, and with the help of measurements reconstructed the Negro-Paria race, which he conceived to have been subdolichocephal (C.I. 75 or 76) and slightly taller than the Andamanese. There is thus definite evidence as to the existence of a frizzly-haired population in the south of India, while the evidence from Northern or North-Eastern India (Assam excepted) is not convincing in the same degree. Doubtless, the investigations which are being carried out for years in the Rajmahal hills by the Bose Research Institute will soon enable us to decide what significance to attach to the isolated instance of "wooly" hair noticed by Sarkar in this area and to determine whether the frizzly-haired population of the South have any connexion with the wooly-haired individual reported from the North.

III. *The Brachycephals:*

Chanda's identification of the brachycephaly prevailing in the Outer Indo-Aryan countries characterised by flat occiput and prominent nose as non-Mongolian in origin has been fully corroborated by the researches of Guha, who carried out an extensive anthropometric survey for the Indian Census of 1931. Guha writes:

"In the western littoral and Bengal, A brachycephalic element of medium stature with flattened occiput, but also high head and not infrequently receding forehead. * * * the face is short and orthognathous, but somewhat broader. The nose is long and high pitched, but quite often arched and convex. The skin colour varies from a pale white to light brown * * * among the Nagar Brahmans, to tawny brown among the Kannada non-Brahmans. The colour of the eye is usually dark brown, but a small per cent. shows light eyes. The hair-colour similarly is black with a small proportion showing the dark brown tint. The hair is generally straight and the pylous system well developed." Typical representatives are Nagar Brahmans of Gujrat, Kayasthas of Bengal and the Kannada non-Brahmans.

In Bengal, besides the Brahmans and Kayasthas among whom the type is represented in high percentages (the Uttararādhiya Kayasthas so far known from Chanda's data are an exception), it is also found among the Vaidyas, Gandhavaniks and Suvarnavaniks, Sadgops, Mahisyas, Namosudras and Sunris. (It may also be present in other groups,—further research will reveal its distribution). It would not be unjustified to claim that instances of brachycephals with slightly or moderately curved occiput in Bengal are variants of this type, in so far as such appearance is not produced by mixovariation; and that the true curvoccipital brachycephaly as found among Alpines of Europe is not found here.

Chatterjee found the same strain among the Maithil and Kanaujia Brahmans of North Behar, to 9% and 11.3% respectively (1934). For part of the western littoral, *viz.*, Curg, independent corroboration has been received by the work of Cipriani (1935); for N. W. India, among the Sikhs by Weninger (1920) and Nuristan by Herrlich (1937), while Chanda's own data on the Kashmir Brahmans shows that no part of the Outer Indo-Aryan belt is altogether free from this element.

As regards the origin of these brachycephals whom Chanda traced from the Pamirs and consequently designated Pamirian, it is interesting to note that Huxley and Haddon recognize a Pamirian type of the Eurasiatic race (Sergi) in the sense of Chanda and describe it as follows:—

"The Pamir or Iranian type is prevalent from Persia to Manchuria. Its most noticeable character as compared with other Eurasiatics is the abundance of facial hair which varies in colour from brown to light. The eyes are inclined to be light in colour and occasionally blue. It is doubtful whether this group has influenced Europe to any appreciable extent". This type is distinct from the Armenoid or Anatolian type widely distributed in the Near East, of medium stature, stocky and fleshy built; head extremely broad and high, flattened occiput, face broad; Hittite type of nose in a noticeable proportion.

To which of these types do the Indian brachycephals conform? Guha terms this race "Alpine-Armenoid" (—distinct from Montadon's "Alp-Armenien", a mixed form between Mongolids and europid brachycephals), "Armenoid" and "Dinaric", the apparent confusion being due to certain characteristics, particularly taller stature present among Indian brachycephals. The term "Dinaric" refers to the other type of planoccipitals found on both sides of the N. Adriatic, the Illyrian mountains, etc., which differs from the Armenoids, principally in its tall, slender build and its long narrow nose. As a matter of fact, facial profiles of both the varieties are present in the mixed populations of Western and Eastern India. The Hittite or nutcracker type of

^{*} I am indebted to my colleague Dr B. K. Chatterji for this reference.

nose with over-hanging fleshy tip is comparatively infrequent among Indian brachycephals of Hindu persuasion.

This variability of Indian brachycephals may explain itself by reference to conditions in Middle Asia, which has been recently investigated by the Russians—Jarcho, Ginsberg, Oshanin and others. As a result of 11 years' work in Middle Asia and W. Pamir, Oshanin distinguishes between the following brachycephalic types of the europid class:

1. *The race of the Middle Asiatic Duab.*—Predominating among the Uzbeks and Tajiks inhabiting the plains and foothills between the Amu- and Syr-Darya basins. Medium stature, dark colour of eyes and hair (typical brunets), moderate development of the hair-cover, rather small nose with a straight or sinuous bridge. The brachycephalic europid type revealed in E. Turkestan by the expeditions of Sir A. Stein is closely related to this race, which also inhabits the Ferghana valley.

2. *The race of Asia Anterior, or Armenoids.*—Introduced into Middle Asia by immigrants from Asia Anterior. Distinguished from the race of the Middle-Asiatic Duab by much richer hair and the typically Assyroid form of the nose. In its purest form found among the Middle-Asiatic Jews, who preserve the general Armenoid habitus, wherein they differ from the race of the Middle Asiatic Duab. But they also deviate from the classical Armenoid type by their rounded occiput, rather low and slightly bulging forehead, and less fleshy nose with its considerably narrower base.

3. *The europid brachycephals of the Western Pamirs.*—Found among the Iranian tribes inhabiting the sources of the Amu-Darya: brunets of medium stature, who occupy an intermediate position between the race of the Middle Asiatic Duab and that of Asia Anterior, being more related to the latter in respect of abundant hair and high prominent nose. The Pamirian type may have resulted from a crossing of the first two, but not necessarily so. It may also be a local type or one representing a transitional stage in racial evolution.

A comparison of the above results with those of Herrlich who found both the Anterior Asiatic race and the Dinaric race among the Kafirs of Kafirstan leads to the conclusion that the Middle Asiatic region including the Pamirs, Chinese Turkestan and Kafirstan are inhabited by Europid brachycephals some of whom are more or less of the Armenoid or Anterior Asiatic type and must be regarded as immigrants or intrusive elements; such immigration, as shown by the Armenoid skulls of Harappa may have been taking place repeatedly from the pre-historic times. On the other hand,

there are others who diverge from the Armenoid habitus particularly in regard to their hair-covering and nose form (through mutative changes or new acquisitions; or through their comparative immunity from miscegenation with foreign elements) though less so in cranial build. It is one of these latter types that has been located by Herrlich among the Kafirs, and this he designates as "Dinaric". The presence among the Hindu population of both the Armenoid type, though not in so strong a form as in Asia Anterior and of another type which deviates from the Armenoid habitus and has been termed Dinaric by Guha and Cipriani, leads to the conclusion that the Indian brachycephals are due to a migration which brought to this country a mixed population in which both types are represented.

We should however never lose sight of the fact that unlike the race of the Middle Asiatic Duab, the Indian brachycephals did not settle in regions where they were comparatively unexposed to foreign influences. Always, there were influences from below. In Western India they were open to penetration from the north and the east, and the Arabian Sea was the opposite of a barrier. In the delta of Bengal where they actually lived on the high roads of population movements, there are few families I know of which do not show the characteristics of two, more frequently of three races. The intensive miscegenation which has been going on for tens of centuries makes it extremely difficult to determine the original racial types of the brachycephalic immigrants with a moderate degree of exactitude.

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Notes and News

EFFECT OF SOLAR ECLIPSE ON THE IONOSPHERE

THE hours during which the sun's disc is hidden totally or partially by the moon offer opportunity for studying the nature of ionisation decay of the various ionospheric layers when the solar rays are withdrawn. If the laws regarding the decay of ionization are known, the rate of diminution of same, as also the hour at which the ionization would attain a minimum value, can be calculated and checked with the observed results. Further, observations during eclipse provide data for deciding the much debated question as to whether the cause of ionisation of one or other of the two main regions of the ionosphere, E and F₂, are solar ultra-violet light or solar corpuscles.

According to observations made hitherto it has been definitely established that the ionisation of region E is affected during the total eclipse in such a manner as to show that the ionisation is due to a solar ultraviolet rays. Results regarding the F₂ ionisation had till recently been inconclusive so far as the effect of the eclipse totality on the ionisation is concerned. As such, the source of the ionisation also—corpuscular or ultraviolet solar radiation—was uncertain. Observations made during a total solar

eclipse which passed over S. Africa on October 1, 1940, seem to throw new light on this vexed question.

There were three expeditions to South Africa, one from the Harvard University under Dr Pierce, another under Dr Higg of the Radio Research Board of the Commonwealth of Australia and another from the University of Johannesburg, South Africa.

Dr Higgs has published his results in the Monthly Notices of the Royal Astronomical Society, Vol. 102, March 1942, and he records that the South African observers are in agreement with his findings.

According to these observations, there is marked ultraviolet light effect in the F₂ region, a decrease of about 20 per cent in the maximum electron density being recorded. Further, there is a lag of about 30-40 minutes between the hour of minimum electron density and the totality of eclipse. No such lag is found in the case of the E region ionisation. It should, however, be mentioned in this connection that some previous observers report such a lag (about 15 minutes) for the E-region also (Mitra, Rakshit, Syam and Ghose, Nature, 132, 442, 1933). Theoretical considerations show, in fact, that there should be a lag on account of the time taken for the disappearance of the electrons by recombination and by attachment

after the solar rays have been withdrawn (Chapman, *Mon. Nat. Roy. Asn. Soc.*, 92, 413, 1932). In the case of the F_2 region, which may normally be expected to be completely ionised, the lag should be much larger on account of the extremely low pressure in that region. The mean free paths are probably extremely long, and the time interval between two collisions is of the order of 30 minutes. The observation is of great interest, both to theorists and to experimental workers.

QUININE PROBLEM

In a malaria-ridden province like Bengal quinine is as essential as food and drink. The problem of the supply of quinine has during recent months assumed gigantic proportions though we have been watching with great anxiety and uneasiness the rapid worsening of the quinine situation in India ever since the outbreak of the present war. The sudden intensification of the quinine problem in India has been in the main brought about by the Allied reverses in the Far East resulting in the removal of Java from the list of supplier countries in quinine and partly by the hoarding and profiteering mentality of dealers and middle men eagerly bidding their time for a like opportunity.

From the record of past consumption we find that about 210,000 lbs. of quinine are required annually to meet the civic needs of which the indigenous production is responsible for only 70,000 lbs., the remaining supplies of 140,000 lbs. being obtained from Java alone prior to its capitulation to the Japanese. Even then the total consumption of 210,000 lbs. falls far short of the real demand of quinine in this country, as much as two-thirds of this demand being left unsatisfied. This unfortunate state of affairs is largely due to the high price of quinine even in times of peace, dictated by the Kina Bureau of Java on the strength of their monopoly of quinine supply and humble acceptance of the same by the Indian producers for want of any Government protection against Javanese dumping.

It may be recalled that, in 1939 the Imperial Council of Agricultural Research carried on an investigation to explore the possibilities of increased cultivation of cinchona in Bengal. As a matter of fact, Bengal alone can score a maximum production of 50 to 60 thousand pounds. The report of the investigation, prepared by Mr Wilson, revealed the existence of sufficient lands in various parts of India, suitable for cinchona cultivation and a promise for future self-sufficiency with regard to quinine supply. But this far reaching suggestion of the report was neglected by the Government which insisted on the short sighted policy of obtaining an easy supply from Java with the bitter consequences that we are now experiencing.

The Government appears to have realised, of late, the importance of quinine problem in India fully in keeping with its old tradition of belated consciousness of Indian problems and have concentrated on the improvement in the methods of cultivation and an extension of acreage under cinchona. We, however, appreciate the Government measure to follow the Russian methods of cultivation, which guarantee substantial yields of quinine from two and half-year old plants. Already about 700 acres of land in Bengal are undergoing this new experiment in the Russian methods of cultivation. Also we note with satisfaction that by introducing a system of rationing of quinine in this province the Government of Bengal has recently decided to control the situation. Furthermore, a five-year rationing scheme has been adopted, whose successful execution, it is understood, will effect the distribution of the total stock at the hands of the Central Government together with the annual production of Bengal and Madras all over India for the said period and will make 75 per cent. of the past consumption available for each unit of distribution. While some such rationing scheme is doubtless indispensable under the present circumstances, we wish if Providence could only temporarily ration the incidence of malaria out of consideration for the people of this wretched province.

SCIENCE ON THE POSTAGE STAMPS

DESIGNS on the postage stamp have always constituted an interesting study in all civilised parts of the world. As a matter of fact, postage stamp design in Europe and America has almost developed into an art in itself of no mean order with which is associated not infrequently great literary and historic interest. But we have hardly noticed any scientific subject being represented in the designs of the postage stamp of any country. According to a note appearing in *Nature*, the Government of Mexico has recently issued stamps with designs devoted to scientific subjects following the dedication of the National Astrophysical Observatory at Tonanzintla. In all a series of six different stamps, viz., 2 c., 5 c., 10 c., 20 c., 40 c. and 1 peso stamp, have been issued so far. On the first five varieties will be seen the beautiful designs of astronomical bodies like the dark nebula in Orion, the solar corona at a total eclipse, the open spiral nebula N. G. C. 4594 and the ring nebula in Lyra respectively, whose grandeur and magnificence will at once strike the onlooker. But the 1 peso stamp has surpassed them all by attempting to represent on the facial design such a difficult and technical subject like the Hertzsprung-Russell diagram showing the relation of stellar luminosity with spectral type. Such attempts will doubtless go a long way in popularising science

among the common people and rouse a genuine interest in scientific subjects.

HEAT FROM TERRESTRIAL RADIO-ACTIVE SOURCES

THE problem of the heat energy derived from terrestrial radio-active sources has always commanded considerable geophysical interest and has formed a subject for much experimentation and discussion. Previously such energy in particular specimens used to be determined from a knowledge of the radon and thoron content of the specimens in a very complicated way, and as such very few specimens indeed did lend themselves to such determinations. A simpler way of measuring the production of thermal energy, involving the counting of α -particles in an ionisation chamber, was experimentally investigated by William D. Urry of the Geophysical Laboratory, Washington, with some interesting results. According to Urry, the production of heat energy 'H' in calories per gram of the specimen in a year is related to 'N', the total number of α -particles liberated per gram of the specimen per hour by a simple equation: $H = 2.1 \times 10^{-9} N$. This has, however, to be corrected for heat energy associated with the disintegration of potassium, the correction terms also admitting of an easy calculation. The most significant conclusion derived from his investigations appears to indicate a more or less constant production of heat inside the structure of the earth since its formation some two thousand million years ago. At any rate, however, our information on the subject of heat energy derived from radio-active sources in the earth is yet incomplete, and this new method, in consequence of its great simplicity of application to the study of rock specimens, is expected to lead to an accumulation of important data which will help throw a flood of light on this old and outstanding geophysical question.

MEXICAN OIL CONTROVERSY

THERE seems, as it were, to be no end to the tug of war between the British and the American Oil companies on the one hand and the Mexican Government on the other over the old question of the expropriation of the sub-soil rights formerly enjoyed by these companies. Despite the Supreme Court's decision in favour of the expropriation and declaring such action legal in December, 1939, the companies during all these years were never tired of appealing and reappealing before the Supreme Court for a revision of the decree. Here runs the recent Reuter report on further developments of the controversy over Mexican Oil:

The last recourse of British and American Oil companies to appeal against the Mexican expropriation of

their properties was lost when Judge P. H. Ortega refused an injunction asked for by the Aguila (Eagle) and other companies. The judge ruled that the expropriation was constitutional, and rejected the companies' request that in future private interests should be guaranteed their sub-soil rights.

We cannot help appreciating the tenacity with which the Mexican people are holding their own and defending their sub-soil rights against foreign exploitation notwithstanding the various devices and endless appeals of these foreign companies before the Supreme Court to regain the ground which they so deservedly lost. We simply wonder how these companies can at all make a case for further appeal after the Supreme Court's declaring, on December 2, 1939, the 1938 expropriation legal and recognising the right of the foreign companies to claim compensation for capital directly and legitimately invested. The episode of Mexican oil simply illustrates how difficult it is to abandon property rights and privileges of exploitation for people strongly entrenched in the cults of Imperialism and economic exploitation. What a strange contrast does this action of U. S. and British oilmen bear with the recent profuse appreciation by the joint Anglo-American Press of Mexico's alignment with the United Nations against the Tri-partite Powers and with the much advertised cause of democracy and world freedom which the British and the American people are said to be championing and fighting for!

INDIAN SCIENCE CONGRESS ASSOCIATION

THE University of Lucknow, which had invited the Congress to hold its next Session there, very recently intimated their inability, owing to unforeseen difficulties, to make the necessary arrangements for the Session being held in the first week of January, 1943. They suggested postponement, which, in effect, would ultimately have led to the dropping of the Session altogether. The Executive Committee, however, felt that every effort should be made to maintain continuity of the Congress Sessions, particularly as all work for the scientific part of the Session had been completed. The Executive Committee, made enquiries from two Universities—one in Northern and the other in Western India—about the possibility of holding the Session under the auspices of any of them. Having failed in these attempts the Committee approached the University of Calcutta and they very kindly extended an invitation even at this late hour to hold the Session at Calcutta.

The Session will open at Calcutta on January 2nd, 1943 and close on January 5th, 1943. In the absence of Pandit Jawaharlal Nehru, President-elect for the next Session, Mr D. N. Wadia, the present

President, will continue in office and conduct the deliberations of the Session.

The Local Secretary's office will be located at the University College of Science and Technology, 92, Upper Circular Road, Calcutta, and will remain open every day during the Session from 9 A.M. to 4 P.M. and also on January 1st, 1943.

NATIONAL INSTITUTE OF SCIENCES OF INDIA

At a meeting of the Council's Committee of the National Institute of Sciences of India, held on the 11th December, 1942, the following were duly elected as Ordinary Fellows of the Institute:

Dr J. C. Bardhan, D.Sc., Calcutta; Mr R. C. Bose, M.A., Calcutta; Dr N. C. Chatterjee, D.Sc., Dehra Dun; Dr M. N. De, M.B., M.R.C.P., Calcutta; Dr R. D. Desai, D.Sc., D.I.C., Bombay; Dr B. N. Ghosh, D.Sc., Calcutta; Dr C. S. Pichammuthu, Ph.D., Mysore; Mr K. Ramiah, M.B.E., M.Sc., Dip. Agr., Indore; Prof. T. R. Seshadri, Ph.D., Guntur; Dr S. C. Sirkar, D.Sc., Calcutta; Mr V. V. Sohoni, M.Sc., New Delhi; Dr. N. R. Tawde, M.Sc., Ph.D., Bombay; Mr R. T. Vanchell, M.A., F.G.S., Digboi.

THE BEVERIDGE PLAN

INDIA has received only a cabled summary of Sir William Beveridge's social security plans for Britain. It contains, we are given to understand, proposals for complete and compulsory insurance against every form of personal want and insecurity pensions in old age, funeral expenses, medical treatment, children's allowances, unemployment benefits, etc., to be administered by a Minister of Social Security.

The main features of the scheme are as follows:—

1. It covers all persons, irrespective of age, sex, income or job and provides a flat rate of benefit for a flat contribution.
2. Contributions to the fund would be 5 sh. per week per head.
3. Employers as well as employees would contribute.
4. The scheme would cost the Exchequer about £800 millions.
5. Everybody would get retirement pensions, men at the age of 65 and women at 60. Housewives are included in the scheme as a class of the community performing special services and possessing special needs.
6. All persons excepting children and old people are covered in respect of risks which threaten them

with hardship and want, such as sickness, unemployment, maternity, widowhood and death.

7. Children are specially provided for.

The Beveridge scheme is in essence an extension of the principles of social insurance already in operation in Britain. Britain has followed Germany's lead in this respect. Britain is already spending £530 millions a year on the various social services—the Beveridge proposals are for a step up to the 800 million figure. It is not a revolutionary scheme nor does it presage a millenium.

Working classes in England do no longer want 'doles' from the Government—they demand co-partnership in industry and the elimination of the profit-making motive from the economic field. If the scheme is intended to steal the thunder from socialists in England, it is not likely to succeed in that respect.

It has no interest for India because it offers nothing to India's hungry millions but India may be concerned with it because to finance their scheme of social betterment in Britain, a British Government may, in future, need India and the colonies.

PAPER STARVATION

PROTEST against the latest restriction imposed by the Government on the paper market for ordinary consumers has been universal. Persons and associations who have protested represent interests of various kinds—it is not merely trade and industry which have been hard hit but education and culture are also threatened.

The Government of India in commandeering 90 per cent. of the output of the mills has behaved in a most thoughtless and anti-social manner. Civilian consumption in India in pre-war days has been estimated at 170,000 tons a year. The following table would show the imports and the production of paper in India. The residue of 10 per cent. of Indian Mills' output would amount to a bare 10,000 tons a year for India. This would be much below the irreducible minimum. We do not know who is responsible for this bureaucratic thoughtlessness but we have seen it stated publicly that while the Commerce Department of the Government of India is responsible for paper production, the Labour Department is responsible for paper consumption. It is the duty of both the departments to see that more paper is produced and imports of paper arranged without delay and that less paper is consumed by Government departments. 'Economy' is a blessed word in these days as much for individuals as for the Government. For it cannot be that what the public consumes is necessarily wasteful and whatever is consumed in the Government departments and bureaus is essential for their needs. Authors of

official reports and publications which are not read by many may wait in the queue in their morning frocks along with private individuals with no urgent social needs to satisfy.

Year	Imports of paper in India.	Production of paper in India.
1937-38	1,82,000 tons.	59,200 tons.
1938-39	1,54,000 "	70,800 "
1939-40	1,35,000 "	50,900 "
1940-41	1,05,000 "	87,600 "

"BLACK MARKETS"

THE demand has recently been voiced in influential circles that as the price controls adopted by Government have failed to work, control economics as a principle, should be abandoned and the markets left entirely to themselves. This is ridiculous. It would be foolish to argue that since the present controls have failed we should revert to a state of economic anarchy. There is no ground to think that prices and supplies would be better in an uncontrolled market so long as speculators and hoarders are not brought to book. It must, however, be said that the controls which have been applied so far have failed to yield satisfactory results. The control organisation ought to be strengthened and careful State planning is needed along with much wider powers over production and distribution. It is reported in *Capital* of December 3, 1942, that in the "black market" of paper, "prices rule at anything between 500 and 1,000 per cent. over mills' prices". The food grains trade similarly brought a black market into existence for food grains. The price of food grains has shot up by 100 to 250 per cent. What is needed today is more control, more efficient and drastic control of rackets and racketeers. The Food Ministry in Britain is making a short shrift of these hoarders and speculators, if necessary, by a death sentence for anti-social acts. They have set up a special Intelligence Bureau for this purpose. It is also reported that the National Government of China has recently shot a Mayor of a provincial town for anti-social hoarding. The fact remains, however, that a socio-political system which caters mainly for the rich and is neither national nor socialist can hardly provide adequate social and economic control in the interests of the people.

ECONOMIC PLANNING

FOR many years before the war, politics was the only profession for which no special training seemed to be necessary. To this must now be added the art of economic and financial administration in this country.

In India, the problem of economic planning and control has been aggravated by the fact that an essentially *laissez-faire* state has been suddenly confronted with a situation that can be effectively handled only by a policy and a programme that will bring about the temporary end of *laissez-faire*. It was difficult enough for a State, so deeply imbued with the traditions of *laissez-faire* as ours, to evolve at short notice, a positive policy and a constructive programme regarding control; it is obviously more difficult to produce an organization that could formulate such a policy and work out such a programme. That is the true explanation of the failure of the various control measures adopted by the different governments in this country, and, consequently, of the relative infructuousness of their economic administration as compared with their administration in the other spheres of social life.

The needs of the times, therefore, call for an adequate and comprehensive economic organization. These needs may indeed transcend the immediate requirements of the war, and lead us to a project of the post-war future that we can afford to ignore today only at our peril in the not distant tomorrow. To plan for our present-day needs will thus become a much-needed contribution to the building of the future.

The outlines of the plan of economic organization that may be visualized are:—

- (i) the establishment of an Economic General Council, which will
 - (a) ruthlessly cut across departmentalism in the economic field;
 - (b) evolve a coherent and complete economic policy for India as a whole.
- (ii) the establishment of an Economic General Staff that will draw up a comprehensive programme of work based on the policy formulated by the Economic General Council;
- (iii) the establishment of Regional or Provincial Advisory Bodies to assist the General Council in the formulation of policies;
- (iv) the establishment of Regional or Provincial General Staffs to give technical assistance to the Provincial Advisory bodies, and to act as local agents and advisers of the All-India General Staff;
- (v) the establishment of a new cadre of "Economic Administrators", who will possess the necessary training and competence to administer the programme worked out by the General Staff, and also to assist in the formulation of a practical programme of work.

The details of such an organization and its functions will be developed later.

—'Economicus'

ANNOUNCEMENTS

It is understood that the last year's president of the Indian Science Congress will deliver a short speech on the occasion. No advance copy of the same has been sent for publication in the press. As usual the abstracts of the sectional presidential addresses will be published in subsequent issues of the journal.

Owing to scarcity of paper we have been compelled to curtail the number of pages per issue of 'Science and Culture'. There has also been necessarily some alterations in the typography. As soon as normal conditions will be restored we hope to remodel the present arrangement in a suitable way.

A CORRECTION

In the last December, 1942 issue in line 3 of the filler entitled 'Plastics from Bagasse' on p. 265 read "glass-like" for "gas-like".

SCIENCE IN INDUSTRY

SULPHUR IN RUBBER

A WIDE variety of characteristics exhibited by vulcanised rubber remained inexplicable for a long time owing to our lack of knowledge as to the real mechanism of behaviour of sulphur in rubber. It is a common knowledge to rubber manufacturers that similar compositions and conditions of vulcanisation do not always produce rubber having identical physical characteristics. Sulphur passes through various stages of existence before it finally takes a place in the molecule of rubber. Vulcanisation is always preceded by a thorough mixing of sulphur with rubber generally carried out in a mill. The purpose of such mixing is to effect a uniform dispersion of the element through the entire mass of rubber. In such a dispersed state sulphur particles, though microscopic in size, are too coarse to attain a homogeneous distribution as in solution. Such a homogeneous distribution or what is called the solution of sulphur in rubber, takes place during vulcanisation when the mass is kept at some suitably high temperature for a considerable length of time. Transparency or cloudiness in the final appearance of vulcanised rubber depends on whether sulphur dissolves wholly or partially in the rubber mass. G. G. Winspear (Bell. Lab. Rec. 20, No. 8, April, 1942) finds that the interval between mixing and vulcanisation is extremely important as it determines whether sulphur will entirely or partially go into solution and hence the transparency or foggiess of the resultant rubber. In the period intervening the mixing and the vulcanisation sulphur crystallises in fine structure of dendritic form as the mass cools down. If the intervening period be sufficiently long the dendritic form slowly passes into rhombic sulphur crystals. During vulcanisation while the dendritic form readily goes

into solution the bigger rhombic crystals refuse to dissolve so readily and therefore develop the familiar cloudy and spotty appearance of rubber.

DRYING OILS FROM HYDRO-CARBONS

THE possibilities of preparing drying oils from high molecular hydro-carbons have been recently explored by German chemists according to a report appearing in the *Chemical Age*. The shortage of vegetable oils like tung oil, linseed oil, etc., led to the investigation of such possible substitutes. Paraffin wax, ozokerite and ceresine, paraffinous residues and crude lubricating oils have been found particularly suitable as starting hydrocarbons. To start with paraffin wax, for example, the hydrocarbon is first subjected to repeated cracking at a temperature of about 500°C. 100 parts of the product obtained are then dissolved in 30 parts of ethylene chloride to which 30 parts of aluminium chloride and 15—20 parts of phosgene are added, the whole mixture being afterwards subjected to a temperature of about 50°C to 60°C for several hours. Dilute hydrochloric acid is used to dissolve the aluminium chloride, the aqueous solution removed, and finally the solvent is separated from the reaction product by means of distillation. It may be noted that carbon tetrachloride may be used in place of ethylene chloride. Besides aluminium chloride, the other metal halides that can be satisfactorily used for the purpose are the chlorides of aluminium, zinc, iron and titanium and the fluoride of boron. The iodine values of mineral drying oils, however, vary from 110 to 160 depending on the use of the particular reagents mentioned. The drying time can further be considerably minimised by the additional use of some oxides, acetates and borates of metals, lead, cobalt and manganese. The

use of the mineral drying oil, either as such or mixed with the natural vegetable oil, is however permitted.

NATURE OF METALLIC FRICTION

AN interesting account of the mechanism in the frictional forces between metal surfaces has been given by Bowden and Tabor in a recent lecture given to the Royal Society of Victoria, reported in *Nature* of August 15, 1942. The sliding of metal over metal is not all a surface phenomenon as is usually supposed to be. "Penetration and distortion occur to some depth beneath the surface, and the frictional force and the nature of sliding are both influenced by the bulk properties of metals. The physical properties of metals, such as their relative hardness and melting point, play an important part".

As a matter of fact when the slider rests on the stator the contact is not thorough; they rest on the summits of the surface irregularities. These peaks however flatten out according to the load until the blunt surfaces are sufficiently wide to support the pressure. It has been observed that these points of contact which take so much of pressure produce sufficient heat so as to weld up the contact points. The subsequent sliding means therefore shearing off the welded junctions. This contributes a large fraction to the observed frictional force.

When again the two parts are of different metals (e.g., softer bush bearing for a steel shaft, etc.) the peaks of the surface irregularities of the hard metal embeds into the softer one and has actually to plough through the latter. The total frictional force is thus the sum of the forces required to shear the metallic junctions and the harder peaks to plough through the softer metal.

The lubrication, however, amply modifies the two effects by separating the two metallic surfaces, but the surface irregularities of the two parts are usually able to penetrate through the lubricating film and make metallic contact between them. As for the oxide films it has also been found that the film helps sliding without much friction, but the abrasion usually tears off the film, and the metallic contact does occur. It was found that when the surface film is carefully removed by outgassing in vacuum the metallic contact between the slider and stator is very intimate so that the frictional force increases for the pure metallic surfaces more than for those contaminated with a surface film. For nickel and

tungsten the coefficient of friction was found to increase twenty times for clear metallic surfaces than for contaminated ones.

K. R.

LARGE WIND-DRIVEN ELECTRIC GENERATOR

OF the natural powers of wind, water and sun, only the water power has been effectively harnessed in the hydroelectric generators. Wind-driven electric generators and solar engines have so far been in the hands of amateurs. Recently it is reported in *Nature* that a 1,000-Kw. wind-driven electric generator is being erected on the top of a mountain peak of 2000 ft. height in the State of Vermont, U.S.A. The plant is the first of its kind and is on the experimental stage. The electricity will be used by the Central Vermont Public Service Corporation. It has been estimated that it will be possible to use the power of the wind for 4,000 hours a year.

The wind generator consists of a two-bladed wind turbine and a 1,000-Kw. alternator. Each blade is 65 ft. long and 11 ft. wide and weighs about 6¾ tons. The giant fan describes a circle of 175 ft. in diameter, and revolves at a speed of 28.7 revolutions, per minute. The alternator will generate three phase current at 60 cycles and 2300 volts.

K. R.

PRODUCTION OF COTTON CLOTH WITHOUT SPINNING OR WEAVING

A NEW process has been developed in New Brunswick for the production of cotton cloth without spinning or weaving. This is done by pressing carded cotton into a fabric with the help of a plastic material as binder. The cotton fibres are then reinforced by putting on cross lines of adhesive plastic in a printing machine. This new fabric is called 'Masslinn'—it is now being made for the military. The new fabric, as it is, is not suitable for clothing—it can however replace only some of the cheap woven goods; it also can replace paper for many purposes. For instance, it is likely to be used for table cloths, window draperies, sheets, book bindings, etc. It has a greater flexibility than paper; it does not disintegrate when wet. The fabric can also be washed. The cost of its production is rather low, being approximately equal to that of paper.

P. B. S.

PRODUCTION OF TUNGSTEN

In a recent number of the "Electrician" the present position of the production of Tungsten has been discussed in some details.

The statistics of the world's production of tungsten ore appears in details in the different annual issues of "Metal Statistics", compiled by the United States Bureau of Mines. These are quoted in metric tons of concentrates containing 60 per cent. of tungsten trioxide. It shows that the Chino-Malayan provinces supplied about three quarters of the world's output. Thus one finds that in 1924 when the world's total production amounted to 6159 tons, the Chino-Malayan provinces contributed 4848 tons. By 1934 the world's production rose to about 15,900 tons and the Malayan contribution was 11603 tons. Korea and United Kingdom produced 469 and 223 tons respectively.

There has been considerable amount of literature on tungsten since the last war, but they chiefly relate to methods of dressing and treating the mined product, systems of wet extraction and subsequent uses in the steel industry, and various patents had been taken out for these processing operations. It is, however, noticed that electro-thermal process of smelting has not been dealt with in the same elaborate details, largely because of the almost unnaturally refractory disposition of the metal.

Tungsten melts at a higher temperature than that of any other metal so far isolated, and all thermal treatment is limited to electric furnace practice. Although its melting point is recorded as 3080°C, it is sometimes pasty at this temperature and according to recent observations it requires higher temperature to reach the liquid state.

The electric furnace can provide a temperature of 3600°C but in view of the pasty disposition mentioned, the furnace is not infrequently strained to give the full output of heat.

Tungsten was one of the many metals, the recovery of which at first provided a new opening of utilising calcium carbide hearths when calcium carbide manufacturers were seeking new markets. In earlier years a cheap source of electric power, an abundant supply of charcoal and lime was all that was necessary to manufacture calcium carbide, which used to be sold at a high price. When competition became unduly keen, efforts were made to utilise the hearths for smelting tungsten, though it required a fair amount of adaptation of the hearths.

It has to be pointed out at this stage that Swedish Government realised the importance of electro-thermic processes in its industrial application and the Technological Institute of Stockholm was

provided with a department with ample provision of accommodation and equipment for the purpose. Every facility was afforded for experimental and practical research work on all forms of electric hearths up to the electric blast furnace. It is claimed that many of the ferroalloy enterprises developed in Germany originally hailed from Sweden, where intensive investigations could be conducted with the facilities provided. An improvised process is worked out on a small scale which is gradually modified from the experience gained in the course of working.

After the last war, attempts were made in England, America and France to work out different processes for the extraction of the metal. In England wolframite was ground and mixed with sodium carbonate, heated in a coal-fired furnace followed by wet extraction and separation of tungsten oxide which eventually had to be reduced in the electric furnace or on a small scale by hydrogen reduction. It was taken up on a commercial scale with an output capacity of about 3 tons daily producing tungsten of 99 per cent. purity. But in the German process the metal was obtained by more or less direct smelting methods which permitted working in greatly increased tonnages in less time.

According to German patent No. 147326 of which there are many adaptations, tungsten concentrates along with the slags are first reduced to a spongy form with a fixed proportion of carbon in a blast furnace, connected to an electric refining furnace, where they are subjected to a strong current. In view of the high consumption of current, arrangements are provided for passing all hot gases from blast furnace into the refining hearth to pre-heat it before it receives the spongy product. The surplus heat from the electric furnace is utilised for raising the high temperature of the blast furnace. Due to the action of exceptionally high temperatures involved in the process the flaxing, slagging and volatilising of impurities proceed at a rapid rate and the product obtained is comparatively pure, though not up to the standard of wet extraction.

According to Davies, pure tungsten oxide can be reduced to metallic powder condition at comparatively low temperature, though it would not ensure the complete elimination of iron which reduces the purity. For steel makers this however is of little importance, after the combined process of blast furnace and electric refining found favour with steel makers.

In American practice, one finds direct smelting of wolframite (previously roasted free from sulphur), using single square sectioned graphite electrodes for each hearth, with provision of trunnions for tilting

and water cooled hearth contacts. The arrangement is practically a copy of existing steel hearths. Two phase 25 cycle 50 volt is applied with current consumption of 1000 amperes. The output is 15 cwt. for a 30 hour run at a consumption of approximately 2 kwh. per lb. Though impurities exert an appreciable influence on the current consumed, on an average a ton of tungsten (containing tungsten and manganese) consumes 4900 kwh. The process had to be altered to suit the demands of different steel makers. For example, while certain armament manufacturers insisted on the pure tungsten powder for using in the production of special armour plates and shock-resisting steels, the melters experienced considerable difficulties in turning out the product due to infusibility. Though in some works calcium tungstate has been tried, the most popular practice is the addition of ferro-tungsten containing 60 to 82 per cent. of the metal. The presence of 20 per cent. of iron removes much of the strain of the electrolytic process as the product melts more easily.

The Ampere Company of Berlin took out a patent for the direct smelting of scheelite (tungstate of calcium). In this process the concentrates were fused with ferrous sulphide, lime and carbon. The ferrous sulphide melts readily and in the presence of the electric arc confers its sulphur content to the lime forming calcium sulphide, whilst the remainder of the carbon passes off as carbon monoxide leaving at the bottom the fused mass as ferro-tungsten regulus. The slag so formed is both light and fluid which facilitates the process as the original silica of the raw material is separated as the slag.

The mineral "ferberite" which occurs in certain outcrops has the composition of tungstate of iron and offers facilities for direct conversion to ferro-tungsten and attracted the attention of several American refiners. Theoretically the reduction of 122 lbs. of "ferberite" should produce 100 lbs. of ferro-tungsten alloy by addition of 16 lbs. of carbon, but keenly pointed out that unless there is atmosphere of CO the reactions are not satisfactory. Hence 25 per cent. of excess carbon is imperative to success. Using single phase 25 angle 50 volt hearths for concentrates containing 60.36 per cent. of tungsten oxide, 22 per cent. iron oxide, 8 per cent. silica and remainder chiefly made up of manganese, sulphur, phosphorus in varying small proportions, ferro-tungsten alloy was secured with 1000 amperes; and the slag contained less than 1 per cent. of tungsten.

It would be interesting to relate here the process as adopted in the Stockholm Institute for the study of the extraction of tungsten.

The prepared charge is fed into a specially lined magnesite crucible which has holes drilled in the

sides to permit the introduction of carbon electrodes. The crucible is laid on a carbon block and the bottom covered up with a mass of fine graphite. Smaller scissor types of carbon arrangements will suffice, but the bucket holding them is fitted up in a vertical position, i.e., the tray has to be rigidly connected complete with centering attachments. These are built for amperages ranging from 8 to 20A, while the more expensive types are equipped with adjustable resistances.

The charge consists of 200 grams of "ferberite" concentrates (or similar tungstate of iron residues from tin smelting, etc.), 38 grams of graphite finely pulverised, 53 grams of quick lime and anything from 4 to 8 grams of flour-spar. It has been found that by using 20 amperes for 1½ hours one can get fairly satisfactory result. Sometimes the proportion of flour-spar is increased according to the refractory nature of the mass but too much of it has a tendency to produce a pasty mass from which the tungsten alloy separates with difficulty. At first a crude bottom is obtained and then it is remelted after removing the slag and adding half its weight of original raw material and not more than 5 per cent. of flour-spar, when after another working period of 1 hour pure ferro-tungsten bottom is produced.

In the direct reduction of tungsten from the oxide with carbon the final product rarely is in true liquid state and generally occurs as a pasty mass. Immediately the current is turned off and the dazzling white mass has to be forged under a small automatic hammer to form a solid button of pure metal, otherwise it reveals an open porous broken structure containing inclusions.

When dealing with residues of tungstate of calcium type, the addition of lime is essential though it increases the refractoriness of the charge, as otherwise silica is reduced to silicon and pollutes the resulting metal.

In the Stockholm Institute a miniature electric blast furnace is used for this class of work which permits of much larger charges being smelted under similar conditions to what obtains on the large scale.

Electric hearths of this kind might be worthy of consideration at the present time, where sufficient A. C. power is available and research could be carried on tungsten bearing materials and similar unduly refractory metal products which are required for special steels. Improved apparatus suffices for experimental tests, and allows research to be performed on the melting capabilities, approximate current and power consumption required for any such materials.

It would be worth mentioning that there are indications of the occurrence of tungsten bearing ores

in India but so far there is no record of any attempt of the application of electro-thermic processes for their extraction, though there is no dearth of A. C. power at least for experimental purposes. Besides

tungsten, there are other refractory minerals in India which are also amenable to electro-thermic treatment.

P. N. G.

MEDICINE AND PUBLIC HEALTH

THE EXCHANGE OF RADIO-ACTIVE POTASSIUM WITH BODY POTASSIUM

The *American Journal of Physiology* recently published an account of some experiments by W. O. Fenn, T. R. Noonan, L. J. Mullins and L. Haeghe who investigated the exchange of radio-active potassium with body potassium. They experimented on a number of different animals and found an exchange of the body potassium taking place within a few hours with the injected radio-active material in all these animals. Thus KCl containing radio-active potassium was injected into rabbits, cats and frogs, and tissues of the animals, killed at various intervals after the injection, were analysed for total K and radio-active K. The ratio of radio-active to ordinary potassium within the first few hours of the injection has been generally found higher in the liver and other viscera than in the plasma—a fact which cannot be satisfactorily explained by a simple exchange of K^{42} for 39 by diffusion. It is believed that the viscera quickly removes the excess of potassium in the plasma together with an anion and afterwards slowly releases it to the muscles. The experiments were further extended to the case of human beings. Radio-active potassium in the form of KCl through drinking solution was introduced to the system, and the ratio of radio-active K to ordinary K determined. The results indicate that man also exchanges his body potassium for its radio-active isotope, but less rapidly than the rat (50—60 per cent. exchange in 12 hours).

X-RAYS IN THE TREATMENT OF PNEUMONIA

It is interesting to note that physics is increasingly making its mark in the control and treatment of difficult diseases where chemotherapy is still strongly believed to hold an undisputed monopoly. X-ray treatment, it is needless to say, has already proved very useful in many diseases. The effect of this radiation has recently been studied on experimental pneumonia in the guinea pig with satisfactory results. A type of bronchopneumonia very similar

to that observed in man was developed in guinea pigs by introducing into the bronchi through the surgically exposed trachea a definite quantity of bacterial emulsion of staphylococcus aureus hemolyticus. The guinea pigs were then exposed to X-rays for 6, 12 and sometimes even for 24 hours. The irradiation was followed by definite clinical improvement as subsequent examination of the animals revealed. Thus the lungs of the guinea pigs receiving X-ray treatment were more normal in colour and soft and flabby in consistency, whereas those of the untreated animals were indurated and deep red in colour. Microscopic examination revealed that X-rays inhibit the growth of pneumococcus bacteria even when the disease has made some progress.

FRUITS IN THE DIETS OF CHILDREN

HAROLD H. WILLIAMS and Icie G. Macy reported in the *Journal of the American Dietetic Association* the nutrition value of fruits in the diets of children. Fruits like banana, oranges have been found to produce an increased retention of a number of important elements in the system. Thus an addition of 100 gs. of banana to the nutritionally adequate diet of 5-10 year children produced an increased retention of nitrogen and the electro-positive element e.g., calcium, magnesium, sodium and potassium and a slightly greater retention of the electro-negative elements e.g., phosphorus, chlorine and sulphur. Fresh orange juice containing 26.4 mgs. of ascorbic acid produced on an average an increased retention of nitrogen and electro-positive elements, but the retention of electro-negative elements, however, suffered a slight reduction. In strong contrast with this a daily addition of 20 mgs. of synthetic ascorbic acid brought about a reduction in the retention of both the electro-positive and electro-negative elements, particularly the latter. It is, therefore, not the vitamin C, but some other unaccountable factor which partly determines the superior nutritive value of fresh orange juice over the synthetic acid.

DENTAL EDUCATION AND PROGRESS IN INDIA

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ALTHOUGH modern dentistry as we know it to-day, dates back to only 75 to 100 years, dental science as a branch of medicine, has been known in India since ancient times. The earliest mention of dentistry in Hindu literature according to the author of Satpatha Brahmana, which is the commentary of the Sukla Yajurveda, dates back to about 5000 B.C. Lokamanya Tilak, in his epoch-making book¹ also confirms this.

In the Vedas, we find description of the mouth, its anatomy, its hygiene, its diseases and their treatment. Susruta who flourished about the fifteenth century B. C. was a great anatomist and surgeon, and at that early period counted the jaw bones and left a description of them². A dental condition, such as Dalana³, i.e., odontologia, was recognized, treatment of conditions incidental to teething and instructions for hygiene of the mouth were given. Susruta recognized 65 *Mukha Roga*, i.e., diseases of the mouth⁴. Of course, the treatment according to our standards of to-day was empirical. But what I want to point out is that we have lost all historical sense when we are told that a gun was fired from the Fort William in Calcutta, when the first Hindu student dissected a human body or when we enter a certain well-known Medical College in Bengal we find adorning the staircase a statue of Hippocrates (460 B.C.) who is supposed to be the father of Medicine. No one seems to have the courage to say that instead of the bust of Hippocrates the bust of Susruta (1500 B.C.) should be there.

In ancient times, *Krimi-danta*, i.e., caries of the tooth, *upakusha*, i.e., pyorrhea alveolaris, were treated by means of extraction⁵. That artificial teeth were also made may be deduced from the fact of the mention of Asvins having supplied a set of artificial teeth to Pushan⁶. Coming to more modern times (1194 A.D.) we find a reference to artificial teeth, in Elphinstone's History of India⁷, where he says that "after having been beaten in battle, Jei Chandra, the Rathor Raja of Kanouj was recognized by his false teeth." If we recall that porcelain artificial teeth were not invented till 1788, we can only conclude that the artificial teeth made in those days

(1194 A.D.) were carved from ivory. A fine specimen of much more recent origin of this kind of ivory denture work in the Museum of the Calcutta Dental College and Hospital shows what ancient craftsmen were capable of.

During the Moghul period we have examples of gold and diamond inlays in the anterior teeth, and one can easily see how such artistic craftsmen must have flourished, in the heyday of the Moghul Empire, which produced jewels like the Taj, the Etmadud-Dowla and the Pearl Mosque. Then came the dark days for India. India was wiped off the map of the world as far as art and science was concerned. We were depicted as if we had no background of art and science and we had to borrow everything from the West. That we had contributed to the advancement of science and culture of the world was forgotten.

In 1857, the first Medical College in India was established, mainly to train up only assistants to Surgeons, who were to be imported from Great Britain, as they could not be produced in Susruta's country. No attempt was made to start any dental training institution in India, for the simple reason that dentists were not needed for the Army at that time.

The result was that quacks flourished, not only Indian, but foreigners from all parts of the world. As there was no dental educational standard, nor dental laws of any kind, was it any wonder that our bazaars became flooded with "dandansazs", who squatted on the mud floor next door to the grocer's shop and handled people's teeth and mouth without any compunction about sepsis or sterilization. We find glaring descriptions of these in the English papers of the big cities and great public indignation is sought to be aroused against these charlatans. But the point remains that the Government of the land made no attempt whatsoever to remedy this state of affairs. Only the dead dog was beaten further, because it was mangy, and it was pointed out to the world what an ugly creature it was.

From 1857 to 1920 there was a long interval, but it was not till this latter date, did we find any attempt at reviving dentistry in the land of its birth. During these sixty odd years, European and American dentists, coined money in our bigger cities and in turn their assistants and mechanics set up lucrative practices in towns, small and big, and as is to be expected, when no laws regulated the practice and

¹ Orion by Lokamanya Tilak, pp. 206—7.

² Hindu System of Medicine by Dr. Wise, p. 68.

³ Studies in the Medicine of Ancient India, Part I, by A. F. Hoernle, p. 173.

⁴ Hindu System of Medicine by Dr. Wise.

⁵ History of Aryan Medical Science by Thakore Sahib of Gondal, p. 29.

⁶ Dentistry in Ancient India, by J. J. Modi, p. 10.

⁷ History of India by Elphinstone, p. 265, 5th Edition.

profession of dentistry, quacks flourished. In 1920, the first dental training institution in India, the Calcutta Dental College and Hospital was established not by any government agency, but by the efforts of a few Indian dental surgeons and medical men. They associated with themselves other practitioners with an altruistic bent of mind and gave practical evidence of the fact that God helps those who help themselves.

Originally, the College started with a two years' course in 1920. It was raised to three years' in 1924 and to a four years' course in 1936. The curriculum is based on the general model of the American dental educational system and of the Royal College of Surgeons of England. The entrance requirement is the passing of the Matriculation Examination of an Indian University. After a great deal of up-hill work, the Government of Bengal was prevailed upon by the authorities of the institution to appoint a Dental Education and Registration Enquiry Committee in 1935. This Committee recommended a standard of dental education and suggested that a Dental Registration Act be passed in the province. Matters would have remained where they were, were it not for the fact that an energetic dental surgeon drafted a Dental Bill, and presented the same as a private member's Bill before the Bengal Legislative Assembly in 1937. This Bill was later on taken up as a Government measure and passed through the Bengal Legislative Assembly and Council in August, 1939. Under this Act a Dental Board for Bengal came into existence, the examinations in Dental Surgery began to be taken by the State Medical Faculty of Bengal and the registration of dental surgeons began to take place under this Act. For the present, all those who have been in practice as a dentist for not less than five years previous to the commencement of this Act; Indian dental surgeons qualified abroad whose qualifications entitle them to practise in the country where the qualification was obtained; persons holding qualifications registrable in Great Britain; graduates of the Calcutta Dental College and Hospital and medical practitioners who were practising dentistry at the time of the commencement of the Act are eligible to registration.

There is as yet no bar to practice because it is thought that if a bar is put, a large number of the public will not get the dental treatment it is getting from unregistered dentists and because the only dental training institution in the province is as yet unable to turn out as many dentists as may be required to meet the needs of the fifty million people of the province of Bengal.

The Bengal Dental Board has now set up a standard of dental education, mainly along the lines followed by the Calcutta Dental College and Hospital.

There are three examinations held by the State Medical Faculty of Bengal, the Primary, which consists of Physics, Chemistry and Biology; the Intermediate which consists of General Anatomy and Physiology, Dental Anatomy and Physiology, Dental Histology and Dental Prosthetics and Metallurgy and the Final Examination in General Surgery and General Medicine and Dental Surgery in all its branches and Dental Prosthetics. This in brief is the present course followed in Bengal, and it is necessary to add that the authorities of the Dental College insist on treating dentistry as a speciality of medicine and the necessary stress is laid on the biological concepts regarding the progress of dental science and art.

Coming now to more mundane affairs we find that all this development has taken place due to the self-sacrifice of a few men and neither the Government of Bengal nor the Government of India has contributed anything to the coffers of the Calcutta Dental College and Hospital, which has pioneered dental education in India since 1920. Although the Government of India has taken full benefit of the dental education imparted in Bengal, and that they have appointed graduates of the Calcutta Dental College and Hospital to the Army as Dental Surgeons in the Indian Medical Service, still they are oblivious of their obligations. Of the 77 or 78 Dental Surgeons appointed to the Indian Medical Service (Dental Branch) fully 60 per cent. has been contributed by the Calcutta Dental College and Hospital. But why is this apathy? The only reason I can think of is that the Calcutta Dental College and Hospital is a national institution and does not employ covenanted foreign experts with overseas pay and allowances.

It was not till 1936, fully sixteen years after, that Government of the Punjab founded the de Montmorency Dental College at Lahore and is spending about Rupees Seventy thousand annually for its upkeep. This is a good development but what strikes an Indian is the glaring fact that no Indian was found good enough to be appointed as the Principal of the Lahore institution and he had to be imported from New Zealand. A fee of Rs. 1,150/- per year is charged from non-Punjabis and Rs. 250/- per year from Punjabis. The corresponding fee in the Calcutta Dental College and Hospital is Rs. 300/- per year from everybody and there are students there from China, Iraq, Iran, Mauritius and Afghanistan. In order to get a prospectus of the Lahore Dental College, one is to remit by Money Order Rs. 1/8/- to a certain Government Book Depot. The result has been that annually only half-a-dozen or ten students from all over India have been able to take advantage of the excellent facilities of the de Montmorency Dental College Lahore. My...

that any development that is sponsored by the Government of the land puts too much stress on non-essential buildings and outward show rather than on the actual work that is carried out and the spirit that moves the organization. About 1918 or 1919, I happened to visit the Imperial University Medical College in Tokyo. We had to take off our shoes (according to the Japanese custom) before we could enter the Hospital, which was then situated in a single-story barrack-like building with a tiled roof, wooden walls and cemented floor. It was most unimpressive but we found all the paraphernalia of modern science inside. The development of dental art and science, as of any other, should, in my judgment, have been encouraged by the Government, Provincial and Central, in however humble a way as possible, from the very early days when medical education was started about 1857. However, we have seen that patriotic and far-sighted Indians have done all that could be done under the circumstances and have put dental education on the map, so that with the passage of time, the foundation which has been well and truly laid may be built upon.

No profession can progress without an organ of its own. With this view, the Indian Dental Journal was established in Calcutta in the year 1924. This publication has since then put forward the point of view of the Indian dental profession, brought about a spirit of inquiry amongst its practitioners and helped Indian dental surgeons to bring before the world whatever it could contribute towards the progress and advancement of the science. The Indian Dental Association was established in the year 1928 and has done yeoman's service to the cause of the profession in India. This body was the pioneer in the field of organized dental opinion in the country. And although there are now provincial dental organizations all over India, the parent Association is still carrying on very useful work.

Now as to the future. Dentistry must be organized to meet the health needs of the masses of the people. Our aim should be to provide dental care of all classes of the people rather than the development of a luxury dental service available only to the rich. It is a truism to say that a modern health service must also see to the dental needs of the people. So far in all health programmes, the dental aspect has been sadly neglected. The health authorities forget the fact that preventive and curative methods will not act to the maximum benefit of the person unless the mouth, the gateway of the body is also put in a hygienic condition. For this purpose the training and education of a competent class of dental surgeons should be one of the main objectives. Like in Ancient India, mouth and dental ailments,

should be taken as a part of the whole and the training imparted in such a way that the practitioner may develop a broad perspective of the dental diseases in relation to the systematic ones. For this purpose our present day dental schools should be incorporated with our existing medical schools. The dental students should get their education of the basic medical subjects e.g., Anatomy, Physiology, Materia Medica, Medicine and Surgery along with the medical students and the purely dental subjects such as Operative Dental Surgery and Dental Prosthetics should be taught in separate classes. This will simplify the cost of dental education to a great extent. This development would be easy if our universities take a little interest in dental education. So far we find the University Medical Colleges all over India are apathetic towards dental educational developments. They should look ahead and peer into the future and make such developments possible at an early date. When that is done we will be able to train up a large class of dental practitioners who will be able to take care of the total needs of the people. Dental education must be cheapened and popularized and that can only be done when the universities all over the country take a hand in the matter.

In the promotion of dental education and practice we must not lose sight of the fact that dental research is one of the most important branches of dental education. Opportunities should be opened up for delving into the problems facing dental science. In this matter the universities can give a helping hand. Apart from the purely scientific investigations that must be carried on a class of research workers should devote their time to the commercial aspect of the dental preparations. Every country must be self-sufficient with regard to the materials it has to use for the practical application of the various arts and sciences. For example, in dentistry, many articles are in use which can be easily produced in the country. It would be unwise to develop dental science in India in such a way that we have to buy everything necessary for its practice from abroad. The country must be self-sufficient with regard to the dental instruments, apparatus and materials used in its practice. Research workers could very well go into the problems of better dental rubbers, acrylic resins, cements and medicaments, and show the manufacturers the way to produce the same in the country. We will be making a mistake to develop dental science only and not see to it that the materials used in its practice are produced in the country at an economical cost. This is necessary, if we want to bring the benefits of dental science to the mass of the people.

At the present time only in a few of our larger cities are dental technicians or dental mechanics who

carry on their business exclusively for the profession. Most dentists process their own dentures and dental appliances. A few send their work to be done in a commercial dental laboratory. It has been found by the experience of other countries, that these dental mechanics abuse their knowledge and prepare dentures for their patients direct, instead of obtaining their orders through a qualified dental surgeon. For this reason, certain countries have passed laws prohibiting them from practising dentistry, but they are quite at liberty to prepare dentures and dental appliances in a laboratory at the direction of a qualified dental surgeon. In India it is too early yet to think of prohibiting anyone from practising dentistry. But a time will certainly come in future, when we have to put a bar to the practice of dentistry except by qualified practitioners. Such

a time has not yet come. In our generation we will be doing a great service to the people and the country if we can whip up the interest of our Government, and our universities to the imperative need of extending dental education. At present there are only three dental educational institutions in India, viz., at Calcutta, Bombay and Lahore. This is like a drop in the ocean, for 400 million people. Dental education should be made cheaper and popular and that can only be done if the universities take the matter in right earnest. From the point of view of the universities, they have nothing to lose but everything to gain. All universities can at very little cost, inaugurate dental education in Medical Colleges under them and it is expected that a dental college attached to a medical one, can be made self-supporting.

LETTERS TO THE EDITOR

ACETIC ACID-WATER MIXTURE

G. V. L. N. Murty and T. R. Seshadri¹ have studied the Raman spectrum of acetic acid-water mixture and have drawn certain conclusions which are at variance with the results obtained earlier by Koteswaram². Acetic acid and water are highly associated liquids and so their mixture is expected to show some interesting properties.

Murty and Seshadri conclude that dimers of acetic acid are broken up and the freed molecules form hydrogen bonds with water molecules whereas Koteswaram deduces that there is depolymerisation. The case of mixtures of alcohols in water is evidently allied in nature to the present problem and this has been studied by the method of ultrasonics³ employing the concept of intermolecular forces. It has been shown there that the breaking up of associations occurs in both the liquids and complete randomness prevails, and this fact is supported by evidence from other lines of work also. The velocity-concentration curve shows a maximum and the compressibility-concentration curve a minimum. The same maximum and minimum have also been recently reported for the acetic acid mixture. If there were hydrogen bonding in acetic acid-water mixture the compressibility curve would not have shown a minimum or even lowering from the value for an ideal mixture. Further the molecular weight⁴ of acetic acid in water is normal as in the case of alcohol in water showing that there are no associations of any kind.

Now we take up the argument of Murty and Seshadri in the order given by them.

(1) They assert that benzene and carbon-tetrachloride should show the same effect in acetic acid as water does if only depolymerisation takes place, which they think can be only due to dilution. It must be stressed that depolymerisation is not only caused by dilution which is only a mechanical effect. Indeed this is a very minor effect. The depolymerisation concerned is instead due to active dipoles of water breaking up the associations of acetic acid molecules. Carbon-tetrachloride and benzene are nonpolar liquids and inactive and are, therefore, fundamentally different from water. In these liquids the depolymerisation can only take place at extreme dilution of acetic acid, though it is significant that dilution required is more in the case of carbon tetrachloride than in benzene because the latter is more active of the two, due to its high molecular field arising from its high polarisability. The corresponding case of alcohol in these liquids is very well treated by Wolf⁵.

(2) Taking the case of acetone and water in acetic acid, Murty and Seshadri believe that if C=O of acetone could form associations with O—H of water, so could the C=O of acetic acid. But as they themselves admit later that acetone and acetic acid are vastly different liquids, the former being entirely unassociated due to the absence of any O—H with which it could form any linkages. Hence its behaviour in water cannot by any means be the same.

(3) Further considering the temperature effect, they argue that if water only depolymerises acetic acid, it should not produce a much bigger change in the C=O frequency than does the increase of tem-

perature which is recognised to be a dissociating effect. The effect of temperature on causing depolymerisation is expected to be small, as it is after all a mechanical effect. That it is so may be shown thus. All liquids except water show a decrease in ultrasonic velocity for increasing temperatures. This shows that associations are strong and that the effect of increase of intermolecular distance and the random kinetic motion due to increase of temperature is unable to overcome the increase of velocity due to gradual breaking up of associations. This increase of velocity continues up to about 80°C showing thereby that even above these temperatures associations persist. In the case of acetic acid it has been shown that even vapours contain dimers⁶.

Murty and Seshadri consider that acetic acid dimers open up and form associations with water molecules. But what about the water molecules themselves? They are hard knit up among themselves already and cannot be, so to say, spared. Indeed their structure is a massive one; of the pseudo-tetrahedral nature, as shown by Bernal and Fowler⁷ and others. So what happens is that both the associations break up and the mixture becomes a simple liquid. About the argument that the 1740 cm⁻¹ line does not appear in the mixture which they ascribe to the free C=O of the acid, it may be said that there are many other considerations playing their part which reduce the frequency, notably the high dielectric constant of water. It has been pointed out that it becomes difficult to make positive statement that hydrogen bonding is present. Small shift in absorption frequencies do not inevitably point to the hydrogen bonding. For example, in our own case even nearness of O—H of water to C=O of acetic acid will be sufficient to reduce the frequency of the latter due to intermolecular field of O—H upon C=O without going to the extent of forming hydrogen bonds as postulated by Murty and Seshadri and still there is some departure from complete depolymerisation which escapes detection by the methods described. Thus the method of Murty and Seshadri is not competent to decide the intricate form of linkages postulated by them without corroboration from other fields, notably from the electron-diffraction results.

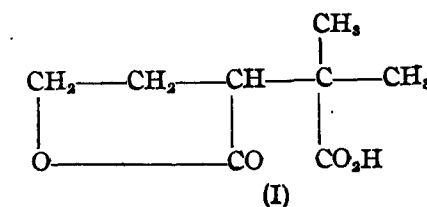
BAWA KANWAL SINGH
RAM PARSHAD

Physics Laboratory,
Government College,
Lahore, 31-10-1942.

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³ R. Parshad, *Ind. Jour. Phys.*, 15, 28, 1941; 15, 64, 1942.
⁴ Lassettre, *Chem. Rev.*, 20, 259, 1937.
⁵ Wolf, *Trans. Farad. Soc.*, 33, 179, 1937.
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⁷ Bernal and Fowler, *Jour. Chem. Phys.*, 1, 515, 1933.

SYNTHESIS OF 'DINIC ACID'

N. P. Kirjalov¹ isolated biglandic acid from the juice of *Euphorbia Biglandulosa*. Biglandic acid on catalytic hydrogenation yields a dihydro acid which readily eliminates CO₂ to give a lactonic acid which the author has named 'Dinic acid'. From the fact that on oxidation with potassium permanganate it yields α -methyl butane $\alpha\beta\gamma$ -tricarboxylic acid it has been concluded that the structure of Dinic acid is represented by



The synthesis of the above acid has been accomplished by the following method.

Acetone cyanhydrin was condensed with ethyl cyanacetate and then β -ethoxy ethyl iodide was allowed to react on the resulting compound *in situ* according to the method of Thorpe and Higson² when ethyl- α -ethoxy- $\gamma\delta$ -dicyano- δ -methyl-pentane- γ -carboxylate (b.p. 152°/6.5 mm.) was obtained. This on hydrolysis with glacial acetic and concentrated hydrochloric acids at 180° in a sealed tube yielded the γ -lactone of α -hydroxy- δ -methyl-pentane- $\gamma\delta$ -dicarboxylic acid (I) which on crystallisation from acetone melted at 128.5° (Literature records 129—131°).

My thanks are due to Prof. P. C. Mitter for his advice and encouragement during the course of this investigation.

BIDYUT KAMAL BHATTACHARYYA

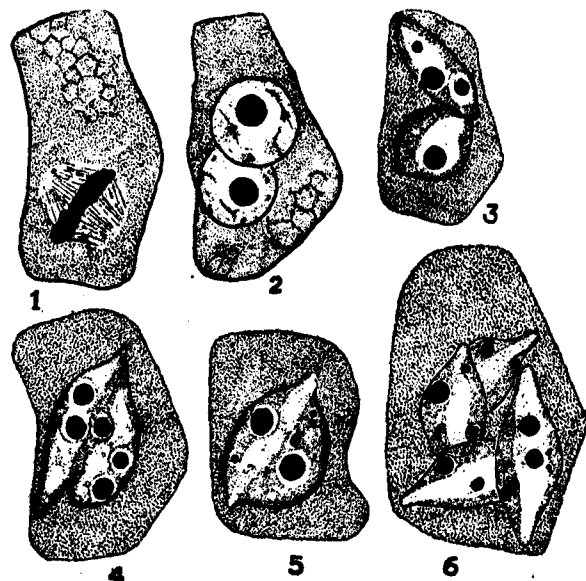
Palit Laboratory of Chemistry,
University College of Science,
Calcutta, 7-11-1942.

- ¹ *Jour. Gen. Chem. Russ.*, 8, 740, 1938; 9, 401, 1939.
² *ibid.*, 89, 1455, 1906.

DEVELOPMENT OF THE MICROSPORES AND THE NUCLEAR BEHAVIOUR IN THE TAPETAL CELLS OF *PUTRANJIVA ROXBURGHII* WALL

Putranjiva Roxburghii is a dioecious Euphorbiaceous plant which is cultivated as a road side tree in Calcutta. A study of the development of the microspores was undertaken primarily with a view to determine if sex-chromosomes are responsible for the dioecious nature of the plant. In the present note are embodied briefly the observations made in the course of the investigation.

In the resting stage of the pollen mother cells, the nucleus is centrally situated and the nucleolus shows a papilla like outgrowth. With the onset of prophase the volume of the nucleus becomes greater



FIGS. 1-6. *Putranjiva Roxburghii*.

and the presence of leptotene threads becomes evident in the nuclear cavity. Close examination reveals that these threads are double in nature and are closely intertwined. Zygonematic pairing of the threads next becomes evident and the nuclei pass into the synizetic stage. At this stage the pollen mother cells round off and lie free inside the microsporangium. In the diplonema stage the paired chromosomes tend to open out, but are held together at certain regions, thus showing the evidence of previous chiasma formations. Condensation of the chromosomes now proceeds rapidly and at diakinesis the bivalents become very compact in form and are disposed mainly towards the periphery of the nuclear cavity. The nucleolus becomes smaller and disappear by gradual reduction in size. At metaphase of division I, 20 bivalents are noted. The gemini show slight difference in size, two pairs appearing larger than the others. In no case, however, was a heteromorphic pair observed. The mode of arrangement of the chromosomes at this stage suggests a secondary association of the bivalents. An interkinetic stage is passed through before the commencement of the division II. At this stage daughter nuclei are organised and the chromosomes which are unconnected by anastomoses show the split for the next division. The division II is regular. Cytokinesis takes place by the process of furrowing. The mature pollen grains are uninucleate. They are tricolpate and show the presence of three germ pores.

In the early stages of their development the tapetal cells are uninucleate and form an uniform lining layer inside the microsporangial cavity. With the growth of the anther, the cells become loosely arranged. Division of the nucleus of the tapetal cells takes place when the p.m.c. are in synizesis and binucleate cells are produced (Figs. 1 and 2). The nuclei grow in size and become somewhat spindle shaped in appearance (Fig. 3). Most of the cells remain in this condition. The spindle shaped nuclei which normally lie very close to each other have been observed to fuse in some instances, resulting in the production of tetraploid nuclei (Figs. 4 and 5). Such nuclei could be easily made out on account of their larger size. Division of the tetraploid nuclei also takes place, and could be made out at the anaphase stage on account of the larger size of the spindle and the greater number of chromosomes. The normal diploid nuclei of a binucleate cell may also divide to give rise to four-nucleate tapetal cells (Fig. 6). In rare instances, tapetal cells were found to contain either three or five nuclei, probably as a result of aberrant divisions of the nuclei of the mother cell.

My best thanks are due to Prof. I Banerji for his kind interest and helpful suggestions.

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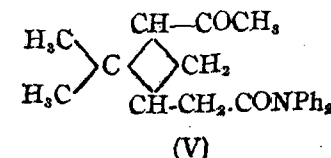
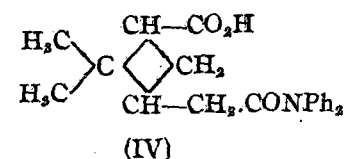
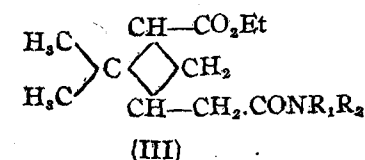
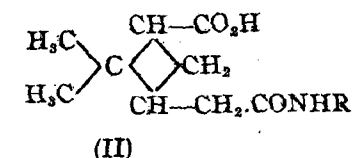
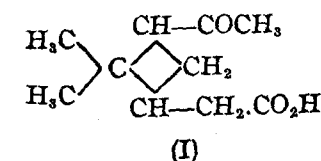
SYNTHESIS OF PINONIC ACID

Pinonic acid, the well known oxidation product of α -pinene has been of more than usual interest. The presence of tetramethylene ring in α -pinene itself was inferred from its constitution. Starting from this acid, Ruzicka and Trebler¹ effected a partial synthesis of pinocamphone and thus α - and δ -pinenes. The acid itself exhibits muta-rotation in its active forms and is very labile². Tiemann³ claimed to have effected an unusual synthesis of this acid from dihydro-dihydroxy- α -campholenic acid involving a contraction of a cyclopentane ring to a cyclobutane one which was however recently disproved by Komppa and Beckmann⁴. This acid defied many attempts at synthesis⁵.

The total synthesis of pinonic acid has now been effected starting from *trans*-pinic acid⁶.

Attempts have been made in the past to prepare a suitable derivative of pinic acid such as (II) with a view to applying Blaise-Mair's reaction for the synthesis of a pinonic acid derivative.⁷ This could not be successfully carried out because of the diffi-

culty of effecting a preferential hydrolysis of the ester grouping in compounds (III).



It has now been found that this difficulty could be overcome by hydrolysing the *diphenyl derivative* (III) $\text{R}_1=\text{R}_2=\text{Ph}$, m.p. 99–100° by means of 95% sulphuric acid and the acid (IV) m.p. 139–40° was obtained in very good yields although the preferential hydrolysis of the ester group in (III) $\text{R}_1=\text{R}_2=\text{Ph}$ could also be effected, but less readily by other hydrolytic reagents. A Grignard's reaction on the acid chloride of (IV), as is to be expected, went beyond the stage of the formation of the ketone (V), but Blaise-Mair's reaction using zinc methyl iodide produced only traces of a ketone giving mainly the methyl ester of (IV). This behaviour of the acid chloride of (IV) towards a Blaise's reagent appears very similar to that of benzoyl chloride as observed by Gilman⁸. In view of these circumstances a reaction was tried using acid chloride of (IV) and cadmium dimethyl (or cadmium methyl halide), and (V) was then obtained in about 30 per cent. yield. It was characterised by a *semicarbazone*, m.p. 204–205° identical with a sample prepared from *dl-trans*-pinonic acid of Delepine. It gave on hydrolysis pinonic acid (*semicarbazone*, m.p. 203–5°). Full details of this synthesis of pinonic acid will be published elsewhere.

My sincere thanks are due to Prof. P. C. Guha, D.Sc., F.N.I., for his interest in the progress of these investigations.

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⁴ Komppa and Beckmann, *Ber.*, 69B, 2783, 1936.
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Guha and Narasimha Rao, *Jour. Ind. Inst. Sci.*, 22A, 317, 1939; Komppa and Klami, *Ber.*, 70, 788, 1937.
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TEMPERATURE AND COMPRESSIBILITIES OF LIQUIDS

Recent developments in the measurement of acoustic velocity have opened up an easy method of determining the compressibilities of liquids. Various workers have determined the velocity of sound in liquids at various temperatures and have incidentally determined the compressibility also. Recently a determination of the adiabatic compressibilities for various liquids has been attempted by Suryaprakasam¹. In the present communication the author gives a useful relation giving adiabatic compressibility of a liquid as a function of temperature.

The author has shown semi-empirically that an equation²

$$v = L e^{\frac{S}{T}} \dots \dots \dots (1)$$

where v is the acoustic velocity, T the absolute temperature and L and S constants characteristic of the liquid, is easily applicable for many liquids. The accuracy of the law has been remarkable. Since then it has been found that the equation is applicable for mixtures also.

The well known equation between adiabatic compressibility and acoustic velocity is

$$\beta\phi = \frac{1}{v^2\rho} \dots \dots \dots (2)$$

Where $\beta\phi$ and ρ are the adiabatic compressibility and density respectively. Taking $\rho = \rho_0 (1 + \alpha t)$ ³ where α is the temperature coefficient of expansion and t the temperature in °C, by combining (1) and (2) we get

$$\beta\phi = A e^{\frac{B}{T}} (1 + \alpha t) \dots \dots \dots (3)$$

The applicability of the equation is shown in Fig. 1 in graphical form, where $\log \left(\frac{\beta\phi}{1 + \alpha t} \right)$ has

been plotted against $\frac{1}{T}$. The equation is applicable with considerable accuracy that it is possible to calculate beforehand the value at any temperature

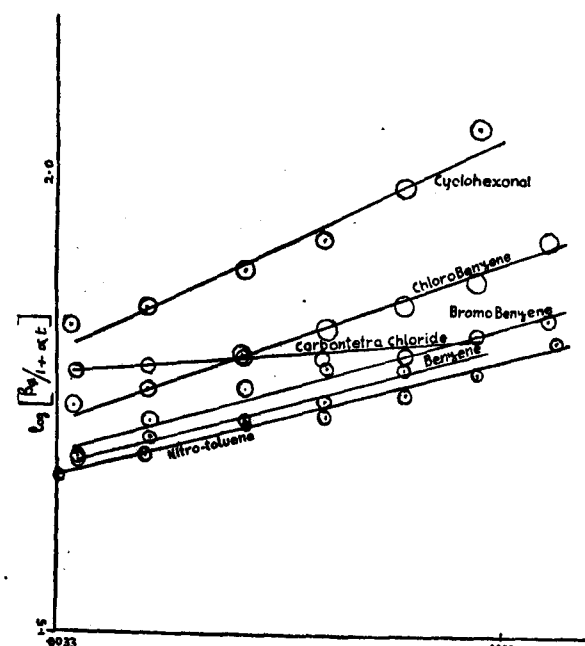


FIG. 1.

within reasonable range once the values for two temperatures are known.

The characteristics of the two constants A and B may be discussed in the following way.

In (3) extracting the logarithm of $\beta\phi$ we get

$$\log \beta\phi = \log A + \frac{B}{T} + \log (1 + \alpha t) \dots (4)$$

Now $\log (1 + z) = z - \frac{z^2}{2} + \frac{z^3}{3} - \dots$ to ∞ when $|z| < 1$ usually α is such a small quantity that it satisfies the condition $|\alpha t| < 1$

Thus writing (4) in full we get

$$\log \beta\phi = \frac{B}{T} + \log A + \alpha t - \frac{\alpha^2 t^2}{2} + \frac{\alpha^3 t^3}{3} \dots \text{to } \infty \quad (5)$$

Now substitute $\frac{B}{T} = B^1 a T^{-1}$ and $\log A = a^1 (a t)^0$ we get $\log \beta\phi = B^1 a T^{-1} + a^1 (a t)^0 + \alpha t - \frac{\alpha^2 t^2}{2} + \frac{\alpha^3 t^3}{3} \dots$ (6)

Now two more terms containing lesser powers of αt has been added and apparently the series for $\log \beta\phi$ is complete. By this it appears that B is a constant containing α as a factor. However it remains to be seen and discussed, whether this process elucidates the real matters. As it is only the temperature coefficient of expansion that is important in the temperature variation of physical entities of liquids it may not be out of place to say

that the constant B is a function of α . A detailed discussion is hoped to appear soon.

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¹ Suryaprakasam—*Proc. Ind. Acad. Sci.*, 1941.

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ON THE INTENSITY OF DISTRIBUTION OF FRAUNHOFER DIFFRACTION PATTERN AND THE RAYLEIGH CRITERION FOR THE LIMIT OF RESOLUTION

In accordance with Rayleigh criterion two point objects or two lines can just be seen separated without mingling with each other if the central maximum of the diffraction pattern of the one just coincides with the first minimum of the other. We are, however, ultimately concerned with the resultant intensity distribution of the pattern produced, whether we adopt the subjective method, such as simply viewing through a telescope, or the objective method, such as a microphotographic analysis of the photographic records of the images obtained. Let I_p be the intensity at the peak of the central maximum of the diffraction pattern of one line or point object and I_h the intensity at a point just half-way between this centre and the first minimum adjacent to it; and

let K represent the fraction $2\left(\frac{I_h}{I_p}\right)$. Then formulating the Rayleigh criterion in terms of intensity variation, we may state that if the ratio, P, of the intensity of the minimum between the two lines or small discs to the intensity of either maximum be just equal to K, the two lines or point objects of equal intensity can be observed as just distinctly two; if P be $> K$ the images will be mingling with each other. It has often been remarked that the Rayleigh criterion for the limit of resolution is quite arbitrary. If for the analysis of an intensity curve a registering microphotometer be employed the ratio P may be greater than K, as has been pointed out by Meissner¹. A critical review of the various criteria for resolution has been made by Ramsay² and others. The object of this note is to discuss further the arbitrariness and incongruity of the criterion when it is examined in terms of intensity distribution.

In the case of the Fraunhofer diffraction due to a single slit the value of K is $2\left(\frac{4}{\pi^2}\right) = 0.8106$, as is well known. In the case of a circular aperture we may get the values of I_p and I_h by putting $m=0$ and $0.61 \frac{\pi}{2}$ respectively in Airy's³ expression for the intensity, $I = (\pi R^2)^2 \left[1 - \frac{1}{2} \left(\frac{m}{1} \right)^2 + \frac{1}{2} \left(\frac{m^2}{1^2} \right)^2 - \frac{1}{2} \left(\frac{m^3}{1^3} \right)^2 + \frac{1}{2} \left(\frac{m^4}{1^4} \right)^2 - \dots \right]^2$

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Thus, $I_h = 0.367 (\pi R^2)^2$ and $I_p = (\pi R^2)^2$; therefore, $K = 0.734$ which is nearly 9.5 per cent. lower than the value of K for a single slit.

Let us now examine the case of a grating (acting by opacity only); the expression⁴ for the intensity of the Fraunhofer diffraction pattern due to it is

$$I = C^2 \cdot \frac{\sin^2 \alpha}{\alpha^2} \cdot \frac{\sin^2 n(\alpha + \beta)}{n^2 (\alpha + \beta)^2} \dots (i)$$

where $(\alpha + \beta) = \frac{\pi}{\lambda} (a + b) \sin \theta$, and $\alpha = \frac{\pi}{\lambda} a \sin \theta$, θ

being the angle of diffraction of a normally incident beam; a and b are the widths of transparent and opaque spaces respectively, and n is the number of apertures in the grating. Substituting $m\pi$ for $(\alpha + \beta)$, and $\frac{m\lambda}{a+b}$ for $\sin \theta$, we get, in the case of the

$$m^{\text{th}} \text{ order, } I_p = C^2 \cdot \left[\frac{\sin m\pi \frac{a}{a+b}}{m\pi \frac{a}{a+b}} \right]^2 \cdot n^2$$

The value of the corresponding I_h can be found out $\left(m\pi + \frac{\pi}{2n} \right)$ for $(\alpha + \beta)$, and $\left(m\pi + \frac{\pi}{2n} \right) \cdot \frac{a}{a+b}$ for α in the expression (i), since $\alpha = (\alpha + \beta) \cdot \frac{a}{a+b}$. Thus,

$$I_h = C^2 \cdot \left[\frac{\sin \left\{ \left(m\pi + \frac{\pi}{2n} \right) \frac{a}{a+b} \right\}}{\left(m\pi + \frac{\pi}{2n} \right) \frac{a}{a+b}} \right]^2 \cdot \left[\frac{\sin n \left(m\pi + \frac{\pi}{2n} \right)}{\sin \left(m\pi + \frac{\pi}{2n} \right)} \right]^2$$

Now the numerator of the last factor of the above expression $= \sin^2 n \left(m\pi + \frac{\pi}{2n} \right) = \sin^2 \left(mn\pi + \frac{\pi}{2} \right) = 1$, since m and n are whole numbers; and the denominator, $\sin^2 \left(m\pi + \frac{\pi}{2n} \right) = \sin^2 \frac{\pi}{2n}$.

$$\therefore \frac{I_h}{I_p} = \left[\frac{\sin \left\{ \left(m\pi + \frac{\pi}{2n} \right) \frac{a}{a+b} \right\}}{\sin m\pi \frac{a}{a+b}} \right]^2$$

$$\left[\frac{m}{m + \frac{1}{2n}} \cdot \frac{1}{n \cdot \sin \frac{\pi}{2n}} \right]^2$$

Thus for a given value of m, a and b, i.e., for a given order and dispersion, $\frac{I_h}{I_p}$ is dependent on the value of n. Further only when n is very large, we get $\frac{I_h}{I_p} = \frac{1}{n^2 \frac{\pi^2}{4n^2}} = \frac{4}{\pi^2}$, whatever may be the order

number m. This value of $\frac{I_h}{I_p}$ for very large n is identical with that for a single slit. It may be noted that this limiting value $\frac{4}{\pi^2}$ has been employed by Williams⁵ in deducing an expression for the resolving power of a Fabry-Perot interferometer.

We may thus sum up this discussion by observing that, for different types of apertures producing the diffraction patterns the Rayleigh criterion for the limit of resolution gives different values of the relative intensity of light, $2\left(\frac{I_h}{I_p}\right)$, at the centre of the resultant minimum between two just distinctly separated central maxima.

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¹ K. W. Meissner, *Jour. Opt. Soc. Amer.*, 31, 415, 1941.

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⁴ T. Preston, *Theory of Light*, Fifth Edition, Macmillan & Co., 1928, p. 312.

⁵ W. E. Williams, *Applications of Interferometry* (Methuen Monographs, 1930), p. 79.

DOUBLE TRANSPLANTATION OF PADDY AND ITS EFFECTS ON THE YIELD OF GRAIN AND STRAW

Double transplantation of paddy is, in spite of the extra-expenditure involved in it, practised in a few places, in order, it is said, to have an increased yield of grain. The seedlings from seedbeds are first transplanted in a well puddled plot, and, after an interval of some time, the plants are uprooted and re-transplanted in another plot. Sengupta¹ reports that the practice is prevalent in Goalpara district of Assam and the cultivators consider that it increases the yield by at least thirty per cent. There are, of course, other advantages, such as, saving of large seedbed area, stronger straw of plants, easier management, etc. Ramiah² is of opinion that the only advantage with this practice is that it is possible to use much older seedlings than would otherwise be the case. He holds that it is possible to tide over unfavourable planting seasons, viz., when there is scarcity of water or too much of it, by double transplantation.

The results obtained by Sen Gupta conclusively demonstrate the beneficial effects of the practice. The experiments conducted by Madras Agricultural Department as reported by Ramiah on the other hand, showed that there was nothing to be gained by the second transplantation. He reports that the double transplanted crop, however, produces more grain and less straw.

The present investigation was taken up at the Botanical Section of the Dacca Farm to determine the merits of different number of transplantations on the yield of two strains of Aman paddy (Latisail and Jhingasail). The experiment consisted of two factors—varieties and transplantations. There were five different kinds of transplantations:—

I. Single (Ordinary).

II. A. Double: The seedlings from the seed-beds were transplanted as usual on the same date as in I in the experimental plots. After an interval of 15 days they were uprooted and re-transplanted in the same plot after thorough puddling.

II. B. Double:—The seedlings from the seed-beds were first transplanted on the particular date (as others) in a well puddled plot other than the experimental one. They were uprooted after an interval of 15 days and transplanted in the experimental plot.

III. A. Treble:—The first and second transplantations were done as in IIA. The seedlings were uprooted after an interval of 15 days after the second transplantation and transplanted again in the same plot after thorough puddling.

III. B. Treble:—The first transplantation was done as in IIB. After 15 days the seedlings were transplanted in another non-experimental plot. The seedlings were again uprooted after 15 days and transplanted in the experimental plot.

The treatments were replicated six times in randomised blocks, the size of unit plots being $20' \times 3'' \times 9' - 9''$. A uniform spacing of $9''$ was given between seedlings which were planted singly.

When the plants were mature 50 of them were harvested at random from each unit plot after rejecting a border of one row all round and the yields of grain and straw were recorded. The number of tillers in each of the 50 plants was also counted and the average number of tillers per plant was worked out.

The data were statistically analysed and the results obtained prove that single or ordinary transplantation yields definitely less than the other treatments.

The ratio of variances in each case (for transplantations only), viz., average number of tillers, yield of grain, yield of straw, and, the ratio of grain to straw is significant. The summary of results for each is given below:—

(1) Number of tillers.

	I	IIA	IIB	IIIA	IIIB	S.E.	C.D.
Average no. of tillers	8.59	10.16	10.29	10.04	11.93	0.517	1.472
Conclusion:—	IIIB, IIB, IIA, IIIA, I						

(2) Yield of grain.

	I	IIA	IIB	IIIA	IIIB	S.E.	C.D.
Average yield of grain in oz.	1.88	2.22	2.24	2.08	2.27	0.092	0.26
Conclusion:—	IIIB, IIB, IIA, IIIA, I						

(3) Yield of straw.

	I	IIA	IIB	IIIA	IIIB	S.E.	C.D.
Average yield of straw in oz.	48.50	46.50	47.67	42.58	42.58	2.297	6.541
Conclusion:—	I, IIB, IIA, IIIA, IIIB						

(4) Ratio of grain to straw.

	I	IIA	IIB	IIIA	IIIB	S.E.	C.D.
Average ratio	62.34	77.35	76.80	78.37	86.71	3.381	9.631
Conclusion:—	IIIB, IIIA, IIA, IIB, I						

The results obtained here confirm those obtained by Sen Gupta and are, therefore, different from those of Ramiah.

Our results show that ordinary (or single) transplantation is definitely inferior to other treatments, so far as number of tillers and grain-yield are concerned. In both the cases, transplantation IIIB gave the best result followed by IIB, IIA, IIIA and I in that order. In the first, i.e., number of tillers, IIIB is significantly better than the rest and IIB, IIA and IIIA are significantly better than I, though there is no such difference within themselves.

In the case of grain-yield, I is significantly inferior to the other treatments, the differences within the latter being, however, statistically insignificant. The very similar results obtained with number of tillers and grain yield clearly demonstrate that double and treble transplanting lead to the production of greater number of ear-bearing tillers in the plants, which is probably related to greater root development. Our results agree with those of both Sen Gupta and Ramiah in so far as ratio of grain to straw per plot is concerned. In this case IIIB has proved to be the best, followed by IIIA, IIA, IIB and I in that order. Although the difference between the first two just misses the 5 per cent. level of significance, IIIB is significantly superior to IIA, IIB and I. The ratio of I is significantly less than those of others.

The results obtained from grain to straw ratio show that in double and treble transplantations the plants yield more of grain and less of straw than in single transplantation. As regards yields of straw, there is however, no significant difference between the treatments.

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SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

MARCH, 1943

No. 9

RAISON D'ÊTRE OF GOVERNMENT

"Let us not cease to grasp the guiding hand of history.
History has made us all, history can alter all."

—Ernst Mach.

THE concept of Government and its functions has undergone evolution through the ages along with the evolution of the social and economic system. It is worth while tracing the evolution of this system in brief. In the earliest times men were nomads living on the chance products of hunting and forest produce. They belonged to different tribes under their chiefs, who personally led them in war and exercised rudimentary functions of Government in peace. With the increase in population and the discovery that agriculture and tending of cattle would give a surer means of livelihood than nomadic life, men gradually settled into agricultural communities. This raised the question of permanent shelters and amenities for which a settled life would produce a natural desire. This led to man's first efforts at the construction of artificial abodes, villages and towns (as opposed to caves and other natural shelters) and to the gradual development of many handicrafts, which to this day are the characteristics of a rural civilisation. The form of Government of settled agricultural communities has varied widely; sometimes it was a City State which alternated between democracy and tyranny as in Greece or early Babylon (Sumer), or ancient India. But more often larger units were formed, under kings, emperors, or oligarchies of aristocrats (e.g., Egypt, Babylon, the empire of Macedon and Rome). At times, these vast units were ruled by a network of officials under a central authority, but more often when the central authority declined, areas fell to surviving officers, adventurers, soldiers of fortune. When something like a central authority again appeared, this authority preferred a path of least resistance, and in exchange for a promise of loyalty in vital State matters, confirmed the occupants of special areas in the possessions of the rights and properties they had usurped. This is the origin

of the feudal system in medieval Europe, in ancient and medieval India. The feudal chiefs, of whom our princes and zeminders are the present relics, collected revenues, meted out rough-and-ready justice and provided amenities for their subjects not according to any particular or settled canons of civilized life but mostly according to their individual inclinations. In India under this system Government from the centre was rarely strong and a considerable amount of self-government was left to villages and caste organisations.

EVOLUTION OF CAPITALISM

The feudal system had a fairly long life in all the world. But the material forces of production consequent on growth of settled life made it untenable in course of time. The first signs of social and governmental convulsions appeared in Western Europe. The pressure of population and the need for foreign adventures with consequent development of mechanised transport and the growth of industries to supply inland and particularly overseas markets led to the development of merchant capitalism. This developing capitalism found itself cramped by and finally opposed to the feudal systems of the 17th and 18th centuries, which were essentially unprogressive, steeped in their own privileges and growingly suspicious of the wealth and power of the rising bourgeoisie. The clash led to the overthrow of the feudal governments and the establishment in some countries of what have been called the democratic forms of Government, first in the Italian City States, and then in England. Hitherto the king, as head of the privileged class, had ruled by 'divine right', but by beheading Charles I and later driving James II to exile, the English people, for the first time,

established the principle that *Sovereignty is vested in the People*, and the king derives his power from the people and not mystically from any higher power. With the decline of the prestige of the king, the power passed to the English bourgeoisie, which represented the then progressive forces of capitalism. In course of time, Western capitalism developed into finance capital and monopoly capital and enveloped practically the whole of the world in its orbit. Its power is immense. The imperial and colonial system is its natural sequel. Even before our eyes its power grows.

POLITICAL DEMOCRACY vs. ECONOMIC DEMOCRACY

The political democracy of Western Europe and of Northern America found one of its most notable expressions in the stirring slogan of Abraham Lincoln—"government of the people, by the people, for the people". It has, however, been pointed out by many thinkers that the mere form of political democracy without the content of economic democracy may be largely a sham and even a snare. It was Marx who first pointed out that in every epoch the State, which is usually considered to be impartial and above all social classes ("super-class"), is in reality the political and military caucus by which the dominant class in society seeks to impose its will on the other classes of society and make them subservient to its economic interests. For example, in France, the autocratic Government was overthrown in 1792 and the democratic age was ushered in under the slogan of Liberty, Equality and Fraternity; but the leadership of the Revolution was in the hands of the bourgeoisie, who, in spite of Napoleon, the restored Bourbons and the new Republic, remained the dominant class and controlled the State apparatus then and thereafter. When in 1870 the bourgeois Republican Government of France fled from Paris before the onslaught of the German forces and the workers of Paris prepared to defend their city from the invaders and set up their own Government (the Commune), the bourgeois Government of Thiers actually conspired with the invading Prussians and overthrew the Commune after the slaughter of thousands of the defending workers of Paris. This would only show to what length a so-called "super-class" Government can go in order to suppress a particular class in the interest of another, of which it is, in fact, the veiled agent.

How the political democracy of England is to a large extent nullified by the lack of economic democracy, by the concentration of capital in a few hands and by the resulting gross economic inequality, has been pointed out by many British writers (*viz.*, Strachey, Laski and others). One may consider, for instance, the press of England. The vast majority of the newspapers are owned by the richer class of society,

in fact, by the conservatives, who are wedded to the Capitalist and Imperialist system. Even the *Daily Herald* which started as a Labour Daily has now gone to the hands of capitalistic share-holders. The press is the most powerful moulder of public opinion (Fourth Estate of Carlyle) and, if this public opinion is largely influenced by the vested interests directly or indirectly, how can the vote be really independent and democracy truly operative?*

The medieval barons have been replaced by press lords, chemical and armament barons, power and fuel lords. The finance barons rule the Empire in their own interest from behind the scenes. Even the great democracy of America which owed its existence to the revolt on the part of colonial against the imperialistic capitalism of Britain, has not been able to strike out a more liberal path where, as we read in "The 50 Rulers of America" 90 per cent. of her vast wealth is concentrated in a few hands.

SOVIET DEMOCRACY

In contrast to the British and American capitalist democracy, the features of the Soviet system are well worth looking into. Here it is a question of economic democracy. Here there is no social class, which owns millions of roubles, the factories and mines, the press, etc., which it can use in its own class interest. On the other hand, the State on behalf of the people, owns all the means of production in land, mines and factories, which are run for the profit of a particular class but for the economic, social and cultural progress of the people as a whole. The form of Parliamentary democracy freedom of talk without freedom of action, as we are used to in capitalist countries, may be absent. In the U. S. S. R. the State may be considered to be the apparatus by which the working class maintain its power—the reason why it has been called proletarian dictatorship. But the working class is in any case, a larger section of the people than capitalist coterie, which maintains its power in capitalist Parliamentary democracy by direct or indirect control of the State apparatus. That the Soviet system contains, in fact, larger elements of real democracy than capitalist democracies (if democratic Government is really for the people) has been ably shown by Pat Sloan in his book "Soviet Democracy".

* To pass from the sublime to the ridiculous, the writer may point out that several years ago a working-class woman voter in England was asked whom she would vote for. She said she would vote for the Prince of Wales. When she was told that she could not do so, she replied in that case she would vote for Mr Baldwin. When asked why, she said it was because she loved his pipe. This reminds one of more recent press propaganda regarding Mr Chamberlain's umbrella and now about Mr Churchill's cigar.

In 1936, even the outward form of Soviet Government was sweepingly democratized by the adoption of the so-called Stalin Constitution. The Soviet Government has thus become both in form and in content the most democratic Government of the world, bringing as it does the vast mass of the people into the actual day-to-day working of the administration through the wide-spread local Soviets. Regarding the intimate contact between the Bolshevik leaders and administrators on the one hand, and the masses on the other, the following words of Stalin may perhaps indicate the direction of his thought and action:

"In the mythology of the ancient Greeks there was a celebrated giant, Antaeus, who, so the legend goes, was the son of Poseidon, god of the seas, and Gea, goddess of the earth. Antaeus was very much attached to the mother who had given birth to him, suckled him and reared him. There was not a hero whom this Antaeus did not vanquish. He was regarded as an invincible hero. Wherein lay his strength? It lay in the fact that every time he was hard pressed in a fight with an adversary he would touch the earth, the mother who had given birth to him and suckled him, and that gave him new strength. Yet he had a vulnerable spot—the danger of being detached from the earth in some way or other. His enemies were aware of this weakness and watched for him. One day an enemy appeared who took advantage of this vulnerable spot and vanquished Antaeus. This was Hercules. How did Hercules vanquish Antaeus? He lifted him from the earth, kept him suspended in the air, prevented him from touching the earth, and throttled him."

"I think that the Bolsheviks remind us of this hero of Greek mythology. They, like Antaeus, are strong because they maintain connection with their mother, the masses, who gave birth to them, suckled them and reared them. And as long as they maintain connection with their mother, with the people, they have every chance of remaining invincible. That is the clue to the invincibility of Bolshevik leadership."

THE FUNCTIONS OF A MODERN GOVERNMENT

In the new Soviet Constitution is illustrated the *raison d'être* of a modern rational Government. The scope of a really civilised and modern Government, which calls itself democratic, should embrace the entire gamut of the material, intellectual and cultural progress of the people. According to modern notions, which are now widely accepted, the maintenance of 'law and order' by police methods does not constitute a Government's first and only responsibility. In fact, the physical well-being of the people is the first and foremost charge of a modern Government. As Frederic Soddy, thinking on Marxian lines, wrote more than two decades ago: "The physical conditions of existence are more fundamental than the aesthetic, moral or intellectual. A child must be fed before it can be taught. A certain standard of living above that of animals is a preliminary condition for the development of any of the special qualities of human beings."

Governments in some western countries have theoretically more or less accepted this responsibility of Government and have discharged it in varying degrees. The unemployment dole, the old age pension, the widow's pension and other social services have thus come into being to a greater or less extent. A little reflection would however show that in the frame-work of capitalism such benefits can at most be only palliative and perfunctory and can never lay the strong and broad base for the continued and uninterrupted economic and social progress of the people. The interests of the small capitalist coterie come into clash with the larger interests of the people, and the State, being mainly an agent for the former, the interests of the community can hardly ever be the sole guide for State measures. The Beveridge Plan of England, which was heralded with so much fanfare as the harbinger of a new era representing the cause for which the democracies were fighting, has only within the last weeks been largely 'torpedoed' by the British Government in the language of certain Parliamentarians themselves. Sir John Anderson, whom Bengal knows, and Sir Kingsley Wood on behalf of the British Cabinet stated in Parliament that they accepted the 'principle' of the Plan but not its entire programme or commitments. (It is curious to note in this connection how our predictions about the fate of the Beveridge Plan in the January and February issues of SCIENCE AND CULTURE have been not off the mark).

As a contrast, the Soviet Constitution may be looked into. Here it is not merely the Government for the time being which introduced social measures, which may perhaps change with the change in the complexion of the Government, as often happens in the western capitalist democracies. But the new Soviet Constitution itself lays down the following as the inalienable rights of the people of the U.S.S.R., which therefore cannot be taken away by any passing Government unless the Constitution itself is overthrown:

"Article 118. Citizens of the U. S. S. R. have the right to guaranteed employment and payment for their work in accordance with its quantity and quality."

Article 119. Citizens of the U. S. S. R. have the right to rest and leisure."

Article 120. Citizens of the U. S. S. R. have the right to maintenance in old age and also in case of sickness or loss of capacity to work."

Article 121. Citizens of the U. S. S. R. have the right to education."

It is note-worthy that the constitution of no other country in the world provides such economic, social and cultural guarantees for the people. It is also well-known that the Soviet Government, before

the outbreak of the present war, was valiantly trying to implement these guarantees through the Five-Year Plans in spite of a hostile world, against which the Soviet had to make huge defensive preparations, which would have been unnecessary in a socialist world. The striking difference between the problem of unemployment in the Soviet and that in the capitalist democracies is that while the latter try half-hearted palliatives which could never go to the root of the evil owing to the inherent contradictions of the capitalist system, the former had no problem of unemployment at all and would never have it in future as the socialist system of production and distribution is characterised by no inhibitory contradictions and therefore can lead a community to literally unending prosperity.

POSITION IN INDIA

If we accept the above functions as criteria of a modern civilized Government, are those criteria satisfied by what we have in India? The Indian people have first to establish the right that sovereignty is vested in them, and any ruling body must derive its power only from them, and from nobody else. We are still far from this goal, but we can have a strictly scientific estimate of the efficiency of the present Government from its records alone. Production, agricultural and industrial, is at the very root of the economic and material well-being of the people and it may roughly be represented by the national income and by the average income per head. The standard of health of the people would be indicated by the average expectation of life and the progress in education may be indicated roughly by the percentage of literacy. Let the following statistics tell their tale:

	India	Britain	U. S. A.	U. S. S. R.	Germany	Japan
National income (hundred crore rupees) ...	26	77	254	76	—	—
Average annual income per head (Rs.) ...	65	1610	1940	447	1028	260
Average expectation of life (years) ...	27	62	62	45	43	62
Literacy (per hundred adults) ...	10	100	95	100	95	100

It will be seen that in every one of the items listed India is at the bottom. In the above table the U. S. S. R. also looks relatively backward but it will be realised that her modernisation really began barely 20 years back, while that of Britain and U. S. A. began much more than a century ago.

It is obvious that nothing but industrialisation can improve the economic status of India. Yet that is not to be, because India must be held as a market for foreign manufactured goods, as a source of raw materials and a field of investment for surplus capital which does not find so profitable employment in the home country. Even the Report of the Grady Mission, which recommended some limited industrialisation of India owing to the exigencies of the war, has been officially shelved on the plea that American technical help under Lease-Lend needed for such industrialisation should at present be utilised better for equipping the North African expeditionary forces. A Reuter's message that emanated from Washington on this subject was full of rigmarole, which, as far as could be understood, yielded the meaning that according to the American allies of British Imperialism, the North African campaign was more important at the moment, and that the eventual clearing of the Mediterranean would speed up supplies of the manufactured equipments from the West to India and therefore new Indian manufactures at the moment were not needed.

The standard of industrialisation can be judged to some extent by the number of cities. India with her vast territory has got only 17 cities with more than 2 lakhs inhabitants while vastly smaller England has 22. The deplorable stage of urbanisation in India is indicated also by the fact that 89 per cent. of her people are rural and agricultural. And recent census returns show that a progressive ruralisation is still going on owing to the increase in population and lack of industrialisation.

Regarding Government's function with reference to unemployment dole, it has only to be said that no such thing is known in India. In fact, wisely enough, no statistics are kept on the subject. Regarding old age pension, widow's pension, sickness insurance and other social services which are performed by every modern civilised Government, no such thing occurs in the vocabulary of our Government. The result may be seen in the pervading destitution and in the look of immeasurable misery and despondency in the eyes of the people you meet in every day life.

It would appear that the task of the maintenance of what is called law and order is considered to be the first and foremost State function in this country. As the Secretary of State for India declared the other day, recent disturbances in India have been dealt with by nearly a thousand orders of whipping and by firing on crowds on about seven hundred occasions. The efficiency of Government in this respect cannot be doubted. That, however, Government should be more responsible for maintaining tranquility than for feeding the famished people

who are tranquil, does not appear to be a canon of administration adopted any where else in modern times. The tragic-comic story of a man who was arrested for trying to take his own life as he was not able to bear the pangs of starvation and was let off without food but with the warning not to try to commit suicide again in future by a British Court in India has hardly any parallel in the world! It is in India that an official once said on a particular occasion that so long as there were leaves on the trees and women had not become prostitutes there could not be said to be a famine in the land.

The *raison d'être* of Government, as we have seen, consists primarily not in maintaining peace among a starving and illiterate people but in devising and putting through planned measures for the rapid economic, social and intellectual betterment of its

people and in making itself fully responsible for their physical well-being. It is not honest to say that the backwardness is due to the social habits of the people for every person wants employment, and social customs rarely stand in the way. To-day, in the factories and in the army, Brahmins and Pariahs are working side by side and nobody bothers to know the other man's caste or social position. It is the function of a modern Government to overcome obstacles, if they exist, and to institute gigantic measures of progress as the Soviet Government has done for its once backward people. Judged in this light, does the present system of Government, which gives no indication of a change of heart, hold out any remotest hope that elementary problems of life—what Sun Yat Sen calls 'The Livelihood of the People'—for four hundred millions of India, will ever find a solution?

PHYSICS OF RADIATION THERAPY

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(Continued from the last issue)

INTERACTION OF RADIATION WITH MATTER.

NO biological change can be brought about by radiation unless there is an energy transfer from the incident photon to the absorbing tissues. Therefore, those photons which succeed in passing through matter without suffering any energy loss will contribute nothing to the final reaction. But a majority of the photons will encounter electrons in their path and transfer to these electrons either a part or the whole of their energy. This transferred energy is at the root of all subsequent biological reactions.

A photon may lose energy in two ways viz.,— (a) by photoelectric collision or (b) by scattering collision.* In the former a photon collides with an atomic electron and transfers to it its total energy. The photon therefore disappears from the beam and the electron, freed from the attraction of the nucleus, shoots out of the atom with the energy received from the photon. Such an electron is known as the photo-electron. Since the energy necessary to free an electron from the attraction of the nucleus is very small, the kinetic energy of the photo-electron is almost equal to that of the incident photon.

* We shall neglect the third probability, i.e., the creation of pairs of positive and negative electricity which is only possible at energies much higher than we are concerned with here.

The photo-electric process is just the reverse of generation of X-rays. Here a photon disappears after setting free a highly energetic electron, while in the production of X-rays a photon is created at the expense of the kinetic energy of an electron.

The second method of interaction of radiation with matter is by scattering. This may be pictured as an elastic impact between two balls—one of energy and the other of electricity. After collision the struck electron moves away in one direction and the photon in another. The photon is deflected or scattered away from its course and generally loses a part of its initial energy in the process. The moving electron known as a Compton or recoil electron carries away only the difference in energy between that of the incident photon and of the scattered one.

The energy loss of a beam of photons is due to the combined effect of the two processes just described. A part of the energy goes to the photo and recoil electrons released within the absorbing material; the other part goes to scattered photons. These originating inside the absorbing medium are continuously added to the attenuated fraction of the primaries. The scattered photons behave in the same way as the primaries i.e., they give rise to further photo and recoil electrons until their energy is exhausted. If we start with a definite number of

photons incident on the skin surface, their number will diminish with depth due to losses in photoelectric and scattering collisions. The number of scattered photons will increase at first with depth and then diminish with the primaries. The rate of decrease is dependent on the energies of the incident photons. If this energy is high, then photons suffer fewer collisions per cm path and therefore lose a smaller fraction of their energy. Such energetic photons are able to reach and release secondary electrons at depths which are beyond the reach of photons of lower energy. The penetrating power of the radiation therefore increases with the energy of the photons.

In a substance of low atomic number such as human flesh the absorption by photoelectric process is important only when the energy of the photon is low. At an energy of ten thousand volts the probability of a photoelectric collision is about 30 times as great as that due to scattering. At such low energies, the photon can hand over all its energy to a single photo-electron produced by it and thereby disappear from the beam. As the energy of the photon increases, the probabilities of both photoelectric and scattering encounters diminish but the chance of a photo-electric encounter diminishes much more rapidly. The result is that when the energy of a photon has reached about 30 thousand electron volts the absorption due to scattering has become as important as that due to photoelectric collision. At higher energies the chance of a photo electric collision becomes more and more negligible compared to scattering. At 90 thousand volts scattering is 20 times more probable than photoelectric absorption.

An X-ray beam consists of photons of different energies. To have an average energy of 90 K.V. the voltage on the tube must be considerably higher—near about 200 K.V. (with the usual filters). Thus in the deep therapy range (200-400 K.V.) and more so in the supervoltage regions (>400 K.V.) the absorption of radiation is mainly due to scattering. Such energetic photons are scattered several times before their energy drops to such low values that the whole amount can be transferred to electrons in single photo-electric impacts. The energy of the primary photon is therefore shared by different recoil electrons, generated along the path of the photon.

Whether a photon loses energy by photoelectric or scattering process, high speed electrons are set free within the absorbing material in each case. This is the first stage in the process of interaction of radiation with matter. The released electron, then begins to plough its course through the numerous molecules of the complex substances present in our body. It constantly comes into collision with those atoms which happen to lie in its path and knocks out elec-

trons from them. This continues until the wandering electron has lost all its energy. Some of the electrons it has generated will attach themselves to neutral molecules forming *negative ions*, while molecules which have lost one or more electrons become positively charged and are known as *positive ions*. The path of the electron is littered with such positive and negative ions, the total number of which is proportional to the energy of the electron.

In a substance like human flesh the matter is so congested that the electron can travel only a very short distance before it is brought to rest. Suppose a photon generates a secondary electron with an energy of 20 K.V. This electron has a range of about 0.7 mm. in the human body. In this short distance it generates about 600 ion pairs. The ions are clustered along the electron path which is very much crooked due to frequent collisions with other atoms and consequent deflections. The ions are therefore practically crowded together in one place and appear like a *dot*. Each dot of ionisation occurs at a place where a photo or a Compton electron happens to be released by the action of the X- or γ -rays. As the energy of the incident photon increases, the energy of the average recoil electron produced by it, also increases and the electron tracks become longer. The density of ionisation along the track changes, as it varies inversely as the square of the velocity of the electron. Towards the beginning of the track where the velocity is great the ions are spread out. As velocity diminishes towards the last part of the track ion density increases and finally the ions are so much crowded together that they give rise to the familiar appearance of a *dot*. This means that the track of a very high speed electron has the appearance of "oomma" where the tail end constitutes the initial high speed part of the electron track. The length of the tail increases with the energy of the electron. The biological response is a function of the density of ionisation, therefore the dots are possibly more effective than the sparsely ionised tails.

But it must not be supposed that ions once formed persist indefinitely. Due to mutual attraction and thermal agitation, ions of opposite signs come close together and recombine. However as long as radiation lasts secondary electrons are liberated at random, ions are produced by these electrons which again recombine and disappear within a short time of their formation. No part of the cell is immune to the action of radiation. In the cell wall, in the cytoplasm, in the nucleus and even inside the chromosomes such small islands of ionisation form and disappear absolutely at random. During such production and recombination of ions chemical changes take place; many complex compounds are broken up and new ones are

brought into existence. Only the initial energy of such a change is supplied by the photon but much greater energy may be released by the subsequent chemical reactions.

The cell itself is an exceedingly complicated system consisting of proteins, water, electrolytes and other organic compounds; its life depends on the maintenance of a state of physical, chemical and physiochemical equilibrium. This equilibrium is destroyed as a result of photo-chemical changes and there is consequent disorganisation of cell life and its functions. However a living cell is capable of recovery from radiation injuries if they are slight, but if the injury exceeds a certain limit the damage is beyond repair.

APPLICATIONS TO THERAPY

We shall now consider the applications of the above physical principles to a few problems of therapeutic interest. It will be clear that radiation is essentially a destructive agent. No particular quality of radiation has been found which will discriminate between the malignant cells and healthy ones. Radiation that destroys cancer cells will also destroy healthy tissues if used injudiciously. One must therefore be cautious in the use of radiation in therapy, and try to adjust the clinical conditions, so that an adequate dose of radiation reaches the cells to be destroyed and at the same time the surrounding healthy tissues are not radiated beyond the safe limit. If we assume that a definite minimum quantity of radiation is necessary to destroy effectively the malignant cells, the aim in radio-therapy is to deliver this amount at every point within the neoplasm without undue damage to the healthy tissues.

When the malignant growth is situated on the skin surface and does not extend deep into the tissues, it is comparatively easy to radiate it effectively. The use of low energy photons (low voltage, thin or no filters), closeness of the source of radiation to the skin surface would produce a beam of radiation whose intensity drops rapidly with distance. Both the increased distance, and absorption inside the tumor will then work in favour of protection of the healthy tissues situated below and all round the malignant growth. In interstitial therapy with radium needles or radon seeds, the source is actually placed within the malignant growth which receives the greatest amount of radiation and also serves as a protecting shield for surrounding tissues.

Difficulties appear when the tumor is located at a great depth below the skin (e.g. in the abdomen or chest). Any radiation (from an external source) reaching the malignant cells has to pass through normal tissues and one is handicapped by the limit

of tolerance of these. Under such circumstances, it may be possible to arrange multiple fields and so direct different beams that they converge on the tumor. Although the radiation delivered through one field is small, due to cross-firing by several correctly directed beams an adequate dose may be built up within the tumor mass. Even then in particular cases it may not be possible to deliver a cancer dose at a depth, without severely affecting the overlying tissues.

The amount of radiation that may be delivered through one field is limited by the skin tolerance. Only a fraction of the radiation received by the skin can reach the tumor situated at a depth. This fraction is known as the *depth dose*. The higher the percentage depth dose, the greater is the amount of energy that can be sent in through one portal for the same limiting skin damage and the more efficient is the radiation technique.

One must remember that the dose of radiation received either on the skin or at a point within the tissues below the skin is due to the combined effect of (a) the primary rays and (b) scattered rays. This has been shown in fig. 2 where the scattered rays

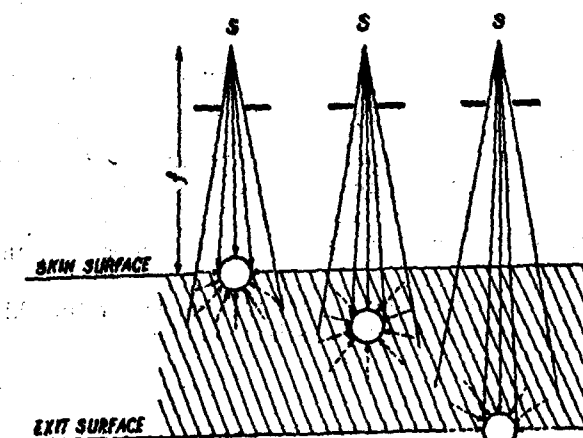


FIG. 2. Effect of scattered rays on skin dose and tissue dose.

have been shown, by dotted lines and the primaries indicated by full lines. It will be seen that when the tumor is within the tissues, scattered rays can reach it from all directions, whereas either on the skin or on the exit surface scattered rays from one side are missing. On account of the presence of these scattered rays, dose at a point on the skin or inside the body may differ considerably from that in air at the same position with respect to source. In order to find the correct tissue dose one must add to the air dose the proper scatter factor. To take an example, with 200 K.V. radiation and 5 mm. copper and 1 mm. aluminium filter and 100 cm.² field the actual skin dose may be as large as 135 rontgens

when only 100 rontgens measured in air have been applied. It is evident that unless these large additional doses due to scattered radiation are taken into account the skin reactions will be much greater than anticipated.

The total dose at any point varies with the clinical factors *viz.*, (a) quality of radiation, (b) skin focal distance, (c) location of the tumor with respect to the skin, (d) field area. The two fractions of the total tissue dose *viz.*, the fraction due to the primary beam, and that due to the scattered rays are affected in different ways by changes in the above quantities. We shall discuss the two fractions separately.

Let us first consider the fraction of the depth dose arising from the primary radiation alone. The skin-focal distance defines the amount of radiation reaching any part of the body. The source of x-radiation in the case of deep therapy can be regarded as point source, since its area is small compared to its distance from the body. With such a point source the intensity varies inversely as the square of the distance.*

If we assume that such a source (Fig. 2) is situated at a distance of f cms. from the skin, then the intensity of radiation on the skin surface is given by:

$$I_{\text{surface}} = \frac{Q}{4\pi f^2} \quad \dots \quad (1)$$

$4\pi f^2$ is the surface area of a sphere of radius f surrounding the source. If Q is the total energy emitted by the source, it is distributed uniformly over the surface of the sphere. The equation (1) gives the amount of energy per unit area *i.e.*, the intensity.

The intensity at a depth d cms. below the skin on the same considerations is given by

$$I_{\text{depth}} = \frac{Q}{4\pi(f+d)^2} \quad \dots \quad (2)$$

Hence the proportion of radiation reaching the depth compared to that incident on the surface is given by

$$\frac{I_{\text{depth}}}{I_{\text{surface}}} = \frac{f^2}{(f+d)^2} \quad \dots \quad (3)$$

The percentage depth dose is $100 \frac{f^2}{(f+d)^2}$

If we now consider the absorption of radiation in the d cms. of tissues above the point under consideration the percentage depth dose at a depth of d cms. is given by

$$D_d = 100 \frac{f^2 e^{-\mu d}}{(f+d)^2} \quad \dots \quad (4)$$

* This is not true for radium therapy when the source of radiation may be in contact with the skin or may even be placed inside the tissues (interstitial therapy). Radium dosage in these cases is based on different considerations and will be discussed elsewhere.

where μ is called the coefficient of absorption and denotes the rate of absorption per c.c. Here the factor $e^{-\mu d}$ takes into account the absorption of radiation by the layers of tissues between the skin surface and the point under consideration. The harder the beam, the less is the absorption coefficient μ and greater is the proportion of primary radiation reaching any fixed depth. In the treatment of a deep seated lesion one therefore uses penetrating radiation (high voltage, thick filter etc.) which leaves behind less energy per cm. path and hence are capable of delivering a greater dose at a depth for the same absorption by the skin.

The first factor $f/(f+d)^2$ in expression (4) takes into account the effect of the geometrical spreading of the beam with increased distance from a point source. The greater the distance of the skin from the focus of the tube the greater is the corresponding depth dose on account of this factor. The increase of skin-focal distance is therefore a convenient means of increasing the percentage depth dose. But this increase in depth dose like that due to a filter is at the expense of the intensity of the beam. As equation (1) shows the intensity of radiation at the skin surface varies inversely as the square of the focal distance. Hence every increase in focal distance necessitates an increase in the treatment time in order to deliver the same dose on the skin surface. At the expense of this increased exposure time one gets a greater percentage of radiation at a depth.

We will next consider the other fraction of the depth dosage *viz.*, that due to scattered radiation.

The quantity of radiation received at any depth due to the primary rays alone is given by equation (4). When the field irradiated is infinitely small (very narrow beam) this will represent the total depth dose, for all scattered rays will then be deflected away from the direction of the main beam. As the field of radiation increases, the greater is the scattering volume and larger the quantity of scattered radiation reaching any point. The total depth dose therefore differs from that given by equation (4) and increases with the area of the field. However after a certain limit the increase in depth dose with field is not so great as the amount of scattered radiation that can reach any point approaches saturation.

The primary radiation decreases with depth and the scattered radiation increases up to a certain extent. Finally both the primary and the scattered radiation diminishes with depth causing a rapid fall in depth dose with depth. The proportion of the scattered radiation in the total depth dose increases with depth. With 200 K.V., 100 cm.² field, 70 cm. skin focal distance and 2 mm. cu filter 21 per cent

of the total dose received on the skin surface is due to scattered radiation. At depths of 10, 15 and 20 cms. below the skin, 52, 66, 71, per cent of the total dose is contributed by the scattered radiation. Only the remainder is due to the primary rays. Since such a large part of the dose is due to scattered radiation, reduction of the field will affect the scattered radiation and therefore the total dose very appreciably. In the above example a reduction of the field of irradiation from 100 to 20 cm.², will cause a reduction in depth dose at 10 cm. by nearly 40 per cent.

A radiologist equipped with a 200 K.V. machine has to rely largely on scattered radiation in order to deliver a sufficient dose of radiation at great depths. He will have to use a large field and radiate a large volume of tissues. However with a harder beam say 1000 kilo volts, the proportion of primary radiation reaching the depth of 10 cm. will be greater and the percentage of scattered radiation in the total depth dose correspondingly less. A very hard beam is therefore less dependent on scattered radiation and reduction of the field of radiation affects the depth dose to a much smaller extent. With 1000 K.V. beam a reduction of field area from 100 to 20 cm.² causes a drop in depth dose at 10 cm. depth by 18 per cent. Hence with very hard radiation it is possible to utilise the skin surface to a greater advantage, by using multiple small beams of just sufficient size, so as to include the tumor volume. Super voltage (>400 K.V.) is therefore particularly useful in treating tumors at great depth below the skin surface, the relative advantage diminishes at smaller depths or with very large portals.

The presence of a considerable number of scattered photons at a depth of tissues makes the beam more and more diffuse. As each scattered photon is deflected away from its original directions, after several collisions the scattered photon may be travelling in a direction which is quite different from that of the primary. Tissues and organs lying outside the geometrical contour of the beam will therefore receive some amount of scattered radiation. The

higher the energy of the primary photons, the less is the back and side scatter, and greater the scattering in the forward direction, the amount of radiation reaching the neighbouring organ is therefore minimised with very high voltage.

The scattered radiation is softer than the primary, since a scattered photon originates after a loss of energy by the primary. The increase in the number of scattered photons in the beam as it penetrates into the tissues, means a change of quality. The quality measurements described earlier refer to the incident beam. If the quality is measured, after the beam has traversed a few cms. of tissues or at the exit surface, it will be found that the quality has changed. The physical differences in ionisation tracks that are to be expected with gross changes of qualities have been described in detail. Whether such differences correspond with any change in biological effectiveness can only be settled as a result of clinical experience. Clinical evidence is not unanimous on this point. According to some observers there is a definite advantage in favour of extremely short waves or very highly energetic photons. But according to very careful observations by Stone, it seems that both immediate and later reactions on the skin may be exactly identical when the opposite halves of the same patient are irradiated with 200 K.V. and 1000 K.V. radiations, provided the radiations are delivered in biologically equivalent doses. More observations are needed to settle this point definitely. If the latter view is found to be correct, then quantity and not quality is the most important factor in therapy, and such differences in quality as are met with in ordinary X-ray therapy are not of much significance. But as we have shown earlier, the quantity of radiation that is delivered at a depth is a function of quality. In other words the influence of quality of radiation is an indirect one in determining the quantity at a depth.*

* The author expresses his sincere thanks to Sir Jamshedji N. Duggan, Kt., C.I.E., O.B.E. D.O. (Oxon.), Superintendent, Tata Memorial Hospital, for his constant encouragement in the preparation of this article and for permission to publish it.

THE THREE 'M'S OF INDUSTRIAL PSYCHOLOGY

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INDUSTRIALISATION is gradually becoming one of the main features of our national life. Many industrial establishments, big and small have already been set up in the country and there are indications that unless prevented by the war conditions prevailing now, many more will develop in the near future. It is time now for us to consider the various factors that help the healthy growth of industries. Along with the physical, chemical and other objective sciences psychology which deals with human materials can also be a great contributory factor. This latter fact is generally missed by our countrymen. How psychology can help industries has been a specialised subject of study in the Western countries. The object of this paper is to present within a brief compass, the nature of this specialised science and to indicate some general conclusions which have already been achieved by it.

Industrial psychology is an applied science. Its purpose is to apply our knowledge of mental processes to the various conditions prevailing in modern industry. It deals with human as contrasted with the mechanical and economical aspects of labour. Its chief aim lies in reducing unnecessary efforts and irritations, and increasing interest and attention amongst the workers in industrial organisations.

'Maximum output, minimum labour', is the goal of every industrialist, for the attainment of which conscientious efforts are made and every available factor is utilised. Unfortunately however, for want of proper psychological guidance, these efforts have been made in a more or less unsystematic way which has retarded rather than helped the expected development. Men (workers), Materials (raw materials and machinery equipments) and Management, are the principal bases upon which every industrial concern rests. These may be designated as the three 'M's of Industrial Psychology. Progress of an industry is only possible when all questions relating to these basic factors are given the care and consideration they deserve and proper adjustment between them is maintained. In order that the different industrial fields may yield the best results desired by the industrialists, the main objective to be aimed at is the maintenance of proper co-ordination and harmony between these factors. Ill-coordination brings about the reversal of the above mentioned industrial maxim, and results in heightening of labour with a lowered output, and that is detrimental to the progress of any industry.

Industrial psychologists have brought to light the various factors which result in industrial retardation. These factors may be said to have one common element, viz., some sort of non-conformity between the worker and his industrial surroundings, or in other words, some ill-coordination between the three 'M's. Broadly speaking, two types of such maladjustment are discernible.

A. (I) The type of work and (II) the methods and other conditions of work may not be congenial to the worker.

B. There may exist a strained relation between the worker and the management.

Let us discuss these two points one by one and see what concrete suggestions the industrial psychologists offer to ease off these maladjustments.

A. (I) *Type of work and worker*.—Every worker is not suitable for all jobs and improper placement of an individual in a job for which he is not at all fit, generates irritation and emotional outbalance in him and causes considerable economic wastage on the side of industry. Misfits must, from all considerations, be eliminated from industry. Individuals vary amongst themselves considerably as regards their respective talents and temperaments and so do vary the various vocations in respect of the demands they make upon the individuals. Adjustment between these two variables is essential so that proper selection of the right man for the right job does materialise.

The primary basis for such selection is to have first a knowledge of the essential requisites for achieving success in a particular vocation and then to ascertain whether and in what degree the requisites in question are present in each of a group of applicants. For gaining such a knowledge psychological analysis of individuals as also of the different vocations is necessary. The technique to be adopted for making such analysis has been described in all details in the writer's article on "Employee selection and occupational analysis".*

(II) *Worker and Conditions of Work*.—After the selection of right human material has been made the second essential point to be considered is the planning of proper conditions of work. Unsatisfactory conditions of work promote unnecessary fatigue and boredom in the workers and bring about decrease in production. The chief interest of industrial psychology as has been already stated is to increase

* The Calcutta Review, Vol. 85, No. 3, Pp. 218-228, 1942.

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human efficiency by decreasing the physiological and psychological cost of work. Poffenberger has rightly observed that "the ideal of human efficiency would be the production of maximum output of the highest quality, in the shortest time, with the least expenditure of energy and with the maximum satisfaction". Obviously the conditions of work must be satisfactory, so that this ideal may be achieved. Or to put it differently, factors which bring about unnecessary fatigue and loss of production should be eliminated. These factors and the methods by which they can be eliminated can be summarised as follows.

(a) *Hours of work*.—Fatigue is directly proportional to the length of working period—it increases with the increase of the latter. Shortening of the hours of work has been found to have minimised fatigue in certain cases.

(b) *Rest-pauses*.—Notwithstanding the length of the working period, introduction of suitable rest-pauses at proper intervals within the period, has been almost universally accepted by industry as an aid in increasing production and in reducing fatigue. The length of the rest-pause and the time of its introduction however depend upon the type and period of work.

(c) *Methods of work*.—Unnecessary movements in work may be the cause of unnecessary fatigue. The best method of work can be brought about only by making an analytic reduction of each process of operation to simplest units. Selection of the best and simplest method of operation means elimination of the useless and extraneous movements and the ultimate results are, reduction of fatigue, saving of much time and of loss of energy and maintenance of regular flow of work. After determining the best methods of work the workers should be sufficiently trained and encouraged to utilise those methods. Change of work and posture and introduction of suitable incentives to work have been found to be of much benefit in many cases.

(d) *Working tools and machines*.—Badly designed machines and tools are responsible for a tremendous waste of human efforts, increased dissatisfaction in work and reduced output. Machines and tools should be so selected that they may be suitable for the work to be performed as also to the worker who would use them. A high bench for a worker whose stature is short or too low a one for a long-statured person, may be mentioned as examples of unsuitable tools. When the tools are unsuitable unnecessary efforts have to be made in manipulating them and the consequence is that fatigue is hastened and the output of work falls.

(e) *Illumination*.—Over- or under-illumination causes an extra strain to the workers which indirectly tells heavily upon the output. Intensity of light is to be regulated and direct glare to be avoided as far

as possible. The bright glittering parts of the machines cause undue strain on the eyes of the workers. The standard of requisite illumination in a particular situation can be brought about with the help of photometers.

(f) *Ventilation*.—The principal causes of personal discomfort are (i) the temperature of the air, (ii) humidity and (iii) last but at the same time the most important one, the ventilation or the amount of air movement. Ventilation may be developed either by convection, by means of cross currents or by the use of exhaust fans. The cooling effects of the air condition due to ventilation can be measured by means of the kata-thermometer, which consists primarily of a dry and a wet bulb thermometer. From the amount of difference between the two temperatures due to evaporation within a given period of time and comparing it with a table of absolute temperatures, the estimated reduction can be known from which we can judge whether the surrounding conditions are pleasant, tolerant or unpleasant.

(g) *Noise effects*.—Sometimes noises emanating from machines cause great individual wear and tear, lowered output and mistakes in work. Susceptibility to noise however varies from individual to individual, some accustom themselves after a certain period to pronounced noise, while there are others who cannot do so. To get relief from these noise effects, the usual methods adopted are blocking the ear passages by ear plugs, proper insulation of the machines or the use of sound absorbing materials in the surrounding walls. Of these methods, the first one should always be discouraged because the use of ear plugs is sometimes more disturbing than the noise itself. The last two are comparatively serviceable and adoption of either of them depends upon the local situation.

(h) *Influence of Speed and Rhythm of work*.—Speed and rhythm of work imposed by the machine and by other conditions of work grossly affect the efficiency of the worker. For every type of work there exists an optimal speed by which what is possible can be done with the least expenditure of energy and without increasing the feeling of fatigue, discomfort and ill-health. The optimal speed varies from one work to another and so should be regulated accordingly. It has been also found that working with an imposed rhythm increases production and simultaneously increases interest and satisfaction in the workers.

(i) *Accidents*.—The cost of accidents is a tremendous burden upon the industry. Apart from the economic loss, the adverse effect of accidents upon the workers and the production, is beyond evaluation. It should always be remembered that every possible preventive measure must be adopted so that accidents might not have their sway in industry.

Two types of accidents are generally distinguished: (a) Machinery accidents, or those resulting from inadequate safeguards of machines in industry and (b) Non-machinery accidents or those resulting from causes other than insufficient machine protection. The last type of accidents results either from a personal predisposition, or from the effects of machine or plant conditions, such as ventilation, illumination, etc., upon the individual. The most common and widely followed method adopted for prevention of accidents is the use of posters or following the paths of 'safety first' warnings and devices. This clearly shows that attention is paid only to the first type of accidents and that the liability and fallibility of human beings to accidents are not taken into consideration. The factors that are responsible for the second type of accidents are as follows:

(1) *Individual proneness*.—As suitability for a particular vocation varies from one individual to another so also does proneness to accidents. Some are more accident-prone than others. It has been found as a result of investigation that minor injuries are proportioned in the same way as major casualties and those who suffer minor accidents are among those who incur major accidents. It is desirable that individuals before they take up their duty at dangerous points should undergo proper psychological testing so that their respective liability to accidents may be known.

(2) *Age and experience*.—It has been found that young beginners, due to lack of skill and dexterity, or ignorance and rashness of youth, incur more accidents than others. Adequate training and knowledge of the actual working conditions are of great practical value in saving such workers from accidents.

(3) *Unsuitable working conditions etc.*—Fatigue, illness, domestic troubles and deviation from the ideal working conditions which have been lately mentioned may affect accident liability.

I proceed now to the second type of maladjustment between the worker and the management.

B. Conflicts between the workers and the management may be due sometimes, not to the faults of the workers, but to the lack of tact of the managers leading the workers. The result of such a conflict may in its milder form be resentment, irritation and boredom in the workers or may, if it takes a serious turn, result in a complete labour turnover in the workshop. It is not always the fact that economic factor lies at the root of all labour turnovers. An investigator of the Industrial Fatigue Research Board, London, has after a very careful observation discerned three types of managers or foremen. The influence they respectively exert on the mental equilibrium of their subordinates has also been pointed out by the investigator. These are:

(a) *Emotional type*.—The emotional counterpart of a particular situation is to him the guiding factor in all of his decisions and activities. The utter failure of appreciating the reality of the situation therefore makes him unjust and unbalanced, as a result of which the workers under him always remain "in a state of nervous tension fearing the next outburst, . . . others of robust mould become indifferent either to praise or blame".

(b) *Over-anxious type*.—Such a person due to want of sufficient self-confidence smells wrong in everything. Logical considerations of facts do not impress him at all. He always grumbles and finds fault with his subordinates at the slightest or no pretext and the latter therefore always live in a state of utter depression and find no pleasure in their working life.

(c) *Idiosyncratic type*.—A person of this type has got some peculiar fads and prejudices which in spite of their absurdities he cannot overcome. For example, he may believe that all workers with stunted growths are deceits, or a left-hander always works less than a right-hander, or a man not busy with his hands is not working at all and so on. For the sake of avoiding unnecessary provocations, the idiosyncrasies of such a manager are utilised by his subordinates in two ways. First by supporting the whims of the superior the subordinates please him and second by ensuring confidence of the master in this way they please themselves according to their wish in other really important matters of industrial life. Maintenance of proper discipline consequently becomes a thing of the past.

The ideal manager on the other hand is a categorical contrast to the above-mentioned types, who, as the investigator writes, "gets angry at slackness and bad work, and whose treatment of others is guided by principle, sympathy and humour". Craig and Charters have listed the characteristic qualities of successful executives in industry as follows:—Forcefulness—ability to command—impartiality—control of temper—personal interest in the men—ability to train them—ability to give clear and detailed instruction—ability to follow up and see that instructions are carried out—ability to get and use suggestions of subordinates—ability to get team work—ability to praise wisely and reprimand effectively—ability to create a spirit of accomplishment—ability to develop enthusiasm when that is desirable—self-confidence—ability to develop self-confidence, particularly in the new employee. It is obvious that in order to minimise difficulties arising out of the strained relations between the worker and the management efforts should always be made to secure the services of such a person as manager who most nearly approaches the ideal type.

Such constructive programme forwarded by the industrial psychologist is the one and the only way for properly co-ordinating the three 'M's upon which progress and success of an industry depends. Now the function of an industrial psychologist does not end only by helping the industrialist with better production and maximum satisfaction of the workers. He is also concerned with how and in which way the produced materials will, by gaining popularity and creating demands in the market, maintain a ready and topmost sale. As the sale of products is directly a matter of concern to the public, the natural proclivities of the public mind should receive due consideration of the industrialists. Advertising, designing, salesmanship, etc., are some of the methods which, generate in the public mind a 'desire to buy' and which ultimately exert considerable influence in the sale of products. The consideration and determination of the proper ways by which these methods can be made practically effective fall within the jurisdiction of psychology and the psychologists have got much to offer in this aspect of industry too.

We find therefore that psychology like other scientific subjects is unavoidably interwoven with matters upon which the efficiency and progress of every industrial project rest. That the possible scope and contributions of psychology in industry do not end only in theory, that these theories can be given a practical shape, become apparent when we look to the industrial activities of the leading foreign countries. In some places there are research boards, managed by psychologists and other experts, to which the local industrial concerns approach for help, and in others the industrialists themselves maintain separate psychological laboratories in their respective establishments. In England we find the existence of the Industrial Fatigue Research Board (now known as Industrial Health Research Board) established under the joint auspices of the Department of Scientific Industrial Research and the Medical Research Council. And there is another one, the National Institute of Industrial Psychology which was organised in 1921 under the distinguished leadership of Dr C. S. Myers. Investigations are also conducted independently by eminent university men. Besides these, a few business firms have established psychological research departments of their own. In Germany, individual enterprises as also efforts by some public and private institutes have conjointly accelerated the growth of industrial psychology. In 1916, 14 centres were engaged in work upon problems of industrial psychology and the number came up to 100 in 1926. Of these mention may be made of Greater Berlin Tramways—Osram-Werke, Siemens Company—Auerlichtgesellschaft—Carl Zeiss, Jena, and so on. Institutes for the industrial application of psychology are to be found out in all of the larger cities in Germany. In the United States the growth

of industrial psychology is largely due to the joint efforts of teachers and research workers attached to the universities. In addition to these research workers in the university centres there is a group of industrial psychologists who are attached to different industrial organisations. The development of industrial psychology has been furthered by a few organisations established for cooperative research, for co-ordination of studies, and for the exchange of information in this field. These research organisations, supported by industrial firms, but working under the aegis of the Carnegie Institute of Technology have made important contributions to the advancement of industrial psychology in the United States. Russia has made tremendous progress in the development of industrial psychology. In 1920 there was established in Moscow, under the leadership of Gastev, a Central Institute of Labour. In 1931 the Central Institute alone was reported to have 1000 branches throughout Russia. Among the many prominent centres devoted to the scientific study of work mention may be made of the Institute of Labour in Charkow and the the Institute for the Scientific Organisation of Work in Kasan. In Holland, Belgium, Poland, Italy, Spain, etc., industrial psychology has developed along lines similar to those of Germany. In Australia we find the existence of Australian Institute of Industrial Psychology. In Japan, in the East, semi-private agencies like the Institute of Industrial Efficiency, established in 1921, and certain Government departments utilise psychological principles in industry. The Imperial University of Tokyo has got a laboratory of Applied Psychology where investigations are conducted on problems of personnel selection for the Army and Navy as well as on other problems of practical psychology.

At every country in this world, with the respective dawning of industrial consciousness, the methods and principles of Industrial Psychology, are being utilised with considerable profit.

India is gradually becoming industrial-minded. The establishment of the Board of Scientific and Industrial Research has been a right start in this direction. All the leading scientists in India are taxing their brains and devoting their much valued time to make the attempt of the Board a successful one. But no provision has been made so far for conducting researches in the most important branch of industry, which has been the theme of the present paper. May I draw the attention of the Board, the universities, the leading industrial establishments, the Government and other public bodies of India to this matter. I am fully convinced that investigations in the psychological aspects of industry will prove to be highly profitable to all and will eventually bring about a new era in the industrial life of our motherland.

CONSERVATION OF WILD LIFE IN INDIA*

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COMPARED with other living creatures man is relatively a new-comer on the face of the earth.

Even according to most liberal estimates primitive man did not appear till about a million years ago. In this relatively short period he has developed from a very primitive creature to a highly evolved dominant personality on the face of the earth. Man in the course of this period passed through various stages of development which, according to the material used by him for his tools, are respectively named the Stone Age, the Bronze Age and the Iron Age. In the earlier stages man's relations with at least the larger animals were those of direct competition in a very keen struggle for existence. The animals supplied the major part of his food and primitive clothing and various other products that he required for his very simple way of life. Later, however, when he assumed greater mastery over the surroundings in which he lived, he, in addition to agriculture, took to domesticating certain classes of animals for making them his help-mates and companions. Several of them, such as the cattle and the horse, not only proved invaluable in connection with the advance of civilization but gradually made it possible for man to occupy the proud position which he holds on the face of the earth today. *Inter alia* it may be noted that authorities are at variance in regard to the exact sequence of the agricultural and animal husbandry activities of early man. Modern man through horticulture and animal husbandry has developed numerous varieties of cultivated plants and domesticated animals which have made available a very large range of food materials for his use. With the advance of civilization has also been perfected a very complex and rapid system of communication and transportation, and this renders it possible for man to enjoy not only the seasonal products of one area, but of almost all parts of the world. In fact, as a result of these developments animal and plant products from different areas are, in normal times, easily distributed all over the globe.

No substitutes for plant and animal products, which are so essential for human existence, have so far been discovered and in spite of all scientific advances, man is still and will remain dependent on plant and animal worlds for his continued existence. In both international and national interests, therefore, it is of the utmost importance that carefully con-

sidered long-range programmes for the conservation of wild life be adopted all over the world.

In earlier times extensive areas of undisturbed forests and uninhabited parts in almost all countries provided safe sanctuaries where wild life was able to survive and even flourish, but changed conditions as a result of the rapid advance of civilization and overpopulation, the gradual conquest of forests and grasslands, the opening up of new roads and waterways, and highly improved methods of transport have today left very few areas where wild life can continue to live undisturbed by man. These factors have had and are continuing to have a very devastating effect on wild life. With these developments fortunately a gradual change is taking place in man's outlook towards Nature. This change is due to the spread of education, and the realization of man's dependence on natural resources. Apart from humanitarian measures, authorities are gradually becoming alive to the inherent dangers underlying the uncontrolled destruction of wild life. This movement for the protection of Nature and so of wild life had its origin barely 50 years back. Though the European nations paid a fair amount of attention to this highly important question, it was the Americans who led the field and set an example as to what could and ought to be done for the preservation of wild life. Extensive National Parks or Reserves which would provide inviolable sanctuaries for and preserve wild life were originally established in the United States of America. These have since been set apart in Canada, New Zealand, Australia and the Union of South Africa. In the Kruger National Park, which was founded in 1898 as the Sabi Game Reserve and changed into the Kruger National Park in 1926, South Africa has one of the most extensive and well-managed sanctuaries. Mention may also be made of 'Parc National Albert' in Belgian Congo, which was created by a Royal Decree in 1925 and greatly enlarged in 1929; in 1934 by a Royal Decree its functions were greatly extended and entrusted for management to the Institute for the National Parks of the Belgian Congo which was established with its headquarters at Brussels. Protection of Nature movement in Germany and adjacent countries proved very valuable in connection with the conservation of wild life in the areas concerned, and extensive National Parks were established in Switzerland, Germany, Italy, Sweden, Spain, Holland and Czechoslovakia. The cause of conservation was further advanced by various International Conferences. In 1900 the British

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Government convened an International Conference in London for the preservation of animals, birds and fish in Africa. The convention was signed by seven powers interested in Africa, and was to remain in force for 15 years. In 1913 an International Conference for the Protection of Nature was held in Berne at which 17 Governments were represented. The main result of the work of this conference was to establish a central organization for dealing with the question of wild life preservation on an international basis. The world war of 1914-18 unfortunately greatly delayed the adoption of the recommendations of the Berne Conference.

In 1903 a society for the protection of the fauna of the empire was founded in England by Mr E. N. Buxton 'with the object of awakening public interest in the assemblages of wild fauna still surviving in every part of the British Empire, and taking such steps as may be possible to save them from extinction; further to co-operate with kindred societies in the Dominions and Colonies or in foreign countries with regard to any conjoint efforts'. After the world war of 1914-18 greater attention was directed towards the preservation of fauna in most parts of the world, for as was so well expressed by the president of the society, the Rt. Hon. Earl of Onslow, 'The whole world is becoming so speedily opened up to travellers, traders, tourists and settlers, and so much uncultivated land is coming under the plough that unless some more or less drastic measures are taken to preserve the distinctive fauna it must obviously disappear entirely.' The society started active work for the preservation of the fauna of the empire soon after the world war, and its revised rules, which were passed on April 27, 1928, were brought into force from 1st of May, 1928. Since this date the society began to wield a great deal of influence in connection with the preservation of the fauna of the Empire. Reference may also be made here to the American Society for International Wild Life Protection and the Dutch Society for the International Wild Life Protection, which have done a great deal to further the cause of conservation of wild life in their respective spheres. In 1931 at the instance of the French Government an important International Conference for the Protection of Nature was arranged by the staff of the Natural History Museum of Paris. Representatives of Belgium, Czechoslovakia, Germany, Great Britain, Holland, Italy, Latvia, Norway, Poland, Rumania, Spain and the United States of America attended the Conference, and very useful spade work was carried out for the formation of a central official international organization for the protection of wild life. An International Conference for the protection of the fauna and flora of Africa was convened in London in 1933. As a result of its deliberations it drafted a convention for the better

preservation of the fauna of this continent. Among the measures suggested were the establishment of sanctuaries, National Parks, Strict National Reserves and other Reserves. The Conference recommended that all settlements in National Parks should be controlled so as to ensure that as little disturbance as possible is occasioned to the natural fauna and flora. It also recommended that special steps should be taken to restrict the export and import of trophies, to stop the use of motor vehicles or air craft for the purpose of hunting, killing or capturing or driving away, stampeding or disturbing animals, and finally the use of poisons or explosives or poisonous weapons or the use of nets, pits or enclosures, gins, traps or snares, or of set guns and missiles containing explosives for hunting animals should be prohibited. Mr E. C. Stuart Baker, who is a recognized authority on Indian birds and wild life, attended this Conference as one of the observers on behalf of India. In a report, which he submitted to the India Office, he concluded that the results embodied in the report of this Conference provided a valuable basis for any measures that may be under consideration for the preservation of indigenous flora and fauna of India. With a view to deciding whether it was desirable for the Government of India to become a contracting party to the convention, either in whole or in part, he suggested that the report should be considered by the Government of India at a special conference of representatives of the Government of India, the Provincial Governments, the Indian States and the adjoining territories of Nepal, Bhutan, etc. About the same time the Society for the Preservation of the Fauna of the Empire in London addressed a letter to the India Office directing attention to the urgent necessity for the protection of wild life in India. With the letter it supplied memoranda dealing with the position of indigenous game in some of the provinces and offered to supply expert advice in case the Government of India decided to arrange for a conference on the subject. Meanwhile the Bombay Natural History Society, which ever since its foundation in 1883, has by intensive propaganda and through the medium of its *Journal* and various publications been rendering very useful service in creating and stimulating interest in the wild life of the country, started publishing in 1934 a series of beautifully illustrated articles on the wild animals of the Indian Empire and the problem of their preservation. The Government of India convened an All-India Conference for the Preservation of Wild Life at Delhi in January 1935 with a view to reviewing the position of the fauna and flora as it existed at the time and considering generally the protection of the animals peculiar to India. The conference adopted a set of resolutions and prepared two lists of species, first of animals that were to be protected as completely as

* Adapted from the scientific part of the author's presidential address at the Annual Meeting of the National Institute of Sciences of India held at Calcutta, January 1, 1943.

possible, and second of those which 'while not requiring such rigorous protection', shall not be hunted, killed or captured except under license granted by competent authorities. The conference laid special stress on the establishment of wild life sanctuaries, and desired the contracting parties to explore the possibilities of establishing sanctuaries in which hunting, shooting, killing or capturing of all animals was to be prohibited except under the control of the authorities responsible for the management of the sanctuaries. It was agreed by the conference that the duty of preserving the fauna should be assigned to the forest departments in the areas under their charge, but at the same time urged the necessity of co-operation of police and magistracy in carrying out the necessary measures of protection. Resolutions were also passed for the closest co-operation between the forest departments and associations that may have been or are established with a view to the preservation of game and wild life. It also laid stress on the introduction of nature study in the country and for carrying out such propaganda as would popularize with the general public the urgent necessity of preserving wild life, as without public support no efforts to preserve wild life would be really effective. It, therefore, recommended that societies for the protection of wild life in the country should make propaganda a principal part of their work.

Here it would be useful to include a short summary of the legislative measures which were in force for the protection of wild life in British India prior to the date of the All-India Conference for the Preservation of Wild Life. These measures consisted of (1) Wild Birds and Animals Protection Act of 1912, and (2) the Indian Arms Act—both of which were applicable to the whole of British India; (3) the Provincial Game Rules under the Act of 1912; (4) Provincial Forest Acts and Rules thereunder, and (5) Provincial Acts dealing with protection. The Provincial Game Rules and Forest Acts had unfortunately been drawn up rather haphazardly and were often contradictory. In addition, no definite authorities had been set apart for enforcing these legislative measures particularly in regard to the poaching and the indiscriminate destruction of game, etc. There was no control of trade in meat, hides, skins and trophies, and at the same time there was no provision for the restriction of the modern methods of traffic such as motor cars and aeroplanes which were proving disastrous to wild life all over the world. Cases of shooting animals from motor cars after they became exhausted as a result of long chase had been reported. A more up-to-date and comprehensive measure was enacted in the Punjab in the Punjab Wild Birds and Wild Animals Protection Act of 1933, while the rules made thereunder provided for the better protection and preservation of certain wild

animals including birds and fish. It later resulted in the appointment of a Game Warden for seeing that the rules were strictly enforced and the protective measures were as comprehensive as far as possible. In addition, under the rules, District Fauna Committees were to be established in all districts for performing functions assigned to them under the rules and for advising generally about the protection of the fauna in their respective districts. Acts on similar lines were also passed in the Central Provinces in 1934 and the United Provinces in 1935, while measures were under consideration in other provinces. Mention may also be made here of the Bengal Rhinoceros Preservation Act of 1932, which prohibited the killing, injuring or capturing of wild rhinoceros in Bengal. Under the Act every wild rhinoceros killed or captured otherwise than by permission was to be the property of the Local Government and stiff penalties were provided against contravention of the Act. A small sanctuary for the preservation of rhinoceros in Bengal was also established in Jalpaiguri district. In 1934 a very great advance was made in the United Provinces through the great personal interest taken by the enlightened Governor of the Province, Sir Malcolm Hailey (now Lord Hailey), as a result of which the National Parks Act of 1934 was passed. This Act provided for the establishment of National Parks and for the preservation of wild animal life or other objects of scientific interest and for incidental matters provided therein. As a result the Hailey Park was demarcated as a National Park in the famous Patli Doon and the hill forests to the south of it consisting roughly of an area of 99.07 square miles. Under the Act the word 'animal' was defined as 'mammals, reptiles or birds', and it was an offence to kill, injure or disturb any animals or to take or destroy any eggs or nests of any birds in the park. The conditions under which the people were allowed to enter or reside in the park were laid down in the Act and were to be enforced by the forest department. In Assam certain areas had already been demarcated as game sanctuaries and more stringent action was being taken to preserve wild life which according to some reports had been reduced by almost 75 per cent within recent years. Reference may also be made here to the Chamraianagar Sanctuary of the Mysore State Forests which had been established with a view to offering complete immunity for animals and thereby making it possible for them to thrive without interference. Introduction of other animals not found in the area was to be attempted, and the sanctuary was to provide facilities for the scientific study of the life-histories of different indigenous species of game.

Mention may also be made of the valuable work which the Association for the Preservation of Game in the United Provinces has been carrying on ever

since its foundation. After the All-India Conference for the Preservation of Wild Life this Association extended its sphere of work to the whole of India, and in July 1936 started publishing a journal entitled *The Indian Wild Life*. Its aims and objects are very comprehensive, and the two Honorary Secretaries, Major J. Corbett and Mr Hasan Abid Jafry, have been carrying on valuable work in connection with the protection of wild life throughout British India and in most of the Native States as well. Unfortunately, owing to the abnormal conditions resulting from the war, the membership of the Association has fallen off and it has had to stop publication of its journal, but it is to be hoped that this is a temporary setback, and before long it will be possible for the Association to restart publication of its journal and carry on its activities on a more extensive scale.

From the above it will be seen that a certain amount of spade work had been done and various provinces were becoming alive to the urgency of adopting measures for the protection of wild life in the areas under their control. Unfortunately, however, only one aspect of the conservation of wild life had been considered in all these plans, viz., that of the protection of game mainly from the point of view of sport. Further, in all the measures suggested and partially adopted the work, except in the Punjab, was to be carried out by agencies which were already overburdened with work, and naturally the task of looking after wild life was something which it was not possible for them to carry out efficiently in addition to their normal work.

The problem of wild life conservation is not, however, so simple as would appear from the measures which have been taken in this country so far. In fact the multiplicity of the problems involved in any scheme of wild life conservation has begun to be realized only within very recent years. The greatest advances in this connection have again been made in the United States of America, where under the President's Reorganization Plan No. III a Bureau of Biological Survey was constituted on June 30, 1940, by the consolidation of the Bureau of Biological Survey and the Bureau of Fisheries; this Bureau is responsible for the conservation of wild life in the extensive continental area of the United States of America.

It is essential to point out that, if wild life conservation is to be a success, the conservation of soil, waterways, forests and grass-lands must receive simultaneous attention. The disastrous effects of man's activities on soil and water resources, whether direct or indirect, conscious or unconscious are very serious indeed. As an example of direct and conscious influence of man on waterways may be mentioned the pollution of rivers, streams, lakes, etc. through the

dumping of huge quantities of refuse and sewage of large cities, as also of the untreated raw wastes of large industrial concerns. Such pollution materially affects plant and animal life of these waters, and has been known in many cases to have destroyed extensive and valuable fisheries. Indirect and unconscious destruction of soil for agricultural developments has similarly done a great deal of harm. In this connection it is unfortunately seldom realized that most schemes of development of large tracts of country, whether as living centres or as agricultural land, unless carefully planned, often have very serious repercussions on the plant and animal life of the area. Nature works in a vicious circle and the interdependence of all these factors is now fully recognized by all authorities.

To undo even a small amount of the damage to organic resources which has resulted from the rapid spread of civilization would require carefully planned long-term programmes of reconstruction, and the development of new social concepts in regard to colonization, agriculture, irrigation, forestry and other allied activities of man. In its broadest sense, conservation of organic resources, as has been so well summed up by I. N. Gabrielson, the Director of the Fish and Wildlife Service of the United States Department of the Interior, 'means restoring to the highest possible level and maintaining in a state of high productivity those resources, including wild life, that can be used on a crop basis to sustain human society'.

In wild life management the existence and operation of ecological communities in the domain of nature and man's relationships to them has to be recognized and also the fundamental fact that man's activities often have been and are responsible for disturbing ecological communities. For all schemes of wild life conservation it is essential, therefore, to attempt to restore natural balance which has been and is being disturbed by human activities. With the information at present available most conservation programmes must of necessity be of an experimental nature. They should deal with a few species in restricted areas so that the results could be properly watched and tabulated. Only such work will gradually enable us to acquire the much-needed data and technical knowledge for evolving proper schemes of general ecological management. Meanwhile wild life management must be planned on the ecological and biological data that are at present available. In the large area of the sub-continent of India the problems of wild life conservation are bound to be very complex, but as soon as possible a programme of conservation must be formulated which would deal not only with the necessity of preserving a few species of game but the conservation of animal and plant life in general.

The authorities responsible should see that the recommendations of the Wild Life Conference of 1935 are implemented and carried out as far as possible. Though various provinces are more or less autonomous in regard to the management of the areas under their charge, it should be remembered that wild life conservation in the country cannot be carried out on a provincial basis. The multifarious problems in-

involved cannot be tackled properly until the all-India nature of the problem is realized and a separate department of the Central Government made responsible for this work. While leaving the local problems to various Provincial Governments and Native States, a central department should be responsible for dealing with the policy of conservation of wild life for India as a whole.

Notes and News

OBITUARY

FERNAND HOLWECK

We are grieved to learn of the murder of Dr Fernand Holweck, director of research of the "Centre National de la Recherche Scientifique" and associate professor of Physics at the Institute of Radium of the Sorbonne (Laboratoire Curie) by a Gestapo agent on December 14th, 1941 in a Paris prison. Further details have not been available.

Born in 1889, Dr Holweck graduated in physics from the 'Ecole de Chimie et Physique' of Paris. Since 1912, the year in which he became assistant to Madame Curie, he had been working in the Curie Laboratory which owes much to him for its present state of organisation. Holweck made important research work in the region of soft X-ray spectra of low atomic number. But the work which earned him international fame is undoubtedly his work in the field of the production of high vacuum a subject to which his attention was directed while working with the X-ray vacuum spectrograph. The molecular pump which bears his name was a great improvement on the original Gaede molecular pump and is today the most powerful mechanical vacuum producing device. He had a strong engineering sense and developed a number of important instruments. The Holweck gravimetric pendulum proved a valuable instrument for geophysical prospecting for mineral oils. He constructed the first X-ray tube with successive stages of acceleration, developed a high power radio tube and introduced the use of the focussing of electrons in connection with his research on television. Later on, Holweck became interested in radiobiology, independently studied the biological action of radiation on micro-organisms and established some important results which Crowther observed previously. During the World War I Dr Holweck played an important rôle as a scientist and developed new methods for detection of sub-

marines by ultrasonic waves in collaboration with Langevin and Chilowsky. Astronomy and telescope making were some of his favourite scientific hobbies. He had built in his Paris home an observatory provided with a 10" telescope and other accessories. Besides, he had fine artistic sense and excelled in painting for which he was particularly gifted. He was one of the finest specimens of French scientists whose tragic end has left a substantial vacuum in French science.

AUSTRALIAN ASSOCIATION OF SCIENTIFIC WORKERS

THE wave of scepticism that has recently been violently shaking the British scientific public as to the government efficiency in securing the fullest utilisation of scientific man-power and resources appears also to have broken on the shores of distant Australia. This is clearly manifest in the two conferences of the Australian Association of Scientific Workers held in Sydney and Melbourne. The Melbourne Conference was largely attended and satisfactorily represented by members from both industrial undertakings and government enterprises. The general feeling expressed in the conference was that there existed an undesirable lack of co-ordination and understanding between the Australian scientific men and the government. This lack of co-ordination and the complacent attitude of the government with respect to the emergency has led to serious defects in planning for supplies, especially in agriculture and in pooling information about plant practices. The conference strongly condemned an absence of suitable bodies to study the problem of industrial fatigue in the factories, an unnecessary wastage of scientifically trained man-power in the fighting forces and lack of any arrangement to make the best use of experienced men available. The industrial possibilities of various inventions in the scientific laboratories and the wastes and by-products of some particular industry or other are not being duly considered. The Associa-

tion has framed a number of resolutions to be presented before proper authorities and is extremely keen on establishing the right type of co-ordination between the government and the scientific men. It is pleasant to note that the Australian Association has become so readily conscious of the disease and is resolved to disinfect their atmosphere without undue loss of time.

RECENT PROGRESS IN U. S. S. R. IN GEOLOGY AND MINING

GEOLOGICAL progress in the U. S. S. R. as the war progresses has been reflected in the reports from the Geological Committee of the Council of People's Commissars, published in the Soviet War News. It appears that the increasing pressure of war has intensified the Soviet geological activity in the direct proportion and has made possible new discoveries of important raw materials in the regions hitherto unexplored. As a matter of fact, more than two thousand expeditions were arranged during the summer resulting in the discovery of new deposits of strategic materials, such as, aluminium ores, antimony, manganese, iron, fluxes, fire-proof minerals etc. These expeditions have once more proved the geological potentiality of Siberia and the Urals where geological work of any significance is only of recent origin. Thus in the Urals new and rich deposits of aluminium ore, iron ore, fluxes and fire-proof minerals for the iron and steel industry, and new sources of manganese have been discovered and are already in process of exploitation. Aluminium ores have also been discovered in Western and Eastern Siberia and also in Kazakhstan. Exploration work in Siberia, Kazakhstan and the Central Asian Republics has revealed new deposits of manganese, iron ores, fluxes and fire-proof materials. Manganese is particularly important as a war material and its production in the regions of their occurrence during the seven months of 1942 indicated an increase of about 250 per cent over that during the same period in the previous year. Moreover, several coal mines have been discovered and developed in the neighbouring iron producing regions in the Urals. From the geological standpoint Tadzhikistan, the mountainous Soviet Republic north of Afghanistan, has recently risen to great importance, as new sources of several important minerals like iron, tin, wolfram and lead have been discovered in these regions.

GALILEO, NEWTON AND HALLEY

THE Royal Astronomical Society observes their Centenaries. The year 1942 happened to be a very significant year from the view point of bi-and-ter-centenaries of birth and death of some

of the greatest scientific men the world has ever seen. Thus the year in question was the year for celebration of the ter-centenary of the death of Galileo and the birth of Newton and at the same for the bi-centenary of the death of Halley. Of the several scientific associations that observed the centenaries and drew an air of fresh inspiration through the reminiscences of these great founders of modern science none perhaps deserves a greater notice than the Royal Astronomical Society in so far as they all made fundamental contribution to the science of astronomy apart from their valuable contribution to other branches of natural science. The Royal Astronomical Society arranged in the Grove Hills Library an exhibition of the portraits and other memorials of the three astronomers collected from various sources. The meeting, presided over by Prof. S. Chapman, the president of the Society, was attended by a large gathering including distinguished representatives from numerous scientific societies, institutions and associations of Great Britain. In course of presenting a short account of the lives and outstanding characteristics of Galileo, Newton and Halley as an opening discourse Mrs M. E. Evershed most fittingly drew a contrast in their characters in the following words: "Galileo intensely alive, active and eager, Newton reserved and difficult to understand, and Halley sociable and friendly, with a sunny, open nature." After that highly informative papers discussing the scientific achievements of Galileo, Newton and Halley were read by Prof. H. Dingle, Prof. H. C. Plummer and Dr H. Spencer Jones, the Astronomer Royal respectively. Dr Dingle referred to the characteristic style of Galileo's exposition which bore a stamp of modernity in striking contrast to medieval modes of expression. With perfect candour and lucid expression marked by restraint and an absence of feelings he introduced mankind for the first time in history to a new and hitherto unknown universe. In discussing the various activities of Newton, Prof. Plummer said that Newton devoted as much time to chemistry as he did to physics. But while he was conspicuously successful in tackling physical problems his results in chemistry proved often abortive. Like many previous writers on Newton, Prof. Plummer is also of opinion that the authority and personality of Newton had a retrograde influence on the further progress of physical science, particularly with reference to the wave theory of light. Dr Jones referred to Halley's great versatility. Halley was simultaneously a mathematician, astronomer, physicist, statistician, geographer, hydrographer, geomagnetician, navigator, practical seaman and the first scientific voyager. Though astronomy was his favourite pursuit he excelled in every branch of knowledge he set his mind to. The isogonal lines in the form in which

they are now universally used are the results of Halley's several voyages. He was the first to point out the possibility of determining the sun's parallax accurately from observations of the transit of Venus and was also the discoverer of the proper motion of stars.

PLATINUM AS WAR MATERIAL

THE United States War Production Board recently issued a general conservation order (No. M. 162) and imposed a strict control over stocks, sales and purchases according to a report in the *Economist*. Such steps have been deemed inevitable in view of the importance of platinum as a 'strategic material of war'. The high melting point of platinum, its resistance to the corrosive action of acids, its low coefficient of expansion, its ductility and malleability are some of the physical properties that have made its use indispensable for various purposes. Thus platinum is used as a catalyst in the production of nitric acid for explosives, as a raw material for scientific war instruments, furnaces, chemical processes, fuses and alloys, to mention only a few. Clearly enough platinum is one of the important rare war materials that amply bare on the decision of the present protracted war.

The United Nations have undoubtedly a decided advantage over the Axis Powers with regard to the control, production and supply of platinum, an important war material. The total world out-put of platinum has been estimated at about 600,000 to 700,000 troy ounces per annum. Canada, the most important of all platinum producing countries, produces a little over half this amount as a by-product from the metallurgical operation of copper and nickel from the Sudbury mines in Ontario. Russia is the second largest producer of platinum, thanks to the geological importance of her Urals. Other important producers are U. S. A., Alaska, Transvaal, Colombia, Belgian Congo and Abyssinia of which the supplies from the last two countries have dwindled almost to insignificance. The countries under the Axis Powers do not, however, produce this material whose deficiency appears to be made good by a carefully planned policy of accumulation and expropriation from jewellery in the occupied countries.

SCHWASSMANN-WACHMANN COMET

It is curious that the famous Schwassmann-Wachmann comet should be repeatedly mistaken for a new one. Recently it has been mistaken over again by the Finnish astronomer L. Oterman at the observatory of the University of Turku, who reported his supposed discovery of a new comet to the Harvard Observatory. It may be remembered

that the same comet was observed and announced as a new discovery by Dr G. Neujmin of the Simeis Observatory, Crimea, on August 29, 1941. The American astronomers also observed the comet this time from the McDonald Observatory shortly before the announcement by the Finnish astronomer.

The reason for such repeated misgivings with regard to this particular comet has been attributed to its occasional flaring up in brightness. This remarkable comet, first discovered in 1927 by the two German astronomers and named after them, is a member of our Solar system revolving in a nearly circular orbit which lies wholly between the orbits of Jupiter and Saturn. Its calculated distance from the sun is nearly 500 million miles. The brightness of the comet has been found to fluctuate within wide limits, the minimum being the 18th magnitude, the maximum 12th magnitude a range of 1 : 100. No satisfactory explanation has so far been available for such variation in intensity. Each time the comet which usually looks like a faint star has flared up in intensity, it has lured astronomers to the irresistible vanity of claiming of a new discovery.

AVERSION TO NEGRO BLOOD NOT SCIENTIFIC

If the racial policy of the National Socialists in Germany stands condemnable, as it ought to be, we do not know how we can support the American white peoples' racial attitude towards the Negroes. The much maligned practice of the Nazis to maintain the purity of their Nordic blood to the utter exclusion of the Semitic variety is equally prevalent on the other side of the Atlantic. The white people of America not only avoided contamination with the non-Caucasian blood with religious care but even propounded the theory that the blood of a Negro was different from that of a white man in many physiological characteristics. Recently an order was published in U. S. A. prohibiting the inclusion of Negro plasma in the military plasma bank, according to a note in a recent issue of the *Scientific American*. We are glad to note that many Americans have realised the fatuity of such steps and have already created an agitation against such discriminatory policy towards the Negroes. The question was referred to the American Medical Association. The report of the Association reveals that there is no scientific foundation for such discrimination in the choice of blood, that the aversion to non-Caucasian blood is purely emotional and that the propounded idea about a Negro blood is an unadulterated myth. As a matter of fact, several cases of white men receiving Negro blood for treatment of diseases calling for blood transfusion are on record without any evidence of harm or untoward symptoms on the part of the recipients.

BRITISH SCIENTIFIC AND CULTURAL MISSION TO CHINA

By arrangement between the Chinese and British Governments, two representatives of British learning have just reached China, having passed through India and staying a short while in Calcutta. The representative of the national sciences is Dr Joseph Needham, F.R.S., Reader in Biochemistry in the University of Cambridge, while the representative of the humanities is Prof. Eric R. Dodds, F.B.A., who holds the chair of Greek in the University of Oxford. It is expected that they will stay in China about a year. Dr Needham is to be attached to the National Academy of China (Academia Sinica), while Prof. Dodds will work in connection with the Sino-British Cultural Association.

These scholars have carried with them to China messages of greeting from the Royal Society, the British Academy, and the English and Scottish Universities, addressed to Academia Sinica and other similar learned bodies in China. These messages express the admiration of British scientists and scholars for the fight which the Chinese have so long conducted for their independence, and for the way in which they have kept alight the torch of education and research in the face of almost insuperable difficulties. Both Dr Needham and Prof. Dodds will be doing their best to strengthen intellectual contact between Chinese and Western scholars. They will try to facilitate the flow of books, literature, and microfilms to China, and they will perhaps be able by their presence to mitigate the present intellectual isolation of the Chinese Universities.

Dr Needham's interpretation of culture is a broad one; he believes that pure and applied science are inseparable, and that there is indeed no distinction between them, save in so far that some sorts of science have immediate practical applications, while others have applications which will not become apparent perhaps for many years. Acting on this belief, he has the aim of attempting to establish and maintain a fruitful contact between Chinese scientists and technologists on the one hand, and those of Britain and America on the other. He also believes that it would be very desirable to strengthen the contacts between Indian and Chinese science, especially since there are many questions (arising, e.g., out of a similarity in raw materials, traditional processes, and climatic conditions) which are common to both the Great Eastern countries.

Ultimately, in his view, some machinery on a considerable international scale will be needed to convey the most up-to-date scientific thought and technological advances from the advanced Western countries to the relatively backward Eastern countries which stand in such great need of it. Something of this kind was attempted, not without some success, by the League of Nations, especially in its Inter-

national Health Organisation, but it now requires doing on a much greater scale. It should be taken into account in any proposals and plans which the United Nations form for post-war relief and reconstruction. The present British Scientific Mission to China, together with the experts in applied science which the United States Government is now sending to China, form an experiment in international scientific co-operation.

We may, however, point out that all such contacts would ultimately be frustrated if the Western scientists are not prepared to break with Imperialism and to compel their Governments also to break with it not at some future date but right now in the thick of this war. Future hopes do not mean much for oppressed colonials throughout Asia and Africa.

ANNOUNCEMENTS

We are glad to inform readers of SCIENCE AND CULTURE that Mr D. N. Wadia, Government Geologist, Ceylon, and President of the Indian Science Congress for 1942 and 1943 has been awarded the Lyell Medal by the Council of the Geologist Society, London. The Lyell Medal, established in 1875 under the will of Sir Charles Lyell, British Geologist, is to be awarded annually (or from time to time) by the Council of the Geological Society. The medallist may be of any country or either sex. Not less than one-third of the annual interest of a sum of £2,000 is to be awarded with the medal, the remaining interest, known as the Lyell Geological Fund, is to be given in one or more portions at the discretion of the Council for the encouragement of geological science.

The following is the list of office-bearers and members of the Horticultural Society of India for 1943:—
President—Dr G. S. Cheema, Poona. Vice-Presidents—Sardar Bahadur Sarda Lal Singh, Lyallpur and Mr Percy Lancaster, Calcutta. Treasurer—Mr K. C. Naik, Madras. Secretary—Dr P. K. Sen, Sabour (Bihar). Councillors—Mr M. Mustafa, Quetta; Rao Bahadur H. C. Javaraya, Bangalore; Khan M. Aslam Khan, Peshawar; Mr S. S. Bhat, Baroda; Mr M. R. Fotidar, Srinagar; Mr W. Hayes, Allahabad; Dr S. Hedayetullah, Dacca; Dr N. K. Nandi, Shillong; Dr V. S. Badami, Cuttack; Mr R. S. Singh, Lucknow; Mr M. L. Garg, Shaharanpur (U. P.) and Mr D. T. Desai, Bombay.

CORRECTIONS

In Dr P. C. Datta's Letter to the Editor entitled 'On the Synthesis of Oestrone' in p. 346 of the Feb., '43 issue in the structure for the tricarboxylic acid, the linking of the cyclohexane ring to the benzene nucleus will be *para*—to the methoxyl group and not *meta*—as depicted there.

In line 23 of the second column of page 325 of the said issue, read 'macroscopic vegetation' for 'microscopic vegetation'.

NEW EXPERIENCE WITH ELECTROPLATING

DR OLIVER P. WATTS, professor of electrochemistry at the University of Wisconsin, had a new experience while attempting to produce nickel powder by rapidly electroplating the metal on a copper sheet. He could not, however, produce his expected nickel powder this way, but found to his great surprise a coating of nickel appearing on the back of the copper instead of any on the front in great contradistinction to all recorded experience with plating solutions. Dr Watts had tried with that "bugbear" of the plate, the "burned" deposit, and passed a very heavy current through a dilute solution of nickel sulphate. He had also increased the conductivity of the solution by adding a large amount of sodium sulphate to it and slightly heating the solution, as is usually done in such electrochemical practice. Heavy current generally produces a crumbly deposit which may, therefore, collect at the bottom in the form of powder. Contrary to his expectation, Dr Watts found a film of alkali on the front of the plate, but a good coating of nickel on the back. Measurements indicated that only a quarter of the total current allowed to pass through the solution was responsible for the deposit of nickel. This portion of the current must have managed to pass round the edges of the plate. The phenomenon was observed in the case of other metals, *e.g.*, cobalt and iron using suitable solutions. Attempts with tin, zinc and copper, however, proved abortive.

Dr Watts suggests that this new experience in electroplating has industrial possibilities, though a successful technique has yet to be developed. He believes that by suitably regulating the solution equal deposits on both surfaces of the plate might be effected. But the difficulty experienced so far is that either there is no deposit on the front surface or the deposit is unmanageably heavy.

IODINE FROM FLUE DUST

THE Heinrich Bier Bierwes smelting plant of Mannesmann, according to a report of the *Chemical Age*, has recently developed a process of recovering most of the iodine present in the blast-furnace flue dust accumulated in the course of electrical gas purification. It has been estimated that in every twenty four hours as much as 17½ tons of flue dust containing about 11½ lb. of iodine are produced. The dust contains in addition substantial quantities of sodium, potassium, fluorine and organic compounds.

The process consists in boiling the dust with water to effect the initial concentration without much loss of iodine. The resultant material contains largely the chloride and the carbonate of both sodium and potassium and also some organic compounds, the last being destroyed by calcination at 100°C. The heated salts are next dissolved, and the iron oxide obtained as residue is separated. Calcium chloride is then used to remove fluorine in the form of precipitate and thus reduce its proportion. The clear solution after slight acidification is distilled to recover iodine in a comparatively pure state.

Detailed information as to the economic success of the process is lacking. It appears to depend largely on the possibility of utilising other minerals present in the flue dust. It is reported that, in addition to iodine, the recovery of as much as 70 per cent of the total potash content of the flue dust in the form of potassium chloride has been successfully effected. Attempts to utilise this potash as fertiliser have not been so far attended with success owing probably to the presence of fluorine as a serious impurity.

STRONGER RAYON

It has been established that the length of cellulose chains in fibres is a very important factor so far as the strength of the fibre is concerned—the longer the molecule, the stronger the fibre. The chain length of cellulose in ramie (China grass) is the highest, and it is well-known that ramie is the strongest of all vegetable fibres. In fact, it is nearly eight times as strong as cotton and four times stronger than flax. Cellulosic fibres usually contain a mixture of long, medium and short molecules. Consequently rayon which is made from cellulosic materials is more or less similarly composed. During preparation, cellulose generally suffers degradation with the result that rayon usually has a molecular weight lower than that of the starting material. Poor strength, particularly when wet, was a very serious defect of rayon. By various modifications in the manufacturing process, the strength has been largely improved. If it were possible to separate the long molecules from the short ones and prepare rayon from the former only, the strength would be much enhanced. Very recently, in U. S. A., cellulose acetate has been fractionated by gradually adding alcohol to its solution in acetone. As many as fifteen fractions have thus been separated. By measuring the viscosity of their solutions it has been found that

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the degree of polymerisation which is proportional to the length of the cellulose molecule, varied between 380 and 30, while that of the starting material was 194. In other words, the fraction with the highest molecular (precipitated on adding alcohol) length contains as many as 380 glucose units in the molecule and that with the lowest only 30 such units. This may be rightly considered as the successful step in the production of stronger rayon.

It may be noted here that by stretch spinning, much stronger rayon has been made—the micelles of cellulose are thus oriented in the direction of the fibre thereby imparting strength to the rayon. This technique is followed in making the synthetic fibre, Nylon; by 'cold drawing' giant molecules are arranged more or less parallel to the direction of the fibre axis.

GROUND VIBRATIONS AND THEIR EFFECTS ON BUILDINGS

THE study of the problem of free and forced vibrations as applied to buildings has a great bearing on the structural protection against earthquakes and other seismic disturbances. No country has undertaken the study of this problem as seriously as Japan, the worst sufferer from such seismic disturbances, who has consequently taken a lead and progressed in devising ways and means of structural protection against earthquakes and in evolving new theoretical conceptions, most of which have appeared in The Bulletins of Earthquake Res. Inst., Tokyo.

According to Sezawa and Kanai, two Japanese investigators, the elastic waves propagated from the ground are partly transmitted into the building, partially dissipated and absorbed by the ground in the immediate vicinity of the building foundation and partially transmitted back into the earth from where they would probably never return unless a substratum exists at a horizontally short distance below the building. In very remote cases, when the ground and the building have identical elastodynamic properties, the transmitted wave disappears; in ordinary cases however the value of the transmitted disturbance increases with an increase in the ratio of the rigidity of the ground to the building rigidity. When this ratio becomes less than one the transmitted disturbance to the structure becomes smaller than the incident disturbance and the reflected wave from the boundary between the ground and the building suffers a change in phase. The transmitted

disturbance which travels up the building and which is mainly responsible for producing elastic shear displacements in a monolithic structure has been the subject of recent American investigations. The analysis of a multi-story building subjected to horizontal vibratory motion of its base, is considered in the light of dynamic shears, as applied to an idealised elastic structure which can be theoretically made to resemble the actual building having a considerable number of floors and large horizontal dimensions. According to L. S. Jacobsen of Stanford University, California, the idealised structure is assumed to possess uniformity and constant mass per unit height, and at the same time have a two-fold symmetry of mass and rigidity distribution in horizontal planes. The first story of the structure is treated as one having a definite shearing rigidity but of zero mass, while the structure contained between the ground and the first story is assumed to move in a definite horizontal direction uninfluenced by the dynamic interaction of the whole structure with the ground. In such an idealised structure, the transmitted disturbance travelling up the building is reflected back without phase reversal which on reaching the bottom of the building partly gets transmitted into the ground and partly goes up again, with the result that the ascending and descending single waves interfere somewhere at the top of the structure. A "damping" effect is now noticeable in the ratio of the amplitudes of the two waves and it is this effect which has been compared by Jacobsen to an intermittently operating type of viscous friction having a continuous decay factor of an exponential type. Seismic facts have revealed that buildings resting on elastic soils are subjected to several important forms of internal viscous and Coulomb friction which have not been fully studied as yet because they do not seem to lend themselves to easy mathematical deductions.

In the absence of sufficient literature on the subject the fact that stands out is that a flexible first story protects the other stories from ground disturbances of high frequency, and is also very effective in shielding the higher modes of a large structure whose fundamental frequencies of vibrations are outside the earthquake frequency range. When however the ground disturbance is produced by low frequency waves, though the flexible first story may not protect the superstructure, it will not in the least produce any harmful effects.

S. K. G.

RELATION OF PROTOZOA TO 'BULKING' OF ACTIVATED SLUDGE

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THE phenomenon to which the term 'bulking' is applied results generally in the temporary loss of control of the activated sludge in the plant. When this occurs, the volume of sludge found in the aeration tanks suddenly becomes abnormal and increases with considerable rapidity during several days. The sludge is also changed in colour and character, is slow in settling with less than 50 per cent. purification owing to the large quantity of suspended solids in the effluent.

Although it is generally recognised that bulking of sludge is a sign of deficient air supply and that it can be remedied by reducing the flow of sewage and increasing the air supply for a prolonged period, the exact cause of the phenomenon has so far remained obscure. The views held by different investigators as to its cause are rather conflicting. Thus, Arden and Lockett (1922) reported that, under conditions of bulking, there was a preponderance of certain types of higher organisms, such as, *Carchesium*, *Stentor* and filamentous growths of the *Cladothrix* type, and concluded that the bulked condition of the sludge is associated in some way with the protozoal and bacterial growths. At the same time, they found that, under suitable aeration conditions, the control of the process could be well maintained, without reference to the higher organisms contained in the sludge, and that therefore the necessity for their destruction, either by periodical adjustment of the air supply or treatment of the sludge itself, did not arise. Fowler (1924) observed that bulking is due to filamentous bacteria rather than to protozoa, although numerous forms of the latter may be present. This view is generally shared by Swaminathan (1929), who contended that while protozoa were found throughout the year with low or high air supply without giving any trouble, the immediate cause of bulking was the development of large masses of filamentous growths having the characteristics of *Sphaerotilus natans* or a closely related organism. More recently, Ruchhoft and Kachmar (1940, 1941) studied the role of *Sphaerotilus natans* in bulking and concluded that the appearance of this organism is not a primary cause of bulking, but the same disturbance that affects the sludge floc to produce bulking also provides *Sphaerotilus*, and the interweaving of its filaments within the light floc accentuates the condition. These and other workers, like Sibata (1938) attributed the cause ultimately to deficiencies in plant design or operation or to sudden changes in the character

or volume of the sewage. But Turner (1940) considered *Sphaerotilus* as the direct causative agent for bulking and he found that the application of large quantities of chlorine (10 p. p. m.) was more effective in eliminating this organism than treatment with more air. In this way there has been growing a large volume of literature on the subject of filamentous bacteria and their possible relation to bulking. At the same time, apart from the contention of the special role of any bacterium in bringing about bulking, increasing evidence has been adduced that it is largely a question of supply and demand of oxygen within the flocs of sludge during the 'activation' process. This view, of course, is in conformity with the remedial measure generally adopted when bulking takes place. Heukelekian (1941) thus recently came to the conclusion that the causative factor is a deficiency of oxygen created by the slow rate of diffusion of oxygen from the liquid into the floc and the high oxygen demand within the floc.

Independent of the above studies, there has accumulated a considerable amount of evidence, in the light of which it is being generally accepted that the daily careful microscopic examination of the sludge, with special reference to the nature and extent of its protozoan population, would lend the most effective means of diagnosing operating conditions and difficulties. In this connection again, Arden and Lockett (1936) listed the common types of the protozoan fauna associated with varying conditions. Viehl (1937) made special reference to ciliates although he found that protozoa in general are important. Pillai observed while starting the new Activated Sludge Plant at Cossipore,* Calcutta in September, 1938, that the building up of sludge in the aeration tanks took place simultaneously with the occurrence and development of ciliates, particularly the species of *Vorticella*. Barritt (1940), in a study of the ecology of activated sludge in relation to its properties and the isolation of a specific soluble substance from the purified effluent, found that the presence of ciliates and especially the peritriches almost to the exclusion of other classes of protozoa generally indicated a ripe activated sludge. Further studies of Pillai (1941, 1942, 1942a, 1942b) on the

* The Cossipore installation deals with the sewage from a population of 8,000-10,000. It is designed on what has been termed the 'complete' system, i.e., no provision is made for presettlement of sludge as distinct from heavy mineral grit. Purification is pushed to almost complete nitrification. Aeration is by means of "diffused air".

role of protozoa in activated sludge have clearly shown that the members of the families *Epistylidae* and *Vorticellidae*, more especially the species of *Epistylis* (Fig. 1), are most important in the forma-

ties of fresh activated sludge were collected (to the extent of 10 litres) in bottles; air was bubbled through the suspensions in one set of bottles, while another set of such bottles was kept without aeration



FIG. 1. Photomicrographs† of three of the efficient species of *Epistylis* occurring in activated sludge. The forms were isolated from the aeration tanks at the Indian Institute of Science, Bangalore. Stained ($\times$ about 55).

tion of active, healthy sludge, in the attendant oxidation changes, and in the concentration and conservation of the fertilising elements in the sludge.

Further investigations into the relation of protozoa in the activated sludge process have shown that bulking of sludge is traceable to the inactivity and the gradual destruction and decomposition of the important forms of protozoa, more especially the colonies of *Epistylis*. It has been observed that when there is no adequate aeration in the tanks, i.e., when the supply of oxygen is not sufficient in the sludge flocs, the species of *Epistylis*, in particular, become inactive and are attacked by the bacteria; these protozoa have been found to be extremely susceptible to the condition of oxygen-free atmosphere; but the 'bulking' is not actually noticed until the functioning of the protozoa is seriously impaired and their cells, in consequence, are disrupted and decomposed as to cause deflocculation. Due to bacterial action, the sludge flocs get filled with gases, become light and 'rise', and gradually get dispersed; the settlement is thus protracted and the effluent carries more solids in suspension.

In view of the above observations made under the tank conditions, some direct experiments were conducted in order to study the relationship between the protozoa and bacteria in activated sludge when there was no aeration in the medium. Varying quan-

as the control series. The numbers of active protozoa and bacteria (by direct counting on the haemocytometer for the protozoa, and by taking total counts on nutrient agar and McConkey agar for the bacteria) present in the sludges and in the supernatants at intervals were noted. It was observed that in the bottles kept without aeration, by the end of 24 hours the important colonial forms of protozoa became inactive and the bacterial numbers in the sludge increased considerably; and at the end of 48 hours, when the sludge was tending to rise and float, there was enormous increase in the number of bacteria, and the protozoa were found completely inactive and showed signs of bacterial action on them. It would appear that liberal air supply is essential for the activity of these protozoa and that they die in the absence of air.

The majority of protozoa, especially the ciliates, are aerobic; they take in oxygen and give off carbon dioxide like other animals, and gradually become inactive and die in an oxygen-free atmosphere. Many years ago, Vernon (1897) observed that *Collozoum* (a radiolarian) has the highest respiratory coefficient of all invertebrates, equivalent to forty times that of the frog (the amount of oxygen absorbed per unit of dry body-weight); and although it is desirable to have further evidence before accepting this startlingly high figure, yet it points unmistakably to a very large consumption of oxygen. The work of Putter (1905, 1907) has also emphasised the singular nature of protozoan respiration. During recent years, a number of workers have studied the oxygen consumption of *paramecium* and a few other

† The photomicrographs of the organisms were taken with the kind assistance of Mr V. S. Rajagopalan, to whom the authors' thanks are due.

forms, but imperfections of the methods employed and the presence of associated bacteria cast doubt on the value of most of these data. More recently, Hall (1938), using 'bacteria-free' cultures and a medium containing only salts, found an oxygen intake for *Colpidium campylum* of 112.5 cu.mm. of oxygen per million animals per hour at 19.8°C. Judging from these and other evidences, it would appear that the large colonial forms of *Epistylis* and the allied forms, which predominate in healthy activated sludge and which are some of the most advanced among protozoa, require comparatively a large volume of air for their respiration and normal activity.*

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* Studies on respiration in these forms are in progress. The authors wish to thank Dr Gilbert J. Fowler for his valuable criticism.

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MEDICINE AND PUBLIC HEALTH

IMMUNE SERUM FOR INFLUENZA

SINCE the out-break of the present global war doctors all over the world felt deeply concerned for the likelihood of an influenza pandemic such as swept the world in 1918, also breaking out this time. Studies as to the possible measures for prevention of this scourge were undertaken in right earnest. Dr Joseph Stokes, Jr., of the School of Medicine of the University of Pennsylvania came to the conclusion as a result of his extensive experiments that the use of immune serum from the blood of the first patients can be made with great effect for the treatment and prevention of influenza. The immune serum from the blood of persons who have just had influenza contains antibodies for fighting off the virus. In his mice experiments small amounts of the immune serum which the animals were allowed to inhale proved effective against the virus. A greater amount of the serum is, however, required for injection. The administration should be completed within six hours after infection with virus. Dr Stokes also showed that the immune serum can be developed in a person's own blood by vaccination with influenza virus. Another method of protection against influenza epidemics, suggested by Dr Stokes,

consists in sterilising the air of hospital wards, school rooms or similar places where people assemble in large numbers by ultraviolet rays or by sprays of propylene glycol vapour. Propylene glycol vapour, proved a better sterilising agent. Though there are good reasons to suppose that these methods will prove effective in preventing epidemics of influenza these are hardly expected to be successful in arresting an influenza pandemic. The probable explanation is that in pandemics the disease breaks out suddenly and simultaneously in several widely separated areas, and that, unlike in epidemics, the travel of the virus in air is not perhaps the main factor accounting for the spread of influenza in pandemics.

HYPOTHERMIA FOR INSANITY

MENTAL illness like insanity, schizophrenia or dementia praecox was looked upon as incurable disease until recently. Thanks to the researches of modern psychiatrists, there are now good reasons to expect a safe return to the normal mental conditions from such unfortunate upsets and complications involved in mental diseases. The drugs that played the trick and restored many schizophrenics to their normal state of mind are insulin and metrazol. These

drugs are supposed to produce shocks and bring about structural changes in the operative centres of the brain responsible for the mental upsets. But unfortunately the treatment with insulin or metrazol shock often involves irreparable degeneration, undesirable structural change in the brain and fractured vertebrae during the stages of convulsions. Nevertheless, the satisfactory balance of advantages has justified the wide application of such shock therapy in insanity, schizophrenia etc.

Very recently hypothermia or the human hibernation, as it is popularly called, has been successfully applied in the case of the mental diseases mentioned. In a recent issue of the *Scientific American*, Mr Barclay Moon Newman has given an interesting account of the recent progress in hypothermia and some hospital records. The credit of developing this new treatment goes to John H. Talbott and Kenneth J. Tillotson of the Harvard Medical School. It is to be noted that the foundation of hypothermy was first led by Dr Temple Fay who recently carried on an elaborate investigation about the effect of refrigeration on living organisms and showed the safety of human hibernation. The original idea that inspired Dr Fay in the research was the development of a successful treatment for cancer based on refrigeration. Results of hypothermia in cancer did not however, prove satisfactory, but revealed a mysterious nervous change on the part of the cancer patients undergoing the treatment. Hypothermia was found to relieve the patients of their pains for months. These results caught the fancy of the Harvard Medical School psychiatrists who extended the investigation to the field of mental illness. They have come to the conclusion from their own convincing results that hypothermia is decidedly a milder treatment and involves far less risks than insulin or metrazol shocks which often produce untoward complications. In hypothermia the patients require to be exposed to temperature some 75 degrees

below when life comes within close quarters to death. The patient will relapse into a sort of sleep and unconsciousness whence he will be gradually restored to consciousness. The successful carrying out of hibernation requires the attendance of expert doctors with every hospital facilities. Unfortunately the war has greatly disturbed further investigations and a more detailed study of the possibilities and shortcomings of this new and apparently promising line of treatment.

S. N. S.

IS MENTAL DISEASE REALLY INHERITED?

"FOR most (mental) traits we do not know how they 'run', the traits for which the principles of inheritance are known, even vaguely, are very few. And that hasty inferences from (physical) traits of fruit flies and potatoes to human traits has not been useful." Dr Knight Dunlap, Professor of Psychology at the University of California, further points out that "The fear of hereditary mental disease, played up by eugenicists and other fear propagandists, has driven many young men and young women into maladjustment, and even into suicide or neuroses."

Mental and intellectual inheritance is still a disputed subject, while the heredity of physical traits may be more or less clearly laid down on the Mendelian principles. The statistical data for the inheritance of mental disease or feeble-mindedness is scarce, and even those on the record, as the unbiased psychologists point out, are just the ones picked up to suit the traditional belief, discarding those which do not suit them. As a matter of fact, it has been found that most of the mental disorders and feeble-mindedness or inferiority complex are the results of external environment, malnutrition and a number of known factors, and they are mostly curable by proper medical and psychological treatments.

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VITAMIN C IN HEALTH AND DISEASE

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(Continued from the last issue)

Desensitizing properties of Vitamin C.—Dainow (1935) showed that ascorbic acid has a beneficial action on certain allergic conditions of the skin. In cases of intolerance to arsenical injections intravenous administration of vitamin C desensitizes the patient within twenty-four hours. Patients of exfoliative arsenical dermatitis recover when vitamin C is administered intravenously. Dainow reports several cases of Herpes simplex which are improved if vitamin C is administered early.

Carnia (1941) observed that five of seven cases with previous arspenamine dermatitis with positive patch tests to neoarsphenamine were subsequently able to tolerate more of the same arsenical without further reaction, when first massive dose of vitamin C were given intravenously.

Contrary to the above findings Cammarella (1940) reported that in a large series of persons who received serum therapy vitamin C showed no appreciable effect in preventing serum sickness. Yosikawa (1939) observed that vitamin C inhibited allergy only on the continued use of rather large doses. Smaller doses of the vitamin often intensified the allergy. Hetler *et al* (1940) showed that ascorbic acid has no influence on the development of sensitivity or prevention of shock in guinea-pigs once the animal is sensitive. The fact that scorbutic guinea-pigs are more susceptible to shock is due to increased rate of absorption of the antigen from the intestinal tract as a result of some alteration in the tract itself. McDonald (1941) observed no relation between the quantity of ascorbic acid administered and the sensitivity to repeated intradermal injections of 0.15 per cent solution of neoarsphenamine in guinea-pigs. Flexner *et al* (1940) observed that vitamin C is useless in the treatment of herpes simplex encephalitis in rabbits.

Vitamin C and Infection.—Sufficient proof has accumulated to show that vitamin C plays a very important, though perhaps indirect, rôle in protecting the body against infection.

Several observers have reported that patients suffering from tuberculosis are unsaturated with vitamin C. Hasselbach (1937) observed that all cases of tuberculosis of the lungs with a raised temperature and evidence of tissue destruction as shown by the presence of elastic fibres in the sputum, were suffering from vitamin C deficiency as manifested by diminished urinary excretion of vitamin C and not

responding to test doses of vitamin C like normal individuals.

Heise *et al* (1936) found that in tuberculous patients with stationery or improved pulmonary lesions the excretion of vitamin C was in general higher than in those whose lesion were progressing. In male patients a higher sedimentation rate was accompanied in most cases by a low excretion. All the patients examined were unsaturated with vitamin C when compared with normal subjects.

Petter (1937) and Sande (1938) have studied the rôle of vitamin C in tuberculosis. They have reported that vitamin C combined with gold therapy reduced the tendency to haemorrhage.

Trautwein (1938) treated tubercular patients with intravenous injections of vitamin C, 200 mg. per day until the patients were saturated with vitamin C. He observed a remarkable improvement in the condition of his patients as manifested by gain in weight, fall in body temperature, decrease in red cell sedimentation rate and a favourable blood picture.

Sweany *et al* (1941) studied extensively the rôle of vitamin C in tuberculosis. They tried to estimate the vitamin C content of the body in normal persons and in persons suffering from tuberculosis. The vitamin C content of the normal adult human body varied between 3 and 6 gm. In active tuberculosis the total quantity of vitamin C was less than 300 mg. even after a fair intake of vitamin C. In advanced disease muscle, fatty tissues, bone and skin lost nearly all their reserve of vitamin C while the bulk of the vitamin was retained in tissues like brain, liver, hypophysis, adrenals, gonads, pancreas and spleen. They administered (i) an orange flavoured preparation containing vitamin C, (ii) orange juice containing the equivalent amount of vitamin C and (iii) a synthetic orange flavoured preparation without vitamin C to three groups of patients suffering from pulmonary tuberculosis for a period of six months. The death rate in the control group receiving no vitamin C proved to be the highest. The patients in all the three groups who lived after six months of treatment did not, however, show any marked difference in body weight, skiagram, etc. in the different groups.

Athena (1940) treated 30 tubercular cases with intramuscular injection of 100 mg. ascorbic acid daily

for one month. General condition and blood picture of twentyfive patients were improved.

Abbasy *et al* (1936) observed that the daily urinary excretion of ascorbic acid per 10 stone body weight was 5 to 13 mg. for active cases of pulmonary tuberculosis, 18 to 28 mg. for the healthy controls and for quiescent cases, with an intermediate value for the cases of moderate severity.

Steinbach *et al* (1941) observed that in tuberculous guinea-pigs injection of vitamin C raised the tissue levels of ascorbic acid, increased the tolerance to repeated large doses of tuberculin and retarded the progress of tuberculosis. Fibrosis was more prevalent and caseation less marked in animals that received vitamin C. Combined administration of tuberculin and ascorbic acid gave better results than either substance alone. They have also observed (Steinbach, 1940) that unlike guinea-pigs vitamin C-metabolism is not readily disturbed in tuberculous rabbits who can synthesise their required vitamin C. Administration of vitamin C alone or with tuberculin is not useful in tuberculous rabbits.

McConkey *et al* (1938) showed that adult guinea-pigs receiving a diet partially deficient in vitamin C and fed daily with tuberculous sputum, developed ulcerative intestinal tuberculosis while most of the animals of the other group similarly treated but receiving adequate amount of vitamin C showed no such intestinal ulcers.

Kaplan *et al* (1940) observed that patients suffering from chronic pulmonary tuberculosis suffered from vitamin C deficiency and this deficiency could be corrected by oral administration of synthetic vitamin C. Feeding vitamin C for a period of six months in a group of 101 patients, however, they could not obtain significant favourable effect as judged by clinical criteria.

Bauer *et al* (1938) are of opinion that the action of vitamin C in tuberculosis is not specific but it improves the general condition.

Heise *et al* (1937) observed no clinical improvement after treatment with vitamin C in tuberculosis.

Roy *et al* (1941) observed that tuberculous patients could be saturated more easily by natural vitamin C as sundried pulp of Indian gooseberry than synthetic vitamin C.

The author (Banerjee *et al*, 1940) observed that tubercular patients excrete relatively more combined ascorbic acid in their urine than normal subjects. The author (Banerjee *et al*, 1941) also observed that urinary excretion of combined ascorbic acid was not appreciably affected by the administration of a single high dose of ascorbic acid to tuberculous patients. Combined ascorbic acid disappeared from the urine

of normal human subjects 1-3 days after continued injection or ingestion of ascorbic acid in doses of 70 mg. per stone body weight and the excretion of free ascorbic acid is greatly and quickly increased. Combined ascorbic acid disappeared from the urine of tubercular patients more slowly, 4-10 days after continued oral administration of ascorbic acid in doses of 70 mg. per stone body weight, while the excretion of free ascorbic acid was also increased more slowly than in normal subjects. Clinical improvement in the cases studied had not been observed within the short period during which ascorbic acid was administered though the slow increase of free ascorbic acid in the urine would indicate that the ascorbic acid administered was being needed and utilised by the body.

Harde *et al* (1934) observed that classical symptoms of diphtheria intoxication were not produced in guinea-pigs by injection of 1 or 2 minimum lethal doses of diphtheria toxin which had been left in contact with 10-20 mg. neutralised ascorbic acid *in vitro* for one hour.

Takahasi (1934) observed that both guinea-pigs and rabbits were more susceptible to injections of staphylococci when previously kept on diets deficient in vitamin C and tended to develop abscesses at the ends of the long bones, specially the ribs.

Wachsmuth *et al* (1938) treated a case of osteomyelitis developed after scarlet fever with vitamin C and obtained very good results.

Polonyi (1935) observed that the livers and adrenals of guinea-pigs infected with diphtheria showed a reduced vitamin C-content. He also observed that injections of vitamin C into guinea-pigs infected with diphtheria decreased the severity of the symptoms and increased the survival time.

King *et al* (1935) studied the effects of subcutaneous injections of standardised diphtheria toxins into groups of guinea-pigs kept under controlled conditions and receiving vitamin C at levels termed 'abundant', 'protective' and 'subprotective'. The survival time was shortened by 50 per cent in animals partially deprived of vitamin C.

King *et al* (1940) also observed the effect of different doses of ascorbic acid on the tooth structure of guinea-pigs receiving injections of diphtheria toxin. Guinea-pigs receiving 5 mg. of ascorbic acid per day showed no gross histological evidence of injury to the teeth when diphtheria toxin was injected intraperitoneally in doses of 0.4 or 0.8 m. l. d. Animals that received 0.8 mg. per day of ascorbic acid without toxin injection showed only slight histological evidence of vitamin C deficiency during the experimental period. Injection of 0.4 or 0.8 m. l. d. of diphtheria toxin resulted in marked injury

of the odontoblasts and dentin in the teeth of animals receiving only 0.8 mg. per day of ascorbic acid.

The author (Banerjee, 1942) has observed that septicaemic cases like staphylococcal infection, meningitis, leptospiral infection showed a diminished excretion of free ascorbic acid.

Lyman *et al* (1936) observed that the diphtheria toxin caused a loss of vitamin C from adrenals, pancreas and kidney.

Ghosh *et al* (1938, 1939) have shown that the inactivation of diphtheria and tetanus toxins by vitamin C *in vitro* is not solely a pH effect but is probably to be attributed at least partly to the specific action of the vitamin.

Klinger *et al* (1937) observed that ascorbic acid inactivated vaccinia virus, the virus of anterior polyomyelitis and diphtheria toxin. Jungeblut (1939) observed that ascorbic acid renders polyomyelitis virus non-paralytic if mixed *in vitro* prior to intracerebral infection in monkeys. Amato (1939) observed that virus of rabies can be inactivated *in vitro* by the action of ascorbic acid.

Guha *et al* (1937) have shown that ascorbic acid inhibits the growth of certain bacteria in synthetic media.

Olani (1939) observed that vitamin C represses the growth, induces a degenerative metamorphosis and reduces the toxicity of whooping cough bacillus. The toxin is neutralised and detoxified *in vitro* by vitamin C.

Macchiavello (1940) observed that guinea-pigs receiving injections of vitamin C show abortive, atypical or no febrile reactions when they are inoculated with European typhus. Number of brain lesions is apparently reduced. In human cases of Chilean typhus intravenous injection of 300 mg. ascorbic acid improved the condition of the patient and the fever was diminished.

Dantsiger (1939) contaminated vitamin C concentrate with cultures of the typhus and paratyphus rods. After standing for three days in the dark in a thermostat the vitamin gave no growth of the typhus-paratyphus group.

Reinhart *et al* (1933, 1934a, 1936b) observed that when living streptococci were injected into guinea-pigs suffering from experimental scurvy, degenerative and proliferating lesions were produced in the joints and heart valves, closely resembling the lesions found in rheumatic fever in man.

Bronshtein (1938) observed vitamin C deficiency in various rheumatic conditions. Symptoms of hypovitaminosis C showed a parallel development with the seriousness of the rheumatic process.

Bohnholzer (1937) obtained beneficial results by treating pneumonia cases with 400 to 500 mg. of ascorbic acid three times a day.

Miyao (1938) took two groups of monkeys. They were fed with a nutritionally deficient diet. A few days later one group was given vitamin C per mouth and the other group was kept as control. All the animals were then infected with paratyphus bacilli per mouth. Only one of the seven treated with vitamin C developed dysentery but of the five control animals all died after one or two days. Vitamin C deficiency was therefore considered to increase susceptibility to bacillary dysentery.

Vasile (1940) observed that ascorbic acid produced a greater resistance to the bacillus coli infection in guinea-pigs.

Najib Farah (1938) has treated several cases of enteric fever by intravenous injection of suprarenal cortex extract and vitamin C. Immediate improvement is reported to have followed without untoward reaction. Slutskii (1937) has treated cases of typhoid fever with intravenous injections of ascorbic acid upto 2.4 gm. which checked intestinal bleeding.

Zooke *et al* (1938) observed that in a normal state of nutrition artificially induced fever decreased the concentration of vitamin C in adrenals and kidneys of guinea-pigs. Similarly in man after artificially induced fever there is diminished urinary excretion of the vitamin. They have suggested that in guinea-pigs and possibly in man there is an increased physiological need of vitamin C in a state of fever. Haas (1939) observed that in rats, guinea-pigs and rabbits ascorbic acid prevents the pyretic action of 2.4 dinitrophenol. It is also active against thyroxin and physical hyperthermia in rats. Hansberger *et al* (1939) observed that injected ascorbic acid disappears quickly in patients with a high fever and the concentration in blood returns to the initial level within an hour owing to rapid absorption by the tissues which have been depleted of the ascorbic acid by the fever.

Ghosh (1939) observed that guinea-pigs injected with diphtheria and tetanus toxins excreted increased amounts of combined ascorbic acid in the urine. He suggested that vitamin C combining with the toxin helps in the detoxication mechanism of the animal.

Abbasy *et al* (1937) while studying the excretion of vitamin C in osteomyelitis found that the patients excreted 9 to 15 mg. ascorbic acid daily, while control patients and healed cases on the same diet excreted 20 to 40 mg. Half-healed cases gave an intermediate value.

Abbasy *et al* (1937) observed also that cases of rheumatic arthritis excreted on an average 8.6 mg. ascorbic acid per 10 stone body weight.

Thus we find that what was considered to be the antiscorbutic vitamin is related to numerous physiological and pathological conditions.

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BOOK REVIEWS

A Handbook of Shellac Analysis—By M. RANGASWAMI and H. K. SEN. Published by the Indian Lac Research Institute, Namkum, Bihar. Pp. 106+xvii. Price Rs. 3/4/-.

Shellac has a definitely important position in trade and industry. There are different grades of shellac and each grade suits a particular requirement. Hence the products must be scientifically standardised and strictly classified into different grades so that the consumers may buy according to their definite needs and specifications. This specification and system of grading should obviously be made according to some international and standard methods of analysis.

Different research departments and shellac consuming industries, viz., the U. S. Shellac Importers' Association, American Society of Testing materials, British Standards Inst., American Bleached Shellac Manufacturer's Association, Messrs. Angelo Bros., Indian Lac Research Inst., etc., have evolved methods on different aspects of shellac analysis and these have been published from time to time. Thus the literature on the subject is very scattered.

In the book under review the authors have collected together all relevant information on the subject and have thus incorporated under one cover a comprehensive critical review of the entire field of shellac analysis. Standard and recognised methods as also methods which have been newly suggested are dealt with in the text. Detailed description has been given of the experimental procedure and apparatus required for approved methods. The advantages, defects and adaptability of the methods of testing, have been lucidly explained and ably criticised.

The readers are also made familiar with original references.

The book comprises 15 chapters and an appendix. The first 14 chapters have been devoted to the important tests in shellac analysis and the last chapter deals with the miscellaneous tests. In the appendix are given various purchasing and grading specifications as adopted by the different Research Organisations and Government Departments.

In short the book gives all relevant and up-to-date information on the methods of testing and standardisation and also on specifications for sale and purchase. It is, therefore, truly a Hand Book which must find its way on to the reference shelves of all analytical laboratories and technological-chemical libraries.

The printing and get-up are excellent.

B. K. M.

Cine-Biology—By J. V. DURDEN, MARY FIELD and F. PERCY SMITH. Penguin Books, England.

For the education of the general public and more particularly for popularising Nature Study cinematographic films entitled "Secrets of Nature" and "Secrets of Life" were prepared in England as early as 1908. These films besides providing entertainment for the cinema audiences, have made known to the general public some microscopic but very interesting animals from amongst the invertebrates or that vast assemblage of creatures which possess no backbones. The authors, who are respectively an expert biologist, a non-technical author who is "responsible for . . . human touches" in the narrative, and a naturalist photographer, have collaborated in producing the volume under review as an explanatory text for these films.

The book was first published in 1941. In spite of the scarcity of paper and other abnormal circumstances due to the war there was such a ready sale for it that a reprint had to be issued in June, 1942.

The book contains not only an account of various animals of which films were made in the series "Secrets of Nature" films, but provides in a non-technical language excellent accounts of such animals as amoeba, the Slipper animalcules (*Paramecium*), the fresh-water Polyp (*Hydra*), the Sea Urchin, the Liver Fluke, several fresh-water Crustacea and Insects. Not only have the author provided excellent descriptions in very simple language of the structure of the various animals, but their life-histories and such interesting biological phenomena as the life of Protozoa or the simplest animalcules, building of the body in the various phyla, experiments in communism as illustrated by Obelia and forms, the extraordinarily complex life-histories of worms, natural history of pond life, and so on, are discussed in detail. The usefulness of the work is further increased by an excellent glossary of 13 pages in which scientific terms are explained in simple language for the benefit of the lay reader. There are a few simple illustrations in addition to a representative series of halftone illustrations of the animals taken from the actual films, and these add materially to the utility of the volume. The book should prove invaluable as an excellent introductory volume for Nature Study in high schools in this country.

B. P.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

THE CONCEPT OF "DEPOSIT PROTEIN"

From the time of Voit¹ it is known that when an experimental subject is suddenly changed from a high to a low level of nitrogen intake and *vice versa*, the nitrogen output in the urine is not immediately adjusted to a steady level but there is always a definite time-lag before the attainment of an equilibrium. This phenomenon of lag has been attributed by the present author to the metabolism of the "deposit protein."

The deposit protein occurs in the animal body as a perfect reservoir of nitrogenous material. The size of the reservoir depends mainly upon the previous nitrogen feeding. It has been calculated that the deposit protein N constitutes roughly 2.21 per cent of the total body N. The rate of repletion or depletion of the reservoir i.e., the rate at which the deposit protein is metabolised is determined by a simple logarithmic equation. Liver has been shown to be the chief site of occurrence of the deposit protein, which, however, also occurs distributed throughout the body in cells in which glycogen is also stored—in close association with and in similar manner to the latter.

The deposit protein does not exist in the cells of the tissues as free amino acids, simple polypeptides, end products of exogenous protein metabolism like urea etc. or non-protein nitrogen moiety of tissues. It differs from the structural proteins of the tissues and does not possess the many properties characterising true proteins. However, it is composed of the amino acids as the true proteins are, but it also contains glycogen, most probably, forming an amino acid-glycogen compound of a very complex nature, unlike the ordinary glycoproteins. Although the nature of the amino acid-glycogen combination is yet unknown, a probable hypothesis of its nature has been made. A new term—*Pseudo-protein*, has been proposed to define it.

The unique property of the deposit protein seems to be its extremely labile character. This lability distinguishes it remarkably from true proteins, which are stable within their individual physiological limits. The lability has been explained by the presumption that the chemical equilibrium of the following reaction—

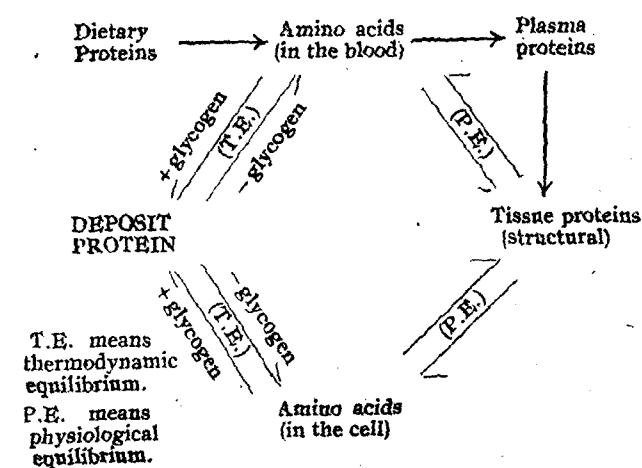
Deposit protein $\rightleftharpoons$ amino acids + glycogen
in the physiological steady state coincides with its

thermodynamic equilibrium, whereas in the following reaction—

Tissue protein $\rightleftharpoons$ amino acids

the physiological steady state is enormously removed from the state of thermodynamic equilibrium and that, this is much further on the protein side of the reaction than the latter state as determined by Borsook and Keighley.²

The physiological rôle of the deposit protein in the animal organism may be briefly represented by the following scheme.



Firstly, the deposit protein serves the rôle of a perfect reservoir of highly labile nitrogenous material from which amino acids required by the organism may be drawn upon in times of need e.g., when the demand of amino acids falls short of the exogenous supply, especially in "nitrogen hunger" (in starvation or N-free feeding). Amino acids thus derived discharge all functions ascribable to dietary proteins. Secondly, it is as much a reservoir of glycogen as of amino acids. Thirdly, its lability of formation and mobilisation seems to contrive a mechanism for the maintenance of the constant concentration of amino acids in the blood and cells. In this respect it exercises the function of a buffering medium or substance between the exogenous amino acids and tissue proteins (structural) and undergoes almost continuous repletion and depletion as necessary in the said process. Fourthly, it forms a biological mechanism for the defence of the most valuable and indispensable protein of the protoplasmic structure.

Whenever an animal organism faces any unphysiological conditions of life demanding the disintegration

of the nitrogenous matter of the body, as in hunger, some wasting diseases, or in the introduction of certain poisons, it is the deposit protein which is disintegrated first, thus protecting the valuable tissue proteins, and this process of disintegration proceeds till it is completely exhausted, when tissue proteins are exposed to attack. In this defensive mechanism the carbohydrate moiety (glycogen) of the deposit protein is likely to play an important rôle by virtue of its reduction potential being much higher than that of amino or fatty acids.

The concept of the deposit protein as described above has found certain important applications in elucidating certain aspects of protein metabolism. For instance, it has reconciled the two existing but opposite schools of thought regarding the nature of nitrogen metabolism induced by muscular work. The Cathcart school³ maintain that muscular activity is invariably accompanied by the disintegration of tissue proteins, while the Lusk school⁴ claim that it can be performed by the oxidation of fuel materials alone. The present concept explains that if the body contains a store of deposit protein then the output of nitrogen in urine will undoubtedly increase by exercise (as claimed by the Cathcart school); but this increase does not arise from the disintegration of tissue proteins but by a mobilisation of the deposit protein. If, however, the organism is initially depleted of this reserve store of nitrogen, then muscular work will not induce any increase in the output of nitrogen provided adequate energy is supplied to the subject (Lusk). Thus the two well-known theories are reconciled.

Schoenheimer and his school⁵ have recently postulated, from metabolic studies with amino-acids containing heavy nitrogen (N^{15}), a theory of protein metabolism in which they assume that the amino-acids of the intact protein molecule of the tissues undergo continuous replacements without changing the character and specificity of the protein in question. This theory fails to distinguish between the two types of nitrogen metabolism (exogenous and endogenous) and even denies the very existence of the latter. Besides this, there are many experimental evidences and theoretical views which this theory cannot explain and sometimes contradicts. If, however, one considers that the replacement of the amino-acids takes place at the molecule of the uniquely labile deposit protein instead of at the comparatively stable structural proteins of the tissues, as there are substantial reasons for happening, then one cannot only excellently combine and reconcile the very many facts and evidences on which the Schoenheimer theory is built up, but the uprooting of all the previous ideas of protein metabolism

demanding by this theory also becomes absolutely unnecessary.

A fuller treatment of the above concept will shortly be published elsewhere.

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¹ Voit, *Z. f. Biol.*, 2, 307, 1866.

² Borsook and Keighley, *Proc. Roy. Soc.*, 118B, 488, 1935.

³ Cathcart, *Physiol. Rev.*, 5, 225, 1925; Cathcart and Burnett, *Proc. Roy. Soc.*, 99B, 405, 1925.

⁴ Luck, *The Elements of the Science of Nutrition*, 1931.

⁵ Schoenheimer, Ratner and Rittenberg, *J. Biol. Chem.*, 130, 703, 1939; Schoenheimer and Rittenberg, *Physiol. Rev.*, 20, 218, 1940.

THE THEORY OF THE ENDOGENOUS NITROGEN METABOLISM

Folin's theory¹ of protein metabolism, which is generally accepted, was a remarkable advancement on the earlier theories² of Voit and others, but at the same time it contained the essence of the earlier theories in stating that the endogenous nitrogen metabolism represents the disintegration of the structural proteins of the tissues. In the light of our present knowledge there are grave objections, as pointed out amongst others by Mitchell and co-workers,^{3,4} against this orthodox view, which has now become untenable. A theory is advanced which postulates that the endogenous nitrogen metabolism in animal organism represents the catabolism not of the tissue proteins but of the non-protein nitrogen, sulphur and phosphorus (organic) constituents of its tissues. This theory, which agrees as excellently with the general findings of Folin as it explains the objections set out against it, is based primarily on the following considerations.

The N:S ratio of the different mammalian muscular tissues has been computed by the present author, from the analytical figures recorded by Masters and McCance,⁵ to be 15.2 ± 1.1 . During starvation when metabolism of the organism proceeds at the expense of body materials, the N:S ratio in urine has been calculated to be 15.2 ± 0.6 in case of human subjects and 15.1 ± 0.5 in case of ruminants. These values are computed from the values obtained by different workers and recorded in literature.⁶ These results clearly prove that starvation is invariably accompanied by the disintegration of tissue proteins. Now, in an attempt to determine the potential source of nitrogen on which the endogenous metabolism subsists, the author has studied the N:S ratio in urine of human subjects, living on a nitrogen- and sulphur-free but

otherwise adequate diet for a sufficient length of time so as to reduce the nitrogen metabolism to true endogenous level, and has found the ratio to be 7.56 ± 0.44 . This experimental fact clearly points to two distinct conclusions: (1) that the endogenous nitrogen catabolism does not represent the destruction of tissue proteins, in which case the N:S ratio in endogenous urine should have been the same as that in fasting urine (15.2 ± 0.6), and (2) that the endogenous nitrogen metabolism does represent the catabolism of the non-protein nitrogen and sulphur moiety of tissues, because the N:S ratio in endogenous urine agrees closely with the same ratio in non-protein tissue extract previously obtained by Mitchell, Nevens and Kendall⁴ (7.04).

The existence of an endogenous metabolism of phosphorus in the animal system, much like that of nitrogen and sulphur, has been established. It has been calculated by the present writer that the minimum amount of phosphorus eliminated in urine of normal human adults living on a phosphorus- (and nitrogen-) free but otherwise adequate diet so as to ensure the attainment of true endogenous level was 0.274 g. per day. If faecal phosphorus was added to it, the endogenous output figure rose to 0.337 g. This may be defined as the minimum amount of phosphorus that undergoes inevitable catabolism in the human adult for the continuation of the vital life processes.

The N:P ratio in muscle was known to be 15.3 .⁷ The ratio in the urine of fasting subjects^{8,9} (human beings as well as ruminants) was very close to this value, showing that in starvation mainly the tissue proteins are degenerated. On the other hand, the N:P ratio in urine of human subjects under endogenous conditions of living specified above, which process does not result in the demineralisation of bone, has been estimated by the present author to be 7.7 ± 1.3 . This value suggests, therefore, that the endogenous metabolism of phosphorus, exactly like that of nitrogen and sulphur, does not represent the disintegration of tissue proteins, characteristic of fasting metabolism; but that, on the other hand, it represents the catabolism of certain non-protein tissue constituents, which are richer in phosphorus than tissue proteins and which contain nitrogen as well. Evidences have also been obtained which seem to indicate that these constituents belong to the non-protein non-lipoid organic phosphorus moiety of the tissues. The remarkable similarity almost amounting to identity between the N:S and N:P ratios in the endogenous urine points to the fact that the nitrogen-sulphur and nitrogen-phosphorus metabolites, on which the endogenous metabolism depends, are somewhat related to one another. It seems that the cellular catabolism of one atom of sulphur or/and of phosphorus (organic) of the non-protein tissue constituents is concomitant with the

cellular catabolism of seven atoms of nitrogen from the same source.

Besides these, other evidences have been gathered which also prove that the endogenous nitrogen metabolism does not involve the disintegration of tissue proteins but is related entirely to the catabolism of the non-protein nitrogenous constituents of the tissues. Certain mathematical expressions have also been deduced connecting the total non-protein nitrogen store of the animal body on which the endogenous nitrogen metabolism depends, as stated in the proposed theory, with the daily loss of its endogenous nitrogen quantum.

Fuller description of the theory together with the evidences in its support and the mathematical expressions will shortly appear elsewhere.

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¹ Folin, *Am. J. Physiol.*, 13, 117, 1905.

² Cathcart, *The Physiology of Protein Metabolism*, 1921.

³ Mitchell and Hamilton, *The Biochemistry of the Amino Acids*, 1929.

⁴ Mitchell, Nevens and Kendall, *J. Biol. Chem.*, 42, 417, 1922.

⁵ Masters and McCance, *Biochem. J.*, 33, 1304, 1939.

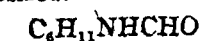
⁶ Kahn and Goodridge, *Sulfur Metabolism*, 1926; Hutchinson and Morris, *Biochem. J.*, 30, 1682, 1936; Morris and Ray, *Biochem. J.*, 33, 1217, 1939.

⁷ Stearns, *Physiol. Rev.*, 19, 415, 1939.

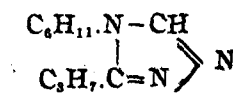
⁸ Aylward and Blackwood, *Biochem. J.*, 30, 1819, 1936.

PROPYL-TRIAZOLES

In the treatment of cardio-respiratory diseases cardiazole, coramine and similar other drugs are often used, but these compounds have certain disadvantages such as the necessity of a rapid bulky intravenous injection and/or occurrence of sclerosis of veins. An investigation has been undertaken to search out a less toxic but readily available product. Behrens *et al.*¹ have recently shewn that 3:4-dialkyl substituted triazole derivative possesses a definite advantage in stimulating the central nervous and circulatory system. Considering that propyl group is again less toxic amongst the commoner aliphatic group various 4-propyl triazoles, substituted at the 3-position by other groupings, are being synthesized.



(I)



(II)

Thus, cyclohexylamine (b.p. 132°) when heated with formic acid (85%) in molecular proportion at

about 200° for about an hour afforded the form *cyclohexylamide* (I) as a colourless viscous liquid, b.p. 168°/30 mm. The yield is about 85 per cent. of the weight of *cyclohexanone* taken for the preparation of *cyclohexylamine*. On reacting (I) with butyric hydrazide at about 180° in an oil-bath a small amount of crystalline substance m.p. 167° (not yet identified) separated out. The mother liquor readily gave a picrate m.p. 177°. [Found: N, 20.3, $C_{11}H_{16}N_3$, $C_6H_5(OH)(NO_2)_3$ requires, N, 19.95 per cent.] This picrate on hydrolysis yielded the 3-propyl-4-cyclohexyl triazole distilling indifferently as a highly viscous liquid [Found: N, 19.6; $C_{11}H_{16}N_3$, H_2O requires N, 19.9 per cent.]. It is extremely hygroscopic and readily soluble in water, alcohol and common organic solvents. The other compounds are being prepared and the pharmacological properties are under investigation.

U. P. BASU.

P. K. DAS GUPTA.

Bengal Immunity Research Laboratory,
Calcutta, 7-2-1943.

¹ Behrens *et al*, *Klin. Wschr.*, 16, 944, 1937.

ON THE DISTRIBUTION OF RANDOM DISTANCES IN A RECTANGLE

If the points within a rectangle of sides a and b are arranged in a *rectangular* distribution in two dimensions (uncorrelated), then the distances x , can be shown to follow the distribution given by

$$f(x)dx = \frac{4x}{a^2b^2} \phi(x) dx$$

$$\text{where } \phi(x) = \frac{\pi ab}{2} - ax - bx + \frac{x^2}{2}, \text{ for } 0 \leq x \leq b,$$

$$= ab \sin^{-1} \frac{b}{x} + a\sqrt{x^2 - b^2} - \frac{b^2}{2} - ax,$$

for $b \leq x \leq a$

$$= ab \sin^{-1} \frac{b}{x} - ab \cos^{-1} \frac{a}{x}$$

$$+ a\sqrt{x^2 - b^2} + b\sqrt{x^2 - a^2} - \frac{x^2}{2} - \frac{a^2}{2} - \frac{b^2}{2},$$

$$\text{for } a \leq x \leq \sqrt{a^2 + b^2}$$

At the transition points $x=b$, and $x=a$, $f(x)$ and $\frac{df}{dx}$ have identical values on both sides of the transition, but $\frac{d^2f}{dx^2}$ has not.

The first four raw moments are given by

$$\mu'_1 = \frac{b^2}{6a} \operatorname{ar} \cosh \frac{\sqrt{a^2 + b^2}}{b} + \frac{a^2}{6b} \operatorname{ar} \cosh \frac{\sqrt{a^2 + b^2}}{a} + \frac{1}{15} \left(\frac{a^3}{b^2} + \frac{b^3}{a^2} \right) - \frac{1}{15} \sqrt{a^2 + b^2} \left(\frac{a^2}{b^2} + \frac{b^2}{a^2} - 3 \right),$$

$$\mu'_2 = \frac{1}{6} (a^2 + b^2),$$

$$\mu'_3 = \frac{a^4}{20b} \operatorname{ar} \cosh \frac{\sqrt{a^2 + b^2}}{a} + \frac{b^4}{20a} \operatorname{ar} \cosh \frac{\sqrt{a^2 + b^2}}{b} + \frac{\mu_2}{105} \left(\frac{a^5}{b^2} + \frac{b^5}{a^2} \right) - \sqrt{a^2 + b^2} \left(\frac{2a^4}{105b^2} + \frac{2b^4}{105a^2} - \frac{5a^4}{84} - \frac{5b^4}{84} \right),$$

$$\mu'_4 = \frac{a^4}{15} + \frac{a^2b^2}{18} + \frac{b^4}{15}.$$

Of the two roots of $\operatorname{ar} \cosh \frac{c}{d}$, the principal value

$\log \{ (c + \sqrt{c^2 - d^2}) - \log d \}$ is to be taken.

The distribution and moments for a square can be easily derived from the above by putting $a=b$. The distribution will then be given in two parts only, one for $0 \leq x \leq a$, and another for $a \leq x \leq \sqrt{2}a$.

When b reduces to zero, the rectangle degenerates into a line of length a , and the distribution becomes $\frac{2(a-x)}{a^2} dx$, ($0 \leq x \leq a$) and the moments can be easily calculated.

The expressions for the corrected moments are still more cumbersome. The corrected moments and Fisher's γ -coefficients have been calculated for some special cases and are shown below.

When $a=b$, (square)	Mean	Variance	γ_1	γ_2
$a=2b$	0.52a	0.061a ²	0.18	-0.66
$a=3b$	0.35a	0.084a ²	0.27	-0.78
$a=5b$	0.20a	0.133a ²	0.60	+0.32
$b=0$, (line)	0.33a	0.056a ²	0.57	-0.50

This problem arises out of the more general problems of *Sample Surveys* in which I am working under the guidance of Professor P. C. Mahalanobis.

Similar studies with other geometrical areas are proceeding. My thanks are due to S. N. Roy for his kind interest and Nimai C. Ghosh for help in numerical calculations.

BIRENDRANATH GHOSH.

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PLASTIC FROM JUTE WASTE

After several trials it has been possible to convert jute waste (from mills) into a moulding powder by heating it under pressure with certain acids and other chemicals. A thermosetting powder has thus been obtained which, with a little plasticiser, can be moulded at 150°C at a pressure of 3000 lbs. per sq. inch in course of three minutes. Addition of a filler improves the hardness, as usual.

The moulding powder is chocolate to brown in colour and is very light. The moulded articles are quite glossy and hard enough to be drilled. Their physical and chemical properties as well as methods for improvement are under investigation. The yield of the moulding powder is nearly 60% of the jute waste. It is expected that the material might be produced at an economic price. It has been proposed to call it "jutelite".

Our thanks are due to the Indian Central Jute Committee for support to these researches.

B. C. GUHA.

B. B. DAS.

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FIXATION OF ATMOSPHERIC NITROGEN BY FUNGI

I was amused to read the two letters on 'Fixation of atmospheric nitrogen by fungi' in the December issue of *SCIENCE AND CULTURE*, Vol. VIII, No. 6 by Mr T. C. Roy and Mr S. P. Roy Chaudhury. Both of them are quoting freely from Waksman's and Russel's books and Bhaskaran's review without themselves carrying out any work in the line. Melin (*Investigation of the Significance of Tree-mycorrhiza—An ecological-physiological study*, 1930) held on the basis of his experiments that mycorrhizal fungi of the mountain pines did not assimilate in nature the free atmospheric nitrogen. As a matter of fact, it has been found that the older notions about the ability of mycorrhizal fungi do not stand closer scrutiny with the help of recent micro-Kjeldahl methods. The only fungi credited with fixing gaseous nitrogen from the atmosphere are probably a few species of *Phoma* (*Phoma radialis*, *Phoma r. Calluna*, *Phoma betae*). My work on a mycorrhizal fungus found associated with the internal tissues of *Casuarina equisetifolia* plants is in an incomplete stage; so, I am not yet in a position to pronounce any opinion till Kjeldahl estimations are finished.

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S. R. BOSCH

Physics

Recent Advances in the Theory of Fundamental Particles

H. J. BHABHA

THE progress in fundamental physics has always been from a set of postulates to a set of more general postulates, as a result of which the arbitrariness in the theory is very drastically reduced, leading to a consequent understanding of the basic properties of the fundamental entities of nature. One such postulate is the basic assumption of the theory of relativity, that all natural laws shall be formulated in such a way as to have the same form for all observers moving relative to each other with uniform velocity. This hypothesis is necessitated by the observation that light has the same velocity for all observers moving relative to each other with uniform velocity. Another is the quantum hypothesis which takes account of the discrete and indivisible character of the fundamental entities of nature, a consequence of which is that since all physical observations are made with the use of these same entities, it is impossible to simultaneously measure the position and momentum of a material particle with unlimited accuracy. The combination of the relativity and the quantum hypotheses into one unified theory has led to a revolution in our understanding of the properties of the fundamental particles of nature. This development is due to the circumstance that it is impossible to formulate a one-body problem in relativistic quantum mechanics. The attempt to formulate a relativistic quantum theory of a charged particle leads invariably to the result that there must also be in nature a particle of the same mass, but of equal and *opposite* charge, and to the possibility of two such particles of opposite charge being created in pairs if sufficient energy is available for the purpose. The discovery of the positron and the verification of the process of pair creation have confirmed this prediction of relativistic quantum theory. The theory also shows that all fundamental particles of half integral spin must obey the Fermi Dirac statistics, while all particles of integral spin must obey the Einstein-Bose statistics, in agreement with experience.

The idea of the fundamental or elementary particles evolved out of the researches of J. J. Thomson and Lord Rutherford with the acceptance of the electron and the proton as two fundamental entities from which all matter could be considered as built.

Both these particles are elementary in the sense that they cannot be split up into smaller or simpler entities by any experiment. The discovery of the process of pair creation shows, however, that an elementary particle need not be permanent and indestructible, since for example, an electron can be created in pairs with a positron. This fact also makes it impossible for an electron to be bound in a region of the size of the atomic nucleus and requires that the neutron, which is a particle of roughly the same mass as the proton but has no charge, should also be treated as another fundamental particle of nature. The atomic nuclei cannot be considered as made up of protons and electrons for the same reason, but must be made up of protons and neutrons, and it follows that the process of the radioactive β -decay in which electrons are shot out of the nucleus, must be interpreted as a transformation in which a neutron changes into a proton in the nucleus, with the emission of a negative or positive electron.

The attempt to explain the force between protons and neutrons as deduced from the stability of nuclei leads to the postulation of a particle of mass some 170 times that of the electron, as an agency for carrying the interaction, with the assumption that such a particle shall be emitted whenever a proton turns into a neutron and *vice versa*. The process of the β -decay then requires that this particle shall be unstable and decay spontaneously into an electron and a neutrino in a time of about a hundred millionth of a second. The discovery of the meson in cosmic radiation, which has a mass of some 170 times that of the electron, and the proof of its instability provide a beautiful confirmation of the theory. The idea of the elementary particles has therefore undergone a far reaching development. They are elementary in the sense that they cannot be split up into simpler entities. They are not, however, permanent or indestructible, but on the contrary take part in a large number of transformations in which particles of one type disappear while those of another type are created. The only physical quantities which are conserved while the fundamental particles undergo their metamorphosis are energy, momentum, angular momentum and charge.

Physiology

Physiology as an Experimental Science

B. NARAYANA

THE growth of physiology is so intimately connected with that of anatomy and of medicine that it is only natural for one to go back to the days of Hippocrates and his followers in attempting to trace the growth of physiology as an experimental science.

The era of rational system of medicine began with Hippocrates, the great Greek physician. Medicine, as practised in his time, was a highly developed healing art and was guided mainly by observations and experiments.

The birth of the modern science of anatomy and physiology began in the sixteenth century with Andreas Vesalius. He was educated at Padua where he also worked as Professor of Surgery and Anatomy. He placed the investigation of the structure of the body on a sound scientific basis. In June, 1543, his book entitled "The Fabric of the Human Anatomy" was published. This book is the beginning not only of modern anatomy but of modern physiology as well. The fame of Padua was maintained by the successors of Vesalius, *viz.*, Columbus, Fallopius and Fabricius.

William Harvey, one of the pupils of Fabricius, was not content with pure anatomical observations. Although an anatomist, anatomy took a new shape in his hands, it became physiology. He was the first to establish the circulation of blood and to prove that blood moved in a circle.

In the nineteenth century, physiologists like Johannes Muller, Helmholtz, Ludwig and Claude Bernard exerted considerable influence on the growth of physiology in Europe.

Physiology was not so well developed in Great Britain as on the continent and it was in 1836 that the first chair of physiology was established in Great Britain. It was in the University College, London and was held by William Sharpey. Later, a chair of practical physiology was also created here and Michael Foster was appointed to this. In 1870, Foster went over to Cambridge and his place was taken by Burdon Sanderson who was made Professor of Physiology after Sharpey's retirement. Foster took an active part in founding the British Physiological Society, in establishing International Physiological Congress and in starting the Journal of Physiology.

Amongst the workers at Cambridge, Balfour's interest in embryology and Gaskell's works on the causation of the heart beat may be mentioned. Langley worked on the origin and course of the autonomic nerves.

Amongst the workers at Oxford, Burdon Sanderson and later his successor Gotch worked on problems of electro-physiology. Sir Charles Sherrington's work on the physiology of the spinal cord forms a very important contribution in the domain of central nervous system.

Physiology is intimately related not only to medicine but also to surgery. It is now realised that physiology must take the help of surgery to solve many of its intricate problems and that surgery cannot make any real advance unless it takes the help of physiology. Many of the distinguished surgeons in the past have been physiologists as well as surgeons. Amongst the surgeons who have contributed immensely to the growth of physiology mention must be made of Lord Lister, Victor Horsley and Harvey Cushing.

Biochemistry has been always linked with physiology and although it is now being recognised as a separate science, rapid advance is not possible unless it goes hand in hand with physiology. It is a happy sign that research work on biochemical problems is making rapid advances and Indian workers are not lacking behind in making valuable contributions.

The position of physiology can be improved in our country by employing whole time teachers and teachers with special competence alone for filling up university posts. Young workers should be encouraged to take up simple problems and investigate. Students should be required to make their own observations, record them and draw their own conclusions. It is also desirable to open departments of experimental medicine at various centres where whole time workers, with no teaching and administrative responsibilities are employed and suitable and keen research workers are given scholarships to work in these departments, the suitability being judged solely by their desire to search into the truth of nature and not alone by possessing high academic distinctions at professional examinations.

Medical and Veterinary Sciences

Influence of Climate on the Incidence of Disease

F. C. MINETT

IT had been pointed out that the diversities of climate in a great country like India provided exceptionally good scope for critical observation. But, on the animal side at least the problem had as yet been little touched. Data regarding climate when studied in relation to disease incidence in man had proved of considerable assistance, not only in elucidating the origin of epidemic disease but in forecasting their appearance and thus had proved of great practical value in their prevention or control. The subject was a complex one and the difficulty of singling out the factors involved was recognized to be great or even impossible by mere study of the data. At the same time, the possibility of an experimental approach to the problem had been stressed. So far, attempts at analysing the effect of weather factors under controlled laboratory conditions had scarcely begun, but experiments for this purpose giving prominence to one factor at a time, were now being attempted. For instance, in connection with the accepted fact that many animal diseases have an increased prevalence during the monsoon, the influence of rainfall on normal and diseased animals

was being tested by exposing them to artificial showers under varying conditions. Work to this end was being carried out at the Imperial Veterinary Research Institute.

At the same time, continued Dr Minett, 'it must be recognized that climate is only one of the secondary factors that may influence the well-being of animals and the origin and spread of disease. Other factors may be even more important such as the mass-movement of men or animals, their racial susceptibility, breeding and nutrition. The problems involved can be faced only by constantly renewed hypothesis and patient trial'.

In conclusion, Dr Minett stressed on the dissemination and adoption of the knowledge and rules of hygiene. Obvious danger spots were the careless disposal of carcasses, the crowding of animals for purposes of commerce without due precaution against infectious diseases, indifference to the existence of carriers whereby sickness such as malaria can give much ground, and lack of observance of the common rules of sanitation which safeguard the community against the germs of cholera and typhoid.

Geology and Geography

The Future Development of India's Mineral Resources

J. A. DUNN

DR DUNN refuted the common statement that India is poor in mineral resources remarking that although not so rich in economic minerals as the U. S. A. this country is by no means deficient. India is, indeed, the world's dominant source of at least two minerals, mica and ilmenite, it shares with Russia in being the world's main producer of manganese, and possesses perhaps the world's largest reserves of high grade iron-ore. In addition there are adequate resources available of many other minerals. No country is completely self-sufficient in mineral raw materials; India's shortcomings comprise particularly tin, nickel, and molybdenum.

Dr Dunn outlined the distribution of minerals in India and drew attention to the concentration of wealth in Bihar which in normal times produces

about 40 percent of India's total mineral output. Mysore, Madras and Travancore in South India are also very important, whilst Central Provinces and Assam provide a useful quota to the mineral supply. With a few exceptions most of the country's mineral resources are situated east of a line from Mangalore to Cawnpore and the Himalaya. Dr Dunn reminded politicians that the provincial distribution of minerals should receive profound study whenever partitioning is under consideration.

The finding of extensive new deposits in various parts of India can be scarcely expected in the future, but useful deposits will undoubtedly be found. Occurrences which we have known for many years will be brought into the industrial picture; for example our resources of bauxite will certainly be the foundation of a valuable aluminium industry.

The greatest expansion is likely to be in the further treatment and utilisation of our mineral resources within the country. At least four of our minerals—mica, manganese ore, ilmenite, and monazite—are of great importance to the world's industries, but to date almost their entire production has been exported in the unmanufactured state. These minerals must continue to be exported, but it is eminently desirable that much of the manufacturing processes through which they eventually pass should be completed in India before export. Within this country there is nothing to prevent the gradual expansion of the mica trade from mica splittings, or the manufacture of titanium white from ilmenite or the extraction of thorium oxide and cerium from monazite, or even the smelting of much of our manganese ore to ferromanganese. The main problem would be in ensuring that other countries accept the Indian manufactured material in place of the raw material.

Dr Dunn then discussed the possible future developments of 43 separate mineral raw materials in India, and showed that as India expands industrially so also will her minerals find an ever widening application. He drew attention particularly to the scope for increased use of such resources as barite, bauxite, chromite, clays, coal, feldspar, fuller's earth, glass sands, gypsum, kyanite, limestone, lithium, magnesite, manganese, mica, mineral pigments, monazite, nitrates, phosphates, potash, salt, strontium, sulphur, talc, titanium, tungsten and vanadium.

In the coal industry efforts should be directed at improvements in methods of mining and marketing, in the more rational use of coking and non-coking coals, and the production of the innumerable by-products vital to the development of other industries. The copper industry in Singhbhum is unlikely to expand considerably; he remarked that the Indian Copper Corporation had been wise in adopting the furnace method of refining instead of the electrolytic. Copper mining in India is always likely to be an anxious undertaking. He also drew attention to the possible development in the near future of an

iron-smelting industry in the Central Provinces based on the iron ores and limestones of Drugh and adjacent States; although the coals of Korea and Rewa are non-coking research may solve this problem. Should the lead-zinc deposits of Udaipur, now being prospected, prove profitable they would provide a most important contribution to India's mineral wealth. The intensive search for oil in northern India may later provide valuable results.

Dr Dunn referred to the several lines along which enquiries may be pursued with a view to the ultimate expansion of the mineral industry. Should Government undertake an intensive search for such minerals as asbestos, barite, chromite, copper, glass sands, gold, graphite, kyanite, lead, manganese, mineral pigments, sulphur etc., a special prospecting staff would be essential.

Villagers might be encouraged by the payment of bonuses for useful find. Dr Dunn is of the opinion that at the present time geophysical methods of prospecting had only a limited application in the mineral industry, but may eventually have a wider scope. Mineral deposits should be studied and mapped in great detail not only before but during exploitation. Mining methods should be improved and advice disseminated by a central Minerals Research Bureau. Ores should be studied microscopically as a guide in treatment.

Dr Dunn referred also to the means by which the State could assist the mineral industry—the selective allocation of leases, the development of power schemes, assistance in marketing, publication of increasingly detailed statistics, review of cess, taxes, import and export tariffs.

Concluding, Dr Dunn observed, that if this country is to take its place amongst the nations of the world it will be necessary to conform to whatever general scheme of international mineral policy that may emerge in the post-war settlement, and it is to be hoped that, when the time for discussion arrives, the Indian mineral industries will have adequate technical representation.

Botany

Systematic and Taxonomic Studies on the Flora of India and Burma

K. BISWAS

THE brief history of the researches on Indian flora reveals that the floristic investigation received attention of the foreigners up to 1900. From 1900 onwards there was a gradual tendency of the Indians taking part in the systematic and taxonomic botanical

researches particularly at the headquarters of the Herbarium of the Royal Botanic Garden, Calcutta along with the researches on other aspects of botanical work. Even then only 30 per cent of the work was done by the Indian botanists and the rest by the

foreigners. During the course of 1900-1940 a considerable amount of work has been done particularly on the flora of Eastern India, Western India, South India and to a certain extent North Western India mainly by the officers of the Royal Botanic Garden, Botanical Survey of India and the botanists of the Imperial Forest Research Institute, Dehra Dun. Since the publication of the Flora of British India from 1895 to 1907 about 2000 species of Indian plants have been added up-to-date. The total number of species of Indian Phanerogams as noted in Hooker's flora is about 13500 to 14000 and the total up-to-date would be approximately 16000 species. The number of genera new to India either added or recorded since the publication of the Flora of British India may be estimated at 300. About a dozen of local flora have also been published during this period.

Apart from the little floristic investigation done in some parts of India there still exists vast unexplored and insufficiently explored regions. Provinces which have already been explored need also further detailed investigation with regard to the herbaceous and shrubby vegetation which failed to receive much attention of the systematists who had dealt with the local floras.

The different elements composing the Indian flora are of special interest to the Indian systematists and taxonomists. Recent researches of Kashyap, Ridley, Biswas and Bor hint towards the presence of sufficient endemism in the Indian flora. Dr Chatterjee from his study of dicotyledonous plants of India and the neighbouring areas definitely established that about 61.5 per cent if not 70 per cent of plants in India are endemic. My rough analysis of the flora of the Eastern India hitherto studied particularly Filicales and Dixon's and Kashyap's analysis of Indian Mosses and Liverworts confirm more or less Chatterjee's view. There can hardly be any doubt as regards the high degree of endemism in the flora of India so far as can be judged from the living present day species of plants found to grow in India. The Algal flora however differs to a considerable extent, but it needs further researches on a more extensive scale before anything can definitely be stated with regard to the correct endemism of the Indian algae. Nevertheless a census of algal flora of India and Burma indicates the predominance of the Malayan elements. Allen on the other hand by his investigation of Charophyta came to the conclusion that about 30 per cent of Chara and Nitella are endemic to India proper.

The scope of systematic and taxonomic studies in India and Burma is enormous. With a view to enlarging the scope of the botanical survey of India

in all the aspects of the studies of the systematic and taxonomic botany, the Botanical Survey of India should without further delay be revived from its moribund condition. The vast vegetable resources of the country confined to the forests and the marine waters of the coastal regions of India should properly be worked out for the benefit of the country.

The present trend of the modern systematic and taxonomic studies has reached a very advanced stage. The description of the plant is no longer confined to a few words or sentences noting only the most distinguishing characters of a species or a group of species as in the olden days. Proper description of the plants in the light of modern researches means "(1) a systematic investigation of material accumulated in herbaria and museums, correlating this with a critical reading of all published literature relevant to the subject, (2) a field investigation, by both phytogeographical and ecological methods, of the distribution of the species concerned in all their varieties and forms, (3) controlled selfing and crossing and growing in experimental grounds; (4) growing genetically investigated material under different environmental conditions in order to study the modifying effects of external factors; (5) cytological investigation of wild and cultivated material, (6) anatomical studies of vegetative and reproductive organs; (7) study of fossil material, so far as available."

There is undoubtedly a bright future for the systematists and taxonomists of India. Systematic and taxonomic researches as revealed by modern investigations are entering "an epoch of differential, ecological, physiological, and genetic classification. It is an immense work. The ocean of knowledge is practically untouched by biologists. It requires the joint labours of many different specialists—physiologists, cytologists, geneticists, systematists, and biochemists. It requires the international world. The most remarkable regions of the world, the cradles of primitive civilizations—the mountainous regions of southern Asia, Central and South America—are still in need of investigation even as to their resources of cultivated plants and domestic animals." It has thus considerable applied aspect. It is hoped that some of the brilliant students who are coming out year after year from the enlarged scope of our universities in India will in right earnest interest themselves in this aspect of the botanical studies and contribute, by their researches, towards agricultural and industrial developments of our motherland and thus occupy their rightful position among the other botanists of the world, and thus play their part in shaping the new world order.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

APRIL, 1943

No. 10

PURE vs. APPLIED SCIENCES

Elsewhere in this issue we publish an article on recent developments in television and their application to various fields. We have now come to a stage when actual events occurring some hundred miles away can be viewed instantly by wireless methods. The achievement is indeed remarkable. A fifteenth century man if he were to visit the Earth to-day, would ascribe it to magic, or to occult powers! But a patient reading of the story of this achievement would show that there is nothing supernatural in it. The achievement is the fruit of co-operative and persistent efforts of hundreds of men in different countries at understanding the secrets of Nature (what we call fundamental researches in pure science); and, when some inkling of these secrets has been obtained, its practical application in unexpected directions. All the steps leading to the great achievement are then known and can be reproduced if there is a proper organisation.

This is where modern science triumphs over medieval methods of occultism or witchcraft. In every age, there have been persons who spend their lives in the attempt of inventing devices which would give man some advantage over his fellow-mortals, e.g. elixir of life, conversion of mercury to gold, subtle poisons for doing away with enemies without the risk of detection etc., etc. Some claims, apart from their extravagance, might have had some basis, particularly those concerning the secret disposal of enemies*. Probably for these latter some poison or chemical process was found which could be used with desired effect. But most of the claims were unfounded and based on fancy:—e.g., the claims to have invented machines for producing perpetual motion, successful devices for flying, ability to foretell weather and future events from examination of livers and intestines of sacrificial animals or

flights of birds or from combinations and positions of stars and planets (astrology)!

In contrast to such unfounded and vague claims, the record of science is clear and straightforward and can be followed at every stage. But, when a spectacular achievement like television is presented for the first time, the public are very often apt to forget the contribution of pure science to it. Take for example 'Broadcasting' which enables us to hear 'voices' from any part of the world. How many people realize that the roots of this grand achievement are to be found in an experiment which Kohlrausch and Weber performed in Germany nearly a century ago, and showed that the unit of electricity defined from current electricity phenomena was larger than the unit defined from statical phenomena by a number which was, within experimental errors, equal to the velocity of light expressed in cm. per second. This was the basis of a series of interesting speculations of a Cambridge professor (J. C. Maxwell); he worked out mathematically the relations which must subsist between electric and magnetic forces and expressed these in the form of abstruse algebraic equations† (Maxwell's field equations) which showed that propagation of light was an electromagnetic phenomenon, in a medium which was identified with the old 'Aether' of the Greeks and Hindus. But Maxwell's speculation did not carry much conviction to his contemporaries till Hertz, a pupil of the famous Helmholtz in Germany made a deep study of Maxwell's equations subjecting to experimental test certain deductions from them and showed that waves similar in nature to light, but of much greater length, can be produced in the laboratory by purely electrical methods. And the public began to be impressed only when the researches of Hertz led, in the hands of Bose, Marconi, Braun, Lodge and others to the invention of wireless

* We may remember the cynical remarks of Voltaire: asked whether priestly curses had any effect, he remarked yes, if they are followed with lethal doses of arsenic!

† Schuster writes: When Maxwell first lectured on his Electromagnetic Theory of Light in 1879, there were only three pupils attending it.

telegraphy. We clearly see from this short sketch that the discovery of wireless telegraphy was only possible because the fundamental pure science discoveries of Maxwell and Hertz preceded it. And, even to-day progress in applied science is not possible, unless the worker has a thorough knowledge of the basic sciences. If the origin of any spectacular scientific invention be scrutinised, it will be found that almost invariably fundamental research was the fountain head of the invention.

It is not infrequent that in spite of best attempts, a problem has to wait for solution till some fundamental discovery has been made. As an example the case of Wireless Telephony which has led to Broadcasting may be cited. Wireless telephony may appear an easy step from wireless telegraphy, but actually all attempts at wireless telephony remained unfruitful for nearly 20 years, until the nature of the electron, and the laws of emission of electrons from hot bodies had been studied in the laboratory, understood and utilized in the construction of triode valves.

Such is also the case with "Television". Investigators had been at work on the problem for over twenty-five years, but it became a practical proposition only when 'pure science' phenomena like electron optics, photo-electric effect, and fluorescence were specially studied and the results were brought to bear on unsolved problems. On the basis of this knowledge, Zworykin in U. S. A. developed the 'Iconoscope' which has been aptly described as the electric eye. It picks up the details of the picture for transmission across space by radio waves. On the receiving side the Cathode Ray Oscillograph, another invention of pure science, rebuilds the transmitted picture. Television still suffers from certain disadvantages, but anybody who is in touch with the subject knows that they can be solved only with the aid of "Pure Research".

Probably the best illustration of the part played by pure research is seen when we look at the train of events which led to the discovery of the "Electron Microscope". This is an apparatus invented in recent years giving a magnification of more than a hundred thousand times, while the performance of the ordinary optical microscope does not go beyond three thousand. With the aid of the Electron Microscope it has been possible to render visible large molecules, bacteriophages and their action on bacteria. It is one of the most powerful tools placed in the hands of man for scientific investigations. The invention of the Electron Microscope is based on the conception that the electron can be treated as a wave; and, what are the events which led to such a revolutionary conception? We have to begin with Planck who, in 1900 developed his celebrated theory

of "Light Quanta" while working out the most satisfactory formula expressing the distribution of energy in the spectrum of a hot black body; with Einstein in 1905, who gave us the "Principle of Relativity" and proved the equivalence of matter and energy; and, with De Broglie in 1922, who combined the two concepts and showed that a material particle possesses wave-like properties. But for these streams of 'Pure Research', the Electron Microscope could never have seen the light of the day!

Even in such subjects as aviation, the part played by engineers and pioneers of flying has been overemphasized. Aviation would have been impossible but for the discovery of the internal combustion engine which again had its origin in the attempt at a deeper understanding of the laws of thermodynamics.

PURE RESEARCH IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

When during the gloomy days of the last World War, England found that by adopting a policy of *laissez faire* with respect to the application of science to industries, she had been brought to a dangerous state of dependence on enemy countries, she sought immediately to remedy the defect by organising the Department of Scientific and Industrial Research. The immediate object was to carry on, or subsidise researches on the manufacture of glass, important chemicals, drugs, fuels, and food. It appeared that the subsidy was to benefit only applied sciences, and the British leaders of science were naturally alarmed. Sir J. J. Thomson, the famous physicist, and President of the Royal Society waited on behalf of British scientific men on the Lord President of the Council and urged on the claims of "Pure Science" in the following memorable words:

"Pure science is the seed of applied science, and . . . to neglect pure science in a thing of this kind would be like spending a very large amount on manuring and ploughing the land, and then to omit the sowing of any kind."

The Advisory Council of 1916 accepted the principle, and in the very first report, they remarked:

"We accept the analogy and we trust that the absence of extended reference to pure science in this report will not be taken as indicating our lack of appreciation of its importance."

The average British politician and industrialist are no better than their counter-parts in India, the officials, and industrialists: very few of them could see beyond their nose.* But fortunately there were

* The attitude of the average British industrialist of the last century is very aptly expressed in the following anecdote related by Sir P. C. Ray. A Scottish manufacturer brought his son to Prof. Crum Brown, and said "Professor, teach him only copper and nothing else."

in the British Cabinet persons like the Earl of Balfour and Viscount Haldane who had knowledge of science, and were in touch with the great men of science like Lord Rayleigh, and others. They realised the wisdom of Sir J. J. Thomson's counsel and gave effect to it. They thought that if the direction of affairs were left to politicians, officials and industrialists, the whole object of the Department of Scientific and Industrial Research would be frustrated; they therefore wisely left the direction to a body (the Advisory Council) which mainly consists of scientists, with a few public men, in spite of the fact that the main object of the Department was promotion of such researches as would lead to industrial prosperity. They clearly understood that the ideal could not be achieved if 'Pure Research' was neglected.

If the records of investigations financed by the D. S. I. R. of England during the last twenty-five years are examined, it will be found that nearly three fourths of the investigations are on "Pure Science". This is of course exclusive of investigations published by such specialized institutions under the D. S. I. R. as the National Physical Laboratory, the Fuel Research Laboratories, the Food Investigation Board, Central Glass Research Institute, most of whose publications are naturally of a practical nature, though even they have very frequently carried out "Pure Science Research".

The D. S. I. R. has financed schemes on various branches of atomic physics (e.g., Spectroscopy, X-rays), nuclear physics, investigations of the ionosphere, vitamin studies, photo-chemistry, organic

synthesis and even sometimes purely mathematical researches.

Success in examinations in science is no certain criterion that the student is fitted for a research career. Hence the D. S. I. R. supplements the financial help given by universities and other educational institutions for training in research. This system has proved of much value both in developing the research activities of the universities and in providing a supply of competent men for research in both pure science and industry.

We would like to stress that the responsibility for planning the programmes of research even when the cost is borne directly by the Government, should rest with research councils or committees the members of which should be distinguished representatives of pure science and of industries directly concerned and not necessarily State servants. This sentiment was shared by the late Lord Rutherford in the memorable address prepared by him for the Silver Jubilee Session of the Science Congress in 1938. He said:

"It is to be hoped that if any comparable organization is developed in India, there will be a proper representation of scientific men from the universities and corresponding institutions and also of the industries directly concerned. It is of the highest importance that the detailed planning of research should be left entirely in the hands of those who have the requisite specialized knowledge of the problems which require attack. In the British organizations there is no political atmosphere, but of course the responsibility for allocating the necessary funds ultimately rests with the Government."

TELEVISION PROGRESS*

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THE closing years of the last decade saw remarkable progress in television service in the Western countries. Television is now a practical proposition; popularly speaking man now possesses the power of looking at a distant object round a corner—a power, which like that of flying and distant hearing used to be attributed only to mythological gods. But for the outbreak of the war, which has checked the expansion projects in most of the

European countries, television service would have been as common as broadcasting in a few years' time. There is little doubt that the modern form of television service in which vision is combined with sound will oust the sound broadcasting just as the talkie film has ousted the silent film.

In the present article a brief survey is made of the recent progress in television service in the different countries and also of the application of television technique in different fields of science. We begin by describing briefly the basic principle of television technique and how it differs from sound broadcasting.

* The article is based on the Mahendralal Sircar Memorial Lecture delivered by Prof. S. K. Mitra at the Indian Association for the Cultivation of Science, Calcutta on February 23, 1943.

BASIC PRINCIPLE OF TELEVISION

Television differs in one very important respect from broadcasting and this difference is to be traced to the very nature of the respective sense organs—the eye and the ear. The ear has a single connection to the brain through the aural nerve and may be considered as a single channel device, while the eye has a multitude of connections (about a million, one for each of the innumerable tiny elements of which the retina is composed) between the retina and the brain and may be considered as a multi-channel device. The eye thus picks up minute details of a scene projected on the retina in two dimensions and conveys the perception of the details separately and simultaneously to the brain. The ear on the contrary conveys to the brain as a mixture and not separately a number of sounds that may strike it simultaneously. It is comparatively easy for such a mixture to be converted into corresponding

is seen through the holes when the disc is in rapid rotation then it is clear that with each revolution of the disc the object will be scanned in horizontal strips, the width of each strip being equal to the diameter of the hole. It is obvious that in order to have enough light coming through the holes the object has to be strongly illuminated.

A variation of the Nipkow disc is the "spot light" method of scanning. In this method the object to be scanned is in a darkened studio and a very strong and narrow beam of light scans the object in horizontal lines from top to bottom. The spot light scanning is still used for scanning motion picture films—the light beam passing through the film and falling on the photo-electric cell. The minute currents of varying intensity produced according to the light and shade value of the different elements in the picture are amplified and made to modulate the carrier radio wave.

The most widely employed method of picking up the picture details is now the electronic method and the apparatus in most common use for the purpose is known under various names as Iconoscope, Emitron Camera, etc. (Figs. 1 and 2). It was first developed by Zworykin in the U. S. A. and it closely resembles the eye in its working. It consists essentially of a lens which may be compared to the cornea and a mosaic of minute photo-electric cells which may be compared to the retina. The mosaic is obtained by spraying a solution of light sensitive material (silver) on a thin sheet of mica (backed by a conducting metal film) on which it settles in the form of globules. The globules are insulated

from one another and each globule constitutes in effect, a separate photo-electric cell. The lens throws the image of the subject to be televised on the mosaic and the different cells in the mosaic is stimulated electrically so to speak to different degrees by the different intensities of the light and shade of the details. There is thus formed an electrical image of the optical scene on the mosaic. For conveying the details to the radio channel a beam of cathode rays scans the electrical image on the mosaic line by line from top to bottom. The minute currents of different intensities thus generated by the different parts of the image are led out, suitably amplified and made to modulate the carrier wave. One complete scanning of the image is done

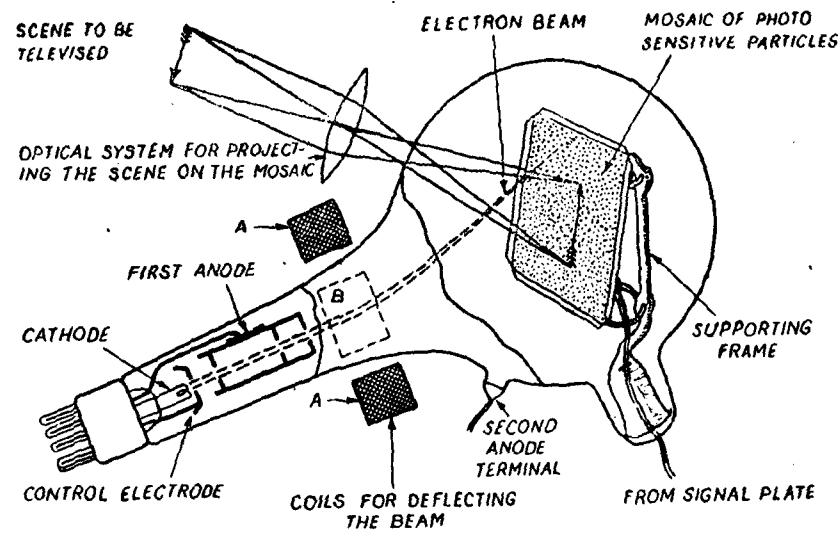


FIG. 1. ICONOSCOPE OR THE ELECTRIC EYE (From Television To-day)

electrical impulses (by the microphone) for being transmitted across the space by the carrier radio wave. For the purpose of television transmission however it is useless to send a mixture of the details of the scene. Each detail (each tiny square element of the scene for example) will have to be picked up and transmitted separately. Thus, in television transmission it is required firstly to dissect the whole picture into tiny elements, secondly to convert the light and shade value of each element into corresponding electrical impulses and thirdly to pick up the "electrical" details and convey them to the desired radio channel for transmission across space.

One of the earliest methods of dissecting the picture is the Nipkow disc which is still used in some special cases. A circular metallic disc is drilled with a series of holes in a spiral path. If an object

in about one-twentyfifth of a second and constitutes an "instantaneous" picture of the scene. At the end of the scanning the electrical image of the scene on the mosaic has been wiped off, and the mosaic is ready to take the image of the scene next instant. This in its turn is again scanned and the details conveyed to the carrier wave modulator. Thus "instantaneous" images of the live scene (each of a duration one-twenty-fifth of a second) are sent out by radio transmission twentyfive times per second.

At the receiving end a cathode ray tube takes the place of the loud speaker. The electron beam in the tube is made to trace out on the fluorescent screen lines in strict synchronism with the lines traced in the iconoscope. At the same time the intensity of the beam is made to vary according to the modulation of the received video signal varying the brilliancy of the spot struck on the fluorescent screen,

reproducing the transmitted scene in black and white. Synchronisation is essential for exact reproduction of the transmitted scene. The transmitter therefore sends out special signals at the beginning of each frame and at the beginning of each line traced for controlling the cathode ray beam of the receiver tube. (Fig. 3).

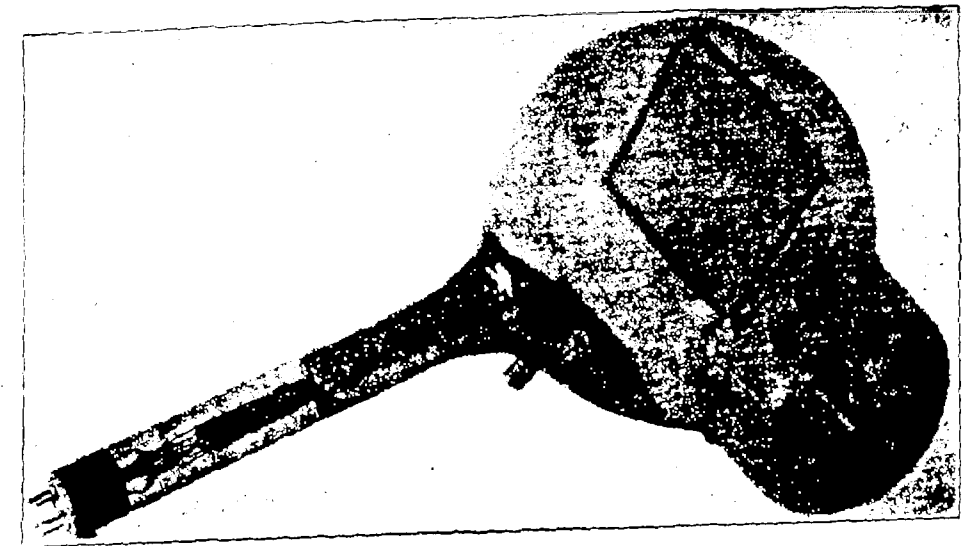


FIG. 2. PHOTOGRAPH OF THE ICONOSCOPE

Mention may here be made of an improved version of the Iconoscope recently developed by the R.C.A. called Orthicon. It is now the most sensitive electron camera and can pick up scenes in ordinary room illumination.

In television the greater the number of lines, the better the definition of the picture. The number of scanning lines per second is equal to the product of number of lines per picture and the number of pictures sent per second. With the increase of the number of scanning lines per second the technical difficulties increase rapidly. In order to reduce this either the

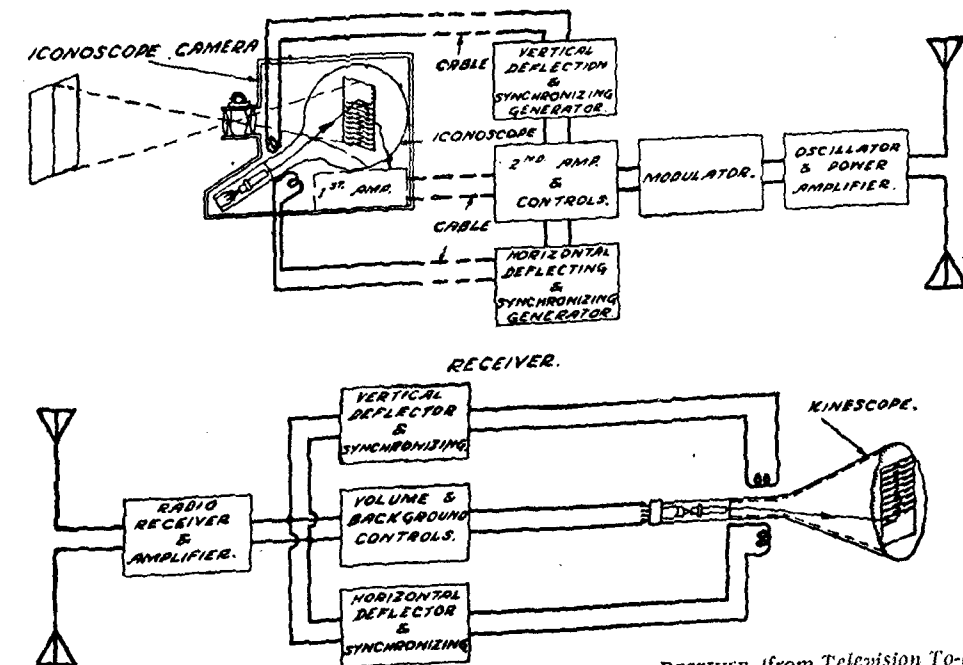


FIG. 3. SCHEMATIC DIAGRAM OF TELEVISION TRANSMITTER AND RECEIVER (from Television To-day)

number of lines per picture or the number of pictures per second has to be reduced. But the former reduces the definition of the picture and the latter increases the flicker. A system of scanning called interlaced scanning is sometimes used for reducing the number of pictures per second without introducing flicker. In this system all the odd lines are scanned first and the beam subsequently returns to scan the even lines completing the picture.

For the so-called high definition television, the standards adopted are 405 lines per picture and 21 frames per second in England and 525 lines per picture and 30 frames per second (interlaced) in U. S. A.

The vision signal—commonly called video signal—for a complete picture is composed of the very large number of details into which the picture has been dissected. The signal, in fact, may be analysed as consisting of a very wide band of frequencies, say from 30 cycles to four million or more cycles per second. The amplification and radio transmission of this enormous range of frequencies present problems of great technical difficulty. For instance, the amplifier system for the magnification of the minute current impulses from the pick-up, the iconoscope—must be so designed that its response is sensibly uniform over this wide band. The amplification itself is also a difficult problem. In order that the amplified video signal may effectively modulate the carrier wave, an amplification of the order of a million million times is necessary. And, for this purpose a sixty four stage amplifier may have to be designed to allow for the losses in transmission! Then again to accommodate the high frequency video signals a carrier wave of correspondingly high frequency—6 metre or less wave-length—has to be used. Waves of such high frequencies have however, what is called only the optical range. As such, the television service area is severely restricted. Reference will be made to this in a subsequent section.

PROGRESS OF TELEVISION SERVICE

England.—Perhaps the country which saw the greatest development of television service before the beginning of this war, is Great Britain. In May 1934 a Committee called Television Committee was appointed "to consider the development of television and to consult the Postmaster General on the relative merits of the several systems and on the conditions under which any public service of television should be provided". The Committee had as its Chairman the Rt. Hon. The Lord Selsdon and among its members were representatives of the B. B. C., the Department of Scientific and Industrial Research and of the Posts & Telegraphs Department. The Committee went thoroughly into the question and

recommended the operation of television service by the B. B. C., using apparatus of both the Baird and the Marconi E. M. I. organisations. The Committee also observed that since the range covered by a single station of about 10 K.W. capacity would not exceed 25 miles, it would be necessary to cover the country with a network of such stations so that at least 50 per cent of the population could be served.

According to the recommendation of the advisory committee, Alexandra Palace was chosen as the site of the London Television Station. Experimental public transmissions by both the companies, were radiated from this station during the Radio Exhibition at Olympia in August, 1936. On November 2, 1936 the London Television Station was formally opened by the Postmaster General.

In September 1939 due to the outbreak of the war television service in England was stopped.

U. S. A.—It was only in 1939 that television received real impetus in U. S. A. by the inauguration of public programme service in New York and by the introduction of receivers on the market. The policy of the U. S. A. Government in regard to television development was announced by President Roosevelt sometime ago. It was to allow the industry to develop in the hands of private commercial organisations like Radio Corporation of America and National Broadcasting Corporation on a competitive basis on the lines of sound broadcasting. The standardisation—such as fixing the number of lines per picture and frames per second etc. is in the hands of the Federal Communications Commission and in this it is assisted by the National Television System Committee, an expert body organised by the Radio Manufacturers Association. There is at present regular television programme service in New York, Philadelphia, Schenectady, Washington, Los Angeles, Cincinnati, San Francisco and Milwaukee. It is estimated that in 1940 about 4,000 home receivers were in use in the New York area. The average price of a receiver varied between 200 and 700 dollars. (These figures might be compared with 14,000,000 radio sets produced in 1941 of which 44 per cent had the average price of 17.70 dollars only).

The peculiar difficulty of U. S. A. in television development is its vastness which makes it difficult to establish television chains. The difficulty is partially solved by using relay stations though this requires large investments. Intensive research is being carried on for relaying television signals over transmission lines for being broadcast from the desired centres. According to the latest report successful test transmission of television signals has been made over a coaxial cable to a distance of 800 miles. Such relaying over long distances allow the

transmission of important events of national interest (like political party meetings during Presidential elections) from the scene of occurrence to large centres of population to be rebroadcast from television transmitters located there.

Investigations on colour television and large screen projection are also being actively carried on in U. S. A. and reference will be made to it later.

The television standards adopted in U. S. A. are 525 lines per picture and 30 pictures per second (interlaced) and are thus somewhat different from the British standards.

The Federal Communications Commission has allocated for use in television transmission 18 frequency channels each 6 Mc. in width, interspersed in the band 50 Mc. to 300 Mc.

The U. S. A. might now be said to be the leading country of the world in television development.

Germany.—Television in Germany like broadcasting is fully under state control. It is under the jurisdiction of the Ministry of Air as well as that of the post office. There is strict control of all publications concerning television and there is little information available regarding the technique employed save those published in official bulletins by the post office and in approved articles in scientific journals.

As in other countries Germany had her early attempts in low definition television broadcasting, but in 1934 the high definition experimental transmission of films was organised by the television research laboratories of the German Post Office. A little later, in March, 1935 the programme service was introduced and a number of viewing rooms were provided in different parts of Berlin to acquaint the general public with this new medium. The television programmes consisted of entertainment films, educational films, and latest edition of news reels. There were also direct transmission of head and shoulder pictures of artists. The television standard in 1937 was a 441 line system. It is not known if this system is still being continued or if there had been any change. In 1939 the television cable network was greatly extended. Broadcast transmissions made from central studio are transmitted over special networks to large-screen projection equipment installed in several theatres in and around Berlin. Standard home receivers have also been developed both for direct viewing and for projection. It may

be noted that Von Ardenne, the famous German radio engineer, had been conducting investigations on coloured television in 1938.

U. S. S. R.—U. S. S. R. has not lagged behind other countries in the development of television. The scientific and technical laboratories of the Union had for a long time been engaged in experimental television research. In 1938 television programmes were being transmitted through land lines and relayed to 500 subscribers. The R.C.A. in the same year also erected two ultra short wave transmitters in Moscow. At the same time the Soviet engineer Praude developed a method of transmitting films. In fact, so far as information goes, till before U. S. S. R.'s entry into the war there were two television systems operating in Leningrad, one using iconoscope and the other the Praude system. It is interesting to note that all the television equipments used had been designed by the Soviet engineers and manufactured from Soviet materials.

Holland.—Television development in Holland is entirely due to the initiative and enterprise of the Philips Company at Eindhoven. After considerable experimentations as in other countries the Philips Company in 1936 successfully demonstrated high definition television. So far as information is available till that year there was no public television in Holland and the Philips Company was working independent of outside aid.

France and Italy.—A 25 K.W. high definition television transmitting station was started in France in 1938 and a public service was inaugurated in 1939. The transmitting centre is at the Eiffel Tower, Paris.

The well-known company Safar (*Società Anonima Fabbricazione Apparecchi Radiofonici*) of Milan has been responsible for the television development in Italy. So far as information is available cathode ray tubes were employed in 1934 both at the transmitting and receiving ends and in 1935 the standard adopted was 240 lines and 25 frames per second. In 1939 a television transmitter built in Germany was installed in Rome and experimental service inaugurated.

Japan.—A regular twice-weekly television service was inaugurated in Japan on February 11, 1940, the Japanese Empire Day, when the 2600th anniversary of its foundation was celebrated.

(To be concluded)

TECHNOLOGICAL REVOLUTION IN INDUSTRY— HOW THE RUSSIANS DID IT

ALL around us, even in India, we see examples of applied physical science. The chemical, and electrical industries, are purely scientific in origin, the metallurgical and transport industries—locomotives, ships, motor cars, aeroplanes—hardly less so. In the days preceding the war, the influence of science was more clearly seen in countries following the economic doctrines of *laissez-faire*, in unused productive power and large-scale unemployment. In war time, applied science provides the key to all war-preparations which now centre round mechanisation.

FUNCTION OF APPLIED SCIENCE

But the proper function of applied science is to increase the production of machinery, goods and services only in so far as it leads to the increased effectiveness and happiness of the great majority of human beings. The Russian socialistic State not only believed in it but acted on this principle. And only when all the efforts of Litvinoff in favour of universal disarmament failed, did Russia divert her attention to war industries. But even in her management of peace time economy, she has proved that unemployment is a man-made evil and that unused productive power is a man-made curse. And faced by the necessity of mobilising all its resources for purposes of destruction, every country has now realised that man-power is among the scarcest of all resources, and that trained and intelligent man-power is the greatest of all assets. Man-made unemployment ought not to exist and need not exist in a post-war world if the motivating influence is conceived as universal prosperity and not exploitation of man by man. Russia has already achieved this by eliminating the profit motive from her industries which belong to and are being developed in the interest of the nation. Planned economic development also becomes easy if the products of lands, mines and factories and the income from transport and other public utility services belong to the State which then becomes the supreme organ for planning.

KEY PROBLEMS

(i) *Power Supply*.—The basis of all mechanical operations in modern industry is power. And wealth is the result of work done by men with the aid of mechanical power. In India, development of mechanical power is meagre, and man depends on bullocks and his muscles for all his power needs. It is not strange that he lives in primitive poverty while other

nations, where per capita use of mechanical power is hundred times greater, should have evolved an altogether different standard of living.

Mechanical power is of two kinds—the universal fluid form of electricity and a localised concentrated form in steam engines, turbines, oil and gas engines. Long before nation-wide industrial planning was conceived, Lenin decided upon the electrification of the whole of Russia; and under his leadership two hundred scientists, engineers, and technicians drew up a plan for the generation and transmission of electricity on a vast scale. Even sympathetic foreigners in England and America considered such a plan as fantastic and referred to Lenin as the Dreamer in Kremlin. Normally where profit motive only operates, production of power keeps pace with the growth of industries which use such power. But Lenin rightly enough put the horse before the cart, and decided that once power was available, the State will have no difficulty in so planning its industrial development that modern machinery becomes the basis of its economic life. The Dreamer was right and the doubting Thomases have been proved to be wrong. Soviet Russia produced 40 billion kilowatt hours in 1938, and the demand has been even for more. The development of power in localised form has been no less spectacular. The production of coal, oil and gas has shot up from 38 million tons in 1913 to about 200 million tons in 1940. And Soviet Union now stands third in the world in the production of power and fuel.

In Tsarist times Russia's coal requirements were almost entirely supplied from the Donetz basin—now the theatre of heroic military operations against Nazi Germany. Soviet planners understood the strategic need of developing industrially the eastern regions; extensive survey disclosed vast fields of coal in the Urals, Kazakhstan, Siberia, Far East and Central Asia, which raised the estimated coal reserve from 200 billion tons in 1913 to 1600 billion tons in 1938.

Similarly with oil. In Tsarist Russia, mineral oil was being produced mainly in the Caucasus; survey work indicated vast oil resources in the Volga region, Urals, Azerbaijan, Bashkir, Daghestan and Siberia; and the proven oil reserves now exceed 4 billion tons which exceed the aggregate reserves of all other countries.

Survey has been followed by the highest possible mechanisation of fuel industries. Sinking of pits and coal cutting have been completely mechanised. The

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fascinating problem of the subterranean gasification of coal has been solved in its technical and practical aspects. Coal can thus be used in the most convenient form of gas and the miner's arduous toil may soon be completely eliminated. The oil industry has fully mastered the technique of deep well and high speed drilling. Sulphur bearing oil is being refined with great success and cracking and polymerisation have made possible the manufacture of high grade aviation petrol.

(ii) *Transport*.—Efficient transport system is essential for the development of a country—the ideal should be that every city with 10,000 souls should have a railway passing through it and every village should be connected with such cities by motorable roads. Again water-transport for heavy goods being the cheapest, maximum use of inland waters should be made for this purpose.

The Soviet Union received a meagre heritage of railway system from the Tsarist regime. There were 36,000 miles of railway tract, where practically no repair work was done for 8 years. War had led to the destruction of 4500 railway bridges and daily car loadings had fallen to 6,200. The Soviet Government wanted to revive the railway system without resorting to foreign loan. The revolutionary enthusiasm of the masses and the splendid response of the railway workers to the appeal of the socialistic State made this possible. It was necessary to build in the country a first class railway engineering industry, if foreign loan for the importation of rolling stock were to be avoided. In India even now not a single locomotive has been built, but Soviet Russia was able in 1940 to meet her ever-expanding demands of rolling stock by production from her own railway workshops; and some of her newly designed locomotives JD, JS, VM-20, VL have justly won for themselves universal praise. The Institutes of Railway Engineering had in 1940 a student body of 21,000, and 200 professors and teachers. Thousands of workers attended railway apprenticeship schools in addition. Just before Germany declared war, Soviet Russia had about 60,000 miles of railway and a freight traffic of 300 billion ton miles.

The rivers of the Soviet Union are important not only as a means of traffic but are also the mighty sources of electric power. Russian feats of engineering in developing rivers and making canals have completely changed the natural geography of the country. A gigantic dam has raised the level of the Dnieper river by 123 ft. and with the aid of a triple chamber lock has made navigation possible from its upper reaches to the Black Sea. Simultaneously it has made possible the generation of 600,000 k.w. of electric power. In Karelia cutting through granite hills and virgin forests, a canal, 140 miles long now

connects the White Sea with the Black Sea. Another splendid feat of engineering is the Moscow-Volga canal which brings the unlimited waters of the Volga to the shallow Moscow river through many locks, and dams, spill ways, and flood gates, with the aid of mighty pumping stations. Moscow is now an inland port connected by water course with Leningrad in the Baltic and the great Volga in the South-east, and handles annually 15 million tons of cargo. A powerful fleet of Soviet Ice-breakers ensure during winter a free passage way for ships in ice-bound parts and maintain a regular service between Murmansk and Vladivostok along the great Northern Sea route. The total investment in water-transport in the first ten years of planning has been 4,000 million rubles, and the total freight turnover of the Soviet water-transport system in 1937 aggregated to 43 billion ton-miles.

(iii) *Mineral Survey*.—Equally important with the development of power and transport system is the survey of the mineral resources of the country. The number of geologists in Tsarist Russia was ridiculously small and the Geological Service confined its activities chiefly to geological charting. It did nothing in the way of exploring and prospecting for useful minerals. All this was changed by the Soviet Government who established a Geological Board charged with the task of placing geological survey and research on strictly planned and systematic lines, ensuring the rational employment of men and materials and rapid and fullest use of the results obtained. The first task undertaken was the training of skilled forces for this work which was so well done that the number of Soviet geologists can be counted to-day in tens of thousands. To the readers of SCIENCE AND CULTURE, the articles by Dr C. S. Fox, Director of the Geological Survey of India, (SCIENCE AND CULTURE, 4, 218 1938-39, 7, 291 1941-42) have brought home the immense development work of the mineral wealth of the country. Apart from coal and oil, Russian territory has now been proven to contain vast reserves of iron ore, chromite, manganese, nickel, aluminium ore, copper, gold, silver, platinum, borax, sulphur, phosphatic and potash fertilisers. Dr Fox thus sums up the activities of the Soviet Government—"A government with immense courage embarked upon the fullest exploitation of its mineral and other resources and established industries in the face of every kind of foreign criticism. When other countries may have 100 geologists the Soviet had 10,000 and the whole land was searched and all mineral occurrences re-examined. New discoveries were made but a vast amount of information already existed although it was not previously followed up. By confidence in its technological personnel and courage and enterprise the Soviet Government already in 1937 astonished all

those scientists, geologists (among whom the writer was one) and engineers who visited Russia."

STATE PLANNING COMMISSION

The economy of any country is an extremely intricate mechanism and planned development is a very difficult task. But given courage and determination, adequate power supply, mineral resources, and transport system, such task is not impossible of fulfilment. Attached to the highest executive organ of Soviet Russia is the State Planning Commission with a staff of experts in all fields of industry and economy. There are subsidiary regional planning commissions, and each factory, mill, institution, etc., has its own planning department. In consultation with the State Planning Commission, the Government determines the chief task that must be carried out in the next few years; and these tasks are formulated in the Instructions for Drawing up Plans.

PROPORTION OF ANNUAL NATIONAL INCOME AVAILABLE FOR REINVESTMENT

The Planning Commission and its subsidiary bodies have to decide each year what part of the entire national income should be made available for reinvestment as capital assets in the form of power stations, factories, mines, railways, technical institutions, etc. in order that the Instructions may be fulfilled. Then they fix a programme of development for the year giving due consideration to the close connection between various industries. Thus the programme for increasing the production of steel requires a corresponding increase in the production of coke, iron ore, fluxes, etc. and in trained personnel. Hence the focal point in the work of all planning bodies is to make out correct proportions for the development of interconnected industries and technical training. Preliminary work prior to fixing the annual programme consists in ascertaining the visible natural resources, the extent to which they have been already prospected, the possibilities of their industrial exploitation, the existing production capacity and the extent to which newly-built establishments are ready for operation, the amount of available labour, power etc. However, existing production capacities cannot serve as the sole guide in mapping out production programme if the Government is convinced that a drastic increase in output in any branch of industry is necessary.

FIVE-YEAR PLAN IN RELATION TO KEY INDUSTRIES

At the end of the year, the planning commission sums up the results of plan fulfilment. In these summaries which are based on a profound and thorough analysis of the economic trends of the

country, are discussed which industries, etc., are lagging behind in plan-fulfilment and the reasons for this, which branches are successfully carrying out their plans and the means they employ to achieve this.

The annual plan and programme are parts of a Five Year Plan which besides drawing up a general scheme of development, specifies the industries to which decisive importance must be attached. The selection of one or two such industries is considered a key problem and development of other branches of industry is regarded from the standpoint of the extent to which they ensure the fulfilment of the plan for the key industry. "Thus, for example, the chief economic task confronting the country in the Second Five-Year Plan period (1933-37) was the technical reconstruction of the Soviet national economy, the introduction of up-to-date machine-technique in all branches of the national economy. In view of this, the development of the machine-building industry was singled out as the key problem of the plan. The plans for the development of the iron and steel industry and of non-ferrous metallurgy and the plans for capital construction were considered from the point of view of the extent to which they would ensure the development of the machine-building industry.

During the Second Five-Year Plan period the output of the machine-building industry increased from 9,400,000,000 rubles in 1932 to 27,500,000,000 rubles in 1937.

PEOPLE'S COMMISSARIATS FOR VARIOUS INDUSTRIES AND ESTABLISHMENTS

When the People's Commissariats receive the Government instructions for drawing up their plans they proceed to determine the preliminary programmes of each of the industries under their jurisdiction. The Chief Administration of the given industry defines the plan for each establishment under its control.

These preliminary plans are then discussed by both the management and the trade union, as well as other public organizations of the establishment. At their production conferences the workers and employees discuss whether all potentialities for increased output, higher labour productivity and reduction in production costs have been taken into account. These conferences thoroughly analyse the experience of production brigades and of Stakhanovite workers who have attained a high degree of efficiency, and make amendments to the proposed plan based on the specific nature and potential capacity of the given establishment.

All these plans, with additions and amendments, are then returned to the respective People's Commissariat, which, after due examination, draws up a single, uniform plan for the whole Commissariat and submits it to the Government for approval. At the same time, on the basis of data furnished by the establishments and industries under its control, the People's Commissariat submits to the Government an estimate of the amount of fuel, electric power, raw material, working capital and funds for capital investment required for the fulfilment of its production programme.

All plans submitted to the Government for endorsement are first of all studied by the State Planning Commission which submits its opinion on each of these plans.

In formulating the final plan for the various People's Commissariats, the Government takes into account the findings of the State Planning Commission. The plan adopted by the Government becomes law.

MANDATORY PRODUCTION PROGRAMME

On the basis of the plan adopted by the Government, the People's Commissariats establish the mandatory production programme for each of their establishments.

The working people of the Soviet Union not only take part in the discussion and drawing up of the plans, but are also vitally interested in their fulfilment. The production programmes laid down by the Government are the minimum of what must be accomplished. It is a matter of honour for the workers of every factory to overfulfil their plan. Premiums are awarded to individual workers and factory managers who succeed in overfulfilling the plan.

The foremost people in industry, agriculture, transport, education, art, trade and other spheres of activity are accorded high honours and enjoy great popularity. Thousands of them have been decorated by the Government for their exemplary work."

FORCED MARCH OF INDUSTRIES

The Soviet Union, the only country in the world where planned economy reigns supreme, is developing at a rate unparalleled by any other country in the world. A comparison of the development of industry in the Soviet Union with that of the principal capitalistic countries shows that while the latter have shown an increase of about 30 per cent in production between the period 1913-38, the industry of the Soviet Union in that period has increased ninefold. Unemployment and anarchy of production are

unknown and there has not been a single year in which industrial output has not considerably increased. A backward and poverty stricken country in the past, it has now become a mighty industrial power, occupying the first place in the world in the production of agricultural machinery and tractors, the second place in the production of gold, iron ore, machines, and freight cars, and the third place in the production of electricity, steel and artificial manures.

A BIRD'S EYE VIEW OF INDUSTRIAL PROGRESS

It is not possible here to give anything more than a bird's eye view of the development of some of the key industries in Soviet Russia. Such a rapid glance may however bring out clearly the superiority of planned economic development to the capitalistic system prevailing elsewhere. Thus "compared with the output of Tsarist Russia, the manufacture of iron and steel has grown more than fourfold. This increase is likewise the result of the introduction of modern machinery and methods. Powerful new, completely mechanised aggregates, blast furnaces, open hearth furnaces, blooming mills and rolling mills of various descriptions, have been installed and their operation is being mastered by the Stakhanovites.

High-grade steels and electro-metallurgical alloys are being produced on a large scale. This has enabled the U. S. S. R. to develop its machine-building, aeronautical, automobile and tractor industries and to equip the heroic Red Army with the most up-to-date armament, which has made possible such wonderful resistance to Nazi invaders.

The U. S. S. R. already occupies second place in Europe and third in the world in the manufacture of aluminium. The building of nickel plants is proceeding apace, assuring increased nickel smelting. Production methods of other non-ferrous and of rare metals have also been mastered and, with the prospecting of the sources of raw materials, their output has rapidly increased.

Very important is the development of the production of numerous aluminium and magnesium alloys, of beryllium bronze and hard alloys with a tungsten and titanium base as well as the manufacture of articles made of tantalum, rubidium, caesium and other such metals. The steadily increasing practice of using substitutes (acid-proof cements, lining tiles, acid-proof earthenware and plastic materials) in place of non-ferrous metals is also worthy of note.

The gold output of the U. S. S. R. has advanced from fourth place in world production (1913) to second place.

Signal successes have marked the road of electrification upon which the Soviet Union has entered. On the threshold of its third Five-Year Plan period, the capacity of the Soviet Union's electric power stations was 7.6 times that of Tsarist Russia, while the amount of electricity generated was 19.3 times the Tsarist figure. The coefficient of utilization of station capacity is from one and a half to two times as high as in the capitalist countries. The Lenin Hydro-electric Power Station on the Dneiper alone produces more electricity than did all the stations of Tsarist Russia combined.

Remarkable strides have also been made by the Soviet chemical industry which was still in its embryonic state before the revolution. Under the Five-Year Plans, synthetic ammonia works have been built and put into operation in the south, the central districts and the Urals. The output of sulphuric acid has increased more than tenfold since 1913, that of superphosphate more than twenty-fold, etc. In the case of sulphuric acid, the increase is due to the erection and proper utilization of powerful towers as well as the application of contact processes. Soviet sulphuric acid plants are equipped with the latest mechanized ovens, electric filtration for the purification of the gas and powerful apparatus for the concentration of the acid. The Stakhanovites in these plants have increased the efficiency of the tower and contact processes. Cases are on record where the specified standards have been exceeded by as much as four hundred per cent.

No bakelite or other composition materials were produced in Tsarist Russia. Today they are used to manufacture not only numerous industrial supplies but also general consumers' goods.

Whereas before the revolution the annual output of rayon was 140 tons, artificial fibre production has now become a large industry.

The manufacture of synthetic rubber from ethyl alcohol, using the method invented by the late Academician Lebedev, is of great importance in

securing the Soviet Union's economic independence. Eighty per cent of all rubber required in the U. S. S. R. for any purpose whatever is now produced artificially in Soviet plants.

IMPROVEMENT IN TECHNOLOGICAL PROCESSES

Soviet engineers are tireless in their efforts to devise and master new, improved technological processes. In determining what method of mechanization is to be applied to any particular plant, quantity and quality of output are not the only consideration. Every endeavour must be made to render working conditions as favourable as possible for the workers concerned. Thus, Soviet engineering talent is diligently applying itself to the problem of replacing pneumatic pick hammers and perforators by electric hammers and perforators, of introducing combines in working steep-gradient coal seams, so as to do away with blasting operations and cave-ins.

The campaign being waged in the U. S. S. R. for the thrifty and complete utilization of raw materials, for prevention of fuel, heat and electric power losses and the elimination of all waste of human energy is bound to yield great economies in view of the tremendous size of the country; and these economies in turn will ensure an extra increase in output, which implies increasing welfare for the people.

Full of daring, the new Soviet technical intelligentsia is carrying out in real life the transition from the technique of the nineteenth century to the latest technological processes. Planned economy, free of crisis and based on the socialist ownership of the means and instruments of production, the right of all to engage freely in creative work, the right to education, the fullest opportunity to develop and apply one's talents, the birth of a new attitude towards work, which is esteemed as a matter of supreme honour, has served as the foundation on which the unparalleled success achieved in the transformation of the country is based.

THE CRISIS IN FOOD

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THE price of rice in Calcutta in the open market has gone up to Rs. 25/- per maund at the moment of writing. Its pre-war price in Bengal was about Rs. 4/8/- per maund. The rise in price of this staple food is therefore of the order of 500 per cent. What this would mean for the average Indian whose income is about Rs. 5/- per month does not require to be told. Besides rice, the prices of most other common food-stuffs and of essential commodities like fuel and textiles have also gone up to levels which were unheard-of during the last war. As it is, even in normal times, probably 90 per cent of our people are undernourished. Now, when ordinary cereals like rice and wheat have also gone up in price to an unprecedented extent, the injury which the situation is causing particularly to growing children and young people is incalculable. We have ourselves seen cases of break-down in young people owing to physical and mental fatigue brought on by partial inanition. The effect of the present situation on the health of the present generation as well as the next is bound to be deleterious. The crisis is causing the deepest anxiety bordering almost on alarm. Re-assuring statements from the Central Government and from Mr Amery regarding a satisfactory food-supply do not fill hungry stomachs nor remove gloomy apprehensions.

Let us examine some of the causes of this food-situation. There are two major aspects to this problem both of which must be faced. One is that of policy, administration and distribution and the other concerns production. Both are vital.

POLICY, ADMINISTRATION AND DISTRIBUTION

There can be no doubt whatsoever that the question of food-supply for the civil population has not been tackled with efficiency. The heads under which measures should be taken immediately are indicated below:

(a) *Co-ordination between the food-supplies for the forces and for the civil population.*

The Army has not gone short of food-supplies. The Army has also its food-stocks. Has the same attention been paid to the food-supplies for the civilian population? Have the food-supplies for the Army been procured with due regard to the needs for food of the local population? Some months

back, it was reported in the press that in some parts of Lyallpore district, the largest wheat-producing unit in India, wheat was not at all available for the civil people for love or for money. This obviously shows lack of co-ordination between the food-policy for the Army and the food-policy for the people. This co-ordination is brought about in Britain by the Ministry of Food under Lord Woolton. The will must also prevail here to bring about this co-ordination and the necessary liaison and changes in organisation should be made.

(b) *Central direction, supervision and co-ordination relating to the needs of different provinces or regions.*

This central direction and inter-regional co-ordination required to be effected quite early. There are, however, signs now that the Government is moving in the matter. The appointment of Regional Food Commissioners who will remain in touch with one another and the Centre may give better results than before, provided transport is released for the carriage of food-stuffs and highly localised autarchy is prevented.

(c) *Provision of more transport for importing major food-stuffs into the deficit provinces.*

At one time lack of sufficient transport caused dislocation not only in the provision of food-stuffs in Bengal but also of coal. It appears that some improvement has been effected of late in this regard. But this provision of transport should be made not on an *ad hoc* but on a planned basis so that sudden crises may not supervene.

(d) *Cessation of export of staple cereals from India and of rice from Bengal.*

It is known that such exports have taken place to the Near East, the Middle East as well as to Ceylon. It is obvious that exports of major food-stuffs should not have been carried out if their production is not quite substantially in excess, which does not appear to be the case. In a country like India where owing to climatic reasons, harvests are notoriously uncertain, provision of food-stocks for the civil population in excess of current requirements should have been known to be essential, particularly as imports from Burma and other Far Eastern countries are not possible.

(e) *Abolition of the "denial policy" at least for the time being.*

The "denial policy" entailing large-scale removal of food-stuffs from particular areas for fear of their falling into Japanese hands in case of an invasion has caused hardship, as the name itself implies. This policy has perhaps been stopped at least for the time being.

(f) *Rationing of the staple food-stuffs.*

When a supply is limited, rationing is essential unless the rich are to be favoured against the poor. Rationing would also impose direct responsibility on the Government for providing food for all and would also bring out the extent of the deficit more accurately. Even though it is a complicated system, it should be resorted to without delay.

(g) *Fixing of universal controlled prices for staple food-stuffs.*

At present there are controlled prices for certain commodities. It is also well-known that in the open market the same foods sell at far higher prices. These black market operations cannot be unknown to the Government. This is shown by the fact that Government would not often agree to provide major food-stuffs at controlled prices to any but certain classes of people, like the workers in the war industries, Railway workers, Secretariat workers and so on. This extra-ordinary and unhealthy situation should disappear with rationing and selling at universal fixed prices.

(h) *Prevention of the accumulation of undue stocks by the military, by the employers of labour of the war industries and by the profiteering and hoarding businessmen.*

It is known that fairly large stocks of food-stuffs are held by the bodies mentioned above. The position should be reviewed by the bodies concerned and by the Civil Government and if stocks can be adjusted to the needs of civil consumption, the situation may be eased to some extent. The Government has not so far taken energetic measures against the profiteering and hoarding businessmen whose operations are unlikely to be unknown to Government. Why is that so?

PRODUCTION

While the above matters of policy and administration, which essentially affect the question of distribution, should be tackled without delay, the problem of production must also be immediately faced. Statistics in this regard are however not sufficiently accurate and plentiful. For the present pur-

pose, we may take chiefly the question of rice production in Bengal.

(i) *Estimated deficit in paddy in Bengal.*—It was stated in the Bengal Legislative Assembly by the Minister-in-Charge that the under-production of paddy for the year in Bengal was estimated at 23 per cent. owing to natural causes. The Maharajadhiraj Bahadur of Burdwan in a recent note calculated the estimated Bengal deficit (taking into consideration the total annual demand of paddy for food at the rate of 9 maunds per head and for seed at 1 maund per acre) at roughly 45 per cent. Statistics are, however, not sufficiently accurate to allow exact predictions. But it would appear that there may be a deficit in the production of paddy of anything between 8 and 25 crores of maunds with reference to a total annual demand of about 57 crores of maunds for the people of Bengal. This deficit is not being even partially met by imports of paddy from Burma, which were annually of the order of 2 crores of maunds. On the other hand, the deficit with reference to the effective demand for the crop is greatly aggravated by the fresh demands arising from (a) the needs of the forces, (b) the needs of labour for the war industries, (c) the needs of evacuees from other places, (d) root-rot disease and insect pests, (e) accumulation of stocks by various bodies and by profiteers, etc. The deficit, so far as the needs of the people of Bengal are concerned, may therefore be even more than 50 per cent, though exact estimates are impossible.

(ii) *Area under paddy.*—The percentage of area under paddy to the total net cropped area in Bengal is about 90 per cent, and the percentage under jute is about 8 per cent. Paddy and jute, therefore, account for about 98 per cent of the total net cropped area in Bengal. Again, Bengal accounts for nearly 45 per cent of the total yield of paddy in India, so that hopes that a large deficit in Bengal can be effectively met by imports from Orissa, Assam, etc., do not seem to be justified though, of course, it may be partly met by such means. It would thus be clear that a serious Bengal under-production in paddy which is the staple food, can hardly be made good by anything but heroic measures. A simple "grow more food" campaign without indicating the precise lines of attack based on scientific considerations can scarcely meet the situation.

POSSIBLE LINES OF PRODUCTION

(r) *Paddy.*—Obviously what is necessary is first of all to launch a production drive for paddy. It is notorious that the yield of paddy per unit area in India is the lowest in the world. The figures on the next page will speak for themselves.

April, 1943

THE CRISIS IN FOOD

Comparative statement showing yield in pounds of rice per acre in different countries in 1935.

(Report of the Paddy and Rice Enquiry Committee, Vol. I—Government of Bengal).

Bulgaria	... 1,904	Korea	... 1,759
Egypt	... 3,179	Siam	... 1,398
Formosa	... 2,220	Spain	... 5,542
Indo-China	... 1,032	U. S. A.	... 2,138
Italy	... 4,743	India	... 828
Japan	... 2,968	Bengal	... 884
Java	... 1,322		

This is indeed a shameful picture. Even Korea gives twice the yield of paddy per acre than India. The chief questions affecting the production of paddy in Bengal are:

(a) *Seeds of heavy-yielding strains.*—As it is, even seeds are short, not to speak of seeds of heavy-yielding strains. But efforts must be made by Government to explore the different agricultural laboratories in as well as outside India and to secure the assistance of other States in order to procure large quantities of heavy-yielding seeds without delay. This may be difficult but must be done even by the use of air transport.

(b) *Manure.*—Propaganda for the greater use of farm yard manure must be carried on. Compost may be made in the villages from ordinary fallen leaves and refuse under a little instruction. There was a Compost Conference in Delhi recently, which, we hope, may bear fruit. The supply of artificial fertilisers should also be attempted.

(c) *Water.*—The question of irrigation in Northern and Western Bengal should have been tackled long ago. Perhaps this problem cannot easily be met on a short-term basis; nevertheless the question of water is exceedingly important and must be immediately faced.

(d) *Bringing cultivable waste under paddy.*—This is very important, because bringing the considerable amount of present fallow land under paddy would also prove of permanent benefit, until Bengal attains at least self-sufficiency in the production of this staple food.

(e) *Reduction of the jute area.*—The Bengal Government had reduced the acreage of jute this year to one-third of that of 1938-39. The Indian Jute Mills Association, as was expected, made a representation to the Central Government and increased the allotment for jute to one-half of that of 1938-39. When the Government itself calls for a "grow more food" campaign in view of the food-shortage, this decision of the Central Government should be imme-

diately revised and land under jute should be brought under paddy to the largest extent possible.

(2) *Food Crops other than Paddy and their Processing.*—It is obvious that, if there is a considerable under-production in paddy, it can hardly be met satisfactorily by the provision of other subsidiary food crops, for which relatively very little area in Bengal is ordinarily employed. Nevertheless, when the distress is great even small additions to the meagre diet should be welcome. Under these circumstances, the question of increasing the cultivation of potatoes, which is a fairly heavy-yielding crop and that of soya-bean may be considered. The selection of such crops for a "grow more food" campaign should be based on agricultural and nutritional considerations instead of being left to individual predilections. The questions of fish and milk production should also be examined in the same category and a comprehensive plan should be thus evolved for implementation by both the Government and the people. The people might be encouraged to grow these particular crops and eat them.

In this connection, Government should also consider the technical aspect of the problem. At present there may be some perishable vegetables in temporary and relative excess, which instead of being allowed to deteriorate in our hot and humid climate, could be dried or otherwise preserved. Such materials may be tomatoes, cabbages, potatoes, etc., which are already being dried in tunnel driers and supplied to the forces. This could also be done on a larger scale for the civilian population, if the Government is interested, with the help of technical equipments and knowledge already available.

The question of processing of milk, which is produced often in abundance in certain limited areas during definite periods and locally used wastefully, should also be considered. Whether milk could be dried locally or butter separated and casein prepared and dried for transport and long-time preservation should be examined. The wasteful use of milk in the province because of local seasonal gluts, although its production relative to the total needs of Bengal is inconsiderable, has long been a matter demanding action. Similarly, technological processing of fish where it is produced locally in abundance should be examined. Bengal had for a long time the need of a fish processing industry and if this can be set up now with the help of the newly established Department of Fisheries, it may confer both short- and long-term benefits on the province.

(3) *Processing of Grass and Green Leaves for Human Food.*—As has been pointed out above, the deficit has occurred with reference to the staple commodity of rice. It would seem therefore that, if a

famine is to be prevented, it may not be enough to cultivate or/and process only the subsidiary crops and to try to preserve milk and fish. All these together are unlikely to cover more than a fraction of the deficit. It is therefore necessary to consider some other relatively abundant material as a source of food.

Some researches have been carried out quite recently in Europe and America regarding the processing of grass and green leaves for food which normally grow in greater abundance than the subsidiary crops used by us. These materials, contain a large quantity of fibre indigestible by man, but the proteins which may be extracted from them have been found to be of high biological value, comparable, in fact, with that of milk proteins. This can be done by maceration of the disintegrated green leaves with water and coagulating the proteins from the aqueous extract by heating. As prepared by us, the grass protein has just a grassy flavour and has hardly any taste. It is associated with some chlorophyll, which does no harm. These proteins may be eaten by man, while the bulky residue of fibre with which a fair amount of insoluble protein is bound would provide excellent fodder for cattle. The salts extracted with water may also be used for cattle feeding. Nothing would be wasted. Apparently nearly all kinds of green leaves may be used, avoiding, of course, poisonous plants. This might mean human competition with cattle for green leaves but since the bulk of the material would come back to cattle it should not matter very much. The fibre itself could be chemically broken down into edible sugar but the technical process is relatively difficult and there would be no fibre residue left for the cattle.

This processing can be done by two ways: (a) processing on a large scale at places where grasses and green leaves are abundant whereby the proteins may be extracted and then dried and transported to the towns and cities and (b) processing on a domestic basis—each family in the villages may procure a certain quantity of grass and green leaves and extract the proteins, which, as indicated above, is a relatively simple procedure, no more difficult than cooking and requiring the use of only domestic appliances.

Proteins have the same order of energy value as carbohydrate materials like rice or potato and therefore, from the energy standpoint, they can replace an equal quantity of rice in the diet. It is not expected, of course, that the grass proteins would replace the whole of the rice in the diet; in that case it would be too high a protein food, which may not be good. But replacement of about one-third or half the rice by an equal amount of the grass proteins would do no harm but, on the contrary, would per-

haps improve the quality of the food for our chronically protein-starved people whose health is adversely affected by a diet normally too high in carbohydrate.

The feasibility of the above propositions should be examined.

ORGANISATION

(a) *Ministry of Food and Scientific Advisers.*—All the questions set forth above could be comprehensively dealt with only by a Ministry of Food, as they have got in every advanced country. This Ministry should be created without delay and have a panel of whole-time Scientific Advisers representing the agricultural, technological and nutritional aspects of food just as the British Ministry of Food has got.

(b) *Food and Nutrition Committees.*—There are a Food Committee and a Nutrition Committee under the Government of Bengal. At joint meetings of these Committees the question of production should be comprehensively dealt with in the completest detail and the programme of action evolved immediately. In such matters the Agriculture Department of the Government can help but cannot replace the Food and Nutrition Committees which will be concerned exclusively with the inter-related aspects of food and nutrition. It cannot replace also the Scientific Advisers to the Ministry of Food, who will be engrossed exclusively with the question of the production of food on the lines laid down by the joint meeting of the Food and Nutrition Committees.

(c) *Advisory Council on Food.*—The Government has proposed the constitution of an Advisory Council on Food. It is desirable that the Council contains a majority of scientific and technical members having direct knowledge of the science and technology of food and food-production. This Council should bring to a focus the recommendations of the Food and Nutrition Committees regarding the production of food as well as the questions of policy, administration and distribution, which have been discussed in the earlier part of this article. It is only by co-ordinating these two aspects of the food-problem that the Council may be able to ameliorate the food-situation.

Ultimately, of course, every thing will depend on the spirit of the Government and its will to feed the people. This is considered the first task of all civilised Governments in modern time. The British Ministry of Food is said to have laid by stocks of food for the civilian people of Britain to last about two years. Will the British Government in India be prepared to make similar efforts for our people and make far greater use of science and technology for this purpose than has been done hitherto?

Notes and News

AMERICA'S PLANNING FOR POST-WAR RECONSTRUCTION

THE report of the U. S. National Resources Planning Board on National Resources Development in 1942 shows how the United States of America is planning for post-war reconstruction. It deals with the problems of industrial location, of transport, of utilisation of special skills, of urban construction, and with development of planning for social security and post-war planning for youth and children. The report which has roused considerable interest in Great Britain, seeking an intimate co-operation of the United States in the matter of post-war reconstruction*, looks forward to securing, through planning and co-operative action, a greater freedom for the American people. The introduction suggests that any translation of freedom into modern terms applicable to the States must include (1) the right to work, usefully and creatively, through the productive years; (2) the right to fair pay, adequate to command the necessities and amenities of life in exchange for work, ideas, thrift and other socially valuable service; (3) the right to adequate food, clothing, shelter and medical care; (4) the right to security, with freedom from fear of old age, want, dependency, sickness, unemployment, and accident; (5) the right to live in a system of free enterprise, free from compulsory labour, irresponsible private power, arbitrary public authority and unregulated monopolies; (6) the right to come and go, to speak or to be silent, free from the spyings of secret political police; (7) the right to equality before the law, with equal access to justice; (8) the right to education for work, for citizenship, and for personal growth and happiness; and (9) the right of rest, recreation and adventure, the opportunity to enjoy life and to take part in an advancing civilisation.

It is abundantly clear from the contents of the report that the entire question of reconstruction has centered round the problem of freedom and the distribution of abundance with a view to eradicating unemployment looming in the midst of adequate resources and men ready to work and in need of food, clothing and shelter. Not only has the idea of full employment been envisaged in the planning, it has also sought to limit the maximum working hours to forty per week and maximum working weeks to fifty per year. The obligations going with such rights

have also been recognised. The programme includes the planning for demobilisation and the study of the consumer market, of industrial location and of management, the relation of Government to private enterprise, schemes of public works, transport and land development, and the extension of such services as health, nutrition and medical care. The international aspect of the planning further indicates the American willingness to share the responsibilities in European reconstruction outlined in a recent pamphlet issued by the Royal Institute of International Affairs.

OIL FROM WESTERN CANADA

A CONSIDERABLE fraction of the world's petroleum, as the geologists would have us suppose, exists in oil sands in a state of adsorption with the sand grains in various parts of the world. Extraction of petroleum from these sands was always considered difficult and expensive though the hope of devising some practical method was never given up. According to a report in a recent issue of *Science*, recovery of oil, gasoline, asphalt and coke from the hitherto untapped vast tar sands in northern Alberta in Canada has been successful as a result of some eleven years of research by American engineers. Fort Norman on the Mackenzie River in Canada 125 miles south of the Arctic circle has risen in importance, being the world's northernmost refinery where crude oil, separated from the sands, is transformed into gasoline, diesel fuels, fuel oils, asphalt and coke. The possibility of producing synthetic rubber from these bituminous sands left after the separation process is at present under consideration. Recently the Munitions and Supply Minister C. D. Howe said in Parliament, "An intensive study of the tar sands is under way at the present time. To-day we think of that area as a source of immediate oil production, provided the problems connected with its development can be solved rapidly and with some degree of certainty."

The existence of oil in the sands along the Athabasca River in Alberta has been suspected for a long time. Since the infiltration of white men in 1788 this area has attracted increased interest and attention as a probable rich source of mineral oils. Besides, the importance of the bituminous sands of this region was early recognised, and in the past people made extensive use of the sands in preparing asphalt for paving. Failure to evolve a suitable extraction process coupled with transportation diffi-

* This forms the subject matter of the editorial article, "Anglo-American Relations in Reconstruction", of *Nature*, Nov. 28, 1942.

culties left the oil resources of this region unworked even in this age of oil. According to recent exploration carried on by the geological department of the Canadian Government, the oil sands along the Athabasca River are considered as one of the largest sources of oil in the world with a proved reserve of some hundred billion barrels of oil even on the most conservative estimate. The oil-saturated sands range in thickness from a few feet to 225 feet and spread over an area of some 10,000 to 50,000 square miles. Unfortunately a considerable portion of this area is overlain with shale and sandstone, sometimes 1,800 feet deep, rendering mining of the underground oil almost unworkable. The bituminous sands stretch for miles on each side of the river, covering roughly an area 115 miles north and south, and 55 miles east and west.

MINERALS AND NATIONAL PLANNING

RECENTLY Dr L. Dudley Stamp, Director of the Land Utilisation Survey of Britain, read an interesting paper on 'The Exploitation of Minerals in Relation to National and World Planning' at the conference on Mineral Resources and the Atlantic Charter, arranged by the Division for the Social and International Relations of Science of the British Association. The paper contains certain important statements and suggestions worth paying attention to. The social and economic repercussions of those industries which draw upon the mineral resources of a country are fundamentally different from those arising from agricultural industries or animal husbandry. This particularly applies to extractive industries involving minerals like oil, coal, iron ore and most metalliferous ones whose supply is unfortunately limited and which have come to play such a vital role in modern civilisation. These extractive industries generally pass through three distinct stages, namely, exploration, exploitation and exhaustion. The social effects of the first two stages, often described as the 'mining boom', are generally reflected in an influx of population, a spate of building and often of extravagant expenditure. The period of steady exploitation depends on the nature of the minerals worked and also of the deposit, and is sometimes sufficiently long to render stabilisation of economic and social conditions possible. For instance, the origin of many important towns and cities of Britain may be traced to the development of some coal fields in the neighbourhood. These are indeed desirable social changes which have always been looked for. But it is the inevitable incidence of the period of exhaustion resulting in considerable human suffering and misery consequent upon the dislocation of the central economic structure of the region, which has of late given so much cause for anxiety. This unhappy

experience has brought to the fore the question of careful planning and the acceptance of responsibility for whatever social and economic readjustments may be needed on the part of those nations of the world whose right to share the world's mineral resources has been recognised. As a matter of fact, it has been found, as Dr Stamp tells us, that 'as a mine approaches the later stage of its career, there is little money left after running costs have been met and, when the mine fails, none at all to remove the old gear and buildings, which thus become unsightly ruins marring the countryside'. Dr Stamp cited a number of cases to illustrate the severe social and economic consequences of the aftermath following the failure and exhaustion of the mines. This has naturally led him to suggest the following:—

"(1) Mineral exploitation inevitably results in a need for restoration, whether it be of land or of the social structure of the community.

(2) This restoration should be obligatory on those, whether nations or individuals, who derive benefit from the working of the minerals.

(3) In the latter stages of mineral exploitation there is never a surplus of money, and therefore there should be some provision, comparable to an amortization insurance, made when the industry is flourishing, for use in the later stages for the work of restoration and rehabilitation."

The problem which Dr Stamp has referred to is doubtless serious for countries like Britain, which has already reached an advanced stage in the development of extractive industries. At present it is not the pressing problem for India where the development of industries utilising the mineral resources for her own national well-being has scarcely begun, though the exploitation of her important minerals has continued unabated through all these decades. We would have felt encouraged about Dr Stamp's suggestions had it not been for the recognition of the rights of nations of the world to share the world's mineral resources envisaged in the Atlantic Charter and Mr Churchill's prompt and significant declaration of the inapplicability of the Charter to India. Though Dr Stamp has talked of international planning of mineral exploitation, in essence the planning concerns only the few 'guardian' nations of the world. We are, however, exceedingly willing to see India pass through that stage of industrialisation, so far as the development of her national resources is concerned, which leads to such economic and social difficulties. We will then gratefully remember Dr Stamp's salient suggestions as to the exploitation of minerals with proper regard to national and international well-being.

AGRICULTURAL ACHIEVEMENTS OF CHINA

THE Chinese National Agricultural Research Bureau, in collaboration with the provincial Agricultural Improvement Bureaus, has made satisfactory progress in the agricultural reconstruction of the country by introducing better seeds and better technique. A small report for 1942 has been given in the *China Information Bulletin*. As an insurance measure against drought 'ti hwo hung' paddy seeds have been introduced and found successful on both irrigated and non-irrigated lands. Rice crops giving two harvests from one planting have been widely promoted. 50 kinds of improved wheat seeds were used last year of which 'Chung Nung' No. 28 is the best known. Potato and some corn seeds have also been improved.

Under the direction of Foreign Trade Commission of the Ministry of Finance, there are Research Institutes for tung oil, tea and silk. Schemes in hand for tung oil relate to propagation of better seedlings, methods of oil cracking and new uses. For tea, experiments are in progress for improving the propagation of the plant and early maturity. The market for Chinese tea has been the United States and the Soviet Republic, but transport difficulties owing to war have affected the trade very adversely. In order to minimise space for transport the China Tea Corporation has extracted tea essence, and the samples of the highly concentrated tea extracts have been favourably received in America. For the sericulture industry better silk worms have been found, and improvement of mulberry trees is proceeding. For improvement of wool, the research work is under joint direction of Foreign Trade Commission and Ministry of Forestry. Tests on cross breeding of sheep and goats and methods of fur and leather treatment are the important items of research. Sheep from New Zealand have crossed over Tibet to China via India, which reflect China's difficulties to get supplies. Gradual extensions of the work of the National Animal Husbandry Research Bureau, of nurseries and plantings, and of disease control measures for cotton fields are also reported.

GRAND COULEE DAM

THE *Engineer* (CLXXIV, 4520, pp. 168-70) has published a short account of the work done so far in connection with the construction of this great dam upon which U. S. A. embarked in the second half of 1934. It is reported in the article that on June 1, 1942, water began to flow for the first time over the spillway. The Grand Coulee Dam excited much interest in U. S. A. and outside ever since the formulation of the plan for this great piece of hydro-electric engineering. The immediate interest, however, centres round the development of power, but the building of the dam was primarily initiated by

the consideration of irrigating some 1,200,000 acres of land in the Columbia basin. This objective has not been lost sight of even in the midst of great pressure for power in war industries. The work in connection with the handling of the water that will be lifted by pumps at the dam and discharged into central basins will be progressively taken in hand.

There are to be nine 108,000 kw. units in the west power-house, of which three are now in service delivering energy to war plants. In view of the urgent demand for power in war industries, the transference of two hydro-electric generators, originally built for the Shasta Dam and now under construction in California, has been decided upon. Each generator is of 75,000 kw. and has in all probability started operating by this time. At the time of writing the article (August, 1942) the east power-house was also rapidly in the process of being completed and expected to come into service by the end of the last year. The two power-houses in the fully equipped condition will be provided with eighteen turbines, each rated at 150,000 h.p. The eighteen connected main generators with the large station service units are estimated to have a combined capacity of 1,981,500 kw., which will be the greatest block of output energy so far produced at any single site.

Dr GEDDES ON POPULATION TRENDS IN INDIA

THE population trends in India have always offered an interesting subject for study to demographers and geographers owing to its great diversity and peculiarity. Accordingly the publication of the preliminary results of the census taken in March, 1941, which places the population of India at 388,800,000 and records an increase of 15 per cent on the 1931 figure (Burma excluded), aroused considerable interest among demographers and geographers in India and outside. Dr Arthur Geddes, lecturer in geography in the University of Edinburgh, who studied and taught sociology in India in 1921-24 and revisited this country in 1938-39, recently contributed a number of articles in the *Geographical Review* on the trends of population in India.—(Half a century of Population Trends in India: A Regional Study of Net Change and Variability, 1881-1931—November-December, 1941; the Population of India: Variability of Change as a Regional Demographic Index—October, 1942). He has developed a new analytical device for interpreting the population trends revealed by the censuses, namely, the method of variability of change or of departures from the normal curve of change. He puts his figures for net change and variability on a line map of administrative divisions. Further he separates the two items in more graphic forms in two half-tone maps. Thus one finds from census reports that the population in

some districts, such as Eastern Bengal and Travancore has undergone a steady increase in course of fifty years between 1881 and 1931. These are instances of low variability. On the other hand, population in Assam and the irrigation colonies of the Punjab indicate high net increase with high variability. Such changes are closely associated with immigration and new agricultural developments. The net decline of 14 per cent with slight variability in the population of the heart of Bengal has been rightly attributed to chronic poverty and disease, particularly malaria, which is rampant in these parts. The arrest of population growth in Rajputana with remarkably high variability points to recurrent famines and alternation of good and bad periods. Dr Geddes thus observes in the concluding remarks of one of his articles referred to: "The application of the index of variability to a series of changes of population, decennial or annual, should do much to bring out the regional character of change. The results require correlation and interpretation, both geographical and statistical. Given these, the index is informative not only of the recent past but, in many cases, of earlier conditions and likely trends. The conditions on which light is thus thrown are environmental and economic in the first place and, acting in combination with those of health, largely determine the rates of survival. The survival rates, in turn, are of the deepest social significance; for they indicate the extent to which the circles of family, neighbourhood, and community have remained unbroken or been disrupted."

CONTROL OF PHOTOGRAPHIC PRINTING

THE control of photographic printing by measured characteristics of the negative formed the subject of an informative article by Lord A. Jones and C. N. Nelson, appearing in the last October issue of the *Journal of the Optical Society of America*.

A large amount of experimental data has been obtained to determine what portion of the D -log E curve of photographic paper is useful in making high quality prints. Psychophysical statistical methods were necessary in solving this problem. Special attention was given to selecting a procedure which would yield results of maximum practical significance. Prints were made from about 200 negatives using five different exposures on each of three contrast grades of paper for each negative. Most of the work was done with a normal, commercially available set of semi-matte surface papers having six different contrast grades. Additional work was done using glossy and matte surface papers. Every set of prints was judged by a number of observers to determine the best print. The location of the "first-choice" prints on their respective D -log E curves was then obtained from maximum and minimum density reading on the prints and on the negatives. The data for second-choice and third-choice prints were also obtained as a matter

of general interest. It was found that the minimum or shadow density of a negative is a much more reliable guide for determining correct printing exposure than the maximum or highlight density. The integral or average density of the negative is nearly but not quite as satisfactory for this purpose as the minimum density.

Of great interest is the fact that the useful maximum density of the printing paper was, on the average, considerably below the available maximum density, while the useful minimum density of the paper was usually very close to, and often equal to, zero density. The primary requirements, however, appear to be expressed by gradients rather than by densities. It was found that the limits of the useful portion of the D -log E curve of the positive material are determined very closely by fractional gradients of $0.1 \bar{G}$ on the toe of the curve and $1.0 \bar{G}$ on the shoulder of the curve, where $\bar{G}$ is the average gradient measured between these two limiting points. This conclusion has an important bearing on the establishment of a significant method for expressing the sensitometric characteristics of photographic papers. It leads to an evaluation of the effective printing speed and the useful exposure scale of the positive material. The proposal is made that speed be defined as $10^4/E$, where E is the exposure corresponding to the limiting gradient on the shoulder of the curve. The useful log exposure scale of the paper is defined as the log exposure interval lying between the two limiting gradients.

The application of these results to the making of prints by sensitometric control is discussed. In general, a negative should be printed so that its minimum density falls on the shoulder of the D -log E curve at the point where speed is measured. A method is given whereby the density scale of the negative can be used with reasonable success to determine the proper contrast grade of paper for making the print.

SIR SHANTI SWARUP BHATNAGAR, F.R.S.

WE learn with much pleasure from a Reuter's telegram that Sir Shanti Swarup Bhatnagar, Director of Scientific and Industrial Research, with the Government of India, and an editorial collaborator of this journal, has been recently elected a Fellow of the Royal Society of London. Sir Shanti Swarup's earlier work was mainly on colloid chemistry, specially on the studies of emulsions, which he carried out in the Chemical Laboratories of the University College of Science, London, under Prof. F. G. Donnan (1919-1921), where he enjoyed the comradeship of Sir Jnan Chandra Ghosh and Prof. J. N. Mukherjee. He was awarded D.Sc. of London in 1922 and, after return to India, was appointed to the chair of chemistry at the Benares Hindu University where he succeeded in establishing a flourishing

school of research. He soon received a call to his Alma Mater, the University of the Panjab, where for the last decade and a half, the study of magnetic properties of substances and their application to the solution of chemical problems have been his favourite pursuit. The Interference Balance for Magnetic Measurements devised by him in collaboration with K. N. Mathur is a distinct contribution to the development of precise methods in this branch of study. More than a score of original papers on the subject have been communicated by him and his pupils on this subject, and an admirable summary of his researches has been given in the Annual Reports to the Chemical Society of London, 1942. His book on the "Physical Principles and Applications of Magneto-Chemistry" provides us with a comprehensive general review of magneto-chemistry. He had carried out extensive researches on many industrial subjects, e.g., plastics, purification of oil, and was entrusted by Messrs Attock Oil Company with investigations connected with the purification of petroleum. He has established a flourishing school of research in physical chemistry in the Panjab University. Since the beginning of the present great War Sir Shanti Swarup as Director of Scientific and Industrial Research, has devoted all his attention and energy to the solution of many techno-chemical problems in connection with war efforts.

Left an orphan at a very early age, he had to struggle in early years through great poverty. He has risen to the present distinction by dint of hard

work and single-minded devotion to duties. He is a 'self-made' man in the truest sense of the word.

ANNOUNCEMENT

THE Council of Scientific and Industrial Research has arranged for the compilation and publication of a *Dictionary of Raw Materials of India*. An Editorial Staff working under the direction of an Advisory Committee has been appointed. In spite of the present unsettled conditions a most earnest endeavour will be made to collect all available knowledge regarding the raw materials of the country. An appeal is made to everyone who has any information of value on any aspect of the subject to communicate the same to Dr B. L. Manjunath, Chief Editor, Dictionary of Raw Materials, 20, Pusa Road, Karol Bagh, New Delhi. Such assistance will be duly acknowledged in the text.

THE following are the office-bearers and members of the BOTANICAL SOCIETY OF BENGAL for the session 1943-44.

President—Mr S. N. Bal; Vice-Presidents—Prof. S. P. Agharkar, Prof. S. C. Mahalanobis, Dr K. P. Biswas, Prof. S. R. Bose, Prof. J. C. Sengupta; Treasurer—Mr I. Bannerjee; Councillors—Mr K. G. Banerjee, Mr E. A. R. Bannerji, Dr P. N. Bhaduri, Dr N. K. Chatterjee, Dr K. T. Jacob, Miss S. Meyer, Dr S. K. Mukherjee, Mr P. N. Nandi, Dr S. R. Sengupta; Hon. Secretaries—Dr B. C. Kundu, Dr J. K. Chaudhuri.

SCIENCE IN INDUSTRY

BULLET-PROOF STEEL

SUCCESSFUL manufacture of bullet-proof steel has engaged the attention of metallurgists and chemists since the closing stages of the World War I. In a recent issue of the *Electrician*, Mr A. G. Arend has reviewed the present position of the manufacture of vanadium steel for breast plates, helmets etc. Though the importance of vanadium as a desirable constituent in bullet-proof steel was realised in so far as it allows of a light strong steel, it could not be successfully produced with the required physical properties for want of systematic furnace operation. It is important that the furnace should permit of continuous uniform working without temporary interruptions. The Heroult three-phase electric furnaces previously employed suffered from the drawback that they were not provided with automatic arc

regulation. This caused much trouble during the initial melting of scrap. Furnaces of different designs, viz., direct arc and arc-resistance types, are available to-day, of which the latter is preferable for smaller charges. The furnaces operate at 110 volts; but as cold scrap is used in the charge, surging momentarily raises the current to as high a value as 10,000 amp. The energy consumption usually ranges from 750 to 825 kwh. per ton.

The percentages of the various constituents of the last approved bullet-proof steel, turned out in the modern form of 6 ton Heroult furnaces, are as follows: nickel 2%, manganese 1%, vanadium 0.20%, silicon 0.20%, phosphorus 0.02%, sulphur 0.02% and carbon 0.42%. The admissible error in the percentages of the constituents employed should not exceed 0.05%. This limit, however, does not apply to

sulphur and phosphorus which must not exceed 0.02%. In the final preparation, following de-phosphorising, the percentage of phosphorus is even less than 0.02% with a consequent reduction in the percentage of carbon content as well. The final percentage of carbon should be about 0.30%. The small range of the percentages of the constituents employed in the manufacture of bullet-proof steel requires absolute precision in control which the modern electrical furnaces equipped with automatic arc regulation are alone capable of.

A NEW PROCESS OF MAGNESIUM MANUFACTURE

A NEW process for the manufacture of magnesium from dolomite, developed by Dr L. M. Pidgeon of the Canadian National Research Council, has been reported in the *Journal of Scientific and Industrial Research* (Vol. I, No. 2), published under the auspices of the Board of Scientific and Industrial Research, Government of India.

The new method which has already been adopted by several manufacturers in U. S. A. and England proposes to replace the well-known Hansgirg process. The method is free from the several difficulties inherent in the Hansgirg method. The process involves the reduction of calcined dolomite to metallic magnesium with the help of ferrosilicon. Ground ferro-silicon containing not less than 75 per cent silicon is briquetted with dead burnt dolomite, and the whole thing heated in an alloy steel retort to about 1,150°C. Silicon dioxide produced in the reaction forms infusible dicalcium silicate with calcium oxide, which can be easily removed. The retort is constructed with an integral condenser tube provided with a removable tubular lining, and a low pressure, less than 1 mm., is maintained in the retort and the condenser. During the reaction magnesium in the pure metallic stage condenses in the lining of the condenser which is removed along with the deposit at the end of the operation requiring about 6 hours for completion. Magnesium separates from steel during the differential contraction of the two metals in a very high degree of purity and can be directly used in the foundry without further purification. It has been estimated that about an equal weight of 75 per cent ferrosilicon alloy is required to produce magnesium metal and that the whole cost of production is less than what the old process could guarantee.

It is further reported that the possibilities of exploiting the deposits of magnesium, which extensively occur in India, but are at present exported after preliminary calcination, for the production of magnesium are being investigated in the laboratories of the Director of Scientific and Industrial Research.

MICHELIA TIMBERS FOR AIRCRAFT CONSTRUCTION

THE Indian Forest Leaflet No. 17 on utilisation matters, recently issued from the Forest Research Institute, Dehra Dun, deals with the suitability of some Indian species of wood for aircraft construction. Of the various *Michelia* species, *Michelia champaca* (champ), is the most important being fairly common in Assam and largely cultivated all over India for its fragrant flowers. There are, however, four other species of *Michelia* which are less abundant. The true habitat of champaca is in the Eastern Himalayas, chiefly in Assam and to a much smaller extent in Bengal and on the west coast from Kanara southwards.

All the five *Michelia* species produce excellent timber of light weight and good strength qualities, which is very similar in weight and strength. The timber is only slightly heavier than spruce (being about 33 lbs. per cubic foot as against about 30 lbs. for spruce), and compares very favourably with spruce in strength. The wood is further straight-grained and can be very easily worked both by hand and machine tools. The timber also seasons without difficulty or degradation. Kiln-seasoning does not produce any difficulty, excepting the fact that during the process of drying the timber becomes slightly darker and duller in colour. But it can, however, be finished to a beautiful smooth surface and can be peeled on a rotary lathe and sliced on a slicing machine to produce excellent veneers for plywood. Tests have revealed that all the Indian *Michelia* timbers are very suitable substitutes for sitka spruce for the manufacture of aircraft. It is stated that though the supplies of this timber is limited, a policy of economy and reservation may yet go a long way towards meeting the needs of the aircraft industry in India.

AIR LIQUEFACTION BY EXPANSION TURBINE

THE low efficiency of the commercial air liquefiers, now in existence, has long stood in the way of increased and more economic production of liquid air which is at present being used for various scientific investigations and in industry in ever increasing quantity. P. Kapitza, the distinguished Soviet scientist, has recently constructed an air liquefier which is reported to be of much higher efficiency than the commercial machines now available. The method does not require unusually high pressure installations. In his model experiment Kapitza used a rotor of 8 cm in diameter weighing 200 gms. and capable of handling 10 kg. of air per min. The air compressor he used weighs 3 tons and consumes 50-80 kwh. The filtered air is compressed to 6-7 atmospheres and is allowed to pass through

water-cooler, oil-purifier and regenerators. The main bulk of the air coming out of the regenerators enters the turbine chamber and suffers expansion. The rotor rotates at a tremendously high speed of about 40,000 revolutions per min. The expanded and thereby cooled down air returns by the inner tube of a condenser into another regenerator. The remaining portion of the compressed air flows through the condenser where it liquifies. The output of his model experiment was $\frac{1}{2}$ kg. of liquid air per min. The increased efficiency of Kapitza's method is due to the greater efficiency of the cooling cycle of the turbine as compared with that of the usual commercial machines. The most striking feature of the method is that air is liquefied at a pressure of 6-7 atmospheres only with a high efficiency and output.

J. M.

USE OF PLASTICS IN ENGINEERING

THE growing demand for iron and steel in various types of structures in the present mechanical warfare has led research workers to investigate the possibilities of new materials capable of replacing them without hampering in any manner the efficiency and the strength of the structure. The recent outcome of these investigations is the plastic materials or plastics which, when reduced to their fundamentals reveal a combination of carbon, oxygen and hydrogen in varying proportions. The plastics which are used in engineering are of two types: thermosetting and thermoplastic. Bakelite, Mouldrite, Nestorite belong to the former group, which during moulding undergo a chemical change and are rendered hard and tough, while Bexoid, Erinoid, Cellomold, etc. fall in the thermoplastic group, which after being heated to ensure plasticity, can be formed to any designed shape.

Recent foreign reports indicate that the use of plastics in mechanical and aeronautical engineering is now extensive. Though the study of their intrinsic strength and properties has not yet been fully undertaken, it can be said that an ideal plastic would

be one which has high strength, low brittleness and low specific gravity. These qualities are found in moulded cast (without filler) and laminated phenol compounds as well as in cellulose acetates and nitrates. Experiments have shown that these plastics have a tensile strength varying from 9,000 to 18,000 lbs./sq. inch; compressive strength varying from 16,000 to 40,000 lbs./sq. inch, and a nearly constant specific gravity of 1.3. Because of their lightness in weight as compared with cast iron, steel or even aluminium, they lend themselves efficiently for use in secondary structural work. Plastics are capable of taking a high finish, good colour and are normally resistant to acids and grease. Unlike steel, however, the ratio of stress to strain is not constant in this case, that is, Hooke's Law is not obeyed, their elongations varying with the temperature, rate and period of loading. Further their creep varies with the composition of the constituting materials and the tensile strength, producing what may be termed "elastic hysteresis"—the analogous of "plastic hysteresis" of metals.

A graphic account of the suitability of plastics in aircraft construction was recently given by G. W. Bell in a paper presented at the annual meeting of the Institution of Aeronautical Science, New York. After reviewing the growth of thermoplastic and thermosetting plastics, it was shown that by replacing aluminium parts by suitable plastics, the American aircraft industry would be saving nearly 21 million pounds of aluminium every year.

Apart from their adoption in purely aeronautical work, high duty laminated plastics are at present used for gear bearings, and sliding surfaces in locomotive work, while coloured plastics are employed for ball knobs from $\frac{3}{4}$ " to 3" in diameter for difficult control levers of machinery and tools. Ordinary plastics find use in heating regulators, blind-cases, lamp sockets, clothes hooks, lavatory fittings, furniture handles, window frames and embossed or engraved name plates and escutcheon plates.

S. K. G.

PETROLEUM—NATURAL AND SYNTHETIC*

J. K. CHOWDHURY

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THE acute shortage of petroleum products at the present time and the strict rationing of petrol and kerosine have brought home to us the importance of petroleum in the conduct of our everyday life. The key to power and prosperity is held by mineral oil—a fuel used for the generation of power; this fact has been fully realised by various nations involved in the present world war. The dash of Axis Powers towards oil-producing regions and the pre-war rivalry of nations for the control and exploitation of oil resources of the world point clearly to the great importance of mineral oil in war as well as in peace.

The world production of petroleum has reached unprecedented figures. It is estimated that in 1941, the world production of crude oil reached 315 million tons, of which more than 200 million tons or 63 per cent came from U. S. A. Next in importance was Soviet Russia with about 28 million tons, of which about 80% came from Baku and Grozny regions which are now directly threatened. Dutch East Indies and Burmah together produced about 10 million tons, which have now fallen into Japanese hands.

India's share in the production is extremely low, the production being confined to Rawalpindi area in the Punjab and the Digboi area in Assam. Both these areas together produce only 84 million gallons or less than 300,000 tons, which is equivalent to only 1/10th of a per cent of world production. In peace time, we were largely dependent on Burmah, Dutch East Indies, Iraq and Bahrain oil fields. Now the oil from the two former regions has been completely cut off while that from the other regions has been diverted mainly to military necessities.

Petroleum is obtained from petroliferous sandy layers, situated 1000 to 5000 feet and sometimes 10,000 feet below the surface of the earth. The location of these oil deposits is the business of geologists who are helped in this respect by modern scientific instruments. The oil is reached by means of deep wells bored by rotary drilling method, with the help of certain acids and other chemicals.

Petroleum obtained from these wells—a dark evil-smelling liquid or semi-solid is usually pumped several hundred miles through carefully laid pipelines to the refinery which is situated near a port.

* Being the material of the author's lecture broadcast from the Dacca Station of All-India Radio, published with the permission of the Station Director.

Here the oil is subjected to complicated refining processes and is converted into important marketable products such as petrol, kerosine, fuel oil, lubricating oil and paraffin wax. A large number of research chemists and chemical engineers work here hand in hand with the refining staff with a view to maintain constant improvement and progress.

The greatest demand is for petrol or gasoline which is used mainly as motor or aviation spirit. Straight-run petrol obtained by distillation rarely exceeds 20% of the crude distilled. This is grossly inadequate to meet the demand. Constant research and co-operation between chemists and engineers have succeeded in greatly increasing the yield to 45% or even more. Cracking of high boiling fractions or refinery residues under high pressure and temperature causes a breakdown of large molecules of oil into fragments of smaller size, yielding petrol to the extent of 60 per cent of the oil used. Further improvements have been made by the Standard Oil Company of America and the I. G. of Germany, who by pooling their resources together, improved the quality and obtained an yield of over 100% by carrying out the cracking process in an atmosphere of hydrogen in the presence of catalysts. Large quantities of gases that are evolved in these processes are converted into high-grade petrol either by polymerisation or by alkylation. Natural gas, casing-head gas and other gases may also be used for the production of petrol by similar methods.

Development of aviation, civil and military, has made new demands regarding the quality of aviation spirit to be used. Octane number is now taken as a standard of the measurement of quality. A high octane petrol for aero-engines leads not only to increased efficiency but also to more speed, more cruising range and more load being carried in the planes. Ten years ago, an octane number of 70 was the usual standard. Before the war, this standard rose to 87, while at the present time, 100 or more octane fuel is used for aviation spirit. An increase in efficiency of about 25 per cent has been effected by improving the octane number from 87 to 100.

The new demand for quality has been met by new methods. The most important of these methods is the alkylation process supplemented by isomerisation, catalytic cracking and addition of the well-known anti-knock compound, lead tetra-ethyl. Hydro-forming of straight run or catalytically cracked naphthas and catalytic polymerisation of unsaturated

gases are also very useful methods used for the improvement of quality. Modern high-grade aviation spirit is a mixture of straight run or catalytically cracked petrol (hydroformed), alkylation products and lead tetra-ethyl. To meet with the unprecedented demand for high-grade aviation spirit, many new factories have sprung up in the course of the last 2 or 3 years. It is estimated that more than 60,000 tons of lead are consumed annually for the production of lead tetra-ethyl to be added to petrol. While the production of high-grade petrol was practically non-existent before the war, the estimated production of 100-octane fuels in U. S. A. in 1941 was 2.5 million tons and at the end of 1942, the rate of production is expected to have risen to 7 million tons per year. After the war, when the demand for aviation spirit is likely to fall sharply, this high-grade fuel will perhaps be used as motor spirit, improving greatly the efficiency and performance of automobile engines.

Another important product is lubricating oil whose importance for industrial purposes can hardly be exaggerated. All the industrial machinery would come to a standstill, if the supply of lubricating oils would completely cease. New methods have been developed for increasing the yield and improving the quality of this important material. It is said that great difficulties are being experienced in Germany in finding suitable substitutes for good lubricating oil.

Researches have also resulted in finding other important uses of petroleum. It would indeed be a reflection on the ability of scientists if no better use could be found for these vast natural resources than to burn them merely as fuel. Petroleum hydrocarbons constitute important raw materials for the chemical industry and are being converted into valuable commodities of all kinds. Alcohols, aldehydes, ketones, acids, esters, plastics, synthetic rubber, dyestuffs, disinfectants, medicinal substances and even poison gases are now obtained from petroleum. It is said that since the discovery of synthetic ammonia by Haber, the most important discovery has been the manufacture of glycerine from petroleum. Novocaine of dentists, glycol for cosmetics or other uses, toluene for explosives, hydroxylamines and chloropicrin of chemists, are only some of the many important chemicals that are made from petroleum. The conversion of the petroleum products, butane and butylene, into butadiene and thence to synthetic rubber is now a large-scale manufacturing process. The achievements of chemists in this field constitute a proud record.

There is considerable apprehension that this valuable raw material will soon be exhausted. Some

oil technologists estimate that the oil resources of U. S. A. are not likely to last more than a decade or so. Every attempt is, therefore, being made to extract as much oil as possible from the sandy strata which retain a large part of the oil. Every year, technologists penetrate deeper and deeper into the earth in search of oil, and oil magnates of the west are now casting their eyes on Asia, particularly on the Himalayan regions, where occurrence of large quantities of unexplored oil is suspected.

Germany and other countries, which do not possess any substantial deposit of petroleum, refuse to remain at the mercy of Nature for the supply of this important material, important not only for war but also for modern civilisation. Processes have been developed for the conversion of coal into oil. It is believed that about 30 factories are now operating in Germany, producing over 4 million tons of synthetic oil from coal—the biggest factory situated near Stettin is reported to have a capacity to produce 400,000 tons of oil per annum. Similar plants are also working in Billingham in England though with a considerably smaller capacity. U.S.A., which is so rich in mineral oil, does not feel the necessity of synthetic oil. Large-scale experiments are, however, being conducted even in that country for producing oil from coal.

Of the two processes which have proved successful, one, the Bergius process, uses high pressure and temperature and the other, Fisher-Tropsch process, uses ordinary pressure and only moderate temperature. From India's point of view this latter process is particularly interesting. Smaller units, requiring less capital and capable of being camouflaged in times of war in order to escape aerial bombing, are believed to be economically feasible; low grade coals can be utilised in this process. The two processes have been scrutinised by the Imperial Defence Committee of Great Britain, the British Labour Party and the Revette Committee of Australia on account of their importance for national welfare. Under British conditions the cost of production has been estimated at -/9/- annas per gallon. This is considerably lower than the cost of petrol in this country. It will, however, be necessary to exempt the synthetic product from excise tax, if it is to compete with petroleum whose cost of production is extremely low. India has a special advantage in the low cost of coal and perhaps of labour. In the case of such important materials, the cost of production should not, however, be the only factor to be considered. The risk of being almost entirely dependent on foreign countries for the supply of vital necessities is great. Moreover the advantages to the country in the shape of technical training such an

industry will impart on the personnel and in the employment it will provide cannot be valued in terms of money alone.

Apart from the use of synthetic oils, large quantities of substitutes are being used in Europe. Alcohol to the extent of 25 per cent and coal tar distillates are widely used in admixture with petrol. In this connection it may not be out of place to point out that India produces about a million tons of molasses, which, if converted into absolute alcohol, can be used as motor spirit. Buses and trucks are being run extensively in many European countries with producer gas and vast quantities of petrol are being saved thereby. Another important development is the use of compressed gases. The discovery of light cylinders capable of standing high pressure

has enabled natural gas, coal gas, producer gas and other gases to be used as a substitute for petrol. An interesting development is the use of sewage sludge gases for the purpose. In Germany, for example, sewage gases estimated at more than 20 million cubic feet are being compressed and used for trucks and cars—the change from petrol to gas being made by merely pressing a switch.

The contribution of the scientists in the field of petroleum and its substitutes is not a mean achievement. The progress is being maintained by constant researches and intimate co-operation between the Government and scientists. Under the stress of the war, such co-operation has also commenced in this country and, if continued after the war, is likely to achieve great results for the welfare of the people.

MEDICINE AND PUBLIC HEALTH

CHEMOTHERAPY OF TUBERCULOSIS

RECENT advances in chemotherapy have marked the beginning of a new era in medical science. Our whole idea of fighting a disease has been revolutionised, thanks to the spectacular success attending the arsphenamines and the drugs of the sulphanilamide group. To-day people falling victims to syphilis, puerperal fever, cerebro-spinal fever, lobar pneumonia and various streptococcal infections need not despair of their lives as they used to do until recently. The success of chemotherapy in various once difficult fields led the medical men to pin their hope in chemotherapy for an effective remedy for tuberculosis. The U. S. medical men have recently investigated the possibility of using 'Promine', the didextrose sulphonate of di-aminodiphenyl sulphone, a member of the sulphonamide group, as an effective chemotherapeutic agent against tuberculosis. Feldman and Hinshaw at Rochester, U. S. A., have found 'Promin' to be active against the tubercle bacillus both *in vitro* and *in vivo*. Prof. W. H. Tytler, of the Welsh National School of Medicine, Cardiff, has clearly demonstrated that 'Promine' is the most effective chemotherapeutic agent for the tuberculous guinea pigs so far examined (Thirtieth Annual Report for the year ended 31st March, 1942, of the King Edward VII Welsh National Memorial Association). The realisation of the full therapeutic effect of 'Promin' in the case of human beings has been limited by the fact that the high continued dosage required unfortunately proves toxic. This

does not, however, constitute a serious difficulty as there is every possibility of combining the administration of the drug with that of an antigenic serum, or of reducing the toxicity by some suitable modification of the formula itself. Already its local application to superficial tuberculous lesions has met with considerable success.

MEDICAL SERVICE IN THE CHINESE ARMY

ACCORDING to the China Information Bulletin, congestion of people and huge casualties at places have made it a difficult problem for the Chinese Army to keep the soldiers fit. Seven hundred and fifty army medical units are working in war areas and in the rear to look after the sick and wounded and the general health of the troops. A total of 35,000 persons are estimated to have enlisted with the army medical service. Their qualities are being improved from time to time by the Emergency Medical Service Training School and its branches which, together with the Army Medical College, also train new personnel.

The army medical service is maintained by four organizations. Though under separate command they run as the component parts of one integral administration, each having its specific duties. The organisations come under the armies, the medical department of the Board of Transport and Supplies of the National Military Council, the Army Medical Administration and the Central Wounded Soldiers Administration of the Ministry of War.

Army medical units serve at the front, clearing the combat zone, rendering first aid and emergency treatment, and evacuating the casualties to collecting and dressing stations and the divisional field hospital.

The medical department of the Board of Transport and Supplies receives wounded soldiers from army medical units, takes care of them while in transit and transports them to army hospitals in the rear. Under its direction are receiving stations and field hospitals which are organized by the Army Medical Administration and assigned to the medical department along lines of communication. For the transportation of the wounded, the medical department has at its disposal stretcher-bearer units, motor ambulances, hospital trains and hospital boats.

Besides organizing receiving stations and field hospitals, the Army Medical Administration maintains base hospitals in the rear, surgical hospitals and hospitals for special cases.

Cured soldiers are sent to the convalescent hostels organized by the Central Wounded Soldiers Administration.

A NEW INDUSTRIAL DISEASE

HUNDREDS of workers handling a very low grade of dusty, stained cotton in cotton mills, rural mattress-making centres, upholstering plants and cotton-seed processing plants are from time to time reported to have contracted a peculiar illness for which no satisfactory explanation was forthcoming until recently. The illness starts suddenly within one to six hours after exposure to cotton dust, and the acute phase

continues for 24 to 72 hours. Irritation of the eyelids, pain under the breast-bone, dryness of the throat, generalised aches, fatigue, head ache, cough, chills, fever, loss of appetite, nausea and vomiting are some of the principal symptoms. The illness, except for its greater severity, closely resembles mill fever, Monday fever and gin fever in cotton mill workers, heckling fever, grain fever, and hemp fever reported in workers inhaling flax, jute, grain and hemp dust respectively.

It was previously thought that the illness could be attributed to some poison gases, fungi, insecticides or chemically extractable substances. Peculiarly enough the samples of cotton incriminated in outbreaks were found to contain none. Recently at a meeting of the American Public Health Association in St. Louis, according to a note in the *Science News Letter*, Roy Schneider, Dr Paul A. Neal and Miss Barbara H. Caminita, of the U. S. National Institute of Health, reported that a rod-shaped bacterium was found in large numbers in the incriminated cotton, but not in high-grade cotton or in the soil in which some of the cotton had grown. It has been found from experiment that the same type of disabling illness can be developed in human beings by inhalation of (1) dust from normal cotton contaminated with this 'cotton bacterium', (2) dust from stained cotton containing a high incidence of the same bacterium and (3) a fine rust of sterile filtrate from cultures of this micro-organism. Further investigations on this problem in co-operation with the U. S. Department of Agriculture are in progress.

SUPPLY OF DRUGS AND MEDICINES FOR THE CIVIL POPULATION

H. GHOSH

STANDARD PHARMACEUTICAL WORKS LTD., CALCUTTA

DURING the last year India has been experiencing a serious shortage of essential drugs and medicines. In villages quinine, emetine, a few important tinctures, ampoules and extracts and a few chemicals such as sodi-bicarb, potassium citrate are all that are prescribed for the treatment of common ailments among the poor population of India. Quinine and emetine are both rare drugs now and the manufacture of common tinctures and extracts has also been restricted due to the shortage of alcohol. The price of chemicals commonly used in the preparation of medicines has gone up by several times the pre-war price. The charitable institutions, whether under private control or under local self-

governing bodies, such as, Municipalities and District Boards, or under Government management, have got a certain grant or income with which they have been dispensing medicines to patients. Due to the rise in prices or to the unavailability of medicines, the patients are now getting an apology for treatment.

This is the state of affairs as regards medicine supply of the civil population of India during war. The healthy individuals are becoming diseased for want of adequate food and the diseased ones cannot get medicine for their treatment. The problem of medicine supply is perhaps more complex than food supply because the latter may be grown in the country by enlarging the scope of cultivation, where-

as almost all the chemicals used in the manufacture of medicines have to be imported from outside. The State authorities never encouraged the growth of pharmaceutical industries in India in peace time. In spite of all odds, the pharmaceutical industries began to develop during the last two decades, mostly using imported chemicals and raw materials. The manufacture of chemicals used in medicines depends entirely on the basic chemical industry which supplies solvents, reagents and raw materials. Unfortunately there is practically no basic chemical industry in this country. During this war whatever small-scale basic industry has developed, the existing chemical or pharmaceutical concerns derive little benefit from them because most of these basic chemicals have been requisitioned for war production. Moreover, no permit for the import of basic chemicals or reagents is issued unless a firm is engaged in war production. In other words, the authorities are not giving due consideration to the need of supplying medicines for the civil population.

Malaria takes a terrific toll of human life in India. Before the war, it was, however, just partially kept in check by adequate supplies of quinine. During the last six months, medical men as well as the victims of malaria have been experiencing an acute shortage of quinine. The pre-war price of one pound of quinine sulphate was Rs. 18/8/-, but it is now selling, if available, at Rs. 175/- or more a pound, though the Government-controlled price is Rs. 38/- per lb. A few months ago the Central Government issued an official communiqué stating that there were sufficient stocks of quinine available to meet the requirements of the population for another two years. Where is that quinine? Why are the malaria-stricken people unable to get quinine? There is unfortunately no answer to this question. During the last 12 years, several schemes were formulated to increase the production of quinine in India. India's requirements of quinine were estimated at 4,00,000 pounds yearly, whereas only 75,000 pounds were manufactured in this country at the two factories of Bengal and Madras. The rest of the quinine used was imported from Java. Now that the import from Java has stopped, the malaria-stricken people are at the mercy of God.

Of the different basic chemicals, sulphuric acid was the only product which was being manufactured on a small scale in India. There are no alkali products; no phosphoric acid; no citric, acetic or tartaric acid; no volatile products of coal distillation, most of them being important reagents and solvents for the manufacture of chemicals for pharmaceutical use and for the preparation of chemo-therapeutic drugs. But in spite of huge resources of coal in this country such an important industry has remained

absolutely undeveloped. Stacks of coal are burnt in the open for the production of coke and the important volatile products are wasted. Two or three concerns have come into being after the war started, which began to distil coal. But these coal distillation products are scarcely available to the manufacturing pharmaceutical chemists as these have been mostly requisitioned by the Government for war production.

Sulphanilamide and its various compounds are important chemo-therapeutic drugs used by medical men in their everyday practice. But for want of chlorosulphonic acid which is not available in this country, their manufacture has had to be stopped while the import of sulphanilamide has been extremely limited.

Lately the Pharmaceutical Manufacturers have been experiencing severe shortage of alcohol for the preparation of spirituous pharmacopoeal products such as tinctures, extracts, liniments, etc. In hospitals and charitable dispensaries it is these pharmacopoeal preparations which are mostly used. If there be a scarcity of alcohol for pharmaceutical preparations, people will have to go without any medicines whatsoever.

Ipecacuanha and its active principle, emetine, are two very important drugs which are used extensively in this country and emetine is regarded as the best specific for amoebic infection and for various liver disorders. But ipecacuanha is not indigenous to India. Some attempts were made to grow ipecacuanha in this country and though encouraging results were obtained to grow the best Brazilian variety in India, the experiment was not continued. An ounce of emetine used to cost Rs. 28/- to Rs. 30/- before the war. Its price is now about Rs. 250/-, if available at all.

In the domain of chemo-therapeutic drugs very little progress could be made because of the unavailability of one or more of the reagents or basic chemicals.

The irony of the situation is that the resources of the country in coal, wood, aluminum, iron, copper, iron pyrites, manganese, chromium and most of the vegetable drugs are enormous.

After three years of war, India cannot yet produce its ammonia. A little is produced in Mysore now. The Tata Chemicals have been working hard to produce alkali products which probably will replace one of the greatest wants of drug industry.

Self-sufficiency of India in the supply of medicines depends mostly, if not entirely, on the development of basic chemical industries. Foreign vested interests worked up to this time against the development in India of basic chemical industry, such as coal distillation, wood distillation, manufacture of acetig

tartaric, phosphoric acids, ammonia and other alkali products. Even after more than 3 years of war there is little indication of any real development of basic chemical industry in this country. Basic chemical industry involves a huge lay-out of capital, plenty of experts, and a desire on the part of the State to encourage the growth of such industry.

The anxieties of the Medical Supply Departments of the Government for finding medicines for war purposes as well as the worries of the civil population would have been allayed, if a realistic view of the problem had been taken, and planned measures for a comprehensive basic chemical and drug industry were undertaken. In spite of a large share of the excess profits tax going to the Government coffers, there are many capitalists in this country to-day who can raise the necessary capital for starting large-scale basic chemical industries, provided they can depend on Government help in importing machinery, etc.

The Board of Industrial and Scientific Research, started about two years ago, is an excellent beginning but its scope of work has been made very limited due to its lack of collaboration with the existing chemical and pharmaceutical industries in India. Successful results of laboratory experiments cannot often be utilized by the industry, because the difficulties of large-scale production cannot precisely be

forestalled by research work carried out in the laboratory. If research work could be carried out actually in the laboratories of the manufacturing concerns with collaboration between the experts of the Board of Industrial and Scientific Research and the experts of the manufacturing concerns, the results would be undoubtedly much more productive.

There are still stocks of essential drugs held by profiteers. As for food so also for medicines, these should be seized by the Government and distributed to the people through *bona fide* dealers and manufacturers. The price control of medicines should be made systematically rigid. The control of price of medicine can be best effected if the collaboration of the medical men is sought.

The time has come when a well-prepared plan for drug as well as food supply for the civil population should be adopted. The want of this planning is vitally affecting the health of millions of our countrymen and the effect of malnutrition coupled with the lack of facility of treatment of diseases owing to scarcity of drugs will, we are afraid, leave disastrous results on future generations for a long time to come. If the Government has only the will to do it, the situation can, to a considerable extent, be remedied.

BOOK REVIEWS

Soil Conditions and Plant Growth—By SIR E. JOHN RUSSELL, D.Sc., F.R.S. Seventh Edition (1937), Longmans, Green & Co. (Reprinted by the Novographic Process, 1942).

To students of soil science and agriculturists in general, 'Soil Conditions and Plant Growth' by Sir E. John Russell, D.Sc., F.R.S., Director of the Rothamsted Experimental Station, is an invaluable text book and a reference book. This is one of the few comprehensive treatises of its kind.

The book begins with an interesting historical chapter on the development of agricultural science. The earliest period consists in the search for the principle of vegetation (1630-1760). The second period is the search for plant nutrients, and has been subdivided into two periods, *viz.*, the phlogistic period (1750-1800) and the modern period (1800-1860). The third and the last period originated from the Russian investigators Dokuchayev, Glinka, Polynov and others who stressed the necessity of studying the physico-chemical properties of soils on profile basis.

The second chapter deals with the six soil factors which profoundly affect the growth of plants, *viz.*, water supply, air supply, temperature, supply of plant nutrients, various injurious factors and depth of soil. The effects of water supply and of various nutrients on the growth of the plants, specially with reference to field experiments, have been discussed and a critical review of the work done so far, on this line, has been given.

The third chapter deals with the composition of the soil with special reference to the four principal constituents, *viz.*, (i) mineral matter derived from the rocks; (ii) calcium carbonate and phosphate, and some resistant organic matter; (iii) residues of plants; and (iv) soil water. Special attention has also been given in the third chapter to the modern conceptions of the constitution of clay fraction of the soil. The effects of various exchangeable ions on the properties of the soil have been discussed in the light of recent experiments and the influences of various

artificial fertilisers on the properties of the soil and on plant growth have been critically reviewed.

The fourth chapter deals with the changes in the mineral composition of the soil, due to organic matter, to rain and river water and to climatic factors. In this chapter, the chief features of the main soil groups of the world have been discussed in relation to the changes in the soil-forming processes in different parts of the world, e.g., podzols, rendzina, terra-rossa etc.

Chapter V deals with the changes in the nature of the organic matter of the soil, specially the changes which are effected through the agency of micro-organisms. Chapter VI deals with all types of micro-organisms in the soil including the algae, fungi, actinomycetes, bacteria, protozoa and the soil insects. Chapter VII gives a review of the recent works on the influences of soil air, soil water and soil reaction on the growth of plants, whilst chapter VIII deals with soil fertility in nature and in farm practice and includes a critical review of the influences of the water supply, food supply, soil reaction, depth of soil and permanence of soil layer on soil fertility.

The literature in agricultural science is vast and is increasing in volume every month. The book however, has been kept within limited size, since, as Sir John has stated in the preface, "it is intended to be read and not merely consulted like a dictionary". In the present treatise, therefore, only the broad outlines of different subjects of agricultural science have been discussed. Fresh materials have, however, all been included, as also sufficient details in each case to give reality to the treatments. At the end there is an extensive bibliography on agricultural science which should prove very valuable to all soil workers.

A fresh edition of this book incorporating all the more recent developments in agricultural science will be very much appreciated and welcomed.

S. P. R. C.

Psychological Determination in the Choice of Vocation—By MR SOROJENDRA NATH ROY, M.Sc. Published by the Calcutta University.

The author richly deserves congratulation for his attempt on a scientific line to find out the psychological and other factors that play an important part in determining our choice of vocation. The right choice of vocation is a problem which cannot be evaded. It presents itself to us with all its seriousness in our daily life when we find so many misfits in their chosen vocation, a situation, deplorable both from the point of view of the individual subject and

from that of the nation as a whole. The author can justly claim that "the work is original". Such a type of work has never been attempted before in India. In this connection we cannot but refer to the difficulties he had to overcome in his investigation. He had to devise the materials for his investigation and had to carry on his investigation practically without any guidance. The importance of the work lies also in the fact that it will serve as a guide to those who will take up the problem in future for investigation, and supply them with certain "basic materials". The present investigation has been confined to successful men of three vocations only, and the author has been in a position to present before us certain interesting facts specially the innate and acquired tendencies constituting the dominant characteristics of successful men of those vocations.

But in view of the fact that the persons examined in each vocation are extremely few in number, it seems rather difficult to accept his conclusions with regard to the dominant traits that determine success in different vocations. Moreover, objective determination of these traits at a period when the decision is practically made as regards the choice of vocation seems to be impossible in many cases, as some of them may be altogether absent or many remain latent. As our instincts may be suppressed or modified in various ways and as some of them may be delayed in their manifestations for want of favourable circumstances, it cannot be argued that the tendencies revealed from the answers elicited, were in a manifest condition from the very infancy. During the period when decision was made with regard to the course of studies etc. that ultimately determined the choice of career in most cases, those instinctive tendencies might have remained dormant, so much so that for all practical purposes they might be regarded as absent. So to decide a career by reference to one's instinctive tendencies seems to be rather impracticable. It would, however, be interesting to analyse a large number of cases in order to investigate if a high degree of correlation is at all achieved and in that connection it would also be desirable to test for negative correlation in cases of men unsuccessful in their professions.

As the actual answers to questions have not been published in the book, the correctness of the analysis could not be judged.

S. D.

Farm Animals—Their Breeding, Growth and Inheritance—By JOHN HAMMOND, M.A., D.Sc., F.R.S., Published by Edward Arnold & Co., London, 1940—Reprinted 1941: Price 14 shillings net.

This is indeed a wonderful little book on various aspects of the scientific breeding of farm animals—

it is even more, a veritable *multum in parvo* of specialised breeding science by an authority. It carries many virtues, being at once both concise and comprehensive; simple but vividly clear in exposition, and so compiled as to meet many of the needs and to solve numerous difficulties of almost everyday life on the average breeding of stock farm. Where progress reigns, this book must find its proper level, for it is written in two parts to suit the solving of a wide range of practical problems previously left unexplored and unexplained to all but the modern student of Zoology and applied Animal Husbandry. Traditional methods and rule-of-thumb omniscience are exposed, but only for the purpose of clearing the decks for action against impediments to scientific progress on the farm—albeit, old labels which have stood the test of time and experience are embellished by such disclosures as exist here and which as facts are established beyond the realm of doubt.

A casual dip into this small 200 page treasure of information on animals, reveals amongst many other anomalies of breeding practice, that horse breeding (a very important coming industry in India) in the Tropics and sub-Tropics of the Northern Hemisphere, is, on general tendencies at least, in a position to take advantage of two heat-periods in the mare—April and May and again October-November; but although meteorologically and even biologically correct, this apparent asset to Indian horse breeding must be taken at its face value, which is in effect, that the "Spring oestrus or heat" must still be considered the period par excellence for breeding operations in horses; as obviously the farther north horses are bred, the more evanescent or fleeting are such autumnal heat periods liable to be; a state of affairs which probably accounts for the reported high percentage of sterility in mares which follows autumnal breeding, on the stud farms of Northern India. As a consequence, it would seem there is little to recommend the more recently promoted idea of confining breeding from mares in India, only and solely during the October-November heat periods. This is all the more to be emphasised by the fact that the suggestion has most probably been based on the analogy of the most prolific breeding season in mares in countries like Australia and New Zealand of the

Southern Hemisphere, where their Spring is our Autumn in India. However, such controversial cross-lights are all the better for being projected on a scientific screen such as this book forms; for in this way only, can most of our doubts be clarified and our many convictions modified when so exposed to sober thought.

Sterility, that bane and thorn in the flesh of the average breeder,—a veritable Pandora's box—receives just attention, and although necessarily a vaster subject than can be dealt with adequately in any compressed treatise such as this under review, the remedial measures indicated are most valuable. In this respect and for other reasons, artificial insemination is given due space, but how far, if to any length comparatively speaking, such operations can be applied in India in the near future is still very obscure.

The only disappointment the writer has encountered in reviewing this book, is that no mention has been made of the part played or at least liable to be played by Vitamin C in sex relations. This Vitamin (ascorbic acid) is to a great extent still lying dormant, so to speak, in breeding activities, although it has been recently recorded from America as of great value in the treatment of impotency in Breeding Bulls. Its importance to the sex-cycle is proved to our mind, by its existence in greatest quantity in the animal body in the Anterior Pituitary, Corpus Luteum and Adrenal Cortex. The significance of this proximate preponderance of Vitamin C to these all important sex-related glands of internal secretion is outstanding, a conclusion confirmed by us in practice and to a great extent by the reference in the text of this book (p. 42) to the beneficial effects to sexual efficiency from the feeding of sprouted oats—(the germination of all grains produces Vitamin C in quantity).

But apart from such a minor omission, this vademecum of breeding information must surely appeal to all concerned with farm animals, and in fact, should find its niche of reference on the book-shelves of all workers in Veterinary Science and Biology.

A. D. M.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

CONTROLLING FRUIT SCAB OF PUMELO, CITRUS GRANDIS OSBECK (=C. DECUMANA LINN)

While much is known about the diseases including their control measures, affecting citruses cultivated in Western countries, our knowledge is limited about the precise nature of the diseases visiting the citruses that are indigenously grown in this country. Pumelo also known as shaddock in English, 'Batavi-Lebu' in Bengali and *Citrus grandis* Osbeck (=C. *decumana* Linn.) in scientific literature, is such a fruit about whose diseases we know not exhaustively.

Scab is reported on "pumeloes". In foreign literatures (mycological) "pumeloes" mean both "the thick skinned pumeloes usually known as shaddocks and the thinner skinned, commercially grown forms known as grape fruits" and sometimes more wide to include "most of the forms of this species and is

the term pumelo is used in the latter sense in this paper (i.e., to mean only the shaddock variety).

Mild infections due to *Sphaceloma fawcettii*¹ Jenkins on pumelo fruits are observed sporadically in Bengal but the disease broke out in very severe form this year in the plantations of the horticultural garden attached to this section. The attack was so virulent and rapid that within a few days all the fruits were heavily infected and not a single plant could escape from it. The infection or the disease was characterised by the production of slightly raised, corky, irregular lesions or warts, rusty in colour, over a small or considerable surface of the fruit. The individual warts were small, usually ran together to form patches or scabs with irregular surfaces. Sometimes droplets of gum exuded over such regions. When the infection was severe the fruits



FIG. 1. Pumeloes attacked with Scab diseases.

a convenient name for all the varieties as a whole". So it is evident that there is no authentic report of its occurrence particularly on shaddock type pumelo. Since there is a growing tendency in recent years to retain the term 'grape fruit' for the thinner skinned variety and 'pumelo' for the thick skinned variety,

became slightly deformed due to unequal growth. The fruit remained susceptible to attack from its setting up to the time it grew to 3½ inches in diameter.

As mentioned earlier, the infection was so severe that it was thought advisable to pick up the fruits

and destroy them. But ultimately it was decided that a last attempt be made to see if the infection could be controlled and fruits revived by the application of any fungicidal sprays. Accordingly Bordeaux mixture (5-5-100) with 5 per cent resin was sprayed thoroughly over the fruits and the entire tree.

It was interesting to note that within a few days further progress of the disease was checked and growth soon revived. A second spray was given after a fortnight and it was now observed that the fruits were growing to normal size and the warty lesions beginning to show signs of flaking off. Bordeaux mixture with 5 per cent resin is thus being proved to be a positive fungicide against the scab of pumelo.

Our thanks are due to Dr S. Hedayetullah, Economic Botanist, Bengal, for his constant interest in the work.

P. C. KAR
J. C. SAHA
Section of the Economic Botanist,
Agricultural Research Station,
Dacca, 30-1-1943.

¹ Fawcett, Howard. S.; Citrus Diseases and their control. London. 1936.

ON THE PRESENCE OF PHOSPHORUS IN THE SOLAR ATMOSPHERE

The author has described experiments which have led to the analysis of the band spectrum of phosphorus in the region about λ2800 and the determination of the nuclear spin of the P₂ molecule. In continuation of this work, it was thought worthwhile to search for the possible presence of the molecule of phosphorus in the solar atmosphere. It is known that a large proportion of faint solar lines (i.e., those having intensities 1 to -3 on the Rowland scale) is still unidentified and that many of these lines must be of molecular origin.

The P₂ molecule has an extensive band spectrum from λ3500 to λ1900 corresponding to a Σ-Σ transition. No doubt, most of the strong bands fall in the region beyond λ2800 and hence are of no astrophysical importance. But the (8,27) and the (9,28) bands which lie in the near ultraviolet and which are no less strong than those that are lying in the far ultraviolet permit a study of the presence of the molecule of phosphorus in the solar atmosphere.

These bands have been photographed by Ashley¹ in the second order of a 21-foot concave grating.

The wavelengths of all the lines in the two bands are compared with those of the Fraunhofer lines in the solar spectrum. Differences of not more than 0.04 Å between the laboratory measurements and the solar wavelengths have been reckoned as coincidences. The wavelengths of the Fraunhofer lines are taken from the revised Rowland tables. The coincidences expected from chance are calculated using the formula of Russell and Bowen²,

C=N(1-e^{-2Mx/I})

where 'N' is the number of solar lines in the wavelength interval 'I', M is the number of lines being investigated for coincidence in the interval 'I' and 'x' is the size of coincidence in Angstrom units. Attention has been paid to possible systematic differences, the numbers of coincidences being determined within 0.01, from 0.01 to 0.02, 0.02 to 0.03 and 0.03 to 0.04 Angstrom units. The results obtained are summed up in tables 1 and 2 given below.

TABLE 1.

	8,27 band	9,28 band
Total number of lines in the P ₂ spectrum.	100	93
Observed coincidences (with previously identified and unidentified lines in the solar spectrum).	67	66
Observed coincidences with previously unidentified lines.	44	45
Number of coincidences from chance.	49	47

TABLE 2.

Band (v', v'')	Size of coincidence in Angstroms	Number of chance coincidences	Number of observed coincidences
8,27	0.01	14	19
	0.01-0.02	13	14
	0.02-0.03	12	14
	0.03-0.04	10	20
9,28	0.01	14	27
	0.01-0.02	12	12
	0.02-0.03	11	13
	0.03-0.04	10	14

From the tables it is seen that in all the cases the number of observed coincidences is more in excess of that expected by chance. Also, it is seen that about 66% of the observed coincidences are

with lines previously unidentified. And a large majority of the lines coincide with faint solar lines.

These considerations show that with the data at present available, we can conclude that the molecule of phosphorus exists in the sun.

This conclusion is supported from physical considerations as well. The P_2 molecule is stable enough for the temperature existing in the solar atmosphere, as its heat of dissociation is 5.1 volts.

The detailed results will be published elsewhere.

K. NARAHARI RAO

Solar Physics Observatory,
Kodaikanal, 16-2-1943.

¹ Ashley—*Phy. Rev.* 44, 919, 1933.

² Russell and Bowen—*A. P. J.* 69, 196, 1929.

NOTES ON PLANT DISEASES OF NEPAL

Although lacs of rupees worth of crops are annually destroyed and localised famines are not infrequent, plant pathology had hitherto received little attention in Nepal. A preliminary survey of plant diseases has now been undertaken with a view to find out the causal organisms and the extent of damage done by each of them. A list of parasites collected during the last two years is given below.

Parasites	Hosts	Distribution
(a) Virus Diseases*		
* <i>Corinum solani</i>	<i>Datura metel</i>	Katmandu
* <i>Mamor cucumeris</i>	<i>Jaltipha curcas</i>	Gorkha
* <i>Mamor oryzae</i>	<i>Oryza sativa</i>	Sisaghat
* <i>Mamor solani</i>	<i>Datura stramonium</i>	Katmandu
(b) Bacterial Diseases		
<i>Phylomonas stewartii</i>	<i>Zea mays</i>	Nuwakot
<i>Pseudomonas brassicae</i>	<i>Brassica oleracea</i>	Katmandu
(c) Fungus Diseases		
<i>Albugo candida</i> ?	<i>Brassica nigra</i>	
	<i>Datura stramonium</i>	Katmandu
<i>Entyloma thalictri</i>	<i>Oryza sativa</i>	Bhadowri
<i>Exoascus cerasi</i>	<i>Prunus puddum</i>	Belgong
<i>Meliola penzigi</i> ?	<i>Citrus medica</i>	
	<i>Citrus aurantium</i>	Pokhra
<i>Peronospora sordida</i>	<i>Digitalis purpurea</i>	Kharpu
<i>Phytophthora infestans</i>	<i>Solanum tuberosum</i>	Katmandu
<i>Phyllosticta cucurbitacearum</i>	<i>Cucurbita pepo</i>	Katmandu
<i>Plasmopara cubensis</i> ?	<i>Cucurbita pepo</i>	
	<i>Cucumis sativum</i>	Katmandu

Parasites	Hosts	Distribution
<i>Puccinia glumarum</i>	<i>Hordeum sativum</i>	
	<i>Avena sativa</i>	Syapru
<i>Puccinia graminis</i>	<i>Hordeum sativum</i>	
	<i>Trictum vulgare</i>	Chowtara
<i>Pythiacystis citriphora</i>	<i>Citrus medica</i>	Katmandu
<i>Tilletia foetens</i>	<i>Hordeum sativum</i>	
	<i>Trictum vulgare</i>	Chowtara
<i>Tilletia horrida</i>	<i>Oryza sativa</i>	Pokhra

* According to the classification by F. O. Holmes (1941).

Office of the Botanist to the
Govt. of Nepal,
Katmandu,
Nepal, 25-2-1943.

K. N. SHARMA

ON SOME ARTIFICIAL FIELDS AND THEIR CORRELATION FUNCTIONS

This problem arises out of the researches on Sample Surveys conducted by Professor P. C. Mahalanobis¹. The field consists of rectangular distribution of discrete points, whose locations are given by x, y , co-ordinates. Each point has a variate $z(x, y)$ associated to it and $\rho(\xi, \eta)$ is the correlation coefficient between all pairs of points separated by an interval (ξ, η) , small compared to the dimensions of the field. Mahalanobis points out that ρ is zero for a random field, and for most of the fields observed in nature ρ is positive and gradually tends to zero as ξ, η increase. To get $\rho=1$, a uniform field ($z=\text{const.}$) suggests itself as one of perfect association, but it has both the covariance and variance equal to zero, and ρ becomes indeterminate. Any random deviation, however slight, from uniformity makes ρ zero. As a variant of the uniform field, we may take a double-valued 'chequered' field, with z equal to α and β alternately ($\alpha \neq \beta$); the structure of the field will be throughout the repetition of a basic quartet of cells of sides a, b along x , and c, d along y , as may be represented by $(a+b) \times (c+d)$. In such a field we will get $\rho=+1$, along with other values, all of which are repeated periodically. The periods (or strictly wave-lengths) are $a+b$ along x and $c+d$ along y , the same as those in the field itself. If $a=b$, or $c=d$, ρ will assume all possible values from $+1$ to -1 , the latter being separated from the former by half a wave-length. If any one of a, b, c or d becomes equal to the corresponding side of the field, the periodicity becomes uni-dimensional. To have $\rho=+1$ for all values of ξ, η however, we may construct fields of the type: (1) $z=k+\alpha x+\beta y$, or (2) $z=k+\alpha^2\beta^2$, or (3) $z=k+\alpha^2\beta^2+L$, all the symbols excepting x, y, z being constants of the field. For (2) or (3), α and β are both positive; otherwise ρ will have real as well as imaginary values of z , and

moreover ρ will be $+1$ and -1 alternately. Number (1) is an 'Arithmetic Progression' field, where $z(x+\xi, y+\eta)=A+z(x, y)$, (2) is a 'Geometric Progression' field where $z(x+\xi, y+\eta)=B.z(x, y)$, and (3) is an 'A.P.G.P.-combined' field where $z(x+\xi, y+\eta)=C+D.z(x, y)$, A, B, C, D being functions of ξ, η and the constants, and independent of x, y . No field is possible with ρ negative for all values of ξ, η ; any negative values must alternate with positive values. A general class of such fields are approximately of the 'chequered' pattern, with some random variation inside each cell. If we take a Simple Harmonic field with wave-lengths λ, μ along x, y , for example, $z=\alpha+\beta \cos\left(\frac{2\pi x}{\lambda}+\theta\right) \cos\left(\frac{2\pi y}{\mu}+\phi\right)$, it can be shown that $\rho=\cos\left(\frac{2\pi \xi}{\lambda}\right) \cos\left(\frac{2\pi \eta}{\mu}\right)$, having all values from $+1$ to -1 in a Simple Harmonic way with the same wave-lengths. If we add to the Simple Harmonic z above, a random component with mean m and variance σ^2 , ρ will be reduced in the ratio of $1+\frac{4\sigma^2}{\alpha^2}$ to 1.

These arguments can be extended to three or more dimensions, the field in the latter case not existing in actual space, but in some representative space. Further work on these lines is in progress. My thanks are due to S. N. Roy for his kind interest.

BIRENDRANATH GHOSH

Statistical Laboratory,
Calcutta, 1-3-1943.

¹ Presidential Address to the Mathematics and Statistics Section of the Indian Science Congress, Baroda, 1942.

PRESSURE VARIATION OF PITCH OF A FLUTE PIPE

The pitch of a note generated in a flute or organ pipe varies with wind pressure in two distinct ways. It is well known that above a critical pressure, depending on size and construction of the instrument, the pitch jumps off to the next higher octave. The other variation, which is small but quite important, is the small variation of pitch due to wind pressure at a particular stop in a given octave. Helmholtz observed similar pressure variation of pitch of organ pipes¹, but the variation was found to be exceedingly small, which can possibly be accounted for by lower notes and wider bore of such pipes.

In the present experiment the flute was excited by compressed air controlled by valve cocks. The blowing pressures were noted in a water-manometer and the variation of pitch was compared on the string of a small sonometer designed for the purpose. This 14 mm. bore flute pipe of approximate

fundamental frequency B 500 cycles per sec., shows total variation in $\frac{\Delta N}{N}$ of about 0.046, 0.059, 0.069 and 0.118 at B, E, B' and E' respectively, where N represents the mean frequency at any stop. Expressed in terms of a tone the total variations amount to about 0.37, 0.48, 0.55 and 0.95 of a tone at these stops.

The curves show that the total extent of variation is smaller at lower notes and larger for higher ones. The pressure rate variation (dN/dP) about

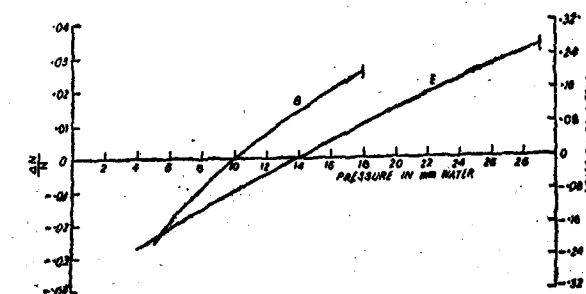


FIG. 1. Pressure variation of pitch for the stops B and E. The upper ends terminate abruptly indicating octave transition at higher pressures.

their mean blowing pressures is higher for lower notes, and vice versa. The values are 0.4% rise of pitch or frequency for 1 mm. rise of pressure (water manometer) for B, 0.25% per mm. for E, and 0.2% and 0.1% per mm. for B' and E' respectively. The

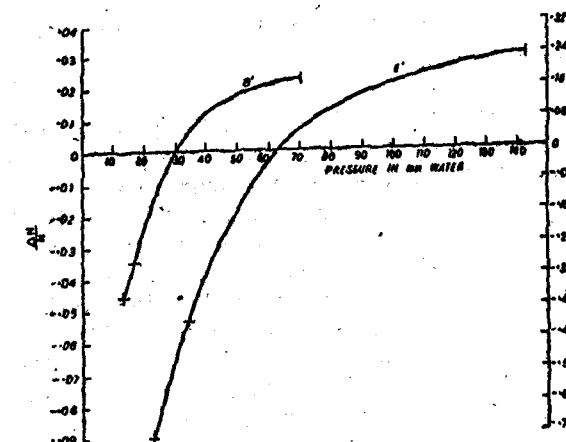


FIG. 2. Pressure variation of pitch for B' and E'. The upper limits indicate octave transition to the next higher. The horizontal marks at the lower portions give the critical excitation of these octaves, while the crosses are the limits down to which they can be maintained after excitation.

rate of variation for any stop, however, falls at higher pressures, and beyond a critical pressure the pitch doubles itself abruptly to its next octave (e.g., at

18 mm., B jumps off to B'). The upper end of the curves are therefore cut off abruptly.

It is also interesting to note that once a higher octave has been excited across a critical pressure, it can be maintained at a pressure much below the excitation pressure. For instance, B' is excited at 18 mm. water pressure while it can be maintained down to 13 mm. Similarly E', B'' and E'' are just excited at 30, 70 and 144 mm. but after they are excited the pressure can be lowered down to 22, 36 and 68 mm. respectively. This extends the total range of variation of pitch still further for upper octaves. In fig. 2, the horizontal mark shows the critical excitation of the octave, while the cross mark shows the limit down to which it can be maintained after excitation.

The importance of this small variation of pitch with pressure lies both in standardization of the instruments which must be done at a mean standard pressure, and for the part of the performer, on the other hand, care should be taken to maintain the standard pressure as far as possible. It is usually observed that during a performance the pitch tends to rise and go off the tune owing to the usual tendency of rise in the blowing pressure. Similar rise in vocal notes during a performance has also been noticed. Even in the voices of trained musicians a rise of about 2 vibrations at the international A 440 cy/sec. (hence $\Delta N/N = 0.0045$) has been noted.² It should be pointed out here that the average limit of pitch discrimination is about $\frac{\Delta N}{N} = 0.003$, as observed by Knudsen.³

The other important effect of the pressure variation of the pitch of a flute pipe is the production of vibrato which is extremely important from the standpoint of an artistic performance. Vibrato is the periodic fluctuation (about six times per second) of pitch and intensity on a sustained note. It has been observed by H. Seashore⁴ that the pitch variation for a vocal music varies through a total width of $\frac{1}{2}$ tone, and A. M. Small⁵ observed that violin vibrato gives a width of total variation of about $\frac{1}{4}$ tone. The present determination of the variation of flute pitch shows that the extent of pitch vibrato in flute, generated by the usual method of puffy blowing through it, would give a width of about $\frac{1}{3}$ tone at the lower octave, and about $\frac{1}{2}$ tone at the higher octave which usually plays very bright.

Details of the work will be published elsewhere.

My thanks are due to Prof. M. N. Saha, D.Sc., F.R.S. for his kindly providing all facilities of the

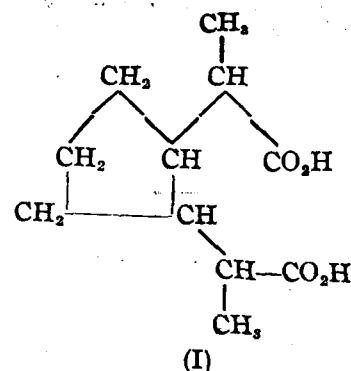
laboratory to carry on the experimental determinations.

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- ¹ Helmholtz—Sensation of Tone, p. 89. Second Eng. Ed. by A. J. Ellis.
² E. G. Richardson—Reports on Progress in Physics, 7, 27, 1940.
³ V. O. Knudsen—Phys. Rev. 21, 84, 1923
⁴ H. Seashore—Univ. Iowa Studies in Psychology of Music, 4, 12, 1935.
⁵ A. M. Small—Univ. Iowa Studies in Psychology of Music, 4, 172, 1937.
(For general discussion on 4 and 5, see Psychology of Music, Chap. 4—Carl E. Seashore (McGraw-Hill, 1938).)

SYNTHETICAL EXPERIMENTS IN THE DEGRADATION PRODUCTS OF VETIVONE

Vetivone is the odoriferous constituent of the oil of vetiver¹. Pfau and Plattner² obtained the dicarboxylic acid (I) from vetivone, the sesquiterpene ketone, by a series of degradative reactions.



The diethyl ester of the acid (I) was synthesised by the following method.

Ethyl- α -crotonate was condensed with ethyl-cyclopentanone-2-carboxylate in presence of potassium ethoxide (a definite fraction of a mole) cooled in a freezing mixture when ethyl cyclopentanone-2-(ethyl- β -n-butyrate)-2-carboxylate, b.p. 158–160°/5 mm. (semi-carbazone M.P. 112–115°) was obtained. It was hydrolysed with concentrated hydrochloric acid to give a hygroscopic acid, cyclopentanone-2- β -n-butyric acid, b.p. 154°/4 mm. The ester of the above keto-acid, b.p. 117°/4 mm. (semi-carbazone M.P. 138–140°) on being reacted with ethyl- α -bromopropionate and activated zinc furnished the δ -lactone of cyclopentane-1-(ethyl- β -propionate)-1-hydroxy-2- β -n-butyric acid, b.p. 160°/4.5 mm.

This lactone is insoluble in ice-cold ten per cent caustic potash solution. The lactone ring was then opened up with phosphorous pentabromide and ethanol. The resulting bromo-ester was refluxed with alcoholic caustic potash solution and the unsaturated acid thus obtained was esterified when the diethyl ester boiled at 158°/6.5 mm. The unsaturated ester on catalytic hydrogenation yielded the diethyl ester of the acid (I) b.p. 160°/9 mm.

My thanks are due to Prof. P. C. Mitter for his advice and encouragement during the course of the investigations.

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- ¹ Pfau and Plattner, Helv. Chim. Acta., 22, 640, 1939.
² Ibid., 23, 768, 1940.

FURTHER SCIENTIFIC STUDIES ON THE NEW ANTI-DIABETIC PRINCIPLE OCCURRING IN NATURE

Physiological significance of a new antidiabetic compound isolated from the plant kingdom, was reported¹ in this journal. It was suggested that deficiency of this type of compound caused disturbed metabolism within the system bringing about in the long run symptoms of hyperglycemia and glycosuria accompanied with other ailments.

This compound was, for the first time, isolated by the author from *Scoparia dulcis*, Linn., about three years ago and the results of investigations stretching over the past three years, will shortly appear elsewhere in several papers based on work carried out singly by the author and in collaboration with his students S. R. Banerjee, M. K. Chakraborty and N. Chowdhury respectively. The results confirm that this compound (provisionally called antidiabetin), when used in doses of about 5 mgms. per day, not only relieves the symptoms of glycosuria but can also on prolonged use for days and weeks together, even without strict restriction of diet, reduce hyperglycemia thus bringing the percentage of blood sugar

to the normal limit, increase the R. B. C. count and can be helpful in anaemia, albuminuria, ketonuria, neuralgia, retinitis and other complicated troubles associated with diabetes mellitus. Studies have so far been made on about thirty diabetics with success. Statements of the patients countersigned by recognised medical officers also corroborated these findings.

The physiological and therapeutic importance of the compound has further been established by experiments on laboratory animals, e.g., albino rats and dogs, both by chemical and histological studies. These results along with the results of investigations on the effect of the drug on the steroid, inorganic and total phosphate, and calcium content of blood of diabetics which are nearing completion, will soon be released for publication.

Lawrence² stated recently in the preface to his well-known work 'The Diabetic Life' that studies on diabetes progressed even in spite of war but there was no new theory regarding the disease. The present line of work on the antidiabetic principle which is effective by oral administration has thrown some new light on the cause and theories regarding the so-called incurable disease, diabetes mellitus, details of which will be included in the full papers.

As the compound seems to be the specific remedy for diabetes mellitus this will henceforth be known as 'Amellin' instead of 'Antidiabetin'. Work on the constitution of the active principle is also in progress.

The author is indebted to Prof. J. K. Chowdhury for his kind interest and facilities offered and to Sir J. C. Ghosh and Prof. B. C. Guha for their kind and sympathetic advice. He is also thankful to Dr N. Gupta (Civil Surgeon) and Dr S. K. Mitra (University Medical Officer) for their encouragement in this work.

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- ¹ Nath, SCIENCE AND CULTURE, 7, 572, 1941-42.
² Lawrence, "The Diabetic Life", 12th edition, (Churchill, London, 1941.)

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

MAY, 1943

No. 11

THE THIRTIETH ANNIVERSARY OF THE UNIVERSITY COLLEGE OF SCIENCE AND TECHNOLOGY (CALCUTTA UNIVERSITY)

THE recent celebration of the Foundation Day of the University College of Science and Technology, Calcutta, will be received with much pleasure and gratification by every one interested in the progress of research and scientific activities in India. Ever since its foundation thirty years ago, the University College of Science has played a vital part in initiating a spirit of scientific research and enquiry and in promoting the cause of higher education in science in India. It will be quite fitting, therefore, to recall the story of the foundation of this institution which is increasingly becoming a significant factor in our national life. The University College of Science was essentially a product of the hectic days of the Partition of Bengal. This unpopular episode, it may be remembered, caused a wave of patriotic feeling to sweep over the length and breadth of the country and for the first time made the educated public conscious of the gross inefficiency of the educational system then prevailing to cope with modern needs. The picture of great pioneers like Sir P. C. Ray and Sir J. C. Bose, carrying on their original scientific investigations under very discouraging circumstances, was a further stimulus. Two Calcutta lawyers, Sir Taraknath Palit and Sir Rashbehari Ghose, who had risen to great eminence from the middle classes, came forward with offerings of their lives' savings, amounting to 36 lakhs of rupees, for the cause of higher scientific education and research and these endowments enabled the Calcutta University to start the University College of Science.

Experience has shown that the task of devising a suitable programme, and evolving a method of proper administration is very often more difficult than securing an endowment. Andrew Carnegie, who gave away the whole of his life's savings of 400 million dollars to the cause of education, nominated himself

to be Chairman of the Trust, and administered it in that capacity for twenty years. His explanation was that it was more difficult to spend (meaning probably spending correctly) than to earn. Those who are acquainted with the story of many Trusts in this as well as in other countries will realize the wisdom of the action of Andrew Carnegie. In India itself there have been larger endowments for education, but the results achieved have been sometimes rather disappointing, and have evoked just criticism. That such has not been the fate of Palit and Ghose Trusts must be set largely to the credit of that great educationist and man of action and vision, the late Sir Asutosh Mookerjee. Not only did he secure the trusts for the Calcutta University, but he also undertook upon himself the equally important task of devising an efficient programme of action, choosing the professors and other workers, and of administering the fund till he passed away in 1924.

A just assessment of the scientific work done in the University College of Science by the professors and other teachers may be left to a later generation. But it reflects no credit on the successors of Sir Asutosh Mookerjee, that, probably with one exception, none of them has displayed any initiative, or taken any interest in furthering the cause of scientific research in the Calcutta University. Since Sir Asutosh passed away, no new large endowments excepting one from Sir P. C. Ray, which was spontaneous have been secured for the cause of science in the Calcutta University. Let us see what has happened in other provinces. During the period 1921-1923 and subsequently, most of the other Indian Universities took advantage of the New Reforms and of the recommendations of the Sadler Commission (in the shaping of which Sir Asutosh had the largest share) to reorganize their systems of education, create new chairs devoted to research and erect modern scientific laboratories.

To take an example, the United Provinces of Agra and Oudh, which is almost the twin of Bengal in population and income, has now four teaching and residential Universities, two being official, two non-official, and one examining and affiliating University. Of these the non-official Universities of Benares and Aligarh have been almost entirely founded on public endowments; if we confine our attention to the endowments on science alone in each of these places, these will be found to far exceed those of Palit and Ghose. In the cases of official Universities of Allahabad and Lucknow, the Government of the provinces has contributed liberally for the construction of new laboratories and other educational buildings, and for the maintenance of chairs and other teaching posts. (This should not be taken to imply that the expenditure has been sufficient according to modern standards).

The United Provinces Government must have spent over five to six crores of rupees on higher University education and research within the last twenty years. The contribution of the Bengal Government during the same period will be found to be almost negligible in comparison to this amount. Other Universities of India have been recipients of large endowments for science, e.g., the Luxminarayan Endowments to the Nagpur University amounting to over forty lakhs, the gift of the Maharajah of Jeypur to the Andhra University, the gifts of the Raja Annamallai Chettiar etc., etc. The Government of H. E. H. the Nizam of Hyderabad, has, under the initiative of the late Sir Akbar Hydari, spent large amounts in building magnificent laboratories for the Osmania University and for creating a large number of chairs and research posts. In Bombay, thanks to the efforts of Sir Vithal Chandravarkar, a large department of chemical technology has been built up with a capital expenditure of over 25 lakhs of rupees, almost wholly secured from individual persons.

Ever since the last World War, there has been a world-wide movement for the State encouragement of scientific research with a view to utilizing science and scientific methods for developing the country's resources, for helping industries and agriculture in particular. In every country, new laboratories have been constructed, and funds have been provided out of the public exchequer for helping research, training research-workers, and for utilisation of the results of research. Readers of SCIENCE AND CULTURE are acquainted with the activities of the Department of Scientific and Industrial Research in the United Kingdom, of the National Research Council in the U. S. A., Japan, Canada, and above all in Soviet Russia. On account of this movement, funds on a far more liberal scale have been available for all laboratories of the world during recent years.

To give an idea of the way this movement has affected the activities of the individual laboratories, let us take the example of the Cavendish Laboratory in Cambridge, which may be taken as typical. This laboratory was founded in 1877 for imparting higher instruction in physics to the students of Cambridge and for enabling the University professors to carry on research work. The original donation was only £7,000 for building the laboratories and for equipment. The pay of the professors and the staff was met out of university funds. For over twenty-five years the laboratory received no further donation though the fame of the laboratory was spreading all over the world due to the work of the successive professors, Maxwell, Lord Rayleigh and J. J. Thomson. The latter records in his autobiography that it was only in 1905 that he could add a wing to the laboratory out of a saving of £2,000 from the laboratory grant and a gift of £5,000 which Lord Rayleigh, his predecessor in office, gave out of his Nobel Prize award. When in 1915 England discovered that on account of her neglect of science she was on the verge of a disaster, she set herself earnestly to repair the damage. The Department of Scientific and Industrial Research was founded in 1916 and it distributed a State subsidy of 1 million pounds amongst research workers in the different universities. The Cavendish Laboratory then under Lord Rutherford got a substantial part of the grant and was able to finance a large number of research schemes on the fundamental problems in atomic and nuclear physics. But the newer development in the physical sciences soon rendered the equipment absolutely out-of-date. While in the original laboratory a power supply of 10 kw. was sufficient for the whole needs, by 1930, the need grew to be 500 kw., and it is now probably far larger. The Cavendish Laboratory has further developed a number of daughter institutions for investigations on new lines, viz., the Mond Laboratory on Low Temperature research, the Nuclear Physics laboratory and the laboratory for Radio Research with a station outside the city. But the need for expansion was so great that (in 1936) Lord Rutherford was thinking of issuing a public appeal for endowments when he received, through the good offices of the then Premier, a cheque for a quarter million pounds from an automobile manufacturer.

As a matter of fact, not only the State, but the public as well in the United Kingdom have been alive to the needs of science. The Nuffield benefactions to the Oxford University amount to several million pounds, and even lesser known universities have been recipients of large endowments from the public.

In India, during recent years a number of Government organisations have grown up like the Imperial Council of Agricultural Research, the Indian Research Fund Association (for medical research), and the Board of Scientific and Industrial Research. The amount of money disbursed by these agencies is quite inadequate for the needs of the country. But, even as it is, grants from these organisations can be obtained only if the universities can show that they have got adequate scientific talent, and adequate laboratory and workshop provision. It is the task of the university concerned to provide such facilities.

The performance of the professors of the scientific subjects can be judged in the international market alone and if one has to keep abreast in research as well as in education one must have the same equipments and same tools as professors in Europe or America have got. Otherwise it is impossible for the scientific men in this country to discharge the duties which are expected of them.

We have taken advantage of the anniversary of the foundation of the College to review the present

situation and indicate the necessity for planned measures for the future. We need hardly add that we scarcely consider the present facilities available in the Science College commensurate with the needs of the times. We hope the Calcutta University authorities will be able to give their serious attention to the important question of expansion of the activities of the College and issue an appeal to the public for large donations. Within the last twenty-five years, and more particularly during the present war, the Indian industrialist has awakened to the needs of scientific research, as is evidenced from the increasing use he is making of scientific talents in the College of Science. It will be a pity if the University authorities cannot find time to take advantage of the present situation, collect funds, and lay down rules for future direction and development. Unless they do so promptly, they can hardly be said to be worthy of the heritage created by the labours of our great men Sir Asutosh Mookerjee, Sir Taraknath Palit, Sir Rashbehari Ghose, and Sir P. C. Ray, the last of whom is happily still with us.

TELEVISION PROGRESS

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(Continued from the last issue)

PROGRAMME ORGANISATION

Great care is taken in the organisation of television programmes. It is obvious that unless the programme has universal appeal as a form of home entertainment, perfection of the technical side of television will be of no avail. The programme may broadly be classified under two heads—studio broadcast and outside broadcast. The studio programmes cover wide range like drama, opera, talks and varieties. The outside broadcasts which have naturally got a great appeal consist of on-the-spot news-pick up, athletic events, pageantry etc. A mobile television unit which can move easily from place to place is employed for televising the outside scenes and relaying the vision signals to the transmitting station for broadcasting. Amongst the spectacular "actualities" picked up and transmitted at the moment of their happenings mention might be made of the view of Mr Chamberlain, the late British

Premier stepping out of the aeroplane returning from his Munich visit in 1938. In America also great interest was aroused when during the last Presidential election major rallies of the two parties—Republican and Democratic—held in Madison Square Garden, New York were broadcast. A specially interesting variation of the programme was the successful relaying of televised view of New York from an aeroplane. In addition to these cinema films consisting of news reel, cartoon, etc. are also transmitted.

RECENT DEVELOPMENTS

Large Screen Projection.—A very important line of television development is the reproduction of large screen pictures so that it may come into the cinema. The television pictures for ordinary home receivers scarcely exceed 10×12 inch being limited by the size of the fluorescent screen of the receiving cathode

ray tube. It is not possible to produce cathode ray tubes of much larger size for the risk of their collapsing due to the vacuum inside. Demonstration of a cathode ray receiver with 20 inch screen by an American firm has recently been reported. The tube has, however, not been put on the market. Investigations on various lines are being conducted to provide large screen television image and some bid fair to success.

The Fernseh A. G. in Germany developed as early as 1934 the intermediate film method of transmitting television picture for large screen projection. In this method a photographic image of the scene to be televised is first recorded on film by means of an ordinary motion picture camera. The film is developed, fixed and washed immediately after exposure and is scanned by a Nipkow disc and the vision signal transmitted by the usual television process. On the receiving side a light beam, modulated by the received signal, traces out the transmitted picture on the sensitised film which is then developed, fixed and projected by standard cinema method. In order to economise the length of the film used, continuously working intermediate film method has been developed by Fernseh A. G. A continuous endless loop of film is sensitised, dried, exposed in the cinema camera, developed, fixed and televised in proper sequence. The process continued and the exposed sensitive layer removed, the film dried, sensitised and again exposed and so on. On the receiving side there is a similar apparatus also employing an endless loop of film and repeating the corresponding processes and projecting the developed film on a large screen. The time elapsing between the occurrence of an event and projection of the image of same on to the screen at the receiving end is about two minutes.

A simple and direct method is to use a high power cathode ray tube so that the small picture on the fluorescent screen of the cathode ray tube is brilliant enough for enlarged projection. As already mentioned such device has been in use in Germany for some time with a size of the picture $3'00 \times 3'60$ metre. The R. C. A. and the N. B. C. presented in 1941 a complete programme on a 15×10 ft. screen. The voltage used in the cathode ray tube was 70,000 volts. This may be contrasted with the voltage 6000 to 7000 volts used in ordinary home type receivers.

Another method based on a novel principle is also being investigated upon and promises to yield fruitful results. The method employs a remarkable electric property of alkali halide crystals first discovered by Goldshein in 1890 and recently investigated by Pohl. When a halide crystal, subject to an electric field, is struck by an electron, the latter

tends to travel through the crystal lattice as a free electron. The electron however is captured after some time by a positive alkali ion and a sort of loosely bound alkali atom is formed which absorbs light of the visible spectrum. The alkali atom thus produces, what is known as a colour centre. The atom however splits up after some time due to the thermal agitation of the crystal lattice, and the free electron again proceeds towards the anode and is again captured by an alkali ion producing once more a colour centre. The process is repeated until the electron reaches the metallic anode in contact with the crystal. A stream of electrons shot into the crystal thus makes itself visible as an opaque deposit proceeding inside the crystal towards the anode and disappearing there. For the purpose of television projection a small potassium chloride crystal is suitably placed in a cathode ray tube and its surface scanned by the cathode ray beam, the intensity of which is modulated according to the visual signal received. The electrons injected into the crystal produce opaque deposit of a density depending on the instantaneous intensity of the beam, and the transmitted picture is reproduced on the crystal. If now the crystal be strongly illuminated, as in the case of cinema film projection, and an image of it is thrown on the screen, the picture on the crystal will be reproduced on the screen in enlargement. It is obvious that for successful television projection the electric image produced in the crystal by the colour centres must not persist for more than one-twentyfifth of a second—the time interval between two successive frames. In other words the electrons injected must pass out of the crystal within this period. This is accomplished by regulating the temperature of the crystal, since the electron mobility inside the crystal depends upon its temperature and also by adjusting the electric field acting across the crystal.

Coloured Television:—Investigation on the production of television pictures in colour is being conducted in many countries. For obvious reasons full technical details are not available. The method generally employed is to use filters red, green and blue both at the transmitter and at the receiver. When the transmitter filter "sees" blue, for instance, control signals are sent out which actuate the blue filter at the receiver so that on the received picture blue colour is imparted in proper places. Thus, with the three colour filters acting in proper sequence, the colour, as "seen" at the transmitter, are reproduced on the receiver screen. The filters at the receiver are placed inside the cabinet and are rotated by a motor. The Columbia Broadcasting System in the U. S. A. has already introduced regular coloured television transmission. Demonstrations have also

been given by Baird in England and by Von Ardenne in Germany. It has been found that colour imparts a sense of reality and life-like quality into the picture introducing a certain perception of depth. Experts entertain high hopes for colour television and are of opinion that "if television broadcasting be launched in colour, it will be a universal medium of entertainment and instruction, occupying a position compared to the present day radio."

Transmission Lines.—The small range of television broadcasting necessarily limits the range from within which outside events may be picked up for relaying to the transmission centre for broadcasting. This is a severe handicap in the organisation of television programmes of topical events in a big country where the scene to be televised—perhaps some event of great national importance—may be at considerable distance from the broadcasting station. Several methods have been proposed and are in use to obviate this difficulty. Cinema film of the event is sometimes taken and are flown by aeroplane to the transmitting centre without delay for being broadcast. A chain of relaying stations may also be used but this is highly expensive. The method now being developed is to send over special cables the television signals of the scene to the broadcasting centre. Intensive study is being made on the design and manufacture of transmission lines which would carry the modulated ultra high frequency waves over long distances with repeaters placed at suitable intervals. The ordinary telephone lines have been found to work satisfactorily up to a distance of a few miles. For greater distances co-axial cables are used. In certain tests carried out recently in the U. S. A., successful transmission over 800 miles has been made. Long distance transmission lines have been in operation also in Germany, England and U. S. S. R. The ultimate object is to connect the centres of population with a network of transmission lines so that television signals of events occurring in any part of the country may be transmitted to the desired centres for broadcasting.

Amateur Operations.—It is well known that wireless transmission experiment is a very popular hobby all over the world. In fact in the early days of radio broadcasting it is the amateurs who accidentally discovered the extraordinarily long range of short waves with very small power. There are also amateurs keen on experimenting with television and for them small iconoscope camera and picture tubes have been placed in the market in the U. S. A. Most of the amateur work is done in 2.5 metre band.

Ultra short wave propagation phenomena.—As already mentioned the usual range of ultra short waves used in television broadcasting is 25 to 30 miles. Occasionally however the range is greatly

exceeded when the waves proceeding upward are refracted down by some abnormality in the atmospheric density variation in the troposphere. This is the case when the waves encounter a region where a cool layer of air is topped by a hot layer. The difference between the dielectric constants of the two layers is about 5×10^{-6} and the interface of the two layers can produce reflection of ultra short radio waves. For vertical incidence the reflection coefficient is very small but it may be considerable for oblique incidence. It is presumed that such temperature inversions cause ultra short waves to proceed to great distances. The tropospheric propagation phenomena of ultra short waves are being studied in many countries and it has been found that there is a close correlation between the temperature gradient of the upper part of the troposphere and abnormal range of ultra short waves.

OTHER APPLICATIONS

Besides providing televised programmes for entertainments and news, television technique has been utilised for various other purposes.

In War.—Its use in war has been recognised for a long time and at a recent convention of the American Institute of Electrical Engineers it has been proposed to equip aeroplanes with televising device, which flying high above the battle fields could transmit what they "see" to the general head quarters. The commanding general would thus have instantaneous knowledge not only about the distribution of his own troops but also those of the enemies. This knowledge would enable him to transmit appropriate orders to the front to strike any weak spot which may be developing in the enemy lines or to send reinforcements to points of his own lines where they were hard pressed. The details of the equipments and the device could not for obvious reasons be discussed publicly or published. Another possible application of television is the detection of the arrival or the presence of the enemy aircraft within a prescribed area. The method has in fact been developed to such an extent that the R.C.A. has been assigned a patent for it. The image of the approaching enemy plane is seen on the television viewer tube.

Blind landing.—Television methods have also been employed for the blind landing of aircrafts during fog or bad visibility. The pilot sees on the television screen the picture of the aerodrome and a spot of light representing his machine follows the movement of the plane in the scene. This device also has been the subject of a patent.

Coronavisser.—It is well known that solar prominences and corona can only be studied during the

brief period of total solar eclipse. Television methods have, however, been used successfully to photograph the prominences and the corona even under the full



FIG. 4. Prominences around the sun on Oct. 31, 1938 photographed at the Cook Observatory by Coronaviser (From *Bell System Technical Journal*).

glare of the sun. The basic principle of the method is simple. An image of the sun is formed by the telescope objective and its bright disc is intercepted by a mirror. The image surrounding the disc contains solar prominences and the corona but are masked by the glare produced by the light scattered by the terrestrial atmosphere. This region is "viewed" through a small pin hole rapidly rotating round the disc with a slow radial movement alternately outward and inward. The region round the sun is thus scanned in a spiral path and the light from the different regions coming through the pin-

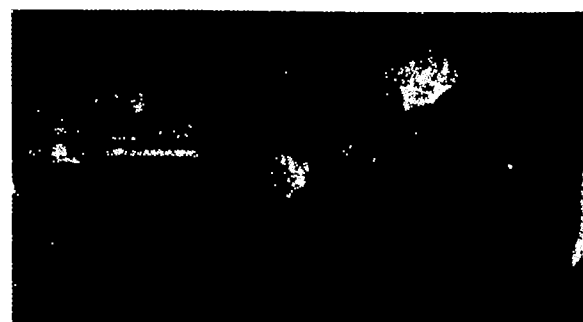


FIG. 5. The input scanner of the Coronaviser of Cook Observatory (From *Bell System Technical Journal*).

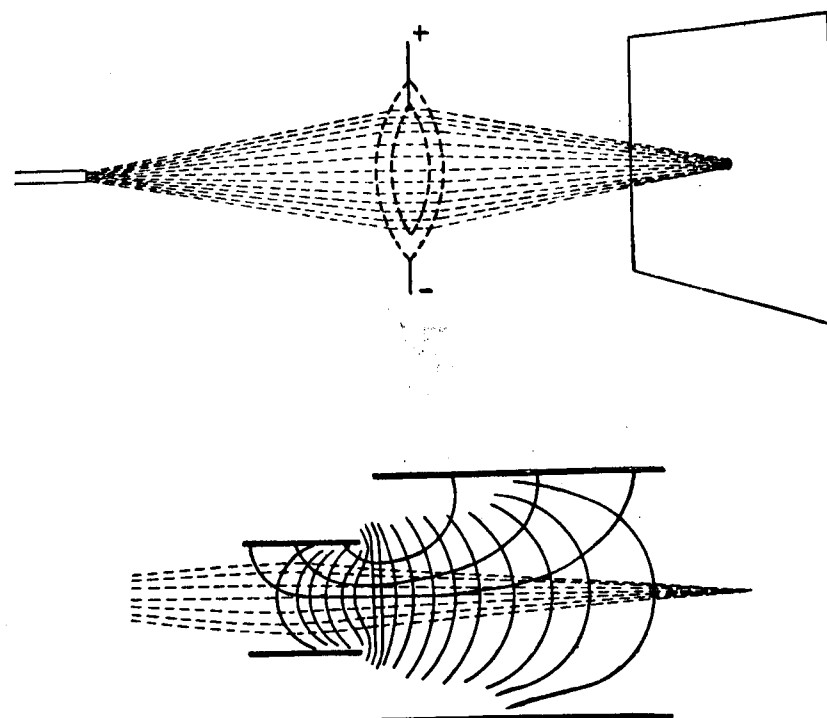


FIG. 6. Illustrating the focussing of an electron beam by means of electric field. In the top figure the field is produced by the positive and negative charges on the two lens-shaped wire gauges. In the bottom figure the focussing field is due to the potential difference between the two cylinders. Some of the equi-potential lines as also a few lines of force are shown. This is a device very commonly employed for focussing the electron beam of a cathode ray tube. (From *Television To-day*).

hole is allowed to fall on a photoelectric cell—the scan frequency being 30 cycles-sec. The current in the photoelectric cell during the circular motion thus consists of two parts, one a steady part due to the strong uniform glare and the other a weak fluctuating part due to the lights from the prominences and the corona distributed non-uniformly round the solar disc. The steady part representing the glare is filtered out and the fluctuating part due to the prominences and the corona is suitably amplified and sent to the "viewer" cathode ray oscillograph and made to reproduce the images on the fluorescent screen.

Electron Microscope.—It is well known that the limit of magnification by ordinary microscope is 2000 to 3000 diameters visually and up to about 5000 diameters photographically. It is, however, now possible, with the so-called electron microscope employing the technique of electron beam focussing as used in television apparatus, to photograph ultra-

microscopic objects with magnifications up to 100,000 diameters. The method is to use electrons, instead of light, emanated from the object for photography and electric and magnetic lenses instead of optical lenses, for focussing (Fig. 6). The object may be made to emit electrons by heating (if it is a metallic one), by incidence of ultraviolet light or X-rays, by bombarding with electrons or, if it be a thin specimen, by being "illuminated" from behind by electrons. For focussing the emitted electrons on to the photographic plate, suitable electric and magnetic fields are interposed between the object and the photographic plate. The whole system is enclosed in vacuum to allow a long free path to the electrons between the object and the photographic plate. Large organic molecules like haemocyanin, phages and filter passing virus have been photographed by the electron microscope. The electron microscope is now a powerful tool for medical and biological research.

TELEVISION IN INDIA

It is futile under the present war condition to talk of development of television service in India, where even the ordinary broadcasting service is in

an extremely backward state compared to other countries. Modern television service in which the figure and the voice of the performer are perceived simultaneously, has an enormously greater appeal to the viewer-listener than the ordinary sound broadcasting. The educative value of television broadcasting can therefore be hardly over estimated and there is little doubt that television will play an important role in the post-war educational reconstruction plan. Let us hope that in any scheme of extending the broadcasting service in India after the war, television development will also receive due attention. The television service cannot, of course, be expected to be self-supporting at the beginning; it has not been so in any country and it had not also been so with broadcasting in its initial stage. It may be recalled in this connection that in England the Television Committee recommended that the cost of the public television service should be borne by the revenue obtained from the 10 shilling broadcasting license fee. There would therefore be nothing unusual if in future development scheme, the Government were to allocate funds to the All India Radio for inaugurating television service in some of the big cities of the country.

DEVELOPMENT OF INDIAN MARINE FISHERIES

B. SUNDARARAJ

FORMERLY DIRECTOR OF FISHERIES, MADRAS

THE history of the efforts made so far to develop marine fisheries, one of the major food producing industries of India, is a dismal tale of neglect or half-hearted local endeavour without any consistent or co-ordinated policy. Unlike its sister subjects, Agriculture, Forest, and Veterinary science, which for a long time received the parental attention of the Central Government and even after transfer to ministerial control in the Provinces by the reforms of 1919 still continue to be actively fostered by all-India departments, officers and institutions, Fisheries never had the benefit of a central agency for control, guidance or even technical advice. With the transfer of Fisheries to provincial control the Government of India seem to have disowned even the moral obligation they had towards this neglected industry. Following a paper on "Fisheries and the problem of food supply in India" which I was invited to read before the Jubilee session of the Indian Science

Congress, a committee of foreign and Indian fisheries experts met in Calcutta in 1938 and resolved to urge the Government of India to take immediate steps to develop the industry on scientific lines. The Government of India, however contented themselves by replying that fisheries was a transferred subject and the initiative lay with the Provincial Governments.

When the Royal Commission on Agriculture began their enquiries in India, I was called upon to report on the possibilities of developing Indian fisheries. The outcome was the two recommendations in the Commission's Report in paragraphs 92 and 415. In the early years of the Imperial Council of Agricultural Research which was established to implement the Commission's recommendations, the claims of agriculture were paramount though some members of the Advisory Board and myself continued to press for a recognition of the claims of fisheries.

The only action taken by the Council in the first decade of its existence was to call for a report from me on fish manure in 1931, later to approve two Madras schemes for research on fresh-water pisciculture and fish manure respectively in 1933 and 1934 neither of which the Council did finance, and in 1935 to sanction and finance fresh-water fisheries research in Bengal.

A great step forward was taken in 1940 when recognition was granted by the Council to the claims of fisheries as being equal with those of agriculture. Yet in the meetings of the Council in 1940 and 1941 fresh-water fisheries absorbed all attention. It is well known that sea fisheries are incomparably larger than inland fisheries. Without sea fisheries there is no possibility of any real improvement in Indian fisheries as a source of food and manure. By paying exclusive attention to fresh-water fisheries, we shall be squandering our resources on trifling aspects of the fishing industry, to the detriment of its major issues. Also the present drive for increased food production (which unfortunately is still concentrated mainly on increasing the supply of cereals, the preponderance of which is the chief defect in the Indian diet) as well as the need for post-war planning, demand immediate attention to marine fisheries, however intricate and insoluble its problems may have proved in the past and however inopportune the prevailing war conditions may appear to make it.

Of the three main aspects of the sea fishing industry, capture, preservation and distribution, the first should receive primary attention as on that depend the rest. The future of the industry here, as elsewhere, rests with the catch. The available statistics of fish supply prove that at present even the seaboard towns do not normally obtain a sufficient supply of fresh fish. Any immediate increase in supply is likely to be absorbed at once without additional transport or storage facilities. Any scheme of reform, therefore, should logically begin with the improvement of the methods and implements of the sea-going fisherman, though, for their final adoption by the trade, better preservation and improved distribution will be necessary in order to deal with the resulting increased catches, after the market needs of coastal areas are met.

IMMEDIATE PROSPECTS OF LAUNCHING INVESTIGATIONS

The dearth of qualified men and high grade material caused by the paramount demands of the war as well as the inordinately high market price of all classes of goods, including boats and nets, occasioned by the closure of foreign markets, renders any large-scale or unfettered experiments impossible at the present time. Nevertheless speaking from personal experience extending over 20 years I do not

consider that all possible investigation is ruled out because of the war, though the outlook for launching large schemes of development is discouraging. In fact, the knowledge and experience we have already gained in past ventures in the Provinces point to the wisdom of launching comparatively inexpensive schemes with the available skill and material but under expert guidance, which should combine a wide local experience of fisheries within India with a practical knowledge of sea fishing methods elsewhere. This combination which is essential for success, though difficult, is not impossible of attainment. Master fishermen, crew, and well-found fishing boats from abroad (trawlers, drifters, seiners etc.) may be unobtainable now, but are they indispensable? Past experiments, at least with trawlers, have not proved so unqualified a success as to warrant similar ventures. One obvious reason was that the requisite experience and knowledge of local conditions, Indian seas, sea bottoms, fish and markets, for selecting suitable apparatus and methods, and modifying and adapting them for Indian needs, were wanting.

The experiments in Bengal, Bombay, Madras and even Ceylon where the market prices are higher and warrant heavier outlays definitely indicate investigations in the future with cheaper methods and machinery found effective under similar if not identical conditions outside India. In other words, what is wanted is neither the most powerful weapons nor the most perfect methods irrespective of the cost which the country can afford, but methods of capture superior to those in the country but at the same time inexpensive to adopt, so as to be in keeping with India's economic status. Our objective should be maximum efficiency consistent with the cost the trade is prepared to pay. Such an outlook has become even more necessary under war conditions.

PAST EFFORTS AND THEIR RESULTS

Sporadic attempts have been made in the past in Bengal, Bombay, Madras and Ceylon by private agencies and by Governments to introduce European methods of fishing into Indian seas. The earliest attempts in India were made by the Ceylon Steam Trawler "Violet" in 1907. Bengal, however, was the first Province in India to experiment with full-powered steam trawlers. The trawler "Golden Crown" was bought in 1909 and conducted trawling experiments in the Bay of Bengal from 1909. The experiment proved the existence of an abundant supply of fish. The market price of catches made was, however, too low to cover expenses. A trade ring is said to have rendered trawled fish unsaleable. The average catch per day was estimated for the whole year 1909 at 26.6 cwt. This included all fish

and turtles and excluded the first seven exploratory voyages in monsoon weather.

Apparently unaware of the conclusions reached in Madras in 1919 on the experiments in Ceylon and Bengal that commercial steam trawling was economically impracticable in India, the Bombay Government commenced trawling experiments with a castle type trawler "William Carrick" bought and equipped at a cost of Rs. 3,52,944, and conducted them for less than a year from May, 1921 to March 1922. The average catch, though 52 per cent less than in Bengal, compared favourably with that in European waters and amounted to 19.04 cwt. per working day. For the first five months, the policy was to work on commercial lines, that is to catch as much fish as possible for the market. Explorative cruises were debarred though later research and exploration were made the main object. Trawling as a commercial proposition did not pay for the following reasons:—

- (1) Want of cold storage (since remedied).
- (2) Lack of refrigerator vans on railways (since partly provided).
- (3) High capital cost. Besides initial cost the trawler needed expensive alteration to suit it for work in the Tropics, chiefly refrigeration on board.
- (4) High running charges. The trawler being a big vessel was expensive to maintain and run. For instance the crew numbered 31 excluding the scientific staff, whereas similar trawlers at British ports carry only 10-11.
- (5) Restricted area of trawlable sea bottom. Only a very small proportion (five thousand square miles) out of the 60,000 sq. miles up to the 100 fathom line appeared to carry an appreciable stock of fish. The trawl could not be worked in ten fathoms or less nor on rocky or coral beds.

In discussing the results, the B. N. H. S. Journal supports the conclusions drawn in the official report by stating in an editorial: "The demand for fish in Bombay city alone and the difficulty of obtaining it under present conditions surely warrant another trial of the commercial possibilities of European methods of fishing in India, but when these trials are made, we hope whoever undertakes them will be guided by the advice of experts in this country who know Indian conditions and what is wanted for India, rather than by the advice of home experts who know nothing of Indian conditions, which is what we fear happened in the case of "William Carrick" Apart from this (i.e., without cold storage, railway refrigerator vans etc.) from the com-

mercial point of view a steam trawler of the size of the "William Carrick" making infrequent and irregular returns to port could not pay even were cold storage provided. The need from the commercial point of view is for small motor fishing boats equipped with all the gear for deep sea seining and drift netting which would, thanks to their speed and independence of wind, be able to visit fishing grounds too far away for native sailing craft and which again in consequence of their speed could return to port in time for the morning market. On such boats there would be no necessity for a refrigerating plant".

Ceylon.—In Ceylon steam trawling has been tried on commercial lines since 1902 by private agencies and later by Government. In the earlier experiments a small steam trawler "Violet" of 57 tons with a 50 feet trawl was used. From 1920—1923 the Government trawler "Lilla" carried out a systematic survey of trawl grounds around Ceylon, the chief of these being the two Indian Banks, the Wadge Bank of 4000 sq. miles adjoining Cape Comorin and the much smaller Pedro Bank off the Tanjore coast. Unlike the muddy flats skirting the coast of India elsewhere, the bottom here is firm sand not unlike the renowned Dogger Bank in the North Sea. For comparison with Bengal and Bombay figures, the average daily catch is assessable at 24 cwt. per working day of 21½ hours on the Pedro Bank and at 29 cwt. on the Wadge Bank. The retail market price of fish in Ceylon is far higher than anywhere in India and ranges between -/8/- as. and Rs. 1/4/- per lb., though for the purpose of calculation the average wholesale rate was taken as -/5/- as. per lb. and therefore, the average earnings at Rs. 840/- per day for the Pedro Bank and Rs. 1,015/- for the Wadge Bank. A private trawling company was floated on the above basis but it worked only for a few years in Ceylon.

Madras.—In Madras, however, it was realised from the start that the jump at a bound from a catamaran or canoe to the steam trawler was both inadvisable and impracticable and a more gradual development of an existing vast industry was, therefore, made the aim with small but improved types of fishing boats and nets. In 1908 an investigation cruise by the Government steamer "Margarita" was conducted to ascertain the most suitable lines on which practical development could be undertaken. As a result of the survey, two small fishing luggers built and rigged to the design of a herring drifter were decided on. The first experiments were made between 1908 and 1912 with two boats, one a sailing vessel "Sutherland" of 12 tons, and the other a motor boat "Turbinella" of 20 tons. Both were designed on European models. The experiments showed that the boats were too large for small work

but not big enough for large work. Moreover, it was difficult to obtain a crew which on their own initiative and without expert supervision would work and modify the methods as occasion required in new and unknown conditions. A proposal to entertain two master fishermen from Scotland fell through on account of the Great War. From 1912 to 1920 experiments were confined to local boats and nets. Experience showed the need for a larger inspection boat for exploration and research and not as a model for commercial work, but Government considered the estimated cost prohibitive. In 1920 the purchase of a Danish seine net and a motor cutter was decided on, but, on the advice of the naval architects in London, the Stores Department, in 1923 bought instead at a cost of £2,250 a sea-going launch, "Sea Scout" with a high speed motor and a hauling winch and rope coiler worked from the engine. The boat proved entirely unsuitable for fishing as its high speed engine could not work the net and the experiments had to be terminated in 1924. The bifurcation of the old Salt and Abkari Departments

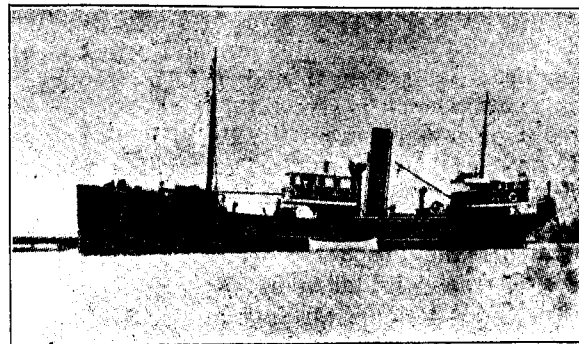


FIG. 1. STEAM TRAWLER "LADY GOSCHEN".

and the transfer of all the fish curing yards in Madras to the Fisheries Department in 1924 enabled the Department to obtain a second hand trawler for the combined duty of the departmental transport of salt to the yards and for deep-sea research. A second hand Admiralty trawler "Lady Goschen" selected by the Stores Department was bought and reconditioned at a cost of £5,699 in 1926. Even on her maiden voyage, she developed boiler troubles which handicapped work and added to her running cost throughout the five years she remained in commission. In 1931 when the boiler burst, the Government of Madras decided to sell the trawler instead of replacing the boiler. "Lady Goschen" was employed only on exploration and survey purposes and not as a model for commercial fishing. As in Bengal and Bombay the trawler proved the presence of fair amounts of trawlable fish in Madras waters also. Her total catch per trawling day of 21½ hours works out

at 27 cwt. which approximates closely to the estimated results of the Ceylon Survey of the Wadge Bank. But the market price of fish in Madras is very low compared with that of Ceylon.

The lessons to be learnt from all the above ventures, brief as they were, are obviously four in number:

- (1) That steam trawling, the most powerful and expensive Western method of deep sea fishing, is not the most suitable for India as the trawl grounds are limited. The bulk of the fish caught are not prime food fish, the better class fish in India being surface and midwater species. Few harbours exist, and cold storage and trade facilities to deal with heavy catches are inadequate.
- (2) Even were all the above conditions favourable for steam trawling, the trade and the public cannot afford to pay remunerative prices for fish to render steam trawling a paying concern. Even in Ceylon which pays the highest price for fish, a private trawling venture did not succeed.
- (3) All available modern methods of fishing have not been tried. Considering the pelagic nature of the prime food fish, sail boats with auxiliary motors equipped with gear for deep sea seining, drifting and longlining are clearly indicated but have not been tried.
- (4) Future experiments should be planned and supervised by men who know Indian conditions and have practical experience of modern fishing methods outside India.

A REVIEW OF DEEP-SEA FISHING METHODS

There is as yet no scarcity of good quality food fish in the sea. What is at fault is inadequate exploitation of these resources. Indian fishermen within their range are experts and there is very little to be taught to them regarding inshore fisheries. Their methods though primitive, are effective within their own limits and they are not to be condemned for operations close to the shore. What is required now is to extend their field of operations and to seek to take an adequate toll of migratory fish which rarely visit shallow waters and of the more or less sedentary bottom fish on offshore banks. For this the fishermen need larger and more seaworthy boats than canoes and catamarans, propelled preferably by motor power, in addition to sails or oars. They require to be encouraged and taught to make use of new types of nets and new methods of using them and to acquire the rudiments of navigation and motor mechanics. Adequate finances for this purpose must

also be found whether by way of co-operative or direct help. Before the education of fishermen can be undertaken, we have to ascertain by carefully planned experiments the fishable content of our off-shore waters at every season, at various depths and on different bottoms and the suitable craft and tackle for exploiting these resources. To obtain a comprehensive idea of the problem, a brief survey of all the available offshore fishing methods, Indian and foreign, is desirable. Such a survey will show the defects in indigenous methods and help in planning future work.

Deep-sea fishing methods all over the world may be classified under four heads:—

- (1) Trawls. (2) Seines. (3) Drift, gill and trammel nets, and (4) Long lines.

(1) TRAWLS

(a) *The Otter Trawl*.—This is the largest and the most efficient weapon which has been evolved within the last hundred years for capturing bottom fish. The net is a large conical bag with projecting wings on each side which serve to increase greatly the width of its mouth. The mouth is kept open by the sheering action of a pair of strong wooden boards fixed on each side of the net, and to each board is attached a rope by which it is connected to the ship

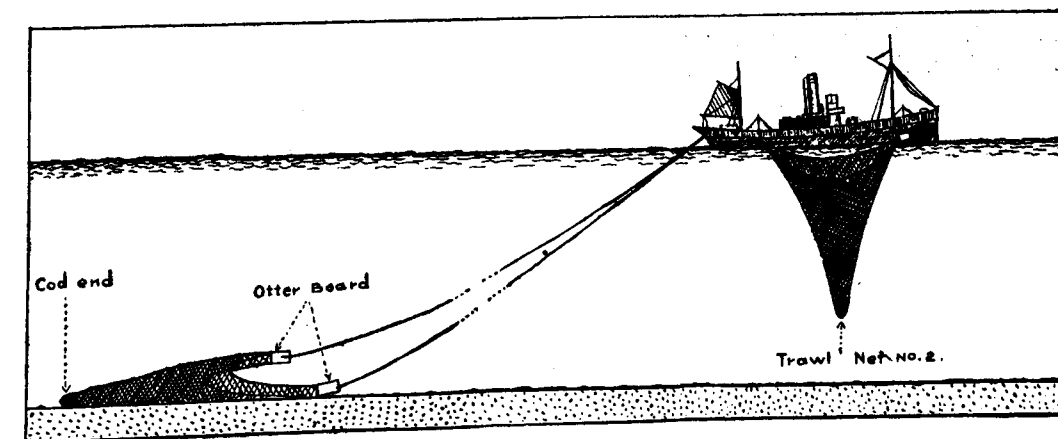


FIG. 2. OTTER TRAWL IN OPERATION.

which tows the net. The net catches the fish by being dragged along the bottom of the sea by a powerful steamer. For steam trawling, a smooth but firm sea bottom is the best and it should be free of rock and coral and other obstructions. The net is 130 feet wide at its mouth. A fully equipped trawler used to cost £20,000, before the war. Steam trawling has been partially tried, as we have seen above, and has not proved altogether suitable to Indian conditions.

(b) *Italian Trawlers*.—Small Italian trawlers measuring only 72 ft. overall work successfully in the Mediterranean. They differ from the regular trawler in being fitted with motors of 150 h.p. and small otter trawls, and in having only one pair of galleys aft. Unlike the regular trawler capable of

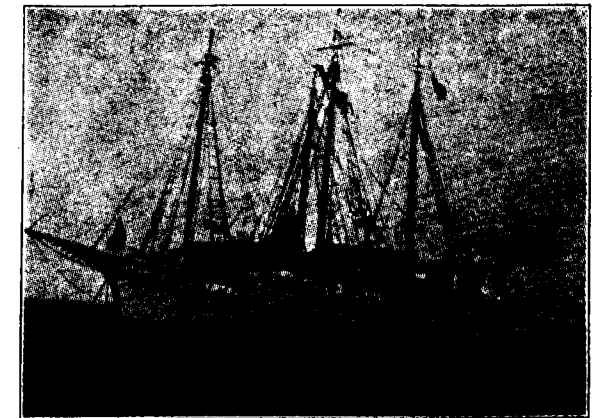


FIG. 3. ITALIAN MOTOR TRAWLERS (Photo—James Hornell).

shooting a net on either side, these entail loss of time when the single net is damaged. The small otter trawl is shot from the stern of the boat. These

trawlers are said to land, for instance in Malta, 2-4 tons of fish a trip, which occupies a week. The price of trawled fish in Malta was £25 a ton, or 2¼d. a lb. wholesale. At this price the trawlers just meet their cost. The catch consists of bream (*Sparidae*), sole, red mullet or goat fish, rays and dog fish.

(c) *Chinese Trawlers*.—Large trawls in China are worked by a pair of sea-going three masted wooden junks towing the net between them. The largest of these boats (*Lai Shun*) measures 90 ft.

in length, 8 ft. beam and 8 ft. in depth. The largest trawl net operated by them measures 312 ft. in width of mouth and 330 ft. in total length, and used to cost Rs. 300. The nets are hauled by hand-operated

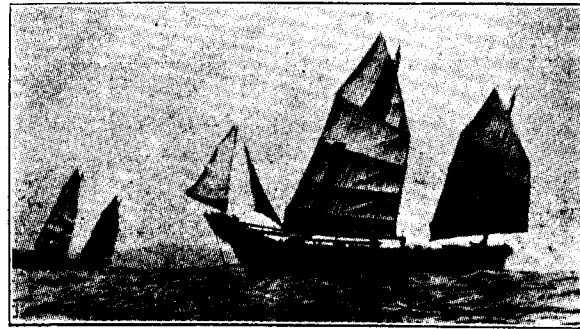


FIG. 4. CHINESE TRAWLERS IN OPERATION
(Photo—S. Y. Lin).

wooden rollers. They carry ice and salt, and fish in deep water, staying out for five or more days. A junk used to cost Rs. 13,125 and its working charges used to be about Rs. 4,375 per year. On an average, the trawler must catch up to 1200 picules or 160,000 lbs. a year worth 12,000 dollars or Rs. 10,500. Each fisherman expects to make 200-300 dollars or Rs. 175-225 in wages, bonus etc. excluding food on board, provided by the trawler owner. The catch consists mostly of small sharks, herring like fish, lizard fish (*Sauridae*), sole and brill, thread-fin (*Polydactylus*), seer (*Scomberomorus guttatus*), black pomfret (*Apolectes niger*), rock cod, snapper, bream, goat fish, jew fish or croaker, crocodile fish and cuttle fish, of which identical or related forms are common in Indian waters. The working cost compared with the regular steam trawl is cheap, about one-fifth. These Chinese methods are well worth a trial.

(d) *The Paranze Trawl*.—This is a yet cheaper and smaller type. In this method a light trawl net is towed by two sail boats as in China. This is a dominant type in all Mediterranean countries and has recently been extended to the Canaries. A fleet of them worked regularly from Port Said. They were introduced into Palestine after the Great War but were ousted by the Italian motor trawlers in 1931. The paranze net measures 86 ft. with wings of 20 ft. length. The average catch of one of these nets per day in the port of Jaffa, for instance, amounted to 37 lbs. and consisted of red mullets and breams. Compared with steamer trawling, it is a clumsy method but, as the capital and working cost is cheap it may prove more profitable than steam trawling to small scale capitalists. The paranze

trawl with motor boats is perhaps worth a trial in India.

(e) *The Beam Trawl*.—There is a variety of small trawl called the beam trawl worked by small sail and motor boats which is not found in India, though well known in Europe as well as in China. The beam trawl was the precursor of the modern otter trawl. The mouth of the conical net in a beam trawl is kept permanently open by a bar of wood usually 50 feet long which is fixed at either end to D-shaped iron runners acting as skids. The beam trawl is used in shallower water than the otter trawl and catches smaller fish, chiefly prawns and shrimps. The entire equipment costs less than a tenth of a regular steam trawler. It is likely to prove valuable in prawn, lobster and cuttlefish fishing.

Two varieties of beam trawl, one with and the other without wings, are indigenous to China, though there are no beam trawls in India or Malaya. The Chinese trawls are all quite small, the width of the mouth varying from five to fifteen feet in length. It is kept open by a rod (bamboo, wood or iron) five to sixteen feet long. The wings, when present, are 7 or 8 ft. in length. A large junk of 50 ft. length may tow as many as 22 such beam trawls at one time.

In contrast with the above, the indigenous type of trawl nets in India are all small paranze type nets whose effectiveness is further reduced by the craft—the primitive canoes or catamarans (rafts)—by which they are worked.

(i) *Turi* is the common trawl of the Coromandel coast which is operated by two rowing catamarans manned by three fishermen each. Its measurements are total length 106-110 ft., width of mouth including wings 140 ft. and depth of mouth 30-40 feet. Towed by 2 rowing rafts, it is comparatively less effective than a proper paranze trawl worked by sail or motor boat.

(ii) *Madi or Korukkumadi* of the Tinnevely and Travancore coasts, towed by two sailing catamarans, is the most effective of Indian trawl nets. An ingenious device in the Tinnevely variety is the provision of a conical trap of netting inside the mouth of the trawl which effectively prevents the escape of fish which have entered the net. The paranze type of trawl with small motor boats and its mouth trapped as in the Tinnevely net is worth a trial in Indian waters.

(f) *Hang Trawl*.—A unique type of net used by the Chinese has been designated "Hang Trawl". It is not a true trawl, as it is not dragged on the bottom. The long conical bag of netting is hung on a wooden frame over the starboard side of the junk and the net is towed parallel with the boat near the surface of the sea. It is generally an inshore

net and is never used beyond the 15 fathom line. The catch consists of small herring like fish and horse mackerel.

(2) SEINES

These are the nets universally used for the capture of midwater and surface fish. Some seines, however, like the Danish seine compete successfully with the trawl in taking bottom fish. A seine is a wall of netting with or without a centrally placed bag or bunt which is used to surround a shoal of fish. The common types of seine are three in number.

- (a) The shore seine.
- (b) The purse seine.
- (c) The boat seine or ring net.

The last two are deep water nets.

(a) *The Shore Seine*.—A shore seine is a long length of netting shot from a boat from the beach and back again in semi-circle. The net is then dragged ashore by the two ends. It is perhaps the oldest type of fishing net in existence and is used in almost every coastline in the world. The net is well developed in India. The "peria valai" of the East Coast and the Rampani of the West Coast costing Rs. 3,000 to Rs. 4,500 are powerful nets which can stand comparison with their congeners in any country. The maximum catch of the Rampani net may amount to as much as ten tons per haul. As inshore fishing does not concern us here the shore seines need not be reviewed.

(b) *The Purse Seine*.—In the purse seine the great wall of net has a series of brass rings along the bottom attached to the foot rope through which passes a strong cord or purse line. After the net has been laid in a circle round the fish, the purse line is drawn to gather up the bottom of the net and prevent the escape of fish from the bottom. This is the most effective engine yet discovered for the capture of shoaling fish in deep water. This type of net is totally absent in India, though indigenous to China. The method has been further developed in Europe and America where the largest purse seines are in use. A typical American purse seine such as the one employed in the menhaden fisheries of the Atlantic coast measures 200 fathoms in length and ten fathoms in depth and costs approximately Rs. 3,000. The purse seine boats consist of a steamer of the tug type, costing 100,000 American dollars or Rs. 2,60,000 which serve as a carrier for the seine boats and the catch. The purse seine boats are small rowing boats, 32 ft. long, 7 ft. beam and 2 ft. 10 ins. deep amidships. They are strongly built to stand the strain. A boat costs 400 dollars or Rs. 1,400. Two such boats are required to shoot a

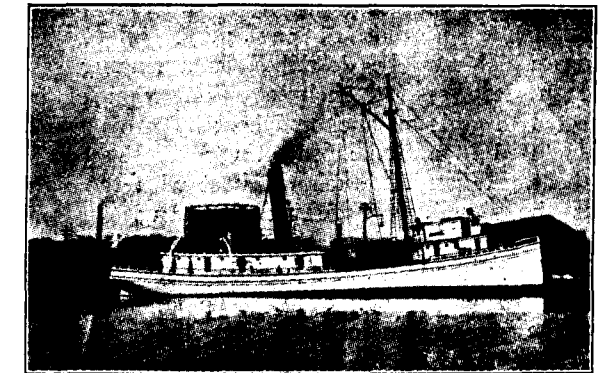


FIG. 5. MENHEDEN PURSE SEINER (From U. S. B. F. Document 811).

On arrival at the fishing grounds, the captain and mate, from the crow's nest on the mast, locate the schools of fish readily distinguished by their reddish hue. The two seine boats containing the net are immediately lowered with the striker boat which goes in advance towards the school to keep trace of the fish and signals to the captain. At the right moment, the seine, one half of which is stowed in each seine boat, is shot round the fish. The striker on the opposite side of the shoal splashes the water with an oar to prevent their escape. When the seine boats come round the shoal and meet, they are fastened together and the hauling of the purse line starts. After the net is pursed and the fish is pounded the steamer is hailed and the fish are baled out on board the steamer.

(i) *The Chinese Purse Seine*.—The Chinese purse seines are small and primitive, compared with the American menhaden net and those of the pilchard fishery. The largest measures only 168 feet long and 132 feet broad and costs 200 Hong Kong dollars. The larger purse seiner is a sea-going boat which carries four smaller sampans. The net is operated by two of the latter and the other two drive the fish into the net, acting as strikers. The large purse seine is used in 20 and 40 fathoms off shore. The smaller purse seine is worked by two small sampans closer to the shore. The fishing is usually done at night with the help of powerful torches and in recent times incandescent lamps which attract fish. Dynamite is sometimes used though illegal. Heavy shoaling pelagic fish like the sardine and mackerel are captured. The Chinese purse seine is worth a trial in India. The fish attracted by light in Chinese waters are the horse mackerel (*Decapterus*, *Caranx*), pouters or silver bellies (*Leiognathus*), and herring-like species, all of which are abundant in India.

(ii) *The Mediterranean Lampara Net*.—This is an efficient type of seine-net peculiar to the Mediterranean. The bottom of this net is also closed to prevent the escape of fish but by a different process (principle) from that of the purse seine. The Lampara net may be described as a ringing seine used in deep sea to encircle a collection of fish attracted towards an anchored boat by two powerful lights fitted in a frame projecting over the bow of the boat. When the anchored boat with the lights gives the signal, a large boat carrying the seine shoots the net round the collected fish, still fascinated by the bright light. Large incandescent petrol or kerosine lamps are employed. The lampara differs from the purse seine in not having brass rings and



FIG. 6. LAMPARA NET BOAT (Photo—J. Hornell).

a purse line along the bottom. Instead of this, after the fish are surrounded, the bottom is closed by a basal platform of netting, attached to the foot rope along the central section of the net. This is the complex part of the net, as it has to be fitted so that it opens out flat when the net has been properly shot. After the fish are encircled, this platform slips below the shoal of fish cutting off their escape downwards. The operation requires skill and is difficult to learn. The history of this net in Palestine is of interest to us in India. The lampara is reported to have been introduced into Palestine as recently as 1934 from Syria and proved such a success that the local fishermen spared no effort in acquiring the net and learning to operate it. Four nets were in operation before the end of 1934 at Haifa, Zeeb and Acre. Until its introduction, the three Mediterranean sardine, (*Sardinella aurita*, *S. maderensis*, *S. eba*) though caught intermittently from January to September in considerable numbers by shore seines, were invariably of small size. After a few weeks' stay in-shore, the shoals of immature sardine disappeared, as in India. It was the belief of the fishermen that

they migrated into deep water where they could not be caught. Therefore, when some Syrian fishermen using the lampara miles away from the shore made a great haul of sardines of large size, excitement ran high. Besides the large sized sardine, the haul contained a considerable number of mackerel of a species never before caught in Palestine, except as odd specimens. So eager were the fishermen to adopt the net that several second hand nets were immediately bought. Nowadays the lampara has obtained a firm footing in the country. What happened in Palestine may well happen in India where similar sardine and mackerel are caught now, chiefly as immature fish. The boats and nets are cheaper than the regular purse seine, though they require greater skill in operation. This again is a method well worth a trial in India.

(c) *Boat Seines*:

(i) *The Chinese Croaker Seine*.—These are seine nets shot and hauled with the help of boats operating at a distance from the shore. A variety of boat seines are found in India and the Far East. The croaker seine is the largest in use in China. It is used for the capture of jew fish (*Sciaenidae*). As the net must reach the bottom it is never used in depths greater than 20 fathoms. A maximum catch of 80 tons of large jew fish by one of these nets in one haul is on record. This seine net is a rectangular sheet of netting 800 fathoms long and 20 fathoms deep, and is used in two halves. A complete net with all accessories used to cost 1600 dollars or Rs. 1,400. Four junks each carrying four sampans work a net. On the fishing ground the presence of croakers and an approximate estimate of the size of the shoal are first ascertained by the grunting noises made by the fish. The fishermen in India often do the same for catching local jew fish whose presence and abundance are detected by expert listeners. If fish are found, the four sampans lay the two halves of the net on the two sides of the shoal, and gradually (each sampan taking one end of the half net) the ends of the two half nets are brought together completely encircling the fish. The fish are then collected within the large seine by a small drag net. This method is unknown in India and is worth a trial with local expert listeners for detecting the presence of the fish. Other Chinese seines are not vastly superior to the Indian types of seine.

(ii) *Danish Seine*.—Denmark is the only North European country with important fisheries which does not employ the steam trawler. In its place, it has developed to perfection a deepwater seine (snurrevaad) known everywhere as the Danish seine. Esberg is the home of the Danish seine, where hundreds of motor cutters are fitted with this net. Each boat lands on an average 47 tons a year or

roughly, just under a ton of fish a week. They fish the North sea up to 100 miles from their home port. In view of its economy and efficiency compared with steam trawling, Norwegian and British fishermen have copied the Danish method. For various reasons, India is not ready to adopt steam trawling and her fisheries are also in comparatively shallow waters close at hand. The Danish seine which has proved economically more successful than steam trawling under such conditions is probably the best suited for the development of the coastal demersal fisheries of India. The dimensions of the Danish motor cutter are: length overall 46 feet, beam 14 ft., height amidships 7¼ ft., gross tonnage 16-18 tons. They are equipped with 35-40 h.p. motors and have a speed of 6-8 knots. A crew of four is sufficient to man and work these handy craft. The Danish seine net is a large seine with wings and hauling ropes but is comparatively easy to operate. Its dimensions differ slightly with the kind of fish to be captured—plaice or haddock. The largest net measures: wings 85 ft., bag 49 ft. and the depth at mouth 13 ft. Such a net costs Rs. 450. On arrival at the bank, a heavy anchor is dropped and a buoy is attached to the upper end of the anchor rope. To this one end of the hauling rope of the seine is tied. The cutter then goes round in a semicircle, with the anchor buoy as the centre, paying out first the rope and then the net. When the net is shot she returns to the buoy, paying out the second hauling rope. The buoy is reached when nearly all the rope is paid out. The end of the first hauling rope is then taken abroad and led together with its companion to a

special winch worked off the boat's motor. Simultaneously the ropes reeled in are coiled by a special rope coiler. This greatly saves the time and labour of the crew. As for trawling a fairly smooth and firm sea bottom is necessary for good results. On loose mud trawling is reported to give better results than the Danish seine. Experience in Palestine proves this. The Danish seine, however, scores over the trawl in more than one respect. Trawl nets are often damaged by rocks and boulders but with the Danish seine an obstruction is felt the moment the net encounters it and this warning permits of the net being lifted over the obstacle without damage. Its other advantages are: (1) It does not crush the fish caught as does the trawl. Some of the fish could be actually transported alive in the live wells provided in the cutter. (2) The capital required is hardly one tenth of that needed for steam trawling. (3) The net requires small and handy boats which could enter harbours with depths of 6 and 7 feet of water. (4) The low upkeep and running costs compared with steam trawlers. The above will particularly suit conditions in India. The Wadgat Bank, which is the finest trawling ground yet discovered in Indian waters, would support a fleet of such craft.

A complete Danish seine net, winch and rope coiler obtained by the Madras Government was scarcely used as the boat "Sea Scout" proved quite unsuitable and these are still available for experiments with any diesel engined motor boat of suitable size.

(To be continued)

INDIAN INSTITUTE OF SCIENCE

AT the Sixth Annual Meeting of the Court of the Indian Institute of Science, Bangalore, Sir M. Visvesvaraya in course of his presidential address presented a brief review of the present state of work and activities and the future needs of the Institute. Speaking of the Quinquennial Committee which functioned in 1936 and was the last of its kind, he expressed his opinion in favour of not appointing any more committees of this type. During the initial stage of existence of the Institute such reviewing committees really did much useful work. A better plan in future, according to Sir M. Visvesvaraya, would be to depute one or two professors to foreign countries as often as the funds would permit to study world progress in subjects in which training is available in the Institute.

In his speech he referred to the budget estimates of income and expenditure. The budget estimates of receipt and expenditure as presented to the Court at its first meeting in March 1938-39, stood at about Rs. 6,00,354 and Rs. 6,05,868 respectively. The corresponding figures in the revised estimates for the year 1942-43 are Rs. 9,55,017 and Rs. 11,30,105. The opening balance in the former budget stood at Rs. 5,34,373 and in the latter Rs. 4,70,413. The reduction of about Rs. 64,000 was due to the increased cost of apparatus and materials on account of war and also to the extra sums that had to be spent on applied research. Several new schemes have also been initiated. The growth and expansion of the Institute's work is adequately reflected from the fact that the expendi-

ture on work done during the life-time of the last Court has increased by more than 80 per cent. Sir M. Visvesvaraya thinks that the credit for this progress is largely due to the wise guidance of the Council and to the activities of Sir Jnan Chandra Ghosh, the present energetic Director and Sir Vithal N. Chandavarkar, the Chairman of the Joint Committee.

Sir M. Visvesvaraya spoke of the new course for post-graduate training in aeronautical engineering, started from January 1943, which is the first scheme of its kind in India. A capital grant of Rs. 1,25,000 for the construction of a Wind Tunnel and the accessory laboratories and a recurring grant of Rs. 41,800 for the salary of the staff and working expenses have been sanctioned by the Government of India. The Institute has further supplemented these grants with a capital grant of Rs. 1 lakh from its funds for laboratory equipments. He rightly laid emphasis on the great future which the aeronautical engineering has before it. Speaking of the fundamental research, he referred to the important investigations in the phenomena of cosmic rays, being carried on under Professor H. J. Bhabha. For the successful prosecution of these investigations the Council has made a grant of Rs. 40,000 to supplement the generous contribution of the Sir Dorabji Tata Trust of Rs. 60,000.

Sir M. Visvesvaraya finally concluded his presidential address with the following significant remarks:—

"As regards research in India as a whole, it is satisfactory to learn that the Council of Scientific and Industrial Research has done some work for the war. But the co-ordination of scientific and industrial research activities in all parts of the country which was to be one of its principal functions has not received much attention. At first only small industries and minor chemicals were allowed to be handled; latterly however heavy chemicals are also coming into favour. Discoveries and inventions are opening up a new era of engineering but there is no sign that research in relation to heavy engineering industries is making any progress at all in India outside the purely military establishments.

I have had occasion from another platform to bring to notice the restrictions and limitations to which heavy industries have been subjected in India as compared with the phenomenal developments that have taken place in countries like Canada and Australia during this war. Till recently research was also treated in the same restrictive spirit. We have seen that several important recommendations made by the committees of the Council of Scientific and Industrial Research in favour of heavy industries, like the internal combustion engine, have not been accepted or even noticed by the Government. It

cannot be said that an industry to manufacture internal combustion engines is not a vital necessity in any country or that it is not needed in India. I understand however that private establishments are attempting its manufacture with some success.

It must be recognised that many industrialists and tradesmen have profited by the business done in textiles, raw and semi-raw materials and other war supplies, but it is a recognised economic axiom that *production of goods and services for war do not contribute to a country's economic welfare.*

There is too much secrecy; no intelligent exposition of policies is available particularly in regard to industries. No official in high position ever gives a comprehensive interpretation of the views of Government, what they propose to do and why their policies and procedure are so different from those followed in any progressive country or even in the self-governing dominions of the British Commonwealth. There is no directory for war work or for civilian industries. Whatever attempts are made are fragmentary. The Governments of countries like Australia, Belgium, Russia and Czecho-Slovakia have set up offices in India to carry on their propaganda in this country. They issue News-Sheets regularly to acquaint Indians with what they are doing in their respective countries, whereas we do not get to know what our Government are doing in our own country. No stock-taking is done here, no review is attempted, of the industrial and economic affairs of the 390 millions of the population of India.

As regards post-war reconstruction, although a beginning was announced and a Committee and Sub-Committees were appointed so far back as October 1941, no reports of those Committees have seen the light. What work the Committees did, whether they did any work at all is not stated. When the Committees began work, industries were excluded from their purview. All these are unusual practices under any Government. Such trends discourage enterprise and even preparations for post-war work. The appointment of a new set of Committees for post-war reconstruction has been announced within the past few days but that is also of the traditional type. No clear statement is made of the aims, or economic policies Government have in view.

"I have had to refer to industries on this occasion because the main object of this Institute is to promote industries by means of research and there is a close interdependence between industries and research. It is needless to state that industrial research will have no value or importance if industries themselves are neglected or starved. Since, at the present time, Government have taken control of almost every activity in the country, they owe a duty to the public to explain their policies and

justify their inaction in respect of these three developments, namely, industries, industrial research for peace-time needs, and post-war reconstruction—as compared with what is happening under other Governments in the British Commonwealth. In the absence of such a statement, the future which India has to face, when the time for post-war reconstruction arrives, will be viewed by many thinking persons in this country with anxiety and apprehension."

We completely associate ourselves with the views expressed by Sir M. Visvesvaraya. As the readers of SCIENCE AND CULTURE are aware, we have from time to time recorded our bitter feeling of frustration regarding the inexplicable Government inaction and complacency in matters vitally concerning the economic future of India. With regard to the recommendations in favour of practical action in connection with internal combustion engines, fuel re-

search, metallurgical industries, dye-stuffs, glass and refractory materials, and manufacture of industrial plants, to which Sir M. Visvesvaraya alluded, the Government have not only discouraged the establishment of these industries, but have, it is understood, asked the Committees to confine their attention to the technical aspects of their problems and not to raise questions relating to administrative support or action in the shape of protection and subsidies. In other words, the prospects of such industries are tightly sealed for an indefinite period. The Government, it would appear, is more keen on safeguarding the vested interests rather than on the industrial future of India. This can alone explain the paradoxical inaction and complacent attitude of the Government, deeply troubling Sir M. Visvesvaraya, and the failure of right and repeated criticism to move our Government, unlike the Governments of other lands, in important matters.

Notes and News

INTERACTING SOLAR PROMINENCES

It has been announced in a report published by the Astronomical Society of the Pacific that Dr Edison Pettit of the Mt. Wilson Observatory recently photographed two interacting luminous solar prominences in eruption. Unlike ordinary solar prominences, interactive prominences are characterised by the pulling of material away from each other in the form of streamers. Great theoretical interest is associated with the study of such interactive prominences inasmuch as they appear to favour the view that both positive and negative charges may exist within the same prominence.

The photographs were taken with a motion picture provided with a special device called an interference polarizing monochromator. When viewed through the monochromator, an instrument only recently perfected for astrophysical use, the sun's disc appears cherry red and also reveals the markings which remain invisible when seen through the telescope in the usual way. The camera and the monochromator were attached to a six-inch refracting telescope. Two small prominences, of which one 22,000 miles high was pouring streamers into another 9,000 miles high and about 37,000 miles away, first attracted the notice of Dr Pettit who suspected the progress of an eruption. The features became unmistakably clear when the prominence attained an

elevation of 62,000 miles, and the photographic recording with the monochromator was started.

The prominences appear to have first blended into a single triangular shaped mass and then developed into a column which bent over like a whip, as it gained in attitude, and subsequently tended to return to a centre of attraction in the nearby solar surface. The speed of ascent of the prominence was measured and found to be 23,400 miles per hour which suddenly changed to 46,800 and then to 93,600. The speed remains uniform in the interval between these abrupt changes which take place within a few seconds. Such abrupt changes in the speed, so characteristic of eruptive prominences, have not so far received a satisfactory explanation and as such constitute an important subject for theoretical investigation.

INDIA'S MICA INDUSTRY

THE Geological Survey of India has recently issued a bulletin on mica by Dr J. A. Dunn, Officer-in-Charge of the Mica Production Section, in order to focus attention on the importance of Indian mica in the world's electrical industry. Mica is so indispensable a commodity in the production of electrical machinery that it is difficult to imagine what form the electrical machinery would have taken but for

existence of this mineral. Muscovite (the potash variety) and phlogopite (the magnesian variety) are, however, the two chief varieties essential to electrical industry. India's predominant position with regard to mica production is adequately reflected from the fact that over 80 per cent of the world's requirements of better quality sheet mica is supplied from the province of Bihar alone. Considerable quantities of mica are also mined in Nellore district, Madras, and in Rajputana. Over 90 per cent of mica splittings, used in the manufacture of micanite and made from lower quality mica, are supplied from India. The figures for world production of mica are given, which record U. S. A., Brazil, Russia, Madagascar, Canada and Argentine as other important producing countries. The total production of mica in U. S. A. is reported to exceed that of India; but it is to be noted that the production of the former country is almost entirely scrap, and its value is consequently far less than that of India.

The bulletin describes at some length the various properties and uses, the occurrences, the trade definitions and trade classifications of mica. Methods of mining, cutting, sorting, splitting and manufacture are elaborated, and the problems relating to the probable channels of marketing, prices, tariffs and Indian and world production and export are discussed. Dr Dunn estimates that in Bihar over 1,50,000 people are engaged in the industry and hopes that his work will create an appreciation of its importance and result in a better standardisation of trade terms and perhaps even of mining and trade practices.

Dr Dunn has concluded the bulletin with a brief remark as to the post-war possibilities of the Indian mica industry. In normal conditions, as the past experience indicates, the industry is extremely sensitive to market conditions. Any sign of depression is likely to be followed by prompt closing down of smaller mines. The production of mica in India has made a headway since the end of the depression in 1933, probably on account of world wide re-armament. It may be apprehended that the development of a suitable substitute for mica on the continent, which can compete with splittings, may adversely affect the post-war future of the Indian mica industry. But it is a fact that in the electrical industry the major demand is for block mica for which, according to Dr Dunn, there is little prospect of a comparable substitute being found. Hence it would appear that so long as block mica remains a necessity and the Indian deposits constitute the chief source of block mica splittings may compete within limits with substitutes, and we need not despair of the future of mica industry in India.

INTERNATIONAL TABLE OF STABLE ISOTOPES

THE International Table of Stable Isotopes was used to be published by the Union Internationale de Chimie in Paris prior to the occupation of France. The table has been supplemented regularly by the report of the Committee on Atoms of the International Union of Chemistry, formed with F. W. Aston as Chairman and N. Bohr, O. Hahn, W. D. Harkins, F. Joliot, R. S. Mulliken and M. L. Oliphant as members. These reports contained accounts of further progress in the study of isotopes. Before the capitulation of France the International Table could be supplemented with the Fifth Report of the Committee, published in Paris. After her catastrophic fall Prof. E. Briner of Geneva opened correspondence with Prof. Aston to consider the continuance of the useful work of the Committee, as Prof. Aston enlightens us in a short note in *Nature*. Prof. Aston readily offered to prepare the sixth report and submitted it to Prof. Briner for publication early in 1941. Unfortunately an immediate arrangement for the publication of the same was not possible. In view of further work done in this direction it was, therefore, decided to draw up a modified report brought up to date for 1941-42, which Prof. Aston completed in February, 1942. Failing to hear anything from Prof. Briner during all these months Prof. Aston decided to release the Sixth Report of the Committee on Atoms for publication, which accordingly appeared in *Nature*, Vol. 150, No. 3809. The following changes in the Table of Isotopes are recommended.

Helium.—Evidence has been obtained by means of the cyclotron that a stable isotope of mass 3 exists in *Nature*¹. The abundance is very small and is estimated at about 10^{-7} per cent.

Sulphur.—The parentheses indicating doubt in the existence of the very rare isotope 36 are to be removed.

Nickel.—Two complete electrometric analyses have now been published, by Straus² and Valley³. Their results are given below together with those obtained in the original photometric observations⁴:

Mass numbers	58	60	61	62	64
Aston (1935) ...	67.5	27.0	1.7	3.8	?
Straus ...	62.8	29.5	1.7	4.7	1.3
Valley ...	67.4	26.7	1.2	3.8	0.88

Valley's work is approved by Bainbridge. His figures are in better agreement with the photometric results, and also with the chemical atomic weight, than are those of Straus. Both observers agree that 61 is 1.3 times more abundant than 64. This is in good accord with the mass spectra previously obtained by Dempster⁵ and also with the original ones of Aston (re-examined) upon which the previous figures

were based, but contradicts the evidence of the parabolas from which Lub⁶ deduced that 61 is "with regard to 64 as 1:10". Valley's figures are now adopted.

Cobalt.—In consequence of doubts expressed on many grounds as to the existence of a stable isotope 57, Mitchell, Brown and Fowler⁷ have analysed COCl_2 with a mass spectrometer. Their results show that 57 cannot be present even to 1 in 30,000 of 59. As in mass spectrometry evidence of absence is much more cogent than that of presence, cobalt is now to be regarded as a simple element.

Molybdenum.—Electrometric measurements on this element have been carried out by Valley⁸. The following percentages, which he considers accurate to one per cent, are recommended:

Mass numbers	92	94	95	96	97	98	100
Abundances	14.9	9.40	16.1	16.6	9.65	24.1	9.25

They show a satisfactory small divergence from the photometric ones of Mattauch and Lichtblau, adopted in the previous report, and the original ones of Aston, and lie roughly between the two.

Rhodium.—The rare isotope 101 of rhodium is subject in considerable degree to the same objections as that of cobalt above mentioned. It will therefore be regarded as doubtful, and given in parentheses, until further experimental evidence is available.

- ¹ Alvarez, L. W. and Cornog, R., *Phys. Rev.*, 56, 379, 1939.
- ² Straus, H. A., *Phys. Rev.*, 59, 430, 1941.
- ³ Valley, G. E., *Phys. Rev.*, 59, 836, 1941.
- ⁴ Aston, F. W., *Proc. Roy. Soc., A*, 149, 396, 1935.
- ⁵ Dempster, A. J., *Phys. Rev.*, 50, 96, 1936.
- ⁶ Lub, W. A., *Proc. Roy. Soc., Amsterdam*, 42, 253, 1939.
- ⁷ Mitchell, J. J., Brown, H. S. and Fowler, R. D., *Phys. Rev.*, 60, 359, 1941.
- ⁸ Valley, G. E., *Phys. Rev.*, 57, 1058, 1940.

CHINA'S NATIONAL ASSETS

CHINA'S industrial possibilities have been visualised by Dr Wong Wen-hao, minister of economic affairs, in a speech (reported in the *China Information Bulletin*) at the Central Political Institute. It would be remembered that it has not yet been found possible to make a countrywide and thorough geological survey. From the example of Russia's wonderful success at tapping the resources in the bowels of mother earth it may be confidently said that is as great a promise before China. However, on the basis of the existing knowledge, a ten-year planned production is estimated to yield annually at the end of the period 100,000,000 tons of coal and 5,000,000 tons of steel. India's production of coal is at present 30 million tons and of steel and pig-iron about 2 million tons. The present production of commodities in China is roughly 1/5th of the above estimates. The production of gold,—so vital for

China's struggle to buy equipment and materials as also for her prestige in international currency world (Great Britain and America have advanced loans)—will go up from 500,000 ounces to 2,500,000 ounces. The cement industry is capable also of expansion and is expected to produce 20,000,000 barrels a year after 10 years. The most important light industry in China is the textile industry of which 2/5th production is however in foreign hands. Silk and cotton have been the staple fibres, and China is self-sufficient in these articles. In the plan, divided into two five-year periods, which has been envisaged by Dr Wen-hao, he has also been given thought to production of foodstuffs and canned foods. Transport is a vital item in ensuring distribution of supplies, and provision has been made for an extension of railways, the total length of which amounted to only 7,000 miles before the war started. Several hydraulic engineering projects are also included in the reconstruction plan, particularly the training of China's sorrow, 'the Yellow River'.

China's industrial structure is loose compared with the rationalisation of the industries in the Western Hemisphere. But the stress of war has cemented some of the holes by the formation of a network of industrial co-operatives ('Indusco's as they are called). The working of these is a great experiment aimed at mitigating the horrors of a roughshod industrial movement. Most of the 'induscos' are engaged in textile work, the percentage being 36.7. Chemical enterprises rank second. Mining projects and machine shops are also attracting attention of the co-operatives.

FINANCING OF NATIONAL PROJECTS IN CHINA

THE conflict with Japan has been a strenuous problem for China. The danger has however led them to discover the loopholes in organisation and has forced on the nation a double-faced programme of resistance and reconstruction. In the matter of reconstruction, there has been a reorganisation of banking services with effect from July 1, 1942. The Bank of Communications has undertaken the promotion of industrial, mining and communication enterprises. Loans have been granted jointly with other government banks and the most important part played by the Bank has been to finance the building of railways. The different national defence and heavy industries planned by the National Resources Commission of the Ministry of Economic Affairs are operated largely by the Bank. The Farmers' Bank has been entrusted solely with rural financing activities, while its note issuing right has been transferred to the Central Bank of China. Some of the more important types of rural credits extended by the Bank include production credit, marketing credit,

farm credit for extension work, credit for rural industries, irrigation credit, credit for war-zone, credit for colonization.

The publishing concerns in China are also being subsidised by the Government Banks and there are two purely government publishing concerns. Even in the war-torn country, books published from various places in Free China between February and October last year averaged 249 a month.

ELECTRIC AND MAGNETIC EFFECTS OF COSMIC RAYS

THE electric and magnetic effects of cosmic rays have been studied by Foster Evans of the University of Colorado, Boulder, Colorado, and the results are published in the *Physical Review*, June, 1942. It is found that slow interstellar electrons moving in the vicinity of the earth under the influence of a radial electric field caused by the earth's interception of cosmic rays as charged particles predominantly of one sign and the magnetic field of the earth's dipole will produce a continuous series of shell currents concentric with the earth. The current density in the shells varies with the inverse fifth power of the distance from the earth's centre and the cosine of the latitude. These currents contribute to the earth's field a uniform component parallel to the magnetic axis in a direction from south to north. It is found that if either cosmic-ray intensity or the density of positive ions in the vicinity of the earth varies, there will result a variation in magnetic field intensity at the earth's surface. It is shown that the ratio $(\Delta I/I)/(\Delta H/H)$ where I represents cosmic-ray intensity and H the horizontal component of the earth's magnetic field intensity, for a variation caused by a change in cosmic-ray intensity is of the same order of magnitude as observed experimentally.

SIR ARDESHIR DALAL ON UNIVERSITY EDUCATION

THE Osmania University of Hyderabad chose this year Sir Ardeshir Dalal to address the new graduates of the University at its annual convocation. The selection was a happy one, as it gave opportunity to one who is outside the scholastic mould to view the university education in a perspective laden with the practical needs of the country. Sir Ardeshir pointed out some of the lines of work that the new graduates in science might take up relating to the utilization of resources of the State. He also pleaded for faculties of Applied Physics and Technology. He felt the need of more and more science for our country.

Touching upon the ideals of university he has sounded a word of caution to the educational authorities of the country. The virtues of restraint, soberness, righteousness and wisdom are absent. Prejudice and intolerance are rampant. Sir Ardeshir says, "If in India today, political and social problems have become more difficult of solution, if the ugly spirit of communalism is eating into the vitals of our national life, I believe it is partly because the universities of India have in some measure failed to achieve their object of promoting culture, and dispelling not only ignorance but passion and prejudice. It is from the universities of the nation that we have a right to expect the promotion of feelings of toleration, mutual understanding and sympathy between the various elements that compose the national life."

He concluded by emphasising on the magnitude of the task confronting the young men of the country as also of the world as a whole. It is the conduct of life through the present phase and hereafter that will require the utmost strain on the training a university can impart.

SCIENCE IN INDUSTRY

WATERPROOFING WITH SOAP

A NUMBER of successful processes for the waterproofing of textiles, involving the use of soap, have recently been developed in America, according to a report in a recent issue of the *Chemical Age*. In one method, the cloth is first treated with a boiling 5 per cent solution and then with a solution of basic aluminium formate at room temperature, containing 1 per cent aluminium oxide. Solution of aluminium acetate may also be employed as an alternative. Emulsification of waxes in the soap solution has been further found to enhance the whole waterproofing operation. The waterproofing of woollen articles requires preliminary treatment of the same with some suitable oxygen-yielding compound, for instance, hydrogen peroxide, before the articles can be subjected to the process of impregnation with emulsions of aluminium acetate and a soap-wax.

In another process, the use of aluminium salts has been completely dispensed with and instead use has been made of the ability of soap to react chemically with proteins. The textile to undergo waterproofing is first impregnated with a dilute solution of a protein, of the albumen or globulin type, till the fabric has absorbed nearly four-fifths of its weight in protein, and the protein is then coagulated by moist heat. The fabric thus treated is then boiled with an aqueous solution of soap and free fatty acid, easily prepared by dissolving the soap in hot water and adding a small amount of acetic acid. The waterproofing property developed in this process is not impaired by laundering and dry cleaning.

There has been developed yet another method of waterproofing cotton cloth permanently, which is now widely used in America. The fabric should be treated with an emulsion of dioctadecyl carbonate in water and benzene. The emulsion is maintained by adding soap to the mixture. The cloth is then mangled, dried and treated to decompose the carbonate and effect a firm combination of hydrocarbon with cellulose.

CHARCOAL FOR PRODUCER GAS PLANT

THE leaflet No. 35, 1943, issued by the Forest Research Institute, Dehra Dun, has given a short account of what may constitute a good quality charcoal for producer gas plant along with a list of fuel woods which on carbonisation yield charcoal of suitable quality. The acute shortage of petrol and diesel

oil supplies and the urgent need for conserving whatever petrol and diesel oil are now available have necessitated the exploration of possibilities of using charcoal gas in a large number of locomotives and stationary engines in India. It has been estimated that a 50 per cent conversion of the total number of lorries and buses in British India into charcoal gas vehicles would require roughly about 5 lakh maunds of charcoal per month. The exact figures for the total number of stationary engines all over India are not available; but for about 5,000 such engines of the United Provinces alone the estimated monthly requirement of charcoal has been found to be about 4 lakh maunds.

According to the leaflet, the following are the specifications for good charcoal which alone can guarantee best results for producer gas engine: (1) the charcoal should show no signs of incomplete carbonisation; (2) the charcoal should be firm to the touch and not easily crushed and, when broken, it should not splinter or crumble, but present a clean fracture; (3) the charcoal should show the original texture of the wood; (4) the charcoal should be free from impurities such as bits of wood and bark, stones and earth, specially the earthy impurities which lead to clinker formation; (5) the charcoal should burn with a bluish flame, free from smoke or odour and from sparking as far as possible; (6) the moisture content of charcoal should not be allowed to rise above 5 to 6 per cent; in the event of an increase in the moisture content due to seasonal variations the charcoal should be dried over fire; (7) the charcoal should have a low ash content; (8) wood infected with fungus and borers should be discarded in the making of charcoal; besides charcoal should be preferably made from hard wood instead of from soft wood, as soft wood charcoal easily crumbles to dust choking up the gas outlet and filters and burns more quickly; (9) the charcoal should be of proper size ($1\frac{1}{2}$ " to $\frac{3}{8}$ "), as experience has shown that graded charcoal gives the best results.

As many as 34 species which are likely to be used for the commercial manufacture of charcoal in India have been tested and found to yield charcoal suitable for producer gas. The leaflet has published a full list of these species with their botanical as well as vernacular names. The account is concluded with a short note on the method of production of charcoal in India. At present it is made in the indigenous paraboloidal (mud walled) kilns. The metal kilns, however, produce the best charcoal, but

the limited supply of steel has left no other choice except the use of indigenous kilns and pits. Charcoal made from these kilns has, however, been found suitable for use in producer gas plants. The report has referred to the important question of storage conditions, good ventilation of the godown and the use of gunny bags, free from oil, both for storing and transport, arising out of the great affinity of charcoal for moisture.

PLASTIC FOR RUBBER IN FABRICS

THE use of rubber as an essential ingredient in the manufacture of waterproof fabrics is widely known. Recently, according to a report in *Scientific American*, Joseph L. Hass, technical director and fabric superintendent of the Hodgman Rubber Company has developed a new process of waterproofing fabrics without the use of rubber. In the new process rubber has been replaced by a plastic called Safflex which is one of the group of synthetic resins, technically known as vinyl acetals. It is possible to use a lighter base fabric with safflex with the result that safflex-coated fabrics weigh much less than rubberised fabrics. Moreover, the application of the plastic after it has been suitably compounded to the fabric requires the same equipment and processes as rubber. Already army rain coats, hospital sheetings, gas protective fabrics, life-preserver jackets and water bags are being manufactured on a large scale from safflex-coated fabric. Needless to say, the new process bids fair to effect a good saving of rubber from factories manufacturing raincoats and waterproof fabrics for various other purposes. It is estimated that the use of safflex will save more than $1\frac{3}{4}$ pounds of crude rubber per coat and a still greater amount in the manufacture of heavier fabrics such as hospital sheeting and gas protective fabrics. It is stated that rain coats from safflex coated fabrics, necessary to equip an army of 10,000,000 men, will alone account for a saving of as much as 17,500,000 pounds of rubber, making it available to other industries where rubber is badly needed.

NEW METHOD FOR SUB-SURFACE EXPLORATION

In a paper entitled "Seismic Sub-surface Exploration on the St. Lawrence River Project", published by the American Society of Civil Engineers in the December "Proceedings", as the U. S. Office of War Information informs us, E. R. Shepard and Reuben M. Haires indicated a useful and practical suggestion for adjusting the method of seismology to engineering problems. The seismic method of exploration is based on the fact that the velocity of wave fabrication in the earth crust differs greatly in different substances. Granular and plastic materials such as sand, clay and gravel transmit wave disturbances at velocities of roughly 800 to 8,000 feet per second whereas rigid rock transmits such disturbances at 10,000 to 20,000 feet per second. The apparatus used for sub-surface exploration on engineering projects consists of one or more detectors or seismograms and an oscillograph recorder. The detectors are connected electrically with the oscillograph so that the time it takes the wave disturbance to arrive at each detector may be recorded graphically. The disturbance is created by exploding a charge of dynamite in the ground at a known distance from the detector by plotting a time-distance graph of the observation. The velocities at various points and depths appear as slopes of the curve and, by noting the changes in slopes, marked changes in the nature of sub-surface material become evident, thus locating the various strata with considerable accuracy.

This method takes on an economic importance when it is realized that the readings will supplement, and can be correlated with, comparable drill-borings and observations. It is not anticipated that it will eliminate the need for borings but that it will reduce them considerably. The method can be adapted with some modification to the exploration of earth strata beneath bodies of water, both still and swiftly-moving. Subaqueous tests, in particular, are believed to be unique for obtaining information of the type required on a river improvement project.

SCIENCE LOOKS AHEAD*

THE recent advances in science and technology and their role in modern civilization have been thoroughly dealt with in a recent book 'Science Looks Ahead' by Prof. A. M. Low. The trend of non-technical writings has greatly changed during the past few years. They are now not exactly what has so far been generally known as 'popular' books. This change has been inevitable mainly for two reasons; first, due to the rapid headway of science and their every-day application, and secondly, due to the growing spirit of scientific mindedness of the general readers. There is yet another side of it at the same time. It is interesting to see that the specialists also need very badly the non-technical writings. This is because a specialist of these days of ultraspecialization is quite a layman in a subject other than his own. But all the branches of science are more or less interconnected, so that specialization is not perfected without broad outlook in allied and diverse subjects. A specialist of to-day can never be expected to keep in touch with other branches of science all of which have gone far beyond general trends and normal expectations.

These facts have rendered necessary the development of a new type of scientific writing to bring home to non-technical as well as specialised readers the technological marvels of modern sciences. We can illustrate such a writing of the day through the review of Prof. A. M. Low's recent book 'Science Looks Ahead' in the following pages.

Prof. Low is an well-known British engineer. Apart from his technical publications as specialist, his popular books, especially those on scientific and engineering inventions have already been very much appreciated by the readers. Here appears his new book 'Science Looks Ahead' primarily meant for non-technical readers, none the less it proves to be a mine-house of information relating to practical application of science in modern civilization. As we have seen how a specialist becomes a layman, the specialists would also be amply delighted to find an apt collection of the most up to date technological information on the progress in various branches of science described in a most beautiful and fascinating manner.

A novel feature of the book is the incorporation of a number of articles, contributed by eminent scientists of the day, sandwiched between different chapters at relevant positions. To mention only a few of them, the book opens with an article

'Evolution—the History of Life' by Julian Huxley. We have also an article on the 'Planets' by H. Spencer Jones, Astronomer Royal.

The first chapter of the book deals with *Power* which obviously forms the corner stone of modern civilization. The *resources* and forms of power, such as, coal, mineral oil, electricity etc., and their *transmission* are just the two aspects of the problems which have been described very clearly. The harnessing of natural power from the sun, wind and water have been explained in an extremely interesting manner. They do not present merely the dreams of engineers, but give accounts of real achievements of actual devices.

A short but stimulating account of the actual progress of researches so far carried out on certain potential power resources by the scientists all over the world is given in these chapters. Account is given of the solar power plant used in Egypt for irrigation and of the high efficiency solar engines developed by Dr Abbott of Smithsonian Institute, Washington. They are interesting because they are attempts at harnessing solar radiation directly. Other methods of bottling and utilizing the solar powers have also been described, the most fascinating one being the new discovery of photosynthesis processes which appear to possess enormous possibilities in future. It may be noted that the influx of solar radiation on the surface of the earth is 12,500 horse-power per square mile and it has been shown, considering losses on various processes of its conversion to a useful form, that it is worthwhile to work out not only large installations but also small units which will have wide utility. Calling on this profuse gift of energy by Nature the author remarked that "they would perform service of tremendous value which would forever banish the threats of a 'power-famine' from failure of coal or oil supplies".

Although windmills are now obsolete on the farmyard, the machine is reviving in its new forms, particularly, as source of electrical power in the countryside. In the U. S. A. and Germany such small 'wind chargers' for storage batteries have been constructed, not only by amateurs, but are being supplied by commercial manufacturers now-a-days for use in places where supply of electricity is not available. As a matter of fact, the cold gales on the polar regions have been successfully utilized to generate electricity for heating and lighting. It is mentioned that owing to the present exigencies of the war, Germany has devoted much attention to the possibility of State organization of mammoth wind generators for the supply of electric power.

* Being a review of the book with the above title by Prof. A. M. Low, published by the Oxford University Press (1942); pp. 640, figs. 15, plates 47; price 12s. 6d.

We read in page 62 "A German engineer, Honnef, has put forward plans for the erection of a great number of large wind towers. Herr Honnef's speciality has been the erection of steel masters; he was once responsible for an 850 feet high wireless mast. He believes that the construction of steel wind-towers to a height of 1,000 feet or more is perfectly practicable". The reason for choosing such large heights is that "because in the region between 1,000 and 1,500 feet the wind blows very much more constantly than on the ground. We could, perhaps, rely on obtaining sufficient power to supply current directly from dynamos, as in the ordinary power station, without the cost and complication of storage.

The proposed size of such wind-mills is a diameter of 500 feet, so that the steel tower would have to be enormously strong. . . . The erection of such a tower is obviously a difficult affair and "Herr Honnef would solve the problem of erecting such a tower by beginning at the top. The top platform with dynamo and other apparatus, would be constructed on the ground, and then pushed upwards by hydraulic jacks so that the second stage could be built underneath. The jacks would then be brought into play again, the third stage built, and so on until complete tower was in position". The estimate shows that the cost is "over a million pounds per tower. But each plant is expected to provide 60,000 kilowatts." The cost of a thermal station of this size is about two and half times as much, so that the cost per kw. is comparatively small. Such a station would produce about 250 million units, and 200 such stations distributed all over Germany would give her the total amount of electricity now generated. But she would be saving about 25 million tons of coal, which could be put to other uses. For countries which have poor coal resources, like parts of India, the idea is indeed very alluring. But we are as yet far from the goal, because the problems of storage, and distribution have to be faced.

In *Nature* of August 15, 1942, we find an interesting report of the installation of 1,000 kw. wind power generation in the State of Vermont, U. S. A. It is possibly the largest of its kind but is still under construction. This information is however not included in the book, the reason of which may be due to the fact that the construction was not begun or announced (if begun) at the time when this chapter (Chap. I) was written by the author.

Hydroelectric power is rather too well-known to require introduction, but the possibilities of utilizing sea wave powers, tidal power and the power available for the heat of the earth's interior prove

no less interesting. It will however be interesting to give an introduction on the power available from the sea. "The sea" to put in author's language "means power in three different ways. First, there is wave-motion itself. . . . The movement of the water by tidal forces represents another vast source of power. Twice a day the gravitational effect of the sun and the moon makes itself felt by the rising of the water to as much as 40 feet in places." These are the two forms of sea-powers which have been tapped, though with not much success. The third form, namely, that which is available out of the temperature difference between top and deeper layers of water, has not been successfully utilized up till now, though attempts were made by the French-engineer physicist George Claude to utilize the heat of the gulf stream.

To illustrate by practical demonstrations the possibility of utilizing sea-wave power, the author says "one of the most interesting plans put forward by a Californian engineer has been tested successfully on a small scale. His apparatus consists essentially of a cylinder consisting of a piston with a stroke up to 4 feet. The piston drives a wheel by means of the well-known ratchet-and-pawl device. . . . The cylinder is placed in a concrete embankment built at the edge of the sea so that there is always water near its level. It inclines at an angle of 45 degrees and the end is open to the sea to receive the thrust of the waves".—There is also arrangement to raise or lower the 'wave-engine' as the sea rises or falls with tides. "The estimated power to be obtained from a cylinder 4 feet in diameter (and 6 feet strokes) is 250 horse power."

Speaking of tides the author remarked that "as this is far more certain and cheaper to harness it is on tide-motors that the majority of engineers have concentrated. All that is necessary is to make the rising water turn a wheel, very similar to a water-wheel used in mill streams, or trap the water when it has risen and allow it to flow back slowly." The trapping of water in a suitable dam at high tide and allowing the imprisoned water to run down through the tide-wheel sluice, is a very efficient method which is usually adopted. Such typical devices are at the Severn Barrage and Fundy Bay Barrage. The Fundy Bay Scheme calls for the generation of 200,000 h.p., with a flow of 500,000 cusecs of water at low tide.

The Severn Barrage Scheme would produce a maximum of 700,000 h.p. and give the equivalent of nearly a million tons of coal a year. The project, as drawn up by Professor Gibson of Manchester University, would entail a furnace of nearly 40 million pounds. A barrage for Tay estuary has been designed for 11,700 h.p. supply with an esti-

mated cost of construction less than 12 million pounds.

The chapter on *Harnessing Water* is a wonderful description of modern engineering feats to control rivers and even seas. The article narrates the interesting stories of Boulder Dam (U. S. A.), Grand Coulee Dam (U. S. A.), Lloyd Barrage at Sukkur (India), and others. The Boulder Dam has been erected for 20 million pounds, whereas the Grand Coulee Dam, not yet complete, calls for a cost of 55 million pounds. This one is 4,300 ft. (4/5 mile) long, 550 ft. high and 500 ft. wide at the base tapering narrower towards the top.

Such dams and barrages are extremely useful for water supply, irrigation and power generation. The Sukkur Barrage on the river Indus "is a mile long, the flow of water being regulated by 66 gates. The result of its construction is that instead of a light flow for three-quarters of the year and a flood in the remaining months, the flow of water has been evened out to provide water over 6,000 miles of major irrigation canals up to 350 ft. width which will eventually feed over 50,000 miles of minor channels. The dam in its successive heightenings has brought many million more acres under cultivation, and has turned what used to be a desert into one of the most fertile valleys in the world". The Sukkur Barrage is however not used for generation of electricity. The author appears to have only second hand knowledge of the story of its construction, otherwise his enthusiasm would have been somewhat damped.

The feature of the present book 'Science Looks Ahead' is that every topic comprises accounts of up to date development, and does not merely repeat the old stories in new language.

Chapter II is on Rays, visible and invisible, including X-rays, Radium and Cosmic Rays.

Next chapter deals in Science and War—the topic of the day. The chapter is preceeded by a contributed article 'War Planes and Their Weapons' by C. G. Grey which also includes a classification of fifteen types of aeroplanes beginning from training plane, light, medium and heavy bombers, flying fortresses, general reconnaissance planes etc. Many interesting points are revealed, for instance, in p. 145, with the naivete characteristic of the type of white men who consider themselves superior to all coloured men, the author describes "The fifth class consists of the medium bombers. Their original purpose as a class was not to play a part in a first-class war between Great Powers so much as to do police work in the Empire. They were to be used for bombing or shooting up coloured folk of any kind who ventured to interfere with the peaceful lives of the tribes under our protection." The

chapter takes up Chemistry in War, Artillery Explosives, Tanks, Anti-aircraft Defences and Warships.

Chapter IV describes materials of industry under four heads: Building materials, Metals, Plastics and Synthetics. It will be appreciated from this chapter how even the most ancient craft of manufacture of bricks can be improved by the application of modern scientific ideas, not to speak of cement, concrete and other building materials. Modern steels and nonferrous alloys possessing widely differing characteristic properties are described, and it is related how the modern machine world has been expanding its range of usefulness on account of steady streams of discovery of new steels and alloys possessing many desirable properties.

The Conquest of Speed is a very proper piece of article by G. E. T. Eyston, placed before Chapter V which is on Transport Developments. The article gives fascinating account and description of world's speed records achieved by motor cars, motor boats, aeroplanes etc.

The chapter of Transport Developments tells us not only the story of Motor cars, Railways and Ships, but also includes Lifts, Pipe lines for petroleum, and the developments in Rocket travel.

Perhaps our readers will be interested to learn that a modern motor car consists of about 7,500 different pieces (or, 12,000 pieces, if electrical components etc. are included) each one machined with accuracy better than 1/1000th of an inch. Apart from components, there are more than 11,000 inspection checks in the course of nearly 10,000 manufacturing operations. The components of a motor car are not built up of one kind of metal, but large varieties of steels and other alloys are used.

The section on Scraping Cars, describing Ford's factory for utilizing and melting down old unusable cars, is extremely interesting.

Chapter VI is on Measurement and gives an account of the standards of measurements, which will be found extremely interesting, and not merely to students of science. The article on 'What shape is the Earth', though appears to be a school boy story of its orange shape is extremely fascinating and well written, giving much new information. How many of the readers know that the highest point when measured from the centre of the earth, is not Mount Everest, or any Himalayan peak, but Mount Chimborazo of the Andes! Other topics such as 'Our Size and Shape', 'Big and Little Brains', etc. are quite as fascinating.

We then come across another contributed article on *Our Food Plants, Past and Present* by F. Kingdon Ward, and pass on to Chapter VII on

New Development in Medicine with a leading article on Transfusion of Blood. It describes the historical development of the science of blood transfusion, and the notable discovery of agglutinins in blood for group classification by Dr Lansteiner of Vienna (awarded Nobel Prize in 1930). The author has mentioned two important developments in connection with the modern method of transfusion. The first is the collection and storage of blood from voluntary donors into what is now known as 'blood banks'. The use of sodium citrate and air-tight refrigerated storage enables the doctors to keep blood for 7-14 days. If the blood is used in course of a few days it is as good as fresh, but if it is kept for about two weeks or more it is less effective, but still valuable.

The other method of blood collection and transfusion has been tried only in Russia. "It is that of using blood from recently dead persons. The idea may seem repulsive to many people, but the work carried out by Professor Schamov in transfusing blood from dead to living animals, and more recently by Dr Judin in transfusing blood from dead to living human beings has attracted wide attention. Several thousands of these transfusions have now been carried out, and the storage of blood makes it unnecessary for that taken from a dead person to be used immediately. A corpse, of course, can give a great deal of more blood than a living person. Only people who have died from accidents and whose blood is healthy can be used. Whether this method will, for sentimental reasons, ever become popular in other countries is a matter of speculation. Soviet Russia takes a realistic view, but is probable that in other countries, while a plentiful supply of voluntary and professional donors remains, what many people would consider a desecration would not be allowed."

In subsequent paragraphs the author has mentioned the use of blood sera and its 'banking' for sera storage. It may be remarked here that some mention of modern method of using dried plasma, a very convenient form for long storage, might have been made for enhancing the interest of the topic.

This chapter also deals with new drugs, vitamins, anaesthetics, artificial respirator, etc.

Chapter VIII on the Science and Sea tells us of its 'farming', first. Sea weed is a valuable source of iodine which is present in a proportion of about 3 per cent. Moreover sponge, oysters etc. are also valuable sea-farm products. Sea water itself is a vast container of minerals and chemicals, for instance; we learn that one cubic mile of sea water contains about 117 million tons of salt, 8 thousand tons of aluminium, 6 million tons of magnesium, 283 thousand tons of bromine, 192 tons

of iodine, 440 lbs. of gold, etc. Certain seas contain more gold than the average and many will recall the experiments carried out by Haber in 1922, to work out an economic method of extracting gold out of sea water. Other sections deal with control of sea such as done in Holland, unusual ships, control and compassing of ships by gyroscope etc.

Chapter IX—Science Explores the Universe—tells us in brief the story of the largest 200 inches telescope, modern electron microscope, and the utility of a cyclotron. Cyclotron is the most modern of the scientific machines requiring for its construction the highest engineering skill, but it is required to perform the most delicate task of dealing with the heart of an atom. By the aid of the cyclotron, it is possible to impart on common materials radium-like properties, so that they can give out invisible rays, which are not only themselves objects of scientific study, but has immense application in medicine and other sciences. These artificially produced radioactive bodies such as radio-sodium, radio-phosphorus etc., are being used for the treatment of cancer, one of the most widespread and painful of diseases which has still defied the skill of the physician. Certain tumour cases can also be cured by radium or these artificially produced radioactive elements. Another application of these artificial radioactivity is that it helps in giving us the deepest insight into the mechanisms of food assimilation and metabolism in our system. For instance, our body—brain, bones, marrow etc.—takes up phosphorus from food. If the phosphorus is rendered radioactive it will continue to emit radiation for a few days and, during its assimilation and circulation in the body, the radiating atoms will speak of their existence at different limbs as soon as a suitable radiation measuring instrument is brought closer. To be more explicit let us suppose that we want to know how phosphorus reaches the brain. By irradiating food which contains some phosphorus, we confer on a minute fraction of phosphorus atom radioactive properties and administering it into man or animal, we can begin tracing the radiation from the limbs of the body by the radiation recorder until we can actually find the radiation coming from the head. This method of radioactive 'tracers' will solve the problem of selection of food for quick and adequate assimilation for nutrition.

Two other stories on 'Helium gas' and march 'Below Zero' towards absolute coldness are quite interesting. It may, however, be pointed out that all the plates of illustrations have not been in proper positions, e.g., plate 30 on 200 inches telescope has been inserted in the article on "Biggest Telescope", and after two articles. Such misplacement has occurred for plates 21 and 22. Proper placing was very desirable.

'Science and Weather' (Chapter X) deals with meteorology and also includes interesting notes on earthquakes, and on setting thunderstorms to work—yet another source of natural power with possibilities of harnessing.

The article on Flying by Sir Verdon-Roe, is full of thrill. It describes his pioneering flights, competitions, accidents, and bitter experience while getting permission and State-support during the progress of his early work.

The chapter on Communication (XI) tells us of the world-wide network of telephone, telegraph and newspaper recording receivers in wireless. It also includes general speech recording apparatus such as Blatterphone—the magnetic recording on steel tape, and gramophone recording. The article on Recording, however, is not quite as happy in exposition. Other articles, Wireless Control, Signalling and the Electric Eye (interesting applications of photocell in preventing accident in a factory, in burglar proofing a safe, fire indicating etc.) are extremely interesting.

'Living Fossils' is a contributed article by F. Kingdon Ward, which shows how some of the very old and back dated species of trees and plants have survived the evolution and still continues to thrive, to be properly called the *living fossils*.

Chapter XII on Exploring the Earth contains five sections. The Unmapped World, Science and Mountaineering, Exploring the Ocean Bed, Polar Exploration, and Archaeology, all give new information and adventurous accounts.

Next one (XIII) is Science Makes Pictures which takes two articles: Photography and the Cinema. It covers a long range of photography from infra-red to X-ray photography with their various applications in science, industry and medicine. The high speed photography and their application in detection of phenomena taking place at high speeds, e.g., photography of flying rifle bullet, study of velocity of explosion in an internal combustion engine etc. are very interesting. The photograph of a golf drive (plate 46) taken at an interval of 1/100th of a second with exposures 1/100,000th second is extremely amusing. Colour photography, stereoscopic cinematography etc. have also been discussed.

The last chapter (XIV) is Science and the Criminal is almost a detective story. It describes in vivid language how science is playing a growing part in the detection and prevention of crime. It gives interesting account of how it has now been possible to detect crime by the application of Microscopy, X-ray, Spectroscopy, Medical and Chemical sciences and other ingenious scientific devices. The author has not forgotten to touch upon the modern ideas and findings on the possibilities of treatment of criminals by medicine and psycho-analysis.

In conclusion the author has again emphasised on the progress of scientific civilization of future.

We must congratulate the author for his very successful manner of presentation of the various topics of modern science before the readers. Such an all-round information book of modern sciences is a necessity in these days of ultraspecialization.

K. R.

MEDICINE AND PUBLIC HEALTH

ADRENAL CORTEX IN ACUTE ANOXIA

In a recent issue of the *Journal of Clinical Investigation*, Roger A. Lewis, George W. Thorn, George F. Koepf and Samuel S. Dorrance discussed the role of the adrenal cortex in acute anoxia. Normal men exposed to an average oxygen tension of 98 mm. of Hg. for 5 hours had average arterial oxygen saturation of 83 per cent, although O₂ consumption was undiminished and nitrogen excretion decreased. Experimental animals exposed to low O₂ for similar periods showed depletion of liver glycogen but no fall in blood glucose concentration unless the anoxia was extreme. Normal animals in low O₂ tension for

24 hours suffered rises in blood glucose and liver glycogen (except in dogs), and increases in the renal excretion of N (in all animals). Adrenalectomized animals succumbed to O₂ tensions that normal animals withstood, and no increase in blood glucose, liver glycogen or N excretion occurred. Treatment with "carbohydrate-regulating" factor of the adrenal cortex, however, enabled adrenalectomized animals to withstand an otherwise fatal O₂ tension. Normal animals in low O₂ tensions for 24 hours showed slight increases in N and P excretion and marked increases in Na, Cl and K excretion, while adrenalectomized animals showed a striking increase in K excretion, but none in N, P, Na or Cl excretion. Treatment

of normal and adrenalectomized animals with "carbohydrate-regulating" factor was followed by striking increases in Na, Cl and water excretion, but none in K excretion. In initial anoxia there is an increased utilization of carbohydrate; normal blood glucose concentration is maintained from liver glycogen stores. Successful adaptation to continued exposure to low O_2 tension depends in part upon increase in protein catabolism with storage of carbohydrate and excretion of N. These changes do not occur without adrenal cortex. The increase in K excretion is probably related to factors other than the adrenal cortex, whereas the increase in Na and Cl excretion is mediated by the "carbohydrate-regulating" factor.

DRIED GRASS AS A FOOD SUBSTITUTE

The problem whether grass can be used as a probable substitute for food has been adequately dealt with in *Nutritional Observatory*, publication of the Heinz Nutritional Research Division of the Mellon Institute, Pittsburgh, Pennsylvania, according to a note in *Scientific American*. It has been found that the requirements for carotene (provitamin A), ascorbic acid (vitamin C) and iron can be readily met by taking moderate quantities of dried grass. The use of grass as food (between 4 to 6 ounces) is also recommended in the case of calcium and the vitamin B complex factors, as thiamine, riboflavin and niacin. Dehydrated grass should, however, be used under all circumstances. The flavour, fibre and high water content and the possibility of eating noxious weeds are the chief reasons against the use of fresh grass. Moreover, human beings, unlike the animals living on grass, are not provided with intestinal bacteria to help digestion.

Dehydration does not destroy any of the nutritive properties of grass. Fresh or dehydrated, grass acts as a laxative and as such the digestive system should be gradually prepared for its consumption. The use of dried grass in small amounts and in a state of fine powder either as an added ingredient in common foods such as bread, or as a supplement to the diet in the form of tablets appears to be the safest recommendation.

SULPHADIAZINE FOR INFECTIONS

ACCORDING to *Scientific News Letter*, issued by the United States Office of War Information, recent

investigations appear to justify the claim for sulphadiazine as the drug of choice for initiating chemotherapy in all cases of acute pulmonary infections and for continuing treatment in such cases as are caused by pneumococcus, streptococcus and probably also staphylococcus and Friedlander's bacillus. The accumulated clinical results in acute gonococcal and staphylococcal infections and in acute urinary tract infections suggest that the efficacy of sulphadiazine in most of these cases is probably similar to that of sulphathiazole.

This new sulpha-drug definitely appears to be of lower toxicity which makes it suitable for prolonged therapy. Complications in the urinary tract are, however, comparatively of frequent occurrence. This warrants the exercise of caution in the control of the dosage of the drug in relation to the fluid intake and output. This precaution is particularly important in old persons, hypertensives and those with some impairment of renal functions. With adequate control, this drug may be administered so as to produce therapeutically effective blood levels wherever indicated, even in many patients with severe renal troubles. In the event of oliguria occurring the fluid intake should be increased promptly or the dose of drug reduced, depending upon the circumstances. One should be, however, very careful about any sign of marked or complete suppression of the urine output which may prove fatal if the fluids be not forced and catheterisation employed in time. The occurrence of agranulocytosis, though comparatively infrequent, should not be overlooked and must be looked for in all patients undergoing sulphadiazine treatment for two weeks or more.

In an examination of 21 patients receiving a second or third course of sulphadiazine there was no evidence of "sensitization". The possibility of sensitization is not, however, negative. Episcleritis was reactivated on early readministration of sulphadiazine in one case. Other instances of rashes and febrile reactions reappearing when the drug is given again after a brief interval have also been known to occur. From the clinical reports and hospital records so far available it is clear that the new sulpha-drug has several promising features to recommend it in the treatment of infectious diseases where other sulphonamides are at present widely used.

VIRUS: THE ENEMY OF LIFE

N. N. DAS

IN that still dim region where the living and the non-living meet an invisible substance have their being. This half-mysterious organism—the virus—less well-known than their scientific kins, the bacteria, is, in our present knowledge, the most primitive form in which life occurs. Some investigators insist that certain types of virus are only heavy protein molecules, with complex chemical reactions, a kind of crystal. It is not possible to say with any finality whether the latter school of thought is right or wrong. But living or non-living, the virus is the most powerful enemy of life in all the forms in which life occurs. In fact, they are, super-parasites. They offer, therefore, one of the acutest problems with which the immunologists have to wrestle.

The virus diseases are of fairly wide occurrence, as they can be readily transmitted from one animal or plant infected with them to another.

Viruses may be spread by air, wind, moisture droplets, insects. Many viruses, like that of tobacco mosaic, can be dried out, yet retain their potency for many years. Their operations are exceedingly delicate. King Edward potatoes, for example, are all infected with virus, but are immune to it. When King Edward plants are grafted on to other potatoes, they die.

The study of virus and virus diseases dates from 1894 when Iwanowsky found that the mosaic disease in tobacco plants could be communicated by an agent which would get through a filter impervious to all bacteria.

Four years later Beijerinck in his experiments was led up to the same fact. In the same year Loeffler and Frosch working on foot and mouth disease not only corroborated the earlier findings but came across the strange fact that the disease could be communicated in series from one animal to another by apparently inactive filtrates.

These disease agents are differentiated from ordinary bacteria in that they are much smaller. This may have accounted for the slow progress in scientific studies on them in the first stages. But the diseases which are now generally recognized as virus-induced are of such wide occurrence and take such great toll of life that the earlier indifference has seemed compensated by intense interest taken in their nature in recent years. The fact that the late Charles Nicholls won the Nobel Prize in Medicine for proving the louse transmission of Typhus fever, shows the importance attached to the study of viruses in recent years.

It is true Jenner gave to the world a method of immunisation against small-pox in 1796 almost a century before the real nature of the causal agent of small-pox was known. But the lack of scientific means to make a systematic study held up all progress. And the next important study of vaccinia virus—still the most well-known type of the whole class—began with the experiments of Beclere, Chambon and Mesnard in 1898. Some years earlier, Pasteur made his classical researches on hydrophobia. Pasteur's work, though it shed no light on the nature of viruses, stirred up great interest in the immunological aspects of infectious diseases. And the immunological aspect of virus-diseases has dominated all studies in this field for obvious reasons.

It is generally known that small-pox, yellow fever, measles, mumps, chicken-pox, influenza, dengue, encephalitis, infantile paralysis, herpes, "Q" fever, rabies are caused by different viruses and it is possible that viruses operate in a much wider field than we are at present able to guess. Thus, though attempts to demonstrate the infective power of the virus-like particles obtained by high-speed centrifugation of exudates and tissues from rheumatic patients have failed, Dr W. H. Bradley has obtained agglutination with sera of patients suffering from rheumatic fever. Further, Homer Swift and Brown of the Rockefeller Institute have been able to isolate a pleuro-pneumonia-like organism from rheumatic fever exudates. This may prove to be the long-sought for aetiological agent of acute rheumatism. These findings have opened up a new field and Drs Eagles, Helga Jahn and E. Klienenberger are engaged in the cultural study of rheumatic material (*c.f.* *Lancet*, July 1, 1939).

DISEASES IN BIRDS AND ANIMALS

Animals and birds are as prone to virus diseases as man, and some of the diseases are of great economic importance while others shed light on diseases that afflict man. For example Shope has demonstrated that swine influenza is occasioned by the combined agency of a virus and a small haemophilic bacillus. Later, Andrews, Smith and Laidlaw, and Shope and Francis, showed that the virus element in this disease, though distinct, had close relationship with the virus of human epidemic influenza.

South African horse-sickness and equine encephalomyelitis may also be mentioned as causing loss to horse-owners. Foot-and-mouth disease which is theoretically important, being the smallest among

the virus bodies, is also of considerable economic significance. It usually attacks cattle, sheep, pig, goat, etc. The actual manner of spread of the disease in remote areas is not clear and its control is quite a problem.

Birds exhibit a variety of virus diseases, *e.g.*, fowl plague, fowl-pox, pigeon-pox, canary-pox and infective laryngotracheitis. But one group of viruses is of great importance at present and this is the group which Rous first demonstrated as being associated with the production of tumours indistinguishable from true sarcomata. For some years a great amount of work—directly starting from Rous' findings on fowl tumours—has been done in search of the possible virus origin of cancer in animals. Invariable occurrence of virus in mammalian cancers cannot be demonstrated, but there is evidence from the work of Rous with Shope papilloma virus and that of Andrews, Ahlstrom, Gye and Foulds with the Shope fibroma virus that viruses may have some part in the production of malignant neoplasms. The investigation is still in its preliminary stages, and the final results cannot yet be foreseen, but it is quite possible that some viruses may be tracked down finally as the causative factors of this baffling disease.



FIG. 1. A tobacco leaf showing mottling and destruction due to infection of the plant with tobacco mosaic virus.

Psittacosis or "parrot fever" is one other virus disease in birds that needs to be mentioned. It is very infectious, capable of attacking man, and is one of the largest of viruses.

DISEASES IN PLANTS

The virus affections of plants not only help a wider study of viruses but some of them cause great economic loss and are therefore important. No fewer than 135 plant-virus diseases have been listed in recent works. Some do not harm their hosts much. Most prevalent types are: tobacco mosaic disease, (Fig. 1) potato leaf roll, sugar beet curly top. For India, the sugarcane mosaic is of special interest. Coons points out that in Louisiana in America the introduction of disease-resistant types of sugarcane increased the yield by almost 50 per cent. The fall in the quality of potato stocks and the inferiority of "seed" potatoes is to be ascribed to virus infection.

BACTERIOPHAGES

The bacteriophages, discovered by Twort in 1915, are thought to constitute an important class of virus-disease agents, and have been extensively studied by d'Herelle and many others. The bacteriophages are thought to possess the capacity of infecting and multiplying themselves into young growing bacteria which in time dissolve out or lyse. True to character, the bacteriophages single out their hosts. But the same type of bacteria may be the victim of different types of bacteriophages and so the number of types of bacteriophages are necessarily great.

VIRUS CHARACTERISTICS

Virus-induced diseases are of such variety that their joint study is only justified by our ability to point to certain characteristics—almost invariable—which distinguish them from bacteria. *First*.—All viruses are infective agents of very small size. The biggest are just within the range of visibility, while most are outside it, *i.e.* not visible under the microscope in sunlight. *Second*.—Most viruses will get through a filter so fine that it will stop all ordinary pathogenic bacteria. *Third*.—Viruses cannot be cultured except in susceptible living cells. Within the cells of living bodies or in tissue cultures, viruses multiply with surprising speed, but again when taken apart from living bodies they fail to show any metabolism and growth.

A pathogenic bacterium must show these characteristics; else it does not belong to the virus category. We are, however, unable to apply this test in all cases, namely, the pleuro-pneumonia-agent of cattle which can be grown in ordinary laboratory culture media and so is not listed among true viruses; yet this organism can be filtered and is small enough to be on the edge of visibility limits of the ordinary microscope.

Acknowledging, however, the fact that the line of demarcation between the smaller pathogenic bacteria and the bigger viruses is an indistinct one, there is no hesitation in grouping most viruses separately.

In addition to the three tests already mentioned there are others which are, however, not applicable to all types of viruses. A majority of viruses resists the action of 50 per cent glycerine more than most bacteria, many also are not destroyed by carbolic acid and other chemical agents.

Some viruses produce "inclusion bodies" inside the cells they attack but such structures do not extend beyond one specific type of cell for a given virus disease and in many virus diseases inclusion bodies have never been detected. Inclusion bodies seem to be, in some cases, small masses of degenerated products within the diseased cells, while, in others, they seem to consist of aggregations of the virus itself, *e.g.* in ectromelia, or the crystalline inclusions occurring in plants affected with tobacco-mosaic disease.

Quite a large number of viruses will undergo drying without being much worse off for the treatment and the majority will continue to survive for long periods in that state.

SOME LABORATORY METHODS

Development of methods for the experimental study of viruses in the laboratory is of recent origin. The following are some of the methods:—

(i) *Inoculation of chorioallantoic membrane*.—In 1931 Goodpasture and Woodruff demonstrated that some viruses would multiply on the chorioallantoic membrane of the developing hen's egg. Later, Burnett and others discovered that this membrane is extraordinarily susceptible to viruses, even becoming a host for many types not harboured by the grown-up bird, and though not unlimited in scope the chorioallantoic membrane of hen's egg is affording a satisfactory method of studying viruses. Viruses unresponsive to this treatment include the two well-known varieties—those of poliomyelitis and foot-and-mouth disease.

(ii) *Tissue culture*.—Viruses which occur in mammals can also be grown in tissue cultures, either in small quantities of tissue fed on plasma and embryo extract or by the simpler method of utilizing the minute growth which we get when small fragments of embryo tissue is incubated in Tyrode solution. Li and River have demonstrated that in this manner bacteriologically sterile vaccinia suitable for human inoculation can be readily prepared, and which may in future replace calf-lymph.

The investigation of viruses offers many difficulties, generally requiring a large set-up, but these difficulties have not checked our work. These are overcome by using the living animals as hosts for culture.

(iii) *Animal inoculation*.—It is a well-known laboratory technique and it has given a clue to many unknown diseases.

SIZE OF VIRUSES

The fact that viruses could be passed through certain types of filters, while the ordinary bacteria could not be so passed, afforded a simple method of measuring the size of viruses. The viruses could be isolated from the bacteria with which it often occurred. The filters made by earlier investigators, *viz.*, Berckefeld's diatomous earth or Pasteur-Chamberland's unglazed earthenware, however, were not fine enough for quantitative measurements. The discovery by Elford of a method of preparing thin and at the same time strong, collodion membranes with fairly uniform pores and the facility with which the size of the pores could be controlled at the time of preparation, was responsible for great progress in the study of the actual size of the viruses. With the collodion membrane method it has been possible to establish that the virus of a particular type is fairly uniform in size. Collodion membranes are also used to filter out unwanted admixtures giving a fairly pure sample.

The data obtained from "Gradocol" membranes fairly agree with the size measurements made otherwise by the centrifuge and the ultra-centrifuge. The larger viruses can however be directly measured by photomicrography using ultra-violet light and dark ground illumination. And this affords us a method not only to check the size measurements of the larger viruses by filtration methods but enables us to test the reliability of the latter method. Measurements of size made by different methods do not tally very well, but the disagreement is small, and may be explained by saying that the calculations made in the filtration and centrifugation methods on the hypothesis that all virus particles are round cannot be maintained. The disagreements however are not large considering the great difference in size between the larger and the smaller viruses.

The sizes of a number of the more well-known viruses are given in the following table together with sizes of some of the smallest free-living bacteria and a few protein molecules for comparison. The figures are those of Elford, the inventor of the Gradocol membrane.

FROM MICRO-ORGANISM TO MOLECULE

Table showing the diameters, in millimicrons, of some micro-organisms, representative viruses and some protein molecules.

Name.	Diameter.
<i>Chromobacterium prodigiosum</i> ...	750 m μ
<i>Spirillum parvum</i> ...	350 m μ
<i>Psittacosis virus</i> ...	250 m μ
<i>Spirochaeta pallida</i> ...	200 m μ
Agalactia of goats and sheep	150 m μ
Organism of bovine pleuropneumonia	
Sewage micro-organisms A, B, C	
Vaccinia virus	
Canarypox virus	125 m μ
Rabbit fibroma virus	
<i>Rabies virus</i>	
Infectious ectromelia virus of mice	
Herpes virus	100 m μ
Pseudo-rabies virus	
Influenza virus—human and porcine	
Borna disease virus	
Newcastle disease of fowls	85 m μ
Vesicular stomatitis virus ...	
<i>Rous sarcoma virus</i>	
Fowl plague virus	
Potato virus X	75 m μ
Bacteriophages Staph. K, C 16, D 4, D 12	
Bacteriophages D 54, S 41 megatherium	
Rift Valley fever virus	
Equine encephalomyelitis virus	30 m μ
Papilloma virus of rabbits	
Tobacco mosaic virus	
St. Louis encephalitis virus	
Bacteriophages T 111, C 36, D 13, D 20, D 48	25 m μ
Haemocyanin (Helix) ...	24 m μ
Yellow fever virus ...	22 m μ
Louping-ill virus of sheep ...	17 m μ
Poliomyelitis virus	10 m μ
Foot-and-mouth diseases virus of cattle	
Bacteriophage S 13	
Edestin ...	
Serum globulin ...	8 m μ
Serum albumin ...	6.5 m μ
Oxyhaemoglobin ...	6 m μ
Egg albumin ...	4 m μ

It will be seen that the size of the viruses varies considerably, e.g., from about a fourth of micron in diameter for psittacosis or "parrot fever" virus down to ten millimicrons approximately in the case of the foot-and-mouth disease and poliomyelitis virus.

The larger viruses are certainly very small bacteria with strict parasitic habits. As can be noticed in the table above, some of the viruses can change place with some of the free-living bacteria as regards size. The psittacosis virus is larger than the small sewage organisms, which are non-pathogenic and free-living. Vaccinia virus is about the same size as that of the infective agents of pleuropneumonia of cattle.

"PASCHEN BODIES"

Small refractile granules are visible under dark ground illumination photographed with ultra-violet light and heavily coloured with dye. These elementary bodies or Paschen bodies (Fig. 2), as they are

called after their discoverer, bear striking resemblance to bacteria. The Paschen or coccoid bodies occur in considerable quantity in infective substances such as calf-lymph or tissue cultures, and they grow with the advance of the disease. The Paschen bodies may be filtered and so separated from admixtures such as cell fragments and if this is followed by centrifugation the elementary bodies are deposited free from the soluble substance or the original emulsion.



FIG. 2. "PASCHEN BODIES" (vaccinia virus) $\times$ 2250. The size of the particles is about 15 millimicron. (1 millimicron equals 1 millionth of a millimetre)—Ultra-violet light photo by S. C. Bernad.

Rivers and Ward have demonstrated that, under the most favourable conditions, the pathogenic power of a virus suspension is in direct ratio to the number of particles, and if the latter are removed the infectivity goes. The inevitable conclusion, then is that the "coccoid bodies" are the pathogenic particles of the virus, and to this extent they are homologous with the visible bacteria. Besides this, the elementary bodies react to specific antisera in much the same way as ordinary bacteria react to their antisera. The virus may be neutralized by an appropriate dose of antisera and these sera may be shown to agglutinate the virus bodies in much the same manner as bacteria are agglutinated by their specific antisera.

ANTIGEN-ANTIBODY REACTIONS

In this connection we may as well note here that the specific problems encountered in virus-antibody reactions are only particular examples of the principles involved in all antigen-antibody reactions. But to gain a fair understanding of the process it is necessary to bear in mind the process of infection of, say, a vertebrate host by a virus from the most general biological standpoint, the ecological one.

The point to remember in connection with any common infectious disease of man or animals, measles in man and psittacosis in parrots, for

example, is that both the host and the virus species persist from generation to generation. Further, over a long stretch of time the extent and nature of the disease continue fairly unchanged. Stated otherwise, as far as the specific problem is concerned, both kinds of organisms continue to live and maintain an approximately constant equilibrium. Epidemiology's main question, with its modern ecological slant then is: how this survival of both species is mediated.

A number of authors, notably, Theobald Smith (1934) and Dudley (1935) maintain that it is against the interests of a parasite that its host should die outright as a result of the lodgment. There are exceptions: healthy animals may frequently be infected with anthrax spores which have persisted in the carcase of a mortally infected beast; but invariably the death of the host bars the possibility of extension of the infection.

Viruses, unlike ordinary bacteria, do not grow independently but enter into a dynamic relationship with their hosts. For example, in certain rabbit tumours, the viruses entrench themselves in a group of cells. The animal's body may react but destroying the cells which harbour the virus. Once the host cells are destroyed the tumours gradually disappear.

To sum up, the viruses seem to be minute obligate parasites, and within the limits of strict parasitism they show growth, multiplication, adaptation to environment and minor modifications.

Studies of the chemical constitution of viruses carried out by Rivers and other researchers show the presence of protein, fats and carbohydrates. So it appears again that the elementary bodies resemble bacteria and other living organisms. It may, therefore, be maintained that vaccinia virus is a small bacterium, qualified by the facts that (1) the purified virus elements have never manifested any metabolism and that (2) vaccinia cannot thrive except inside the living cells.

It may also be noted here that the mycobacterium of leprosy has never been cultured in non-living media nor has it been proved to have a metabolism of its own; for all that no one has tried yet to put this comparatively large bacterium in the same category as the viruses.

Rivers and Ward have been able to obtain purified elementary bodies from the infections of myxomatosis in rabbits, and these are similar both morphologically and serologically to minute organisms.

As we come down the table (*vide supra*) the virus dimensions become so small that accurate knowledge is lacking, yet suggestive observations have been made. Ledington and Gye, for instance, state that they have been able to centrifuge down

minute particles from filtrates which will produce tumours in fowls and ducks, to wash these particles with saline solution without affecting appreciably their infectivity, to make suspensions of the particles and to demonstrate that they are specifically agglutinated by antisera which neutralize tumour-producing agent. The diameters of the infective units of sarcoma virus is only 75 m μ . Such minute size makes their study very hard, but the evidence, though quite scanty, is suggestive.

NATURE OF VIRUS

It is not difficult to build up the theory that the larger viruses are parasitic bacteria, but this theory encounters difficulty when the smallest viruses are considered. For example, in the viruses of foot-and-mouth disease, poliomyelitis and some of the bacte-

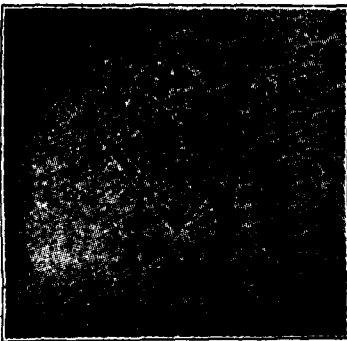


FIG. 3. The crystalline form of the tobacco mosaic virus.

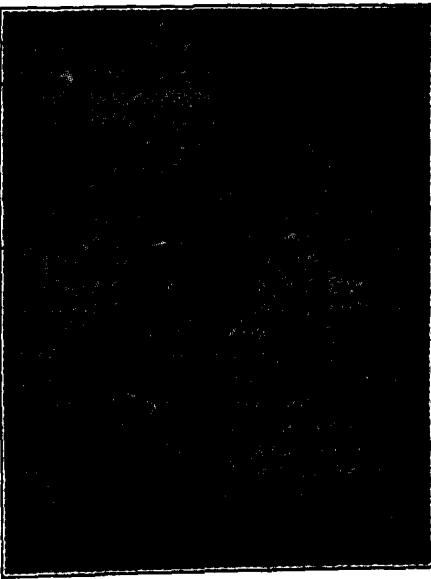


FIG. 4. The viruses causing 'bushy slant' disease in tomatoes.

riophages, there is hardly any space for the complexes necessary for organized life. Thus a school of thought has grown up during recent years which considers the viruses as no more than chemical substances which finding their way into intra-cellular spaces establish themselves parasitically.

Bordet considers bacteriophage as a chemical substance which kills bacteria resulting in the production of more bacteriophage, and he has drawn a parallel with the gradual production of fibrin ferment which takes place when fibrinogen is converted into fibrin.

Great impetus was given to the chemical theory of viruses when Stanley announced in America "the isolation from diseased tobacco plants of a crystalline protein possessing the properties of tobacco mosaic virus", (Fig. 3), and also the crystalline three dimensional form of viruses causing "bushy slant" diseases in tomato was demonstrated by Bawden and Price. (Fig. 4).

Stanley's work has opened up an interesting field for the investigator, but its discussion invariably leads to controversial points which cannot be dealt with in a brief paper like this.

Of the plausible theories on the nature of virus, I shall only mention the highly interesting suggestion made by R. G. Green in 1935 (Vide *Science*, 82, 443, 1935) that the viruses are degenerated bacteria which have lost their power of independent metabolism and growth due to long parasitic habits.

The study of virus is now of fundamental importance, for the smallest viruses may or may not be the bridge that spans the gulf between the living and the non-living, yet a more thorough knowledge of the viruses, especially of the smallest ones, cannot but help our understanding of that spanning. Virus-study always is of vast immediate practical interest for its terrible power to undermine and destroy all forms of life is a perpetual problem to mankind.

BOOK REVIEWS

Theoretical Organic Chemistry—By J. B. COHEN. Revised Fourth Edition (1942) by P. C. Austin, p. I-XV, 1-622. Published by Macmillan and Co. Ltd. Price Rs. 10/-.

This standard text-book has been revised preserving the general plan of the book and incorporating some essential details. According to Prof. Austin 'the rapid growth of Organic Chemistry since the last revision by the late Prof. Cohen, has necessitated the preparation of an entirely revised edition'. The carbohydrates and proteins have been more thoroughly dealt with and new chapters on Stereochemistry and the Theory of Valency have been added. The heterocyclic compounds and other complex substances have been treated in a separate part—Part III of the book. Compounds of biological interest, *e.g.*, proteins, vitamins, hormones, sterols and bile acids, plant pigments and enzymes have been briefly dealt with in the last chapter of the book.

The new additions and the rearrangement of several chapters have considerably enhanced the usefulness of the book. The references, though very brief, to the recent developments in Organic Chemistry, have been very appropriate.

It is noteworthy that even in the war-conditions the get-up of the book and the quality of the paper have not been impaired.

D. C.

Magadha Architecture and Culture—By SRIS CHANDRA CHATTERJEE, C.E., Sthapatya-Visarad. 2 Maps and 32 Plates. Published by the Calcutta University. Price Rs. 5/-.

The science of architecture, the matrix of the national cultural ideals, is an enduring expression of civilization. The architecture of Magadha, which was the cradle of a very ancient civilization of a very high order, recorded in its art forms the aesthetic outlook and psychology of the nation and its emotional reaction to the physical forces of Nature. It responded to the symphony of Nature not out of harmony with contemporary Indian life and thought. Plastic and pictorial art forms, music and dance of the Age were but the mediums of Nature's self-projections productive of all creative conceptions.

Science, Philosophy and Architecture have to serve the identical aims of moral and spiritual elevation in order to solve the complex problems that face humanity to-day. The evolution of humanity will culminate in Beauty and Art. Beauty and Art will be inspiring factors in the new conception of Life with an ideal of service to humanity.

India has immense treasures, material and spiritual, to offer to evolving a New World Architecture in the process of the evolution. In a very scholarly manner the author has recorded his arguments in supporting the claims of India. He suggests to

create in this country a new type of educational establishment to produce a new type of architect that can introduce a new type of civic atmosphere for generating and fostering a new nation with spiritual outlook on life. He appeals for co-operation in the task he has undertaken.

The book is as learned as it is interesting. It encompasses important phases of Indian cultural expressions of over two thousand years ago in respect of mythology, history, religion, philosophy, architecture and engineering and it gives a vivid picture of Rajagriha with its people, its town and rural planning. Full of excellent illustrations concerning the archaeological monuments of the land it presents several thoughtful designs of modern Indian structures inspired by the classical styles of Magadha architecture. Scholars and students will be profited by studying the monograph which deserves to be a text book under any university.

Mineralogy, Petrology and Economic Geology—Tables for the use of Geologists, Prospectors and Mining Engineers—By N. L. SHARMA, Indian School of Mines, Dhanbad. Published by the India Society of Engineers, 7, Clive Street, Calcutta, 1942. Price Rs. 3-8-0.

This pamphlet consists of a number of tables with explanatory notes facing each table for the identification of minerals, rocks and ores, both in

the field and in the laboratory. There are 17 tables of which 11 are devoted to mineralogy, 3 to petrology, 2 to the uses and classification of mineral deposits, and the last one to the distribution of economic minerals in India. The pamphlet will serve as a handy reference to those having working knowledge of the subject. The tables of mineralogy are sufficiently determinative—part of the optical properties being even superfluous in a work of this nature—and will help a ready identification of unknown minerals. The tables of the rocks and ores are complex and more classificatory than determinative by a system of elimination or by specific properties. Data of the specific gravity ranges of the more important rocks would have been helpful. Terms such as gneissose, schistose and foliated require further elucidation. The subdivision of hydrothermal deposits into mesothermal and epithermal and the use of the term hypothermal in preference to pneumatolytic are of doubtful simplicity whatever may be their systematic value. All the deposits mentioned under deposits by circulating waters may not be by meteoric water such as the asbestos deposit of Madras which "is believed to be totally unconnected with meteoric waters" by Coulson.

Apart from its usefulness to geologists, prospectors and mining engineers, this pamphlet will be of great use to students of mineralogy and ore deposits.

S. C. C.

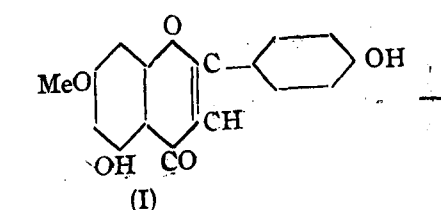
LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

ISOLATION OF A NEW FLAVONE FROM THE BARK OF *PRUNUS PUDDUM* (N. O. ROSACEAE)

A new flavone, $C_{16}H_{12}O_5$, m.p. 278-80°, in 0.04 per cent yield, has been isolated from the bark of *Prunus Puddum* (N.O. Rosaceae), collected from the district of Darjeeling. It has a methoxyl group and two free hydroxy groups. It forms a diacetyl derivative (m.p. 191-93°) and a monomethyl ether (m.p. 168°). The monomethyl ether has a free hydroxyl group as it forms a monoacetyl derivative (m.p. 190-91°). The compound is 7-methoxy-4':5'-dihydroxy flavone (I), isomeric with the naturally occurring flavone acacetin (II) (4'-methoxy-5:7-dihydroxy flavone) and it is 7-methoxy-apigenin. This has been confirmed by the demethylation of the

compound with hydriodic acid (*sp. gr.* 1.7) to apigenin (III) m.p. 344-46° (lit. m.p. 347-48°); which has been acetylated to apigenin triacetate (m.p. 181-82°, lit. m.p. 181-82°). The flavone (I), on hydrolysis with alcoholic potassium hydroxide, gives *p*-hydroxy-acetophenone (m.p. 102-5°, mixed m.p. with an authentic sample 104-5°; semi-carbazone, m.p. 192-93°, mixed m.p. with an authentic sample 194°).



Zoology and Entomology

Prawn Fisheries of India

B. CHOPRA

NEXT to agriculture and perhaps animal husbandry, fishery is the biggest industry of our country. Prawns and crabs form a very important part of our fisheries, and in some markets are of greater importance than any kind of fish.

First in importance are the Penaeids, known in trade circles in many parts of India as the 'sea prawns'. *Penaeus carinatus* Dana is the largest of the Penaeids and is fished on a large scale in all maritime provinces of India. It usually grows to a size of 7"-10", though it may sometimes attain a length of well over a foot. Along the Sind and Bombay coasts, in the backwaters of Malabar and all along the eastern coast of India this species is of great commercial importance.

The most important commercial freshwater prawn is *Palaemon carinus* Fabr. The species is very common in the lower reaches of rivers, lakes, bheels and tanks in Bengal, Madras, Bombay, Sind and several other parts of the country. In the low-lying parts of Travancore, as also in the backwater lakes, at times when the salinity is not high, the species is found in great abundance and during September to November it forms the bulk of the freshwater prawns sold in some of the markets.

Another freshwater prawn of considerable importance, in Bengal and Orissa at least, is *Palaemon rudis* Heller. *Palaemon idae* Heller is a species of considerable economic importance in South India and especially in Travancore. The males grow to about 4½" in size, the females being an inch or so smaller. The species is fished extensively in the backwaters of Travancore from September to December.

Although prawn-fishing is done on a large scale all along the east coast, the Chilka lake is the most

important fishing centre in Orissa. Conditions in the lake are very favourable for the growth and propagation of fish and prawns and especially of species that normally migrate between fresh and brackish waters.

The Presidency of Madras, with its long coast line of about 1,700 miles, excluding indentations etc., has important prawn fisheries in a number of centres.

In Travancore there is a fairly large dry-prawn industry also, but the methods followed are very primitive: Prawns are either sun-dried or boiled and sun-dried, but the latter practice is more in vogue.

Great advances in prawn industry have been made in Norway, California and other countries. In India it is yet in a very backward state.

Dr Chopra hopes that the amelioration of the lot of the fishermen should not be lost sight of in any programme of fishery development, as the progress will be judged not only by the quality, quantity and the price of fish available to our people, but by the conditions, moral and material, under which the fishermen live. In conclusion Dr Chopra suggests that like agriculture, fisheries should have an Imperial Council of Fisheries Research under the scientific control of an expert Fisheries Officer, with a band of scientists working on its staff, with technologists trying to solve the difficulties experienced under varying conditions all over the country, with marketing experts always keen to devise means for better distribution and better utilization, and with the whole body alive to the ideal of providing 'better food, more food, more and better fertilizer, better organization'.

Mathematics and Statistics

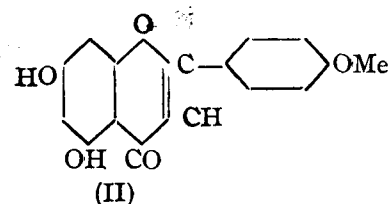
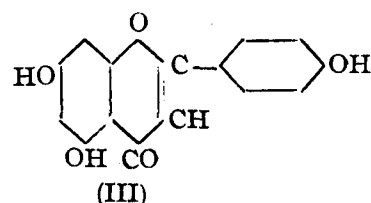
Certain Developments of Mathematics in the Last Thirty Years

S. C. DHAR

WHILE on the one hand the development of physical sciences presented various problems for the mathematicians' ingenuity, on the other hand mathematicians themselves forged methods in the shape of new branches of mathematics which the physicists took advantage of in unravelling the mysteries of nature. An instance of the first is the *Fourier's Analysis* developed for solving the problems of the conduction of heat in an isotropic solid. This

new technique was stimulated by the necessity of solving the physical problem. Another example of this in recent years is the *Operational Calculus*.

In connection with *Operational Calculus*, the author finds that history is repeating itself. The method which Heaviside introduced in the solutions of transient electrical problems met with utmost opposition from pure mathematicians, especially of the Cambridge school, who refused to recognise it



The new flavone has been named *Puddumetin*. Fuller details will be published in the *Journal of the Indian Chemical Society*.

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Calcutta, 7-4-1943.

ON RANDOM DISTANCES BETWEEN TWO RECTANGLES

The distribution of the distances within the same rectangle has been studied in an earlier note.¹ For the present problem, the simplest case will be that of two equal squares of side a , just touching each other at a common vertex on a common diagonal line. The distances x between them will be distributed as

$$f(x) dx = \frac{x dx}{a^4} \phi(x);$$

$$\text{where } \phi(x) = \frac{x^2}{2}; \text{ for } 0 \leq x \leq a;$$

$$= -2a^2 + 4ax - \frac{3x^2}{2}, \text{ for } a \leq x \leq \sqrt{2}a;$$

$$= 2a^2 + 4ax + \frac{x^2}{2} - 8a\sqrt{x^2 - a^2} + 4a^2$$

$$\left(\cos^{-1} \frac{a}{x} - \sin^{-1} \frac{a}{x} \right), \text{ for } \sqrt{2}a \leq x \leq 2a$$

$$= 6a^2 + \frac{3x^2}{2} - 8a\sqrt{x^2 - a^2} + 4a^2$$

$$\left(\cos^{-1} \frac{a}{x} - \sin^{-1} \frac{a}{x} \right), \text{ for } 2a \leq x \leq \sqrt{5}a;$$

$$= -4a^2 - \frac{x^2}{2} + 4a\sqrt{x^2 - 4a^2} + 4a^2$$

$$\left(\sin^{-1} \frac{2a}{x} - \cos^{-1} \frac{2a}{x} \right),$$

$$\text{for } \sqrt{5}a \leq x \leq 2\sqrt{2}a$$

The value for the mean distance comes out as $1.47a$.

The expressions become increasingly complex as we pass on to less simple cases. The next simple case is that of two equal squares of side a separated along a common diagonal line by $\sqrt{2}b$; it reduces to the case considered above, when $b=0$. Here also $\phi(x)$ is given in five ranges. The increase in complexity can be judged from the expressions given below in comparison with the corresponding expressions in the first case ($b=0$). $\phi(x)$ for the first two ranges only are shown.

$$\phi(x) = b^2 + \frac{x^2}{2} - 2b\sqrt{x^2 - b^2} + b^2 \left(\cos^{-1} \frac{b}{x} - \sin^{-1} \frac{b}{x} \right),$$

$$\text{for } \sqrt{2}b \leq x \leq \sqrt{(a+b)^2 + b^2};$$

$$\phi(x) = -2a^2 - 3b^2 - 4ab - \frac{3x^2}{2} + 4b\sqrt{x^2 - (a+b)^2}$$

$$+ 2(2a+b)\sqrt{x^2 - b^2} + 2b(a+b)\left(\sin^{-1} \frac{a+b}{x}\right)$$

$$- \cos^{-1} \frac{a+b}{x} + b(2a+b)\left(\sin^{-1} \frac{b}{x} - \cos^{-1} \frac{b}{x}\right),$$

$$\text{for } \sqrt{(a+b)^2 + b^2} \leq x \leq \sqrt{2}(a+b).$$

The general case of two rectangles, unequal in shape and size (but with parallel edges), separated by an interval (c, d), has also been studied. Here, $f(x)$ is given in fifteen ranges,—instead of five only for the equal squares,—with more complicated terms. Cases of overlapping are covered by negative values of c and d .

A degenerate case may be specially mentioned: two parallel lines of length a and b are separated by the interval (c, d), c along the direction of the lines and d perpendicular to it. Without loss of generality we can put $a \geq b$. Instead of writing down $f(x)dx$ directly, the distribution $f(y)dy$ of a changed variate y , is given below, where $y = +\sqrt{x^2 - d^2}$.

$$f(y) = \frac{1}{ab}(y-c), \text{ for } c \leq y \leq b+c;$$

$$= \frac{1}{a}, \text{ for } b+c \leq y \leq a+c;$$

$$= \frac{1}{ab}(a+b+c-y), \text{ for } a+c \leq y \leq a+b+c.$$

When $d=0$ one line lies on the extension of the other, and x becomes the same as y .

Further studies on similar problems are in progress. My thanks are due to S. N. Roy for his kind interest and to Anil Bhattacharyya for suggesting the problem.

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¹ SCIENCE AND CULTURE, 8, 388, 1943.

as a legitimate method in the solutions of differential equations of mathematical physics.

Many physical problems were solved by the O. P. method. Heaviside solved by his method many transient problems in cable telegraphy and telephony, of electromagnetic waves, heat conductions. Bromwich worked out problems of:—temperature recorded by thermometer with varying outside temperature, sphere cooling by radiation, vibration of circular membranes, electrical problems in diffusion and motion of viscous fluid. Carson like Heaviside applied O. P. method to numerous problems connected with the propagation of disturbances over cables. H. Jeffreys solved problems in wave propagation in strings, cooling of the earth and many other

allied problems. The new method devised by Van der Pol was used by various workers in Europe and India to solve problems in connection with functions of mathematical physics and solutions of differential equations.

The address next deals with another advancement of mathematical knowledge of the time which, unlike the previous one, is the exclusive concern of the pure mathematicians. It deals with Automorphic Functions and Uniformization problems.

By the investigation of various workers the uniformization of algebraic curves is almost complete; but the uniformization of transcendental functions remains to be tackled.

Agricultural Sciences

The Need of Planning on an All-India Basis in Certain Aspects of Agricultural Entomology

Y. RAMCHANDRA RAO

PROVINCIAL entomologists would certainly be greatly handicapped if they have to deal with migrating insects like locusts which usually breed in a far-off place and make long-distance flights to invade distant areas. In such cases, there is obviously a need for the organization of a central agency for keeping watch over their movements and warning provinces likely to be invaded. Happily, such an agency has been functioning in India since the last three years in regard to the desert locust, but there are two other locusts in India which have potentialities for increasing in numbers and appearing in swarms, but they stand in need of fuller investigations, as very little is known about their outbreak centres and the factors that bring about swarming.

Besides locusts, there are pests like the Paddy Army-worm, which have a propensity for appearing all at once in enormous numbers on crops and causing extensive damage. Observations have shown that such outbreaks are due to the appearance of flights of moths by migration from some distant place. Similarly the Cut-worms and the Cabbage White also appear to have the power of migrating from the plains to the hills and back again with the change of the seasons.

The Deccan Grasshopper is another pest that is a problem by itself. Its distribution extends over four contiguous political areas—Bombay, Hyderabad, Madras and Mysore. It generally appears in a serious form for 3 or 4 years, and after subsiding for a few years reappears again. It has no doubt been studied independently in all these different areas, but what is needed now is a unified study of the insect

by a single agency on a broader basis and with a wider perspective utilising all the data accumulated in the different areas, so as to obtain a fuller knowledge of its capabilities, including its ecological reactions, its original habit and its periodicity. Similarly, it would be very useful if information collected in the different parts of India on wide-spread grasshopper pests, such as the rice-grasshoppers, (*Hieroglyphus* spp.) and *Aeolopus affinis* Bol., could be studied by a central agency.

Under the auspices of the Imperial Council of Agricultural Research, a detailed scheme of investigations on the Desert Locust was in operation from December, 1930 to March, 1939, the results of which have been of considerable help to the Locust Warning Organization of the Government of India, now engaged in the study and control of the present locust outbreak. In the course of this work, an examination of all available old records relating to locust prevalence in the past was made, and a mass of information on past locust cycles has been collected. Information on the movements of the Bombay Locust and the Indian Migratory Locust has also been incidentally obtained. In the case of the Bombay Locust, the information gathered from old records shows that the last outbreak of this pest occurred during the period 1898—1908.

Concluding Rao Bahadur suggests that a system of planning out research on an all-India basis should be introduced, whereby a central body of agricultural experts should arrange for all such problems as cannot be tackled by provincial entomologists, being taken up as schemes on an all-India basis.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. VIII

JUNE, 1943

No. 12

INDUSTRIAL RESEARCH AND INDIAN INDUSTRIES

INDIAN industries are at the present time in an unenviable position. Their development has been very unbalanced; while some industries like those of textiles, jute, sugar, and tea have reached a certain measure of development and stability, key industries like those of power, chemicals, minerals and machineries have not either seen the light of day, or are in a very crude state of development. But these are the very roots of the great Tree of Industrialisation, and the effect of their neglect and poor development is now felt in every other industry. The prices of electrical and other types of power machinery, of essential chemicals and of metals have soared to unimaginable heights, and sometimes they are absolutely unavailable. But for these handicaps many new and useful industries could have been started in India during the present war time.*

The Indian industrialist is naturally anxious for his future. While the war has given him artificial protection and enabled him to make a little money, he feels that after the termination of the war he will be faced with relentless competition, and he can expect little relief from his own Government. The relevant passages in the Atlantic Charter, the pronouncements of the allied statesmen, financiers, and economists are absolutely vague on the question of India, and this has added to his anxiety. He wants to find out fresh outlets for his energy and for his surplus money, but does not find much helpful suggestion from any quarter.

* We may particularly refer to the manufacture of many kinds of drugs which used to be imported from foreign countries, but are now unobtainable. Experiments have been successfully carried out in many laboratories on the preparation of these drugs, but their production on an industrial scale is handicapped owing to the scarcity of basic and intermediate chemicals. The same applies to the manufacture of dye-stuffs, which is impossible without a well-developed tar-distillation industry.

It is well-known that up to the present time the Indian industrialist has, with one or two exceptions, been content merely with copying the methods evolved in other countries. He has spent very little on research and in utilising science for his needs. It is absolutely certain that such an attitude will not help him in meeting the post-war situation. The position is not unlike that of the U. S. A., or the United Kingdom at the beginning of the current century. But since then, particularly after the last war, both America and England have spared no efforts in applying Science to Industry. The enormous development of State-organised research institutes for industry and agriculture, the amendment of patent laws, granting of tariff protection to help struggling industries are indications of the extent of the interest of the State in the pivotal question of industrial development. But has the private industrialist in those countries remained indifferent, or allowed himself to be absolutely dependant on Government measures?—we may ask.

The numerous research laboratories maintained by private companies in U. S. A. and Great Britain like Bell Telephone Co., Du Pont de Nemours, United Steel Corporation furnish the answer. The amounts spent on research by these Companies are almost inconceivable in India.

It is only after the outbreak of the present war that the Indian industrialist has begun to take some interest in industrial researches and to be alive to the possibility of utilising Indian scientists for his own and the country's benefit. It is true that the results have not often been encouraging, but that is not entirely the research worker's fault. The industrialist generally thinks in terms of investment and quick return and minimises the difficulties which stand in the way of the research worker in this country viz., lack of organisation, absence of scientific literature and absence of leadership. But these

lessons are being quickly learnt, and today at least in the large manufacturing centres, particularly those having first class universities and research institutions, organisation, scientific literature and leadership can be found. It remains now for the Indian industrialist to establish liaison with such organisations, and work out methods for exploitation of the results of research. The young Indian scientist is as good as any in the world, and he only requires

wider scope for the development of his talents. To use a metaphor, the seed is good, but there is no soil where it can thrive. The present times afford us an artificial protection which may not be available later. If due to the efforts of the industrialist in this country a band of scientists can be trained up for the service of industries in general there is no doubt that the investment will bring ample dividend to the investor as well to the nation in normal times.

HISTORY REPEATS ITSELF

(A Story from the Bible)

"AND Pharaoh said unto Joseph, In my dream, behold, I stood upon the bank of the river: And, behold, there came up out of the river seven kine, fatfleshed and well favoured; and they fed in a meadow:

And, behold, seven other kine came up after them, poor and very ill favoured and leanfleshed, such as I never saw in all the land of Egypt for badness:

And the lean and the ill favoured kine did eat up the first seven fat kine:

And when they had eaten them up, it could not be known that they had eaten them; but they were still ill favoured, as at the beginning. So I awoke.

And I saw in my dream, and, behold, seven ears came up in one stalk, full and good:

And, behold, seven ears, withered, thin, and blasted with the east wind, sprung up after them;

And the thin ears devoured the seven good ears: and I told this unto the magicians; but there was none that could declare it to me.

And Joseph said unto Pharaoh, The dream of Pharaoh is one: God hath shewed Pharaoh what he is about to do.

The seven good kine are seven years; and the seven good ears are seven years; the dream is one.

And the seven thin and ill favoured kine that came up after them are seven years; and the seven empty ears blasted with the east wind shall be seven years of famine.

This is the thing which I have spoken unto Pharaoh: What God is about to do he sheweth unto Pharaoh.

Behold, there come seven years of great plenty throughout all the land of Egypt:

And there shall arise after them seven years of famine; and all the plenty shall be forgotten in the land of Egypt; and the famine shall consume the land;

And the plenty shall not be known in the land by reason of that famine following; for it shall be very grievous.

And for that the dream was doubled unto Pharaoh twice; it is because the thing is established by God, and God will shortly bring it to pass.

Now therefore let Pharaoh look out a man discreet and wise, and set him over the land of Egypt.

Let Pharaoh do this, and let him appoint officers over the land, and take up the fifth part of the land of Egypt in the seven plentiful years.

And let them gather all the food of those good years that come, and lay up corn under the hand of Pharaoh, and let them keep food in the cities.

And that food shall be for store to the land against the seven years of famine, which shall be in the land of Egypt; that the land perish not through the famine.

And the thing was good in the eyes of Pharaoh, and in the eyes of all his servants.

And Pharaoh said unto his servants, Can we find such a one as this is, a man in whom the Spirit of God is?

And Pharaoh said unto Joseph, Forasmuch as God hath shewed thee all this, there is none so discreet and wise as thou art:

Thou shalt be over my house, and according unto thy word shall all my people be ruled; only in the throne will I be greater than thou.

And Pharaoh said unto Joseph, See, I have set thee over all the land of Egypt.

And Pharaoh took off his ring from his hand, and put it upon Joseph's hand, and arrayed him in vestures of fine linen, and put a gold chain about his neck;

And he made him to ride in the second chariot which he had; and they cried before him, Bow the knee: and he made him ruler over all the land of Egypt.

And Pharaoh said unto Joseph, I am Pharaoh, and without thee shall no man lift up his hand or foot in all the land of Egypt.

And Joseph was thirty years old when he stood before Pharaoh king of Egypt. And Joseph went out from the presence of Pharaoh, and went throughout all the land of Egypt.

And in the seven plentiful years the earth brought forth by handfuls.

And he gathered up all the food of the seven years, which were in the land of Egypt, and laid up the food in the cities: the food of the field, which was round about every city, laid he up in the same.

And Joseph gathered corn as the sand of the sea, very much, until he left numbering; for it was without number.

And the seven years of plentifulness, that was in the land of Egypt, were ended.

And the seven years of dearth began to come, according as Joseph had said: and the dearth was in all lands; but in all the land of Egypt there was bread.

And when all the land of Egypt was furnished, the people cried to Pharaoh for bread: and Pharaoh said unto all the Egyptians, Go unto Joseph; what he saith to you, do.

And the famine was over all the face of the earth: And Joseph opened all the storehouses, and sold unto the Egyptians; and the famine waxed sore in the land of Egypt.

And all countries came into Egypt to Joseph for to buy corn; because that the famine was so sore in all lands.

And there was no bread in all the land; for the famine was very sore, so that the land of Egypt and all the land of Canaan fainted by reason of the famine.

And Joseph gathered up all the money that was found in the land of Egypt, and in the land of Canaan, for the corn which they bought: and Joseph brought the money into Pharaoh's house.

And when money failed in the land of Egypt, and in the land of Canaan, all the Egyptians came unto Joseph, and said, Give us bread: for why should we die in thy presence? for the money faileth.

And Joseph said, Give your cattle; and I will give you for your cattle, if money fail.

And they brought their cattle unto Joseph: and Joseph gave them bread in exchange for horses, and for the flocks, and for the cattle of the herds, and for the asses: and he fed them with bread for all their cattle for that year.

When that year was ended, they came unto him the second year, and said unto him, We will not hide it from my lord, how that our money is spent; my lord also hath our herds of cattle; there is not ought left in the sight of my lord, but our bodies, and our lands:

Wherefore shall we die before thine eyes, both we and our land? buy us and our land for bread, and we and our land will be servants unto Pharaoh: and give us seed, that we may live, and not die; that the land be not desolate.

And Joseph bought all the land of Egypt for Pharaoh; for the Egyptians sold every man his field, because the famine prevailed over them: so the land became Pharaoh's.

And as for the people, he removed them to cities from one end of the borders of Egypt even to the other end thereof.

Only the land of the priests bought he not; for the priests had a portion assigned them of Pharaoh, and did eat their portion which Pharaoh gave them: wherefore they sold not their lands.

Then Joseph said unto the people, Behold, I have bought you this day and your land for Pharaoh: lo, here is seed for you, and ye shall sow the land.

And it shall come to pass in the increase, that ye shall give the fifth part unto Pharaoh, and four parts shall be your own, for seed of the field, and for your food, and for them of your households, and for food for your little ones.

And they said, Thou hast saved our lives: let us find grace in the sight of my lord, and we will be Pharaoh's servants.

And Joseph made it a law over the land of Egypt unto this day, that Pharaoh should have the fifth part; except the land of the priests only, which became not Pharaoh's.

If the names of persons and places be slightly changed, we have contemporary history!

THE SARASVATI

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AS one looks through the dim mists of antiquity, he cannot fail to note that civilization in India, as in Egypt, Iraq and China, dawned on the banks of the great rivers. History bears witness to the fact that the tenor of cultural evolution, changes in material prosperity, and vicissitudes of politics have an intimate connection with alterations in the course and flow of the life-giving streams. Literature is full of echoes of such changes. Perhaps no river in our country has excited greater interest in this respect than the Sarasvati.

This is the river *par excellence* in several hymns of the Rigveda, usually regarded as the oldest literary work of the Indo-Aryans. It is also alluded to in numerous later texts. From these references one gets the impression that in the early Vedic age, probably not later than the middle of the second millennium B.C., it was a mighty stream which had its source in the Himalayas and flowed through the Eastern Punjab (past the far-famed Kurukshetra of later ages) and ultimately found its way to the sea (*Vide infra*). From descriptions in numerous hymns and songs found scattered throughout our ancient literature, it is apparent that the river was lined with flourishing settlements of holy sages and prosperous clans on both banks where the broad features of ancient Indo-Aryan civilization and social polity took shape.

But we look in vain for such a mighty river now in the eastern part of the modern Punjab. We have in its place an inconspicuous rivulet called the Sarsuti whose name however recalls the Sarasvati of golden times. This little stream rises in a depression at the foot of the Siwaliks which fringe the outer Himalayas, and enters the Ambala and Karnal districts of the Eastern Punjab. It flows past the sacred sites of Kurukshetra including Sthanu Tirtha (Thanesar), and Prithudaka (Pehoa) near which it receives a small affluent called the Aruna. It is joined by a number of hill streams (the Linda, the Markanda), enters the Patiala territory and unites with a larger stream, the Ghaggar which likewise rises in the Siwaliks. The land between the Sarasvati on the north and the Drishadvati (which has been identified with the Rakshi), a stream running in a south-westerly direction east of the Sarasvati, is the classical Brahnavarta, said to be the holiest region in India (Manusamhita, first century A.D.). Under the name Ghaggar, the united stream passes through the Patiala State, the Hissar

district and the Bikaner territory down to Bahawalpur and Sind where the dry course is continued under the name 'Hakra' which seems to have joined the great Mihran of mediaeval writers. "Throughout the deltaic flats of the Indus, may still be seen old channels which once conducted its waters to the Rann of Cutch". In our own days the Sarsuti-Ghaggar flows in its wide sandy bed below the junction only for some months. "In the lower portion of its course in the Hissar district the bed of the river is dry from November to June, and grows excellent crops of wheat and rice. Even in the rains the water-supply is very capricious, and from time to time it fails entirely except in the immediate neighbourhood of the hills."*

Though the course of the stream described above is recognised by popular tradition to be no other than that of the Vedic Sarasvati, neither its flow, nor its actual expanse at the present day appears to conform to that of the Vedic river, and doubts have been expressed that the Vedic singers might have had some other sheet of water in view when they invoked the name Sarasvati. The great Indus, the Arghandab, and its principal, the Helmand river, in the Kandahar region of Afghanistan (ancient Arachosia), have sometimes been put forward as the Vedic Sarasvati.

On the other hand, it has been held that the notices and descriptions in extant literature leave no room for any other identification; and the present moribund stream called the Sarsuti is really the relic of the once mighty river Sarasvati which, due to physical causes, has shrunk and dwindled down continuously throughout nearly four thousand years of history. There is enough ground for such a belief. For the width of the Sarsuti-Ghaggar depression within the State of Bikaner is in places not less than

* Imp. Gazetteer of India, Vol. I. 30; Rajputana, 1906, p. 98. "The Caggar (Ghaggar), which rises in the Sewaluk, passes Hansi, Hissar, and flowed under the walls of Bhutnair, at which place they yet have their wells in its bed. Thence it passed Rung-mahel, Bullur, and Phoolra, and through the flats of Khadal (of which Derrawal is the capital), emptying itself according to some, below Ootch (Uch), but according to Abu-Birkat (whom I sent to explore in 1809, and who crossed the dry bed of a stream called the Khaggar, near Shahgurb), between Jessulmeer and Rori Bekher. If this could be authenticated, we should say at once that united with the branch from Dura, it gave its name to the Sangra, which unites with the Looni, enlarging the eastern branch of the Delta of the Indus" (Tod, Rajasthan, old ed., II. 253).

two miles. At certain points it is four miles or more. Below Derawar in the Bahawalpur State, the dry beds have a deltaic look.†

The length and the width of the depression clearly indicate that we have to deal with the remnants of an once big river, and the identification would be complete if remains of ancient cities could be traced in its present arid basin. This attempt was made by several writers and explorers. Col. Tod sent a party in 1809. Major Raverty emphasized the importance of the Hakra, of which the Sutlaj was a tributary, more than half a century ago in a paper entitled 'The Mihran of Sind and its Tributaries'.‡

In 1920 Dr L. P. Tessitori published the results of his exploration of the Ghaggar.§ In recent times the problem attracted the attention of Sir Aurel Stein, the famous explorer of Central Asia and translator of the 'Rajatarangini'. In an article published in a geographical magazine he summarizes the results of his survey of ancient sites along the lost Sarasvati river.¶ In view of what has been written on the subject it is necessary to take stock of the facts that can be gleaned from literature, Vedic and post-Vedic, and inscriptions, regarding the original condition and subsequent history of the famous stream.

We may first dispose of the claims of other rivers. In post-Vedic literature the name Sarasvati has often been applied to many other streams and brooks. Nay it has been used sometimes in Puranic texts in a generic sense to include all the sacred streams of our country.

Sarvah Punyah Sarasvatyah

Sarva Gangah Samudragah‡

"All sacred (rivers) are Sarasvati, all seagoing (streams) are the Ganges."

It was specially applied to seven rivers of antiquity besides a number of other sheets of water associated with several holy spots. The rivers enumerated in the *Sarasvatopakhyaṇa*§ of the Mahabharata as *Sapta Sarasvatyah*, are as follows: the Suprabha in Pushkara near Ajmer,¶ the Kanchanakshi in Naimisha to the north-west of Lucknow, the Visala in the Gaya region, the Manorama in Uttara Kosala or Oudh, the Oghavati in Kurukshetra

near Thanesar, the Surenu near Gangadvara, or Hardwar, and the Vimaloda on the Himalayas.

Besides these seven Sarasvatis a few other streams also bore the same name, e.g., the river which takes its rise in Mount Abu traverses the contiguous forest (*Arbudaranya*) and flows past Patan into the little Rann of Cutch. This stream is apparently mentioned in a grant of Mularaja Chaulukya in the tenth century A.D. and the *Prabhasakhanda* of the Skanda Purana. In the Mahabharata, the Vamana Purana, and certain verses of the *Prabhasakhanda* itself we have reference to a Sarasvati at Prabhasa (the Somnath region in the Kathiawar Peninsula). The *Brihadharma Purana* mentions the Sarasvati at the Tribeni (Allahabad), and at the Muktabeni in the Hughly district where the westernmost triad of branches into which the Bhagirathi divided was known as the Sarasvati. The Tribeni at Allahabad is according to some a mystic invention to satisfy the craze for the magic number three.

THE WESTERN AND THE EASTERN SARASVATI

Of course, none of these rivers except perhaps the Oghavati can claim to be the Vedic Sarasvati. There are strong reasons to believe that another river in the west, besides the stream in the eastern Punjab, was also known in antiquity under the name Sarasvati; for in the Pehoa inscription¹² of Bhoja I of the Imperial Pratihara Dynasty, the stream which flows past Pehoa receives the name *Prachi* Sarasvati. The prefix *Prachi*, i.e., eastern, points to a tradition about the existence of a western river of the same name about 850 A.D. and earlier. The existence of a western Sarasvati is also supported by the Avesta which mentions a 'Harahvaiti'¹³ which clearly corresponds to the Sanskrit 'Sarasvati'. This western Sarasvati can hardly be the Indus; as some scholars have thought, because in several passages of the Rig Veda, VII.36.6,¹⁴ X.64.9,¹⁵ and 75.4.5,¹⁶ the Sarasvati is

¹² Ind. Ant. VI. p. 192. *Prabhasakhanda*, Chap. XXXV. 38. Cf. *Progress Report of the Arch. Surv. Ind.* Western Circle, for 1905-6, p. 53.

¹³ III. 82. 58-60; IX. 35. 72.

¹⁴ 84. 28.

¹⁵ Ch. XXXV, 101 ff. cf. also the Cintra Prasasti, *Epigraphia Indica*, I. 275, 283; and *Alberuni*, XXV, p. 261.

¹⁶ I. 6. 27-28; 33-34.

¹⁷ *Epigraphia Indica*, I. 137. The name *Prachi* Sarasvati is also applied to the river which flows past Patan (Anahilapataka) in Gujarat. Ind. Ant. VI. 192.

¹⁸ Ind. Ant. 1903. 291; Cambridge History of India, I. 321 n.

¹⁹ May the seventh (stream) *Sarasvati*, the mother of the *Sindhu* and those rivers that flow copious and fertilizing, bestowing abundance of food, and nourishing (the people) by their waters, come at once together (Wilson).

²⁰ May the very great rivers, *Sarasvati*, *Sarayu*, *Sindhu*, come with their waves for (our) protection: may the divine material animating waters grant us their water mixed with butter and honey (Wilson).

²¹ Like mothers crying for their sons, (the other rivers) hasten towards thee, *Sindhu*, like milch cows with their

† Stein, *Ancient sites along the lost Sarasvati River*, *The Geographical Journal*, April, 1942, pp. 175-181.

‡ J. A. S. B., Vol. LXI, Part I, pp. 155 ff.

§ Ibid., N. S. XVI (1920), pp. 254 ff; *Progress Report of the Arch. Surv. Western Circle*, 1922, p. 112 ff.

¶ *The Geographical Journal*, April, 1942, pp. 173 ff.

§ Markandeya Purana, LVII. 30.

¶ Salya Parva, Ch. XXXVIII.

For the Sarasvati which carries the drainage of the Pushkar valley see Rajputana (*Imperial Gazetteer*, Provincial Series), 1908, p. 449; Tod, *Annals and Antiquities of Rajasthan*, I. 397; II. 253. It is the name of the Luni or Salt river on its upper course which with its numerous feeders has its source in the springs of the Aravalli.

carefully distinguished from the Sindhu (the Indus). The river which has the best claim to be regarded as the Sarasvati of the west is either the river of that name at the shrine of Sarada in Kashmir¹⁴ or the Harahvati identified with the Arghandab, a tributary of the Helmand in Arachosia, or with the Helmand itself.¹⁵ The claim of the Arachosian stream to be regarded as the Sarasvati of certain hymns possibly finds some support in a passage of the Rig Veda, X.64.9, where it is mentioned along with the Sarayu and the Sindhu, provided the Sarayu in this passage is the river of Herat known in early texts as the Haraiya. But the matter is not free from doubt, as the Sarayu of Oudh may also have been meant.

The western Sarasvati can, however, hardly be the stream mentioned in all the Rig Vedic hymns, for in III.23.4^d and X.75.5, the Sarasvati finds mention along with the Drishadvati (modern Rakshi) and the Apaya (another branch of the Chitang), and occupies a place in the enumeration of rivers in the *Nadistuti*, between the Yamuna and the Sutudri (Sutlej). This description can only apply to the modern Sarsuti, the river of Kurukshetra.

THE SARASVATI, A MIGHTY SEAGOING STREAM IN THE EARLY VEDIC AGE.

We may now proceed to find out what indications the passages in the Rig Veda give us regarding its flow and its basin. In Rig Veda VII. 95. 1-2^a the Sarasvati is described as the chief and purest of rivers flowing from the mountains to the ocean (*yati giribhya a samudrat*). It sweeps away in its might all other waters. In VI. 61. 2. and 13^a it is men-

tioned, as the most impetuous of all other streams. "With impetuous and mighty waves it breaks down the precipices of mountains and undermines both her banks," or, according to another interpretation, a people, called Paravatas (*Paravataghni*). It has "water-laden" sisters whose number is seven, and it causes the prosperity of the five folks (*pancha jata vadhayanti*).

The five tribes in Rig Veda, VI. 61. 12^a may have reference to the Bharatas, the Kurus, the Rusamas, the Matsyas, and the Videghas or Videhas before their migration to the banks of the Sadanira, which is identified with the Gandak or some neighbouring stream.¹⁶ The seven sister streams are distinguished from the Sarasvati in Rig Veda, VI. 61. 10^b and apparently also in VIII. 54. 4.¹ But in VII. 36. 6. the Sarasvati is the seventh (*saptathi*). The "seven sisters" of the *Rig Veda* may have formed the ground work of the epic legend of the seven Sarasvatis. The identity of the rivers included in the group seems however to have varied from time to time.

In Rig Veda, II. 41. 16¹ the Sarasvati is styled *ambitama* and *naditama*, best of mothers and best of rivers. These epithets recall the laud in the Mahabharata, XIII. 146. 17:

*Esha Sarasvati punya nadinam uttama nadi
Prathama sarva saritam nadi sagara gamini.*

In the same epic, IX. 43. 28, 39-40, we have the interesting story of the overflow of the Sarasvati as a result of which the Aruna sprang to life.

*Maharshinam matam jnatva tatah sa saritamvara
Arunam anayamssa sam tanum purusharshabha
nighudham asya gamanam ihasit purvamevatu
tato' bhetyarunam devam plavayamasa varina.*

"Ascertaining the wishes of the great sages the best of rivers (the Sarasvati) incorporated the Aruna with her own body; formerly the flow (of the Aruna) was hidden. Afterwards (the Sarasvati) inundated the divine Aruna with its own waters."

It is clear that the Sarasvati described in the hymns and songs noted above was a mighty stream

"Abiding in the three worlds, comprising seven elements, cherishing the five races (of beings), she is ever to be invoked in battle."

¹⁴ Cf. R. V. III. 23. 2-4; VII. 96. 2; Oldenberg, Buddha, 402; Vedic Index, II. 225; Sat. Br., I. 4. 1. 14; XIII. 5. 4. 9.

¹⁵ May Sarasvati, who has seven sisters, who is dearest amongst those dear to us, and is fully propitiated, be ever adorable.

¹⁶ May Pusha, Vishnu, Sarasvati, the seven Sindhus, Water, Wind, Mountains and Trees protect my sacrificial offering.

¹⁷ Sarasvati, best of mothers, best of rivers, best of goddesses, we are, as it were, of no repute; grant us, mother, distinction.

In thee, Sarasvati, who art divine, all existences are collected: rejoice, Goddess, amongst the Shunahotras, grant us, goddess, progeny (the translations are mainly from Wilson).

that gave life and prosperity to a flourishing population. It was closely associated with other rivers including the Sindhu (the Indus) and its tributaries (*sapta-sindhu*; *sapta svasa*).¹⁷ Nay, in VII. 36. 6. it is lauded as the mother of rivers or of the Indus (*Sindhumata*). This last epithet may imply that once its waters mingled with that of the Indus and its affluents, and some of the Vedic singers regarded it as the principal stream, the other rivers of the Punjab being reckoned as its tributaries. This view receives some support from a passage of the *Vajasaneyi samhita*¹⁸ which says that "five rivers flowing on their way speed onward to the Sarasvati, but then became the Sarasvati—a five-fold river in the land."

*Pancha nadyah Sarasvatimapi yanti sasrotasah
Sarasvati tu panchadha so dese' bhavati sarit.*

The description of the Sarasvati as *panchadha*—five-fold, or split up into five parts, may indicate that in its lower channel, while entering the areas now known as Bahawalpur and Sind and perhaps also

DESCRIPTION

On the left bank of the Ghaggar, after it has entered the State of Bikaner, stands Hanumangarh close to the ruined fort of Bhatner. Lower down the riverine belt there is Suratgarh, 113 miles north by north-east of Bikaner city. Mounds in the neighbourhood of these towns yielded fragments of painted or relief decorated pottery, terra cotta sculptures etc. which Stein assigns to the Kushan period.²⁰ More ancient sites were traced within the Bahawalpur area. These include the Sandhanawala Ther (mound) near Fort Abbas a little to the west of Walar and Bijnor between which "an ancient winding bed of the Sutlej" is believed to have joined the Hakra. Excavation at Sandhanawala disclosed remains of chalcolithic (coeval with Harappa-Mohenjodaro) times²¹, i.e., c. 2500 B.C. The ceramic ware of this region is distinct from the pottery found at the mounds up the Ghaggar in the Bikaner State. Stein

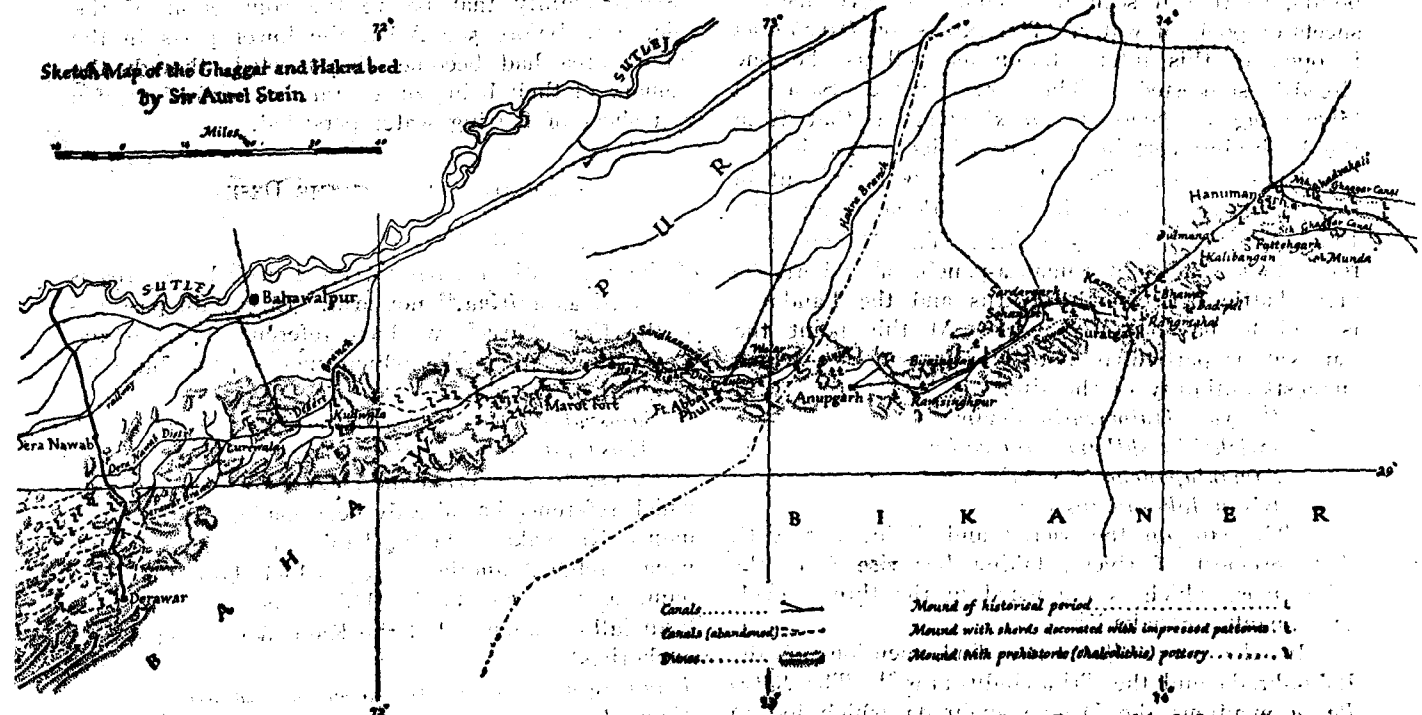


FIG. 1. Sketch Map of the Ghaggar and Hakra bed.—(with acknowledgment to The Geographical Journal).

Marwar and the littoral of the Rann of Cutch, it had branched off into five distributaries or run into an equal number of distinct channels. The inundation of the Aruna may be recalled in this connection.

Significantly enough Sir Aurel Stein in his survey expresses the opinion that below Derawar in the Bahawalpur State "the branching dry river beds" have a deltaic look.¹⁹

¹⁷ R. V., VI. 52. 6; 61. 10; VII. 36. 6; VIII. 54. 4.

¹⁸ Vaj. Sam., 34, 11; Griffiths Trans., p. 281.

¹⁹ Op. Cit., p. 181.

²⁰ Stein, Op. Cit., 177 ff.

²¹ Op. Cit., 180.

The "archaeologically attested" facts regarding the Ghaggar-Hakra bed clearly accord with the data supplied by Vedic and Epic tradition that in Vedic times there was a mighty river named Sarasvati with a continuous and perennial flow down to the sea. The width of the riverine belt, reaching in places four miles or more, the deltaic character of the portion below Derawar, and the presence of numerous mounds marking ancient sites on or near its banks, some of which go back to a remote antiquity, recall many famous hymns of the Rig Veda.

DECLINE OF THE SARASVATI

The story of the gradual decay of the once mighty stream is writ large in post-Rig Vedic literature. It is possible that by the time of the *Vajasaneyi Samhita* the Sarasvati had for most part of the year ceased to be a continuous stream, and the onward move of its waters was interrupted at certain points, so that it seemed to consist of five distinct sheets or pools of water. The expression *Panchadha* is open to this interpretation as well as the one already suggested. The very name Sarasvati 'abounding in pools or lakes' suggests that from the beginning certain portions of its course looked like lakes (*saras*). These became very prominent in the period represented by the *Bṛhmanas* and the Epics 550+x B.C. to 500 A.D. The *Mahabharata* refers to five lakes at Samanta-panchaka²² where the great battle between the Kurus and the Pandavas is said to have been fought. At this point the Sarasvati is particularly noted for its sanctity, which suggests antiquity of the site.

*Punyam Haimavatim devim
sarichchhreshtham Sarasvatim
Samantapanchake yavai-
trishu lokeshu visruta.*

"The site on the sacred and divine Sarasvati, that foremost of rivers, taking her rise from the Himalayas, which is renowned in the three worlds as Samantapanchaka."²³

In the *Vana Parva* we find mention of the Rama-hrada and the Trinavindu-saras.²⁴ The *Salya Parva* mentions the Dvaipayana-hrada which looked like a second sea (*dvaitiyamiva sagaram*), and another lake (*hrada*) not far from the confluence of the Sarasvati and the Aruna.²⁵ Some of these pools of water persisted down to 1,000 A.D., for a holy lake in Kurukshetra was noticed by Alberuni.²⁶ (C. 1000 A.D.). One of the most interesting lakes associated with the Sarasvati is the *Dvaitatanam saras* which

²² *Adi Parva*, 2, 4 ff.
²³ *Salya Parva*, 44, 50.
²⁴ *Vana*, 83, 208; 257, 13.
²⁵ *Salya*, 30, 53; 43, 10-28.
²⁶ Alberuni's *India*, Ch. LXVI.

finds mention in the *Satapatha Brahmana* 550+x B.C. as well as in the *Great Epic*²⁷. The former work informs us that it was named after a king of the Matsya country or the district round Bairat (Viratanagara) to the south-west of Delhi, now included within the State of Jaipur.

To the tradition about the splitting up of the Sarasvati into several parts in a portion of its course is perhaps also to be attributed the confusion that the epic and Puranic poets make in representing the Sarasvati at Prabhasa, the Arbudaranya, Dvaitavana, Kurukshetra etc., as parts of the same stream.²⁸ There were, we are told, invisible links joining the apparently separate sheets of water:

*Snigdhatvad oshadhinancha bhumescha Janamejaya
Jananti siddha rajendra nashtamapi Sarasvatim.*

"Owing to the soothing herbs (or scrub), and the loamy soil, Siddhas (the wise, lit. supernal beings) recognise (the presence of) the Sarasvati, although not visible (to the ordinary man)."²⁹ These passages possibly signify that before the completion of the epic, long before 500 A.D., the lower parts in the deltaic area had become disconnected, though the memory of their being once branches or feeders of a vast sheet of flowing water persisted.

ENCROACHMENT OF THE DESERT

In the period of the *Great Epic*, the south bank of the Sarasvati in a part of the Kurukshetra area is described as *anirina*,³⁰ not arid. In certain passages of the *Vana Parva*³¹ we have reference to trees and reeds lining its banks which mocked the blue (or height?) of the sky.

*Sarasvatyah pare pare nana druma lata vritam
Akasa nikasa talam tira vanira sankulam.*

Close to the Trinavindu saras further south, to which reference has already been made, lay the forest named Kamyaka. On the banks of the lake Dvaitavana stretched another forest which bore the same name as the lake itself. This wood seems to have been full of ranches, but the Kamyaka attracted only anchorites³²:

*Tatah Sarasvati-kule samegu marudhanvasu
Kamyakam nama dadrisu vanam munijana-priyam.*

²⁷ *Sat. Br.*, XIII. 5. 4. 9; *Mbh.* III. 24. 10-12, 25. 1; IX. 37. 25.
²⁸ *Mbh.*, IX. 35 ff; *Skanda Purana*, *Prabhasakhanda*, ch. 35.

In verse 92 we have reference to *Harini Vajrini Nyanku Kapila cha Sarasvati*. *Pancha stotah sthita tatra muntivokta Sarasvati*.
²⁹ *Mbh.*, IX. 38. 84. We have already seen that the name Prachi Sarasvati is applied to the river at Pehoa as well as that at Patan.
³⁰ IX. 55. 18.
³¹ III. 100. 13; 182. 14.
³² III. 5. 3; 257. 13; *Sat. Br.*, XIII. 5. 4. 9; *Mbh.* III. 237.

"Then they saw before them the forest named Kamyaka on the banks of the Sarasvati on a level and arid plain, a favoured resort for hermits."

The word *maru* means a desert, and *dhanvan* has the sense of a dry soil, a tract scantily supplied with water. It is clear that vegetation at this point was nourished by such meagre supplies of water as were still available in the midst of the encroaching sands. The area was noted for its fauna and had a population consisting of hermits and exiled princes. It could hardly have supported an agricultural population, or even a considerable body of ranchmen. In a later passage of the epic we are distinctly told that the Kamyaka forest stood at the head of a desert area (*marubhumeh sirahsthanam*), doubtless the desert of Marwar, close to the Trinavindu lake which must have supplied the water to which the forest owed its continued existence. Knights and nobles who came on pilgrimage to some of the sacred shrines along the Sarasvati had to bring necessities of life including sufficient stocks of food and drink.³³ Among the conveyances used the camel, the ship of the desert, finds prominent mention.

At one point the bed of the Sarasvati seems to have been entirely smothered by the sand. It is apparently mentioned as *Adarsana* or *Vinasana* "place of disappearance" in legal codes and the epic. Neither the *Bodhayana Dharmasutra*³⁴ nor the *Manavadharmasutra*³⁵ which allude to the spot, give us any clue as to its exact location. In the *Great Epic*, however, *Vinasana* is placed on the borders of the land of the Sudras and the Abhiras.³⁶

Sudra-Abhiran pratidveshad yatra nashta Sarasvati

The Sudras may be taken to correspond to the Sodrai of Diodoros, styled Sogdoi by Arrian.³⁷ The Abhiras were doubtless the people of Abiria placed by Ptolemy³⁸ above Patalene or the Indus delta. The royal seat (Basileion) of the Sodrai lay below the confluence of the Akesines (Chenab) and the Indus. The position of *Vinasana* in the epic age (cir 500 B.C.—500 A.D.) was on the borders of the *janapada* of this city and the neighbouring realm of the Sodrai, and could not have been very far away from 'the riverine belt along the Hakra from about the assumed confluence with an old bed of the Sutlej, down to Derawar' which knew no settled agricultural life during historical times.³⁹ The "place of disappearance" in later ages was higher up the Ghaggar-Sarsuti. The *Prabhasakhanda*⁴⁰ informs us that the Prachi Sarasvati was everywhere difficult to be found.

³³ *Mbh.* IX. 35. 16-24.

³⁴ I. 1. 25.

³⁵ II. 21.

³⁶ IX. 37. 1 cf. *Ep. Ind.*, Vol. XXII, p. 132.

³⁷ M'Crindle, *The Invasion of Alexander*, pp. 157; 293.

³⁸ Ptolemy, VII. 1, 55.

³⁹ Stein, *op. cit.*, p. 180.

⁴⁰ 35. 109.

This was particularly the case at Kurukshetra, Prabhasa and Pushkara:

*Prachi Sarasvati devi sarvatra cha sudurlabha
Viseshena Kurukshetre Prabhase Pushkare tatha.*

Sridharasvami in his commentary on the *Bhagavata Purana*⁴¹ locates *Vinasana* in Kurukshetra itself. This must have represented the state of things in his own days c. A.D. 1400⁴² and points to a considerable change since the time of the *Mahabharata*. In our own times, the place where the stream is choked up appears to be have moved up still further towards the north.

Thus in the story of the Sarasvati we have a continuous record of the encroachment of the "thick mantle of sands disintegrated from the subjacent rocks as well as blown in from the sea coast" for over 4,000 years, gradually smothering a great sea-going river, and taking the life out of cities and ranches, fields and forests. The process recalls the happenings in the valley of the Tarim in Central Asia. Is the desiccation attributable to "a long continued and extreme degree of aridity of the region combined with the sand-drifting action of the south-west monsoon winds, which sweep through Rajputana for several months of the year without precipitating any part of the moisture contained in them"?* Or have the moisture-bearing currents of air, whose interception by the lower Himalayan slopes in the Eastern Punjab set free the large volume of water which kept up the flow of the Sarasvati down to the sea in days of yore, been diverted elsewhere?

A third suggestion may be made that the headwaters of the Sarasvati might have been captured by the Jamna or, preferably the Sutlej in historical times, this leading to a shrinkage in the volume of water carried by the Sarasvati, and thus leading to its gradual decay. The evidence of the *Tarikh-i-Mubarak Shahi* suggests the last surmise.†

[THE SARASVATI AND THE JAMNA: The idea that the Delhi-Ambala ridge has been subjected to an uplift at a very recent date is not convincing. This ridge is a remnant of the ancient Aravalli range and there is no clear evidence of any recent tilt. There is incontrovertible evidence that the Sarasvati (Ghaggar, etc.) is a river of historic times, and the drying up of the lower reaches of this river

⁴¹ I. 9. 1.

⁴² Farquhar, *Outline of the Religious Literature of India*, p. 231. In the *Tarikh-i-Mubarak Shahi* (about 1450 A.D.) which is almost a contemporaneous work, we have the following notice of the Sarasvati: "In the vicinity of Barwar there was a hill of earth, out of which ran a stream that emptied into Satladar (Sutlej): it bore the name of Sarsuti. On the other side of the mound, there was another stream called the Salima. If the earthen dike were cut through, the waters of the Sarsuti would fall into that stream (Salima) and (both) would flow through Sirhind and Mansurpur to Sannam, and will have a perennial supply of water. (K. K. Basu's trans., p. 137).

* D. N. Wadia, *Geology of India*, 1939, p. 4, 291.

† Basu's trans., p. 137.

should be attributed merely to the north-ward march of the Rajputana desert. The great Rajput kingdoms would not have been established in northern Rajputana in an arid region and there is no doubt that even towards the beginning of Christian Era Rajputana was forested and far from arid. The capture of the upper reaches of the Sarasvati

by the Jamna does not necessarily imply an uplift; it may merely be due to the head erosion of an upper tributary of the Jamna. Moreover, no one has proved that the Jamna is a river of very recent date and that it is due to the Sarasvati veering to the south-east from its former south-westerly course.*—Ed.—Sc. & Cul.]

DEVELOPMENT OF INDIAN MARINE FISHERIES

B. SUNDARARAJ

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(Continued from the last issue)

(3) DRIFT, GILL AND TRAMMEL NETS

Drift netting is recognised as one of the principal methods of sea fishing. Drift, gill and trammel nets catch fish by almost the same method. They intercept passing fish which get themselves entangled, either by gilling themselves or fouling the net. All three types may therefore be considered together. They consist of a sheet of netting several hundred fathoms in length laid as a curtain of netting at various depths. Drift nets and gill nets are in universal use while trammel nets are rather uncommon and are totally absent in India and China.

Herring Drifters.—The largest drift nets and drifters are used in Europe and America in the herring, mackerel and sardine fisheries. Drifters are next in size to trawlers. They vary in size and may

of the South Bombay Coast are roomy, seaworthy boats of 7 and 8 tons. They carry drift nets $\frac{3}{4}$ of a mile long when set and fish off-shore up to 100 fathoms, usually in 20—30 fathoms. They stay out for 3 to 7 days. They are broad in the beam and lateen rigged and single masted, which is lowered when riding to their nets as in Europe. A fleet may consist of 40 nets, each measuring 20 to 27 fathoms in length and $2\frac{1}{4}$ fathoms in depth. They mostly cure their catch on board. In the Madras experiments with this type of boat, the catch was estimated on an average at 750 lbs. of prime fish a day (seer, pomfret, dorab, chorinemus, bonito and small shark). The catch per month of a boat on a contract basis was found to be worth Rs. 800. As no ice was used for preserving the catch, fresh fish landed was often found to be tainted. Judged by Madras experi-

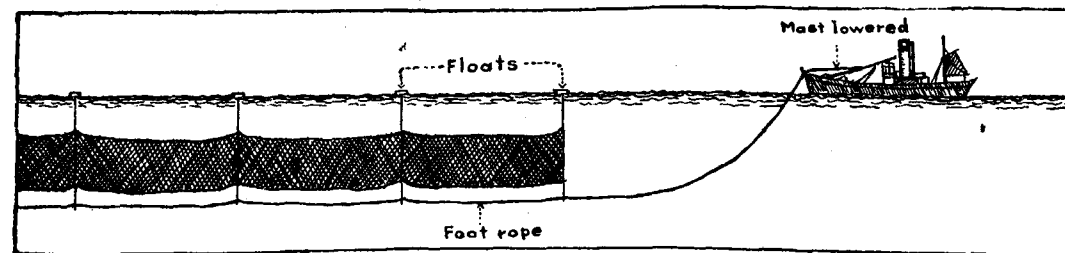


FIG. 7. A FLEET OF DRIFT NETS IN OPERATION

be sail or power-propelled boats. A fleet of herring nets consists of 16 to 100 pieces of netting 25—30 fathoms each in length with a depth of $4\frac{1}{2}$ — $4\frac{3}{4}$ fathoms, mounted end to end. A regular herring net in Western Europe extends to a mile or a mile and a half and is mechanically worked. The mackerel drift net is as much as $2\frac{1}{2}$ miles long. The Chinese Tongue Sole Drift Net is perhaps the largest in the East. It measures 1200 fathoms in length and costs Rs. 210.

Ratnagiri Drifters.—Drift netting is almost the only direction in which indigenous deep sea fishing has been developed in India. The Ratnagiri drifters

ments, good sized motor drifters or sailing drifters, with auxiliary motors, or even a fleet of Ratnagiri drifters with a fast motor carrier boat for daily collecting and landing catches, promises success. Successful as the Ratnagiri drifter is, it is capable of great improvements, such as decking, the addition of a missen so useful in steering and lying to in drift net fishing, the provision of a capstan for hauling the net, and possibly an auxiliary motor with working cost kept low. These improvements would enhance

* Records of the Geological Survey of India, 1940, Paper by M. S. Krishnan and K. N. Aiyengar.

its sea-going and sea-keeping qualities and extend its range. With larger improved types of boats, full length drift nets on the European model are also worth a trial.

The remaining half a dozen kinds of drift nets in use are all very small, 70—100 fathoms in total length and need not be considered here.

Gill nets.—Although drift nets are also gill nets, true gill nets are not drift nets. Gill nets are not economically important, nor are they as common as drift nets. A few are found from the Mediterranean to the China Seas. In the Mediterranean and in India they are used chiefly for the capture of sardine and other small shoaling fish, when the net is not anchored. Anchored gill nets of large mesh and coarse material are used on certain sections of the coast for shark, ray, jew fish and other large fish. The Mediterranean types are three in number and they are all anchored nets. They catch large croakers or jew fish and horse mackerel. One net is used for the Mediterranean sardine. They range in size up to 200 metres in length and 6 metres in width. The largest gill nets in China are used for the capture of parrot fish, rock cod, jew fish, and bream along rocky coasts. As many as 84 such nets are joined end to end. When set they may extend to $3\frac{1}{2}$ miles. A small boat manned by 5 or 8 men is sufficient to work the net which is shot in the evening and lifted the next morning. In India the sardine and mackerel gill nets which are not anchored are the chief types, and may measure 130 fathoms in length by 6 fathoms in width. The net is laid round a shoal and the fishermen splash and shout to scare the fish which in their attempt to escape gill themselves. The Indian anchored gill net for large fish measures 220 feet in length and 18 feet in breadth. Fishes here entangle themselves in the net.

Trammel nets are peculiar to Europe and America. In the Mediterranean they are in use in Malta and along the coast of Europe but absent in Egypt and Palestine. There are no trammel nets anywhere in the East.

(4) LONG LINES

Long lining, whiffing and trolling are the commercial types of angling employed in the deep sea. Long lining is an important method of sea fishing which ranks almost on a par with other methods. It is extensively employed by fishermen both in the East and West. The apparatus is simple and easily made, and consists of lines or ropes with attached hooks. The size of the hooks varies with the size of the fish and the bait with its feeding habits. Predacious and carnivorous species are usually captured by angling though others are sometimes caught with suitable bait.

In Europe long lines extend to five and six miles and carry 5,000 to 6,000 hooks. Next to this China has the best developed long line fishing industry.

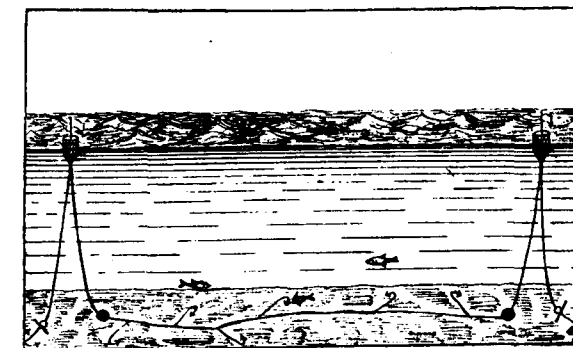


FIG. 8. LONG LINE

In China hand lines as well as long lines are used in deep sea fishing. The liners are large sea-going sailing junks 64 ft. long manned by a crew of 20—30 fishermen, and cost Rs. 4,000 to Rs. 5,000. Each junk carries four to six sampans each worth Rs. 75—110. The hand lines used are termed "dab lines". The junk as well as the sampans, each manned by three or four men, are first arranged one behind the other in a row, some seven hundred fathoms long, with intervals of 100—180 fathoms between the boats. Each boat is connected with the next by warps, and the whole train drifts with the junk. Each boat pays out its short length of dab line with baited hooks. A fully equipped dab line junk with five sampans is said to catch 1800 cwt. of fish valued at Rs. 13,125 a year.

Long lines in China may measure 3—4 miles and carry a maximum of 4,000 snooded hooks. The junk liner may carry as many as 8 sampans. Half of them are line layers and the other half line haulers. The sampans work continuously at the lines when fishing. In striking contrast to these countries, Indian liners are catamarans and canoes of small size. Their long lines measure only 600 fathoms and carry a maximum of 500 hooks. As with nets, so here also the small craft is the limiting factor. With larger fishing boats, the maximum length of long line should be tried as in Europe.

Usually a sport in Europe, whiffing is seriously practised for the capture of seer by Singhalese fishermen in Ceylon. A fleet of fast sailing outrigger canoes, specially designed, regularly take part in this profitable industry. South Indian fishermen in the ports adjoining Ceylon have in recent years copied this method with advantage. Whiffing could be tried with a motor boat.

Trolling is closely allied to whiffing. An unbaited hook is trailed behind a fast moving boat at

such speed that the fish mistakes it for prey. Often various devices made of bone or feather, or metal spinners and spoons to simulate some moving object like fish or squid are added to the unbaited hook to lure the fish. The sailing or motor boats are small, the smallest measure 35 ft. in length and are manned by 2 men. They have 2 booms hinged on either side of the mast which may carry 12 trolling lines. There is a well developed trolling fishery in the Bay of Biscay and in California for Tuna and Albacore.

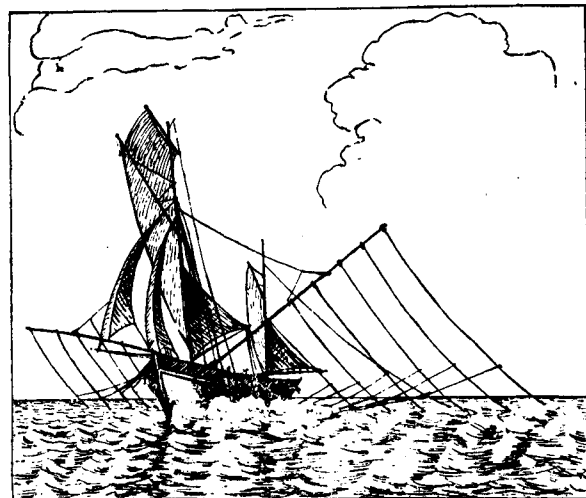


FIG. 9. FRENCH ALBACORE TROLLER (From Pamphlet 104. Australian Council for Scientific and Industrial Research)

Modern Albacore trollers of California measure 35 ft. in length and have 50 h.p. engines. As fishing of this type already exists in Ceylon a trial of this method in India is warranted.

CONCLUSION

The foregoing review shows what is needed for developing deep sea fishing in India and some possible lines of improvement. Summarising the review the main conclusions to be drawn are the following:

The average price of fish wholesale in China is lower than in India, the average being about one anna per lb. whereas in Bombay the price of trawled fish was 1 anna and 1/3 pias to 8 annas and 7 pias a lb. In Madras also just over one anna per lb. was realised for trawled fish. This is admittedly a low rate and the wholesale average price may be safely put at annas two per lb. In the Mediterranean (for instance, Malta) the wholesale price of trawled fish is higher, about 2 3/4 annas per lb., and this only just supports steam trawling, whereas in England for instance, in 1933 the price of plaice was 8 annas, sole 10 annas, cod 3 to 4 annas, hake 5 to 7 annas per lb. The level of prices in the East generally is too low to support steam trawling. Since there is much

in common between the food fish of India and China the adoption of Chinese methods is generally indicated; but as India pays double as much the price for fish as China pays an investment in power boats, the lack of which is the chief defect in Chinese methods, seems warranted. In practically all industries, it is a fact that large scale production is the cheapest method and mechanical production as a rule is cheaper than man-power. India is not economically and otherwise ready for steam trawlers and drifters and large American purse seiners. Further the suitability of these methods to Indian fish and waters remains yet to be established by experiments. The investigations so far made and the experience in Bengal, Bombay, Madras and Ceylon point unmistakably to the wisdom of introducing cheaper power boats. In the proposals that follow, I have adopted an even more cautious procedure by recommending the use of sail boats with auxiliary motors. Ordinarily they will use their sails and resort to motors only when winds fail, and expeditious journeys are essential and for working the gear. The resultant economy in working costs as well as in the wear and tear of the engines will be substantial. With fair weather and steady winds by prevailing through most of the year in Indian seas, sailing vessels should prove both practical and economical.

The scope for harvesting the sea is limited by the power and sea-worthiness of the craft in which the fishermen go to sea and by their skill and hardihood as seafarers. Indian fishermen, especially certain classes among them, possess the elements that make the most daring and skilful fishermen that are to be found anywhere. Their scope is seriously limited by the smallness of the craft which in turn limits the size and power of their tackle. They have proved their mettle in developing the largest shore seine—the Rampani—equal to any in the world, and in drift netting up to the 100 fathom line on board frail open sailing boats—the Ratnagiri drifters. The crux of the problem is therefore the provision of a suitable fishing craft. The types of fishing boats will naturally vary according to the type of fishing, viz., trawling, drift netting or seining, the character of the harbour or the coast from which they have to work, the length of the journeys they have to make and the catch they have to carry to shore.

Modern trawls cannot be operated in less than 10 or 15 fathoms and their extreme limits may extend to 300 fathoms or more. 75 per cent of the world's fish supply comes only from depths from 15–80 fathoms. Fishing grounds in India are on the submarine coastal plateau extending to the 100 fathom line. Beyond this everywhere the bottom slopes so steeply that it does not matter whether 100 fathoms or 300 fathoms are taken as the limits of fishing. Working in less than 15 fathoms on a narrow coastal

strip, which all the fishermen now do, will continue to be done by sailing craft of small tonnage which could be beached daily like the catamaran or canoe. It is here that the beam trawl would be tried. Fishing in 100 fathoms or more is possible only for full powered steam trawlers and drifters. Judging by the trawling experiments in Indian waters, the most profitable trawl grounds lie between 15 and 40 fathoms, which is the depth best suited for the Danish seine. There does not seem to be any need, therefore, to invest in expensive steam trawlers. Fishing with the Danish seine is cheaper and more efficient in many ways, as noticed above. Even in the North Sea, Denmark has not resorted to steam trawlers as her fishing grounds are not in deep water and lie within a radius of 100 miles from her ports. Under such conditions, the Danish seine has proved its superiority over the steam trawl. Similar fishing conditions exist here. *On all accounts, therefore, the Danish seine should be preferred to the steam trawl for the exploitation of demersal fisheries in India*, except where the bottom consists of very soft mud. The boat required is a 16–28 ton motor boat of about 46 ft. length, equipped with a 35–40 h.p. heavy duty engine. I suggest that the boat might be a sailing boat with an auxiliary engine of the above horse power. If the experiments are carried out for at least two seasons and prove that even an auxiliary motor is too costly the same boat could still conduct experiments without recourse to motor power with the series of large size Chinese seine nets, all of which could be made in India. With regard to seine and drift netting and long lining the nets to be tried in India are the purse seine and the full length of drift nets of 1 1/2–2 1/2 miles and long lines of 5–6 miles with 5000 to 6000 hooks. Except for the purse seine, the nets and lines for these trials are locally available as they amount to no more than putting together nets and lines already in use to make up the maximum length. A purse seine of the Chinese type could be manufactured in India at a reasonable cost, preferably with the technical advice of one or two Cantonese fishermen, some of whom may be already in India as refugees. A reference to the Consul-General for China would help to procure their services. Recently a Chinese corps was formed in Calcutta for Chinese marines in India. The best type of boat for all these types of fishing is the Scotch herring boat or British lugger. The sail boat with an auxiliary engine for the Danish seine already suggested with comparatively minor alterations would serve for experiments with the purse seine, drift net and long lines. These latter methods, however, need the assistance of two or four small boats which could be carried on board the lugger. Incidentally they will also serve the purpose of lifeboats if suitably

constructed. Thus the problem of a suitable boat is greatly simplified if as suggested the Danish seine is substituted for the other trawl. A common boat for all projected experiments could be designed as a sailer with an auxiliary heavy duty engine on the model of a British lugger. Decked boats of this type should hold their own in any weather commonly encountered on Indian coasts. Even if a boat could not be immediately built it should not be difficult to select an existing motor boat and adapt it to meet immediate requirements.

We have next to consider harbour facilities for such boats. Sea going boats exceeding 40 feet in length of such a build and depth cannot be hauled up daily on a beach. It would not be advisable to anchor them off the open beach except where headlands and bays afford shelter. Even this may be risky unless there be a safe haven close by in the event of a sudden outburst of foul weather. The possibility of beaching them during the monsoon is however not altogether precluded. For example, the

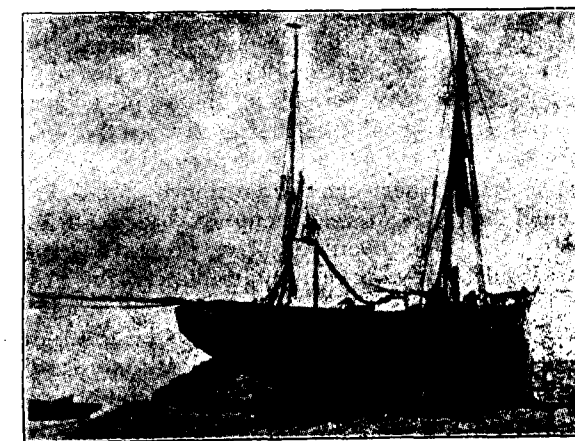


FIG. 10. HASTINGS LUGGER (Photo—J. Hornell)

luggers at Hastings which average 27–30 ft. in length on the keel have been regularly beached since the breakwater at Hastings broke down, by means of strong wire cables and wooden capstans worked by horses provided by the Corporation for a moderate fee. What happened in Europe and elsewhere will no doubt also happen in India when large power boats for fishing become the order of the day. Instead of small boats in each village the larger fishing smacks, cutters and luggers will be concentrated in ports with facilities, though they may serve a whole length of the coast. Moreover, heavy landings of fish cannot be made at each fishing village. For expeditious and profitable disposal, they can be made only where markets, transport and storage facilities exist. As the fishing industry develops, the

concentration of the fishing fleet at ports of shelter and at strategic points with due regard to the proximity of fishing banks will automatically occur. Therefore, the selection of a port such as Bombay or Cochin with harbour facilities to base the present experiments will not necessarily detract from their value for the rest of India.

For the experiments proposed above the equipment and personnel are now in the country. A full sized Danish seine, winch and rope coiler with spare parts, a beam trawl, a miniature otter trawl and several lengths of drift nets are available with the Madras Government for experiment. Motor boats of 40 ft. length and more with Diesel or oil engines are built in the country and could be adapted for the above types of fishing. Many of them have masts and sails in addition. The really difficult problem of the past of securing expert instructors has also been solved, thanks to the war. Among the fighting forces now stationed in India there are a number of professional fishermen of long experience in all the western methods, while quite a few Chinese fishermen have come as refugees. With the co-operation of the Army, who should welcome any improvement in the supply of fish, which is now undesirable both in quantity and quality, and the oft repeated determination of the Government of India to encourage food production by all the means in their power, it should be possible for the Government or the I. C. A. R. to secure the technical assistance of the Army personnel for the development of the sea-fishing industry, so long overdue. The proposed experiments would not only help immediately the Army commissariat and so the war effort, but would at the same time confer enormous benefits on the Indian fishing industry and the country at large. The advantage will be mutual: the Army on the one hand will obtain the much desired good class fish, fresh or preserved, in the absence of imported fish, while the country will see the inauguration of a new deep sea fishing industry on a sound scientific basis.

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Notes and News

NEW COAL RESEARCH SCHEME

THE new Coal Research Scheme, described as "the most important joint research project ever undertaken by an industry in any country for the development of a basic raw material", has been recently announced by Sir Evan Williams, President of the British Coal Utilisation Research Association. The scheme provides for the largest and the most lavish research organisation yet sponsored in Great Britain. It is planned to spend no less than £1,000,000 over the next five years in the expectation of revealing new processes for the better use of coal as a raw material and for obtaining important by-products. A fund is being created out of grants from the Government, the Mining Association and the manufacturers of coal-using plant and equipment, from which it is proposed to spend annually £200,000 for five years. The annual grants from the above sources are respectively £50,000, £80,000 and £70,000. The Government grant has been made available under the condition that the results of research shall be open to the whole country. So far as research for industrial purposes are concerned, the scheme will further provide for a close liaison with the Fuel Research Board of the Ministry of Fuel. The contemplated joint research body will represent every coal-using interest in the country. Though the full details as to the lines along which research will be conducted have not been revealed for obvious reasons, the programme in all probability will be guided by the following considerations:

(a) An increase in the potential energy of raw coal for domestic heating and industrial uses from the present 30 per cent to 45 per cent. This would save £60,000,000 a year to the country.

(b) Increases in the by-products, including oil, plastics and chemicals, which at present number about 4,000.

(c) Development of new standards of heating and cooking in private houses which, besides increasing efficiency, will reduce the amount of smoke by about five-sixths of the present volume.

These research projects are expected to aim at increasing the efficiency of converting coal into heat from the present figure of 30 per cent to the standard attainable figure of 45 per cent. This increased efficiency will release greater quantities of coal for other purposes, such as the manufacture of liquid fuels for internal combustion engines and numerous other coal products now increasingly being used in the chemical industry.

HYDRO-ELECTRIC PROJECT IN SCOTLAND

THE Committee on Hydro-Electric Development in Scotland, appointed on October 27, 1941 to consider the possibilities of setting up an electro-chemical and electro-metallurgical industry in Scotland, has recently submitted its report to the Secretary of State for Scotland. The report is primarily concerned with the sparsely populated Northern area where there is an abundant supply of water power, but no coal. At present this area is characterised by an absence of substantial industries. The Committee has carefully considered the approximate estimates of the amounts and sites of suitable water-power resources and recommended Northern Scotland, in the neighbourhood of the larger hydro-electric sources, as the only possible zone for the location of the electro-chemical and electro-metallurgical industries. The highly controversial subject of the amenities and the general interests of the local population and the question of the preservation of the Salmon-fishing and other fishery interests have received due consideration.

The Committee has further recommended the creation of a new public service corporation, entitled the North Scotland Hydro-Electric Board, consisting of five members, and having all necessary powers and financial facilities as a non-profit-earning body. The programme of the Board would be: (a) to attract to the Highlands, through the offer of cheap and abundant power, a share in the electro-chemical and electro-metallurgical industries; (b) to develop such further power as may be required for the consumers of existing undertakers or for consumers in its own area, and (c) to develop isolated schemes in isolated districts on an experimental basis. An immediate new station is suggested for the extreme north of the Grampian territory.

The production of calcium carbide, calcium cyanamide and the various chemicals of which these products form the base, and of the alloys and graphite electrodes, together with the reduction and refining processes for aluminium, magnesium, copper, zinc, vanadium and cadmium, will at present constitute the main concern of the proposed electro-chemical and electro-metallurgical industries, following the completion of the hydro-electric project.

NOVA PUPPIS

THE new stellar explosion in the southern constellation of Puppis has aroused certain amount of excitement among astronomers. The discovery of

the "new" star, namely Nova Puppis, was first reported by Prof. B. H. Dawson, of La Plata, Argentina, to the Cordoba Observatory whence it was immediately cabled to Harvard on November 10. The nova reached its maximum luminosity (magnitude 0.5) by November 12 and remained for a day or two as one of the ten brightest stars in the entire sky. By this time the nova was discovered independently by many observers. Immediately after its discovery the old Harvard photographs taken at the South African station were closely examined to find traces of the original star in the position of the sky now occupied by Nova Puppis, but without success. It appears that the star must have increased in brilliance by at least 6,000,000 times, which means a rise of about 17 magnitudes.

This great increase in brilliance at first led to the suspicion that the nova in question probably belongs to the rank of super-novae. Ordinary novae generally flare up in brightness by nearly a hundred thousand times, while the order of the increase in brilliance is some hundred million times in the case of super-novae. Besides, the study of the light curve indicates that Nova Puppis resembles more closely an ordinary nova than a super-nova. The observations of brightness, made by the American Association of Variable Star Observers, record the decay in brightness at an average rate of about a third of a magnitude per day during the first two weeks after the nova reached its peak brightness on November 12. Early in December the nova already disappeared from naked-eye view. Such rapid decay in brightness is hardly characteristic of supernovae whose fall in brightness in most cases is considerably slower than this.

The spectrographic evidences regarding the explosional velocities, obtained by Prof. Dean B. McLaughlin, of the University of Michigan, and by Milton L. Humason and Dr Roscoe F. Sanford with 100 inch reflector of the Mount Wilson Observatory, appear to confirm the galactic origin of Nova Puppis. Prof. MacLaughlin estimates the velocity of the expanding shells of hydrogen and ionised iron, titanium and magnesium at about 500 miles per second, while the observations in the Mount Wilson Observatory place the velocity at 620 miles per second, in good agreement with the former value. This is far too small compared to the expanding velocities for super-nova, which generally lie near about 3,000 miles per second.

The origin of nova phenomena is very imperfectly understood. It appears from the evidences so far recorded that perhaps some thousands of years ago Nova Puppis, then an ordinary star, suddenly blew off its outer atmosphere for unknown reasons, giving rise to expanding gases. It is known from the studies of previous novae that a nova generally

attains its peak brightness after a few days of the explosion. The gases travel outwards and become increasingly tenuous and rarefied, sometimes producing the impression of a nebulous cloud drifting away from the star. The heat of the star at the nucleus is sufficiently high to maintain the rarefied gases at higher stages of ionisation; this explains the observed bright line spectrum. The star then gradually returns to the pre-nova condition in course of several years.

CANADA'S INDUSTRIAL DRIVE

THE comprehensiveness of Canada's industrial programme for the duration of the war and her recent progress in industry and commerce have been reflected in a report from a Montreal correspondent, appearing in the December issue of the *Times Trade and Engineering*. The execution of the programme has naturally necessitated curtailment of civilian production in various directions. It is mentioned that by restricting the manufacture of hair-pins and "bobby pins" the production of some 55,000,000 vital airplane bolts of a certain size has been made possible. Canada's industrial progress in some important directions is outlined in what follows.

The utilisation of Canadian wood pulps as substitute for cotton linters in the manufacture of nitro-cellulose explosives has effected an annual saving of several million dollars. The initial difficulty experienced in the uniform nitration of wood pulp cellulose has been solved, and war-time explosive plants using wood pulp cellulose are already in operation. In view of the pressing needs of nickel-mining in Canada, the Government have recently sought to limit the gold-mining operations and undertaken to divert gold-miners to base metal mines. The curtailment of gold production in this way is expected to facilitate the more thorough mechanisation of the base-metal mining, through the release of certain equipment.

Extensive deposits of chrome in the Bird River area in the Province of Manitoba, as proved from recent investigations, have revealed the possibility of the setting up of a large chrome products industry in Canada. It is reported that chromite occurs in strong bands of great length and good width, with at least 22 per cent of chromite oxide content. Surface sampling and diamond drilling have shown enough ore to support plants with a daily capacity of at least 1,000 tons. The high iron-to-chrome ratio at present forms a complex metallurgical problem now receiving investigation at the Canadian research laboratories.

Canada has taken significant steps in developing drug ingredients formerly imported from Europe and other sources which have now been cut off because of the war. A Toronto pharmaceutical house

obtained belladonna seed from botanical departments at Guelph, Ottawa and Washington and succeeded in growing the same in quantity almost sufficient to replace the former supplies from Bulgaria. The same house has also grown hyoscyamus, a drug used as a sedative. Cultivation of peppermint leaves from which menthol is extracted is going on at several places of Ontario. The National Research Council of Canada, working in collaboration with the Navy, developed and adopted milk-weed flows as a substitute for Kapok in life preservers.

ART IN INDUSTRY EXHIBITION

THE possibilities of commercial art have received very scant attention and much less encouragement in our country. One probable reason is that very keen competition is still absent in our country where industries are yet to grow in abundance in keeping with a huge market. Art, when applied to industry, is meant to stimulate public interest in the products, and for this purpose labels and jackets, hoardings and brochures, including press layout for advertisements (to be specific, designs for textile printing and for borders of saris), and all such things require great artistic skill. The most silent but penetrating appeal is made by a careful combination of colours and letters. The artist has rightly been acknowledged to be an important factor in mass propaganda.

For the last three years "Burmah-Shell" has been organising an annual Art in Industry exhibition to show artists the types of commercial art required by industries and also to illustrate to industrialists the art talent available in India. The first two were held in Calcutta and the last one in Bombay. The prize winning entries of this year are being shown now in the principal cities. It must be admitted that we are yet to be charmed by the originality in the entries; but a very good beginning has been made, and the annual exhibitions show good promise both for the art students and the business men. Already the number of entries has increased, and an increasing number of prizes from the industrial and commercial concerns has added impetus to the artists. The fourth Art in Industry exhibition will be held in Calcutta early in 1944 and is likely to be wider in scope than any previous exhibition.

PRODUCTION OF IRON AND STEEL IN NAZI GERMANY

THE production of iron and steel in Nazi Germany has commanded considerable interest and has formed a subject of lively speculation among industrialists and scientific provocation among metallurgists.

Present report, as gathered from an interesting article in a recent issue of *The Engineer*, indicates that though on the whole the position of Germany is not quite satisfactory it should not be thought that the production of high grade steel representing modern achievement in all forms of light construction will ever become impossible through lack of ores.

In the beginning of 1936, the production in the Reich was 19.2 million tons of steel and 7.6 million tons of ore, the latter having hardly 30 per cent iron content. Because of this poor yield, Germany imported ores from various places, such as Sweden, Lorraine, Spain and French North Africa of which Sweden's contribution alone was 50 per cent.

In the latter part of the year mining activities were directed in the Salzgitter district at the foot of Herz mountains in central Germany. This place was at first officially reported to contain a reserve of 1,000 to 2,000 million tons of ores. On detailed investigations, the ore proved to be of a very low grade, having poor iron content, though a high percentage of silicon was found in them. Various means of extracting iron and steel from these ores were tried out, including the Paschke Peetz method; but all of them proved very costly. The result was that the local German mines were capable of producing only 25 per cent of the country's industrial requirements, which evidently was far below the mark. In 1937, therefore, Goering formed a Trust and acquired the whole of Salzgitter district. Irrespective of the heavy cost of coal transportation, huge furnaces were installed in Salzgitter which was 150 miles from the nearest coal mining centre. The production of pig iron was thus raised to 4 million tons per annum. The Herman Goering Trust, as it was named, after its acquisition of Salzgitter, went on acquiring other large concerns, like the Skoda and Austrian Alpine Montan works and various Silesian collieries. By the end of that year, with the exception of Salzgitter enterprise, the Trust made enormous profits and also spread its tentacles further over the Bruenner Waffenwerke in Czechoslovakia, and over most of the Danubian shipping. As these activities went on increasing, Germany found it more and more difficult to obtain sufficient coal to run her vast industries. Since 1938 the output per man-shift is decreasing, and, in spite of various means adopted the problem of its adequate supply remains unsolved.

After the fall of France and low countries, most of the leading metallurgists suggested a reconsideration policy whereby Germany would get the rich ores of Sweden and the ores of Lorraine and Luxemburg. However, instead of following this policy, false rumours were spread that the Minette mines were destroyed and there was no available supply; while in Belgium, where local coal supply is plentiful, the blast furnace production was cut down to

40 per cent of the pre-invasion output. This policy was continued by Nazi industrialists till 1942. It was only after the misadventure in Russia, that the eyes of the Germans were opened, and the new policy adopted, as a result of which its productive capacity in iron and steel stepped up considerably. Side by side with this an organisation, called the "Reich Association for Iron", under Herman Roechling was also founded. It was a huge vertical cartel aimed at the complete rationalisation of all types of steel for industrial, research and productive concerns. It advocated new metallurgical methods of production so as to be able to place in the hands of the manufacturers high tensile and hard steels. The success of these was revealed by the fact that the production of high tensile and hard steels, together with other important researches carried out on other alloy steels, brought about revolutionary changes in the industrial and fighting activities of Germany. However, the most striking recent development was the gigantic scrap campaign, the like of which was never done at any time in the past. Each and every farm and industrial concern was asked to hand over to the Reich not only all excess parts of iron and steel but all semifinished products as well. This scrap campaign, started in July 1942 and continuing for only 3 months, resulted in such an enormous collection that it made certain the possibility of saving nearly 50 per cent of the ores for iron and steel production by substituting scrap metal in their place. Besides, the saving in ores also brought about a substantial economy in transportation. It is doubtful whether Germany this year will be able to acquire a similar amount of scrap, as the enormous collections show that it has exhausted all it had in 1942.

To-day, though Germany's output in steel is more than what it was when she entered the war, its rate of production as compared with the Allies is much below the mark. Since the Russian campaign her requirements have soared up considerably. These are mainly due to the additional steel required for replacing damaged military equipment, for the incorporation of more steel in the newer types of air-crafts and coastal crafts, and the difficulties of transporting scrap metal from the battle fronts to the industrial centres.

As the demand goes up, the production must also increase, if Germany at all intends to stand shoulder to shoulder with the Allies. The world of science and engineering will await with eager interest the reports which come from time to time as to her steel consumption and the ways in which Germany makes an effort to increase her productive capacity or decrease her consumption-production ratio.

S. K. G.

SCIENTIFIC RESEARCH IN CHINA

THE Academia Sinica is the highest scientific research organization under the National Government of China. The necessity of organized research for national welfare was foreseen by the leaders of China, but could not be realised owing to the disintegrating forces operating in China until recently. The institution was founded only in 1928, and since then it has been maintaining ten institutes: physics, chemistry, engineering, geology, astronomy, meteorology, zoology and botany, psychology, history and philology and social sciences. An Institute of Mathematics could not be brought into being owing to impossibility of obtaining equipment caused by difficulties in communications in late years. Until July 1937, before the outbreak of the Sino-Japanese war, the first three institutes were located in Shanghai, where all modern laboratory facilities were available. The central office and the remaining seven institutes were all in Nanking, the capital city. Despite serious limitations on its finance, personnel and equipment and frequent change of sites (all the institutes are now scattered), due to the exigencies of the war, the programme of work has continued almost unabated. The headquarters are now located in Chungking. Many laboratories and plants had been bombed and rebuilt.

Since 1935, a National Research Council is functioning under the Academia Sinica, with the objective of co-ordinating scientific research (including social sciences and historical studies) in the whole country. Besides the directors of the industries, 30 members are elected by professors of the Universities. The Council maintains two journals, *Science Records* (in English, for outside circulation of Chinese works) and *Bulletin of Academic Research* (in Chinese for reference by the Chinese research workers).

ANNOUNCEMENTS

WE deeply regret to announce the death of SIR NILRATAN SIRCAR, which recently took place at Giridih where he had been staying for some time. Sir Nilratan was a distinguished medical practitioner whose death has removed an outstanding figure in the medical world of India. We intend to publish a full account of his many-sided activities in a subsequent issue of our journal.

WE acknowledge with thanks the receipt of the following:—

JOURNALS

(Foreign)

1. Technology Review.
2. Chemical Education.
3. Science.
4. Science News Letter.
5. Scientific American.
6. Sky and Telescope.
7. Scientific Monthly.
8. Geographical Review.

9. Publications of the Astronomical Society of the Pacific.
10. Endeavour.
11. Chemical Age.
12. Beama Journal.
13. The School Science Review.
14. Agricultural Gazette.
15. Journal of the American Chemical Society.
16. The Bulletin of the American Meteorological Society.

(Indian)

1. Current Science.
2. Orient Illustrated Weekly.
3. Journal of the Indian Chemical Society.
4. Indian Review.
5. Indian Journal of Physics.
6. The Indian Medical Gazette.
7. Education.
8. Journal of the Bihar and Orissa Research Society.
9. Modern Review.
10. Man in India.
11. Sanibarar Chithi.
12. Arthik Jagat.
13. Calcutta Municipal Gazette.
14. Bulletin of the Indian Jute Committee.
15. Bulletin of the Indian Central Cotton Committee.
16. Quarterly Journal of the Geological, Mining and Meteorological Society of India.
17. Indian Forests Records.
18. Bijnan Parichaya.
19. Indian Information.
20. Indian Listener.
21. Records of the Geological Survey of India.
22. The Indian Journal of Veterinary Science and Animal Husbandry.
23. Calcutta Medical Journal.
24. Central Board of Irrigation Bulletin.
25. Journal of the Board of Scientific and Industrial Research.
26. Indian Farming.

BOOKS

1. Modern Pottery Manufacture—H. N. Bose.
2. Algebra—Levy.
3. Gleanings from my Researches, Vol. I, Kala-azar—Sir U. N. Brahmachari.

4. Fighting for What—Sir John Orr.
5. Leukaemia in Animals—Engelbreth Holm.
6. A Hand Book of Shellac Analysis—M. Rangaswami and H. K. Sen.
7. Farm Animals—Hammond.
8. Soil Conditions and Plant Growth—Sir E. John Russell.
9. Science Looks Ahead—Prof. A. M. Low.
10. Science and World Order—J. G. Crowther, O. J. R. Howarth, D. P. Riley.
11. Cine-Biology—J. V. Durden and F. Percy Smith.
12. Science for the Prosecution—Julius Grant.
13. Psychological Determinants in the Choice of Vocation—Sarojendra Nath Ray.
14. Theoretical Organic Chemistry—Julius B. Cohen.
15. Mineralogy, Petrology and Economic Geology—N. L. Sharma.
16. J. J. Thomson—Lord Rayleigh.
17. The Philosophy of Love—Dallas Kenmare.
18. Science and Education—S. R. Humby and E. J. F. James.
19. Historical Aspects of the Inscriptions of Bengal—Benoy Chandra Sen.
20. British Dramatists—Graham Greene.
21. A Treatise on Physical Chemistry, Vol. I—Hugh S. Taylor and Samuel Glasstone.
22. Progress of Indic Studies—R. N. Dandekar.
23. British Agricultural Research, Rothamsted—Sir E. J. Russel.
24. Physics and Philosophy—Sir James Jeans.

AN ERRATUM

In lines 3 and 4 of the table on page 356 of the March '43 issue of SCIENCE AND CULTURE read

Germany	Japan		Germany	Japan
62	43	for	43	62
100	95		95	100

SCIENCE IN INDUSTRY

LOAD CENTRE SYSTEM OF POWER DISTRIBUTION

THE installation of a new system of electric power distribution, called the load centre system, bids fair to save several tons of copper and other strategic materials, according to a report in the *Times, Trade and Engineering*, December 1942. The amount of saving effected in the new system is reflected in the fact that in a medium size factory with a power demand of 3,000 kv. a. and using current at 480 volts from two utility 13,200 volts the estimated saving of steel, copper and other materials amounts to 7,800 lb., 11,500 lb. and 1,300 lb. respectively. A rough estimate for the year 1942 indicated that the load centre system would save some 5,000,000 pounds of copper

and steel in U. S. A. alone if all proposed extensions were put into operation.

The distribution systems, now in use, generally operate through the establishment of large substations to transform power from high voltage, ranging from 2,300 to 15,000 volts, to the voltage required for practical purposes. Power is then made available to different parts of the factory through various power cables. The new system proposes to distribute electric power directly to the production, or load centre, where it is stepped down to the required voltage. The plant in which the total power load exceeds 1,000 kv. a. has several small load-centre unit substations distributed throughout the works. Each small substation unit is placed near

the centre of the load area, and the current stepped down, thus largely eliminating the high cost in value in voltage drop of long, heavy, low-voltage circuits.

Saving of the materials arises from the fact that the transmission of power from a large substation to the production area by low voltage, as in the old system, necessitates the use of many times more copper than needed in the new system which supplies power to the load-centre unit substations by high voltage. The use of smaller transformer in the load-centre unit substation, requiring less secondary short-circuit current, and smaller feeder breaks has made possible further economy in the use of copper.

The load-centre system has some obvious advantages to recommend itself in place of the old system in vogue. Unit substations in the new system are completely wired and built in the factory, and reach installation sites, practically ready for operation. In the old power system, on the other hand, thorough and accurate forecasting of the location and magnitude of the load are necessary before the best site for the large outdoor substation can be ascertained. Furthermore, the units, with the load-centre equipment, can be placed on the production floor at the points where they are needed, and additional units can be added when and where wanted without disturbing the operating system. The load-centre unit can also be moved from one centre to the other without any difficulty to cope with changes in electrical demands accompanying changes in manufacturing technique.

FLUID COAL

THE use of pulverized coal for steel heating purposes had received popularity in the days before oil and gas became cheap. It was subsequently relegated to the background with the discovery and development of vast new sources of oil and gas. The apprehended shortage of oil has again revived interest in the use of fluid coal which has recently been studied as a possible substitute for fuel oil in industrial heating processes. The fuel engineers at the Battelle Memorial Institute, according to a note in *Science News Letter*, have been carrying on important research work for several years, and their preliminary work has led them to emphasise the application of finely pulverized coal to forging, heat treating and other metallurgical furnaces which now consume great quantities of oil and gas.

The fluid coal is produced by grinding coal to a degree of fineness comparable with dust in specially designed mills. The fine particles are picked up and delivered to collectors by a stream of air entering the mill. The material when not impacted flows through fingers and pours somewhat like a liquid.

Mixed with air, pulverized coal produced in the manner described exhibits the properties of a fluid and can be made to flow through pipes and spray out in jets. It rapidly burns in air and gives flames of high emissivity releasing great quantities of energy.

There is great possibility of extending the use of pulverized coal to hitherto unexplored fields. It has been tried in radiant-tube furnace which is used in heat-treating, annealing and enameling with promising results. The successful application of pulverized coal to this type of furnace would remove the principal disadvantage of coal in refined metallurgical work, namely, the fly ash, cinder and sulphur, since combustion takes place inside alloy-steel tubes lining the walls of the furnace. Furthermore, the use of fluid coal, in addition to relieving fuel shortage, will prove more economical than the fuels now being used in the industrial processes.

SOYABEAN RUBBER

Science News Letter reports a rubber-like material, called 'Norepol', synthesised from soyabean, corn and other vegetable oils at the Northern Regional Laboratory of the U. S. Department of Agriculture in Peoria. The term 'Norepol' has been coined from the first syllables of Northern Regional Polymer. Chemically, it is a polymer of lineoleic acid, one of the fatty-acid fractions of many vegetable oils. The new synthetic soya-product is not, however, a full substitute of rubber, though it has several important properties of rubber. Norepol offers good resistance to abrasion and aging and is impervious to water and alcohol. Thus its use in the making of shoe heels, fruit jar rings, gaskets and tubing has been recommended in place of rubber. On the other hand, the stretching power of norepol is only twice its normal length compared with six times in real rubber. Furthermore, its tensile strength is only 500 pounds per square inch compared with 3,000 pounds or more for real rubber.

The production of norepol has already been placed on a commercial basis in U. S. A. Two companies, it is understood, are making it under trade names of their own, while others are producing it under coined name given it by the Department. The production of norepol has received greater attention owing to glycerine, the other half of the oil compound, being obtained as a by-product for the manufacture of explosives and other technical purposes. The demand for this new synthetic soya-product in U. S. A. has been estimated at more than 12,000 tons for the current year.

CONTACT LENSES TO BE WORN WITHIN THE EYE

SPECTACLE glasses are usually mounted on a frame in front of the eye. But it is possible to construct specially shaped glasses which can be worn

right on to the eye, below the eye lids. "Today there are between 3,000 and 4,000 wearers of contact lenses" reports Dr Alston Callahan in *Scientific American*, December, 1942.

The idea of contact glasses was conceived long ago by Sir John Herschel in 1827, and about 1888 Mueller and Fick in Germany constructed such spectacles from blown glasses. Zeiss firm also made contact glasses by the blowing process for rectifying eyes suffering from keratoconus or cone-shaped cornea, after this remedy was suggested by Fick. In 1920 Zeiss accurately ground and polished contact lenses of chemically resistant glass, but only of one size.

The proper size of contact lens to suit individual eye-ball has so far remained a serious obstacle against its popularisation. A large number of glasses had to be tried into the eye before a suitable size could be picked out. Recently T. E. Obrig, a New York optician has made use of a new hydrocolloidal plastic, Nagocoll, which is viscous at 107°F and sets at body

temperature in order to take the right mould of the eye-ball, just as a dentist does for teeth. A drop of anaesthetic in the eye helps in taking the plastic impression.

The contact glass does not rest on the eye as a whole. The central part which carries the vision-correcting lens is slightly bulging so as to leave a clearance between itself and the transparent cornea of the eye. The other part of the glass, however, rests thoroughly on the white portion of the eye-ball. The interspace between the lens and cornea is filled with a drop of a special buffer solution when worn.

The contact lens can be easily removed or worn after a little practice, and it is advisable to remove it when going to bed, and re-wear it in the morning just as one does for the false tooth.

The advent of highly transparent plastics has now made the preparation of contact lenses much more practicable.

K. R.

PRINCIPLES OF MODERN GRAMOPHONE RECORDING

NIRODE BANERJEE

RECORDIST, THE HINDUSTHAN MUSICAL PRODUCTS LTD.,
CALCUTTA

INTRODUCTION

EVERY one of us today is familiar with gramophone and gramophone records but few of us know how they are actually produced. An attempt is made in this article to explain the general principles, and the technique required for the production of a standard gramophone record.

The principle of electrical recording of the present day owes its origin to the acoustical or mechanical recording invented by Leon Scott in 1864 and Thomas A. Edison in 1877. It was Leon Scott who first recorded the vibration of a diaphragm, while the inventive genius of the wonder-man Edison made it possible to have a recording of speech and music on a rotating wax cylinder known as phonograph and the subsequent reproduction of the recording.

Briefly speaking, the sound has its origin from vibrating bodies. The motion of vibration of the body causes some vibration in the air known as sound waves. Any amount of vibration will not, however, actuate the sensation of hearing unless it is within

a certain range. The audible range of sound vibration is about 20 to 20,000 cycles per second (c.p.s.). The average frequency of speech and music ranges between 300 c.p.s. to 1500 c.p.s. approximately. In the earliest form of mechanical recording it was the direct pressure of the sound waves which actuated the vibration of the recording diaphragm. The alternate variation of pressure in the air column within the recording horn used to vibrate the diaphragm at the end of the horn. The attached recording stylus in the diaphragm would vibrate with the movement of the diaphragm. This produced the desired indentations on the wax drums or wax discs, which are the representatives of the sound which they received.

Unlike the old fashioned mechanical recording, the modern electrical recording converts the sound energy first into electrical impulses which is amplified to drive the recording needle with sufficient energy. This has the improvement and advantage in maintaining the original quality of voice or musical instruments and in getting proper intensity of reproduction.

RECORDING EQUIPMENT

In a modern form of recording equipment we first come across the microphone which is placed before the musician. The 'mike' converts the musical sound into electrical vibrations which are amplified in the amplifying set, and transfers the amplified energy to the last end of the recording cutter on the wax disc. The cutter head is thus actuated and its sapphire needle vibrates just the same way as the original sound wave and leaves its impression on the wax.

Good recording means the satisfaction of two primary factors: firstly, it must not distort the voice quality so that in the reproduction it must give out as natural voice as possible. Secondly, the loudness level must be normal and reasonable, that is to say, it must not be too feeble nor too howling or noisy.

The quality of voice or musical sound depends on the nature of blending of its harmonic constituents giving the sound wave a particular form. So long as this form or the proportion of harmonics are retained, the quality of sound remains exactly the same. If the recording and reproducing instruments do not affect them, the reproduction is natural, and what is technically known as *fidelity reproduction* is achieved. The consideration of intensity or loudness is also of considerable practical importance. To give a quantitative idea on the intensity it may be noted that the output meter is calibrated not usually in terms of energy or power but in their logarithmic scale. This is known as decibel (db) scale, and $db = 10 \log P_1/P_2$, where P_1 and P_2 are the output and input powers.

The essential quality of a recording microphone is its *fidelity* which means that the A.C. output voltage actuated by the voice at the mike must be an exact representation of the sound-wave. The voltage output as derived from a high-fidelity mike is however remarkably small, but as the cutter requires a considerable amount of power it is essential to amplify the output of the microphone about thousand times to enable it to drive the cutter. A high-gain amplifier is therefore used employing thermion tubes.

WAX BLANKS AND WAX SHAVING MACHINE

The soft wax discs are in reality more of a compound than a simple wax, consisting in them bees wax, resin, lead stearate, burgundy pitch and a number of other products. Their exact composition is however a trade secret. The essential characteristics of a wax blank is that it is of uniform texture and density, being filtered of all foreign matters.

The filtering process is carried on while the composition is in a warm liquid form, then it is

followed by compounding and mixing. The composition is then run into moulds and is slowly cooled to normal temperature. These moulded blanks require a room temperature ranging from 76 to 83 degrees F for proper preservation to ensure best result and long life. These blank waxes are moulded into two different sizes, 12" for standard 10" records, and 14" for 12" records with corresponding thickness of $1\frac{3}{4}$ " to 2". With lesser thickness the waxes get the tendency of warping resulting in a defective recording.

The blank waxes require a smooth mirror-like surface which is essential for clear-cut grooves and the polishing of the surface is done on a machine known as wax-shaving machine. It is to be mentioned here that a blank wax may be used for a good many number of times as after the recording is completed, the inscription of recording may be erased from the surface by the shaving process. The blank waxes should rest perfectly flat on metal containers when not in use and they may be preserved fresh up to a period of 4 or 5 weeks.

The wax shaving machine is somewhat equivalent to a vertical boring mill with a revolving horizontal turntable of heavy construction and a parallel cross-slide carrying a carriage for holding the steel and sapphire tool. The turntable is connected with the flexible coupling with a high revolution motor. The arrangement of an exhaust pipe sucks away the cut chips of waxes into a container. The steel knife is meant for rough cutting and the sapphire knife for final polishing.

RECORDING MACHINE

There are two types of machines as used nowadays by manufacturers of gramophone records, viz., (1) Machines driven by weight and (2) Electrically operated machine employing a single phase synchronous motor 50 cycles. At present electrically operated machines are preferred to the weight-driven ones.

The recording machine consists of a heavy turntable weighing some 50 to 100 lbs. attached to a circular drum filled with heavy oil. A shaft projected from the bottom of the drum is connected to the driving motor by means of flexible coupling. The heavy weight of the turntable and the oil pot keeps the speed of rotation constant. The recording cutter and the play-back pick-up are mounted on a cage resting over an accurate feed-screw. As the turntable spins, the feed-screw drives the carriage slowly across the record to inscribe spiral grooves.

The carriage attached with the bridge has an up and down adjustment as well as a backward and forward movement. The former movement is intended to adjust the difference in thickness of

the waxes and the latter to regulate the starting point of recording. It is interesting to note incidentally that the recording needle which is a sapphire point with a diameter of .05 millimeter at its tip exerts a pressure of approximately 27 ton per sq. inch.

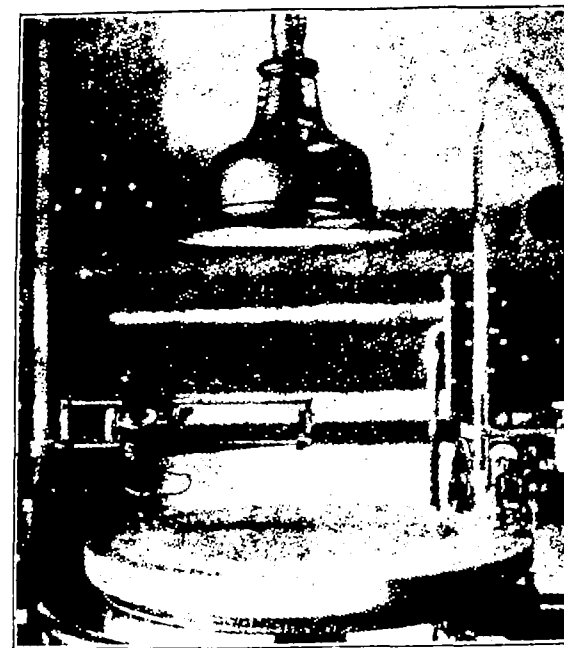


FIG. 1. WAX RECORDER IN OPERATION.

CUTTER OR RECORDER

There are two types of cutters, one employing a horse-shoe shaped magnet known as *permanent magnet cutter*, and the other with soft iron core activated by an exciter coil and magnetised by steady electric current, known as *excitation type* of cutter.

The vibrating element of the cutter is known as armature which is mounted on pivot points in a small air gap between the two poles of the magnet and is centered perfectly. The cutting stylus is mounted in the socket below the pivots in the lower end with an extended projection beyond the housing of the cover case. A coil of very fine wire surrounds the armature directly above the pivots and just below the poles of the magnet. The output of the recording amplifier is connected with the two ends of this coil. An output meter enables the recordist to regulate the maximum amount of permissible power.

The different sound waves originating in the studio are amplified in the recording amplifier and thence sent to the voice coil. The induced voltage in the voice coil regulates the movement of the armature to which a stylus is attached. The stylus carries at its tip a sapphire needle which actually cuts the wax. Sapphire needle is preferable to steel needle for

its accuracy, durability and noiseless cutting of the wax disc.

In order to eliminate the excessive movement of the armature, soft rubber strips or a system of springs are introduced with a view to regulate this lateral action. This arrangement is known as damping and in view of the fact that the rubber block becomes sticky with the effect of temperature and constant movement of the armature it is desired to change the same and to re-calibrate the cutter at least twice a year.

TECHNIQUE OF WAX CUTTER

The function of the cutter as explained before is to record in the form of mechanical vibration the full range of audio-frequency which covers from 20 to 20,000 cycles per second. Here comes the important question of the limitation of amplitude which is the lateral displacement of stylus at different frequencies. There is a maximum latitude beyond which we cannot proceed, limited by the neighbouring tracks. The cutter which we have been discussing is one of *constant velocity* type which means that with the same input voltage in the speech coils, the amplitude of the sound waves on a wax at a frequency of 200 p.c.s. will be double that of 400 c.p.s. and four times that of 800 c.p.s. Since the lateral displacement of the stylus represents the amplitude of the frequency and due to the limitation of space between one groove and another (centre to centre spacing of the grooves = .011 inch, width of the groove itself = .006 inch and the maximum allowable space for stylus displacement = .005 inch) it is imperative that the cutter must have a less amount of response towards the lower frequency end to avoid over-cutting of the wax. With the selection of proper damping material and adjustment of stylus regulating spring, we can regulate the lateral displacement of the stylus in the lower frequencies.

TECHNIQUE OF WAX RECORDING

The standard commercial records are cut at a rate of 84 and 96 lines per inch to ensure a recording time of 2 minutes 50 seconds and 3 minutes 10 seconds respectively on a 10" wax of which

depth of the groove = .004 inch
Maximum width of the groove = .006 "
and width of line or wall = .005 "

For convenience in practical recording it is to be noted that the maximum allowable deflection of the stylus at a frequency of 100 c.p.s. will be .004 of an inch, 200 c.p.s. will be .002 of an inch, 1000 c.p.s. .0001 of an inch and so on.

At the high frequency end the question of the sharpness of the angle of cut becomes an important

factor. The wave length of the groove is inversely proportional to the frequency at any given distance from the centre of the wax, so the distance between successive points at which the groove crosses the mean line decreases as the frequency increases. By



FIG. 2. ENLARGED VIEW OF PORTION OF A WAX RECORD.

recording a number of pure notes on the wax from low to high with a maximum allowable input, we shall find that the dentations cross the mean track at steeper and steeper angles. This shortness of the angle of cut becomes more and more pronounced as the recorder travels towards the inner side, and as the reproducing needle cannot track such a steep wave curve, it becomes imperative to reduce the input of the speech coil to reduce amplitude in relation to the wave front. The maximum steepness for satisfactory tracking is an angle of 50 degrees between the direction of the groove at any point and its mean direction.

DEFECT OF THE CUTTER-HEAD AND HOW IT IS DETECTED

The function of the cutter is to give an exact representation of the sound originated in the studio, and to have it the primary factor is to get an equal lateral swinging of the stylus bothways, *i.e.*, the positive and negative cycles of the cutter should correspond with each other. The following are some of the common causes for the deformation of wave curves on the wax:

- (i) damping material getting sticky due to the effect of temperature;
- (ii) system of springs getting out of adjustment;
- (iii) shifting of the armature from the magnetic balance;
- (iv) formation of high resistance of the speech coils due to sulphating effect.

The variation of the positive and negative cycle of the cutter may be detected by the following device:

Connect an audio-oscillator in the recording amplifier producing a note of say 1000 c.p.s. Cut a few lines with this frequency for, say, 5 seconds, then increase the input (power) of the amplifier cutting the lines for again the same period of time. Now repeat the process for a few times increasing

and decreasing the input. If the wax is examined by a brilliant source of light a pattern of shade will be found by which an experienced recordist can judge whether the response is uniform or defective.

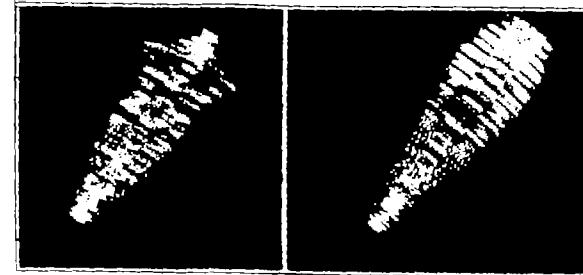


FIG. 3. MEYERS' PATTERNS
(a) Unequalized Pattern. (b) Equalized Pattern.

To check the overall good response of the cutter the experiment done by Dr Meyers is adopted by all the recordists in general which is as follows: Connect an audio oscillator with an output meter. Cut the wax for a short time say 5 seconds with a frequency of 50 c.p.s. and now slowly rotate the dial of the oscillator taking about 3 minutes to cover the full scale of audio-frequency range. If the response be good, the figure marked as 'equalized pattern' will be shown.

MODERN IDEA OF CONSTANT AMPLITUDE RECORDING EMPLOYING PIEZO ELECTRIC CUTTER

We have seen that the constant velocity cutter dents the wax grooves with different width or amplitude, depending upon the frequency. It cuts more at lower frequencies than at higher. The use of such cutter, therefore, always necessitates the careful control of the power input from the mike to the cutter needle during recording. Such manual or artificial control does not give very satisfactory result.

Some device was therefore looked for, and the solution was found through the use of piezoelectric cutters employing quartz crystal which controls the amplitude of the cuts. These crystals have the important property that mechanical pressure imposed on them leads to the development of electrical potential (voltage) and *vice versa*. This property of the crystal has been made use of in the construction of the constant amplitude cutter.

This type of cutter, however, has not yet been used very widely. For it is still in the experimental stage.

The other advantage of the constant amplitude cutter is in the elimination of surface noise, especially for higher notes. It has often been noticed that the higher notes, *e.g.*, those of violin or flute, develop rough or husky noise in the usual records.

This is because of the fact that the constant velocity cutter now used has less cuts for higher notes so that the surface irregularities on the parent wax or the manufactured records are comparatively prominent. The use of the constant amplitude cutters would give much clearer and larger dents, even for the high notes, so as to make the roughness of the records negligible. The surface noise is thus easily avoided.

WHAT A RECORDIST HAS TO MIND ON HIS CONTROL DASK

There are some practical and technical points to which the recordists should be particular. It is to be noted here that the recordist is not supposed to design the machine but he has only to work the machine properly to produce successful records. The recordist should be particular on the following points:

- (1) Pick-up of different musical instruments should be selected in such a way that the sum total may enrich the voice of the artists.
- (2) Proper recorded volume in the disc should be maintained for reproduction in ordinary gramophone. The pointer of the lb meter enables the recordist to calculate the maximum allowable input to the cutter.
- (3) Cross-talk and echo-effects should be eliminated.
- (4) Proper depth of cut and width of line should be adjusted by making a test cut at the extreme outer edge of the wax, which can be examined by the recording microscope.
- (5) Any form of turn-table rumbling should be eliminated. The adaptation of oil dash-pot and the arrangement of oil-viscus drive removes this difficulty.
- (6) A uniform recording level should be maintained. Too much meddling with the fader often spoils a good recording. The recordist should have sufficient musical sense and alertness to anticipate and control the variations to be recorded.
- (7) Attempt should be made to maintain the maximum resemblance of the original voice in the recording.

PROCESSING

After the recording is completed, the recorded wax is placed on a gently rotating table. The surface is sprinkled with a fine powder of copper known as *flour of copper*, to such an extent that every minute portion of the surface and the groove becomes

impregnated with the copper dust. The face of the wax now resembles a bright disc of copper. The wax is held to a strip of hard wood with a pin inserted in the centre hole. Two adjustable clamps are brought firmly against it and a direct contact is formed with the surface of the wax through the metal face of the clamps and the centre pin. The whole unit as the negative electrode is suspended in a plating bath containing sulphate of copper, sulphuric acid and distilled water. The positive electrode is a sheet of pure copper which through the electrolytic process is gradually deposited upon the metallized surface of the wax. In order to assure a deposit of comparatively uniform thickness it is essential to have a careful and accurate compounding of the plating solution and a proper application of electric current which is usually of low voltage and high amperage.

Continuing this process from 10 to 15 hours the wax surface accumulates a coating very close to 1/20 of an inch. Removing the wax from the bath the copper formation is carefully shifted from the wax. This is *negative* in character, bearing ridges where the original recording bore grooves.

The original *shell* known as 'Master' requires further two stages of processing. The face of the master is subjected to the plating process over again and the new metal formation called the 'Matrix', has a surface reverse in character to the master. It is of a harder metal and equivalent to that of original wax. The matrix is again plated, after proper polishing, with a harder metal. This duplicate process is known as *stamper* from which records are pressed. The hard surface of the *stamper* is essential as it has to withstand the wear and tear of continued hard pressing which is not possible with soft master.

The exact proportion of the black stock is very difficult to be given, but it is a type of clay very finely pulverized combined with shellac and other gums in correct proportion. Cellulose acetate and nitrate used in combination with other agents are now-a-days being used to eliminate surface noise. The black material with which the gramophone records are made is a kind of plastic having certain characteristics, the chief of which is the small grain size and slight expansibility during settling. The slight expansion helps it in getting the sharpest impression of the stampers, under hydraulic press.

DESIGN OF STUDIO

The designing of a recording studio is another important factor in the production of a good record. The same recording machine may record up thin, tiny, dull, howling or sober records according to the acoustical condition of the studio itself.

As a matter of fact the perfect form of high-fidelity recording depends to a considerable extent on the recording studio which must have the following characteristics:

1. The room must be absolutely sound proof so that the recording may not be spoiled by any extraneous noise.
2. The room must be free from excessive reverberation. This factor can be controlled by proper damping of the floor, roof and walls of the room with sound absorbing material, e.g., blankets, curtains, celotex board, etc.
3. Over-damping must be avoided as the recording quality sounds thin and tiny if the studio be over-damped. The studio should, therefore, have a reasonable amount of reverberation.
4. The room must be free any resonating frequency.

5. The room must have the ideal condition of sound pick up with 96 per cent of articulation which means that only 4 words out of a total of 100 may be missed.

6. Arrangement to minimize the problem of diffraction and interference of sound waves should be made.

7. The recording studio must have sufficient area as to accommodate a heavy orchestra, and should have a time of optimum reverberation approximately 0.87 seconds.*

* The writer would like to convey his acknowledgments to Mr C. C. Saha and Mr A. Banerji, Directors of M/s Hindustan Musical Products Ltd. for giving him every facility to learn the art under their guidance. His thanks are also due to Mr Kamalash Ray of the University College of Science, Calcutta, for his valuable suggestions in the preparation of the article.

MEDICINE AND PUBLIC HEALTH

VITAMIN RETENTION OF DRIED FOODS

THERE might be a general impression that dried foods suffer from a substantial loss of vitamins contained in them in the pre-dehydration state. Several years of research at the University of California have now proved the high retention of vitamins by dehydrated foods. According to a note in *Science*, Dr Agnes Fay Morgan, head of the Home Economics Department, has recently placed before the representatives of the dehydration industry a summary of the results of research on the vitamin retention of various dehydrated foods. Modern methods of dehydration guarantees in the case of fruits a greater preservation of the vitamin contents than is possible by sun-drying. So far as the stable vitamin A is concerned, it is retained in both dehydrated and dried fruits. But exposure to light proves fatal to riboflavin and thus brings about an almost complete loss of vitamin B₂ in sun dried fruits. Dehydrated fruits adequately protected from light retain it. Fruits like prunes, peaches and apricots retain vitamin C, of which they are good sources, after treatment with sulphur dioxide. Sulphur dioxide treatment, however, is not advisable in the case of fruits containing vitamin B₁, which is destroyed in the process owing to thiamin molecule being split up by SO₂.

Dehydrated vegetables also have better vitamin retention than canned ones. Retention of vitamin B₁ in dehydrated spinach is almost 100 per cent, com-

pared to the fresh spinach, while in the canned variety the loss of the same is as much as 75 per cent. Loss of B₁ in canned peas is 73 per cent, while it is only 10 to 20 per cent in dehydrated peas. The loss of vitamin B₁ in several vegetables tested, as Dr Morgan stated, varies from 14 per cent to 33 per cent, and of vitamin B₂ from 25 per cent to 50 per cent. In dehydrated carrots this loss is very small, being only 12 per cent. Moreover, the carotene destruction in all these vegetables was small, though the loss of nicotinic acid generally amounts to 33 to 50 per cent, probably due to leaching.

The results of research on dehydrated meat are equally satisfactory. The loss of vitamin B₁, B₂ and nicotinic acid in dried meat is less than in canned meat. In fact, cooked dehydrated meat compares favourably with the cooked fresh meat.

Vitamin assay was a lengthy operation until recently. Attempts have been made of late to shorten the process by the use of chemical and micro-biological method with varying degrees of success. "In each case" as Dr Morgan stated, "it is necessary to check the short methods against tests on rats."

TRANSFUSION OF CONDITIONED UNIVERSAL BLOOD

THE Archives of Internal Medicine, 1942 has published an account of clinical observations by N. C. Klendshof, M. Crichton, P. Swanson and Ernest

Witebsky regarding transfusion of conditioned universal blood, made available to us through the courtesy of the U. S. Office of War Information. Clinical observations on 176 transfusions of "conditioned" universal blood are reported. Small amounts of the purified blood group specific substances A and B were added to O blood in order to reduce or eliminate the content of isoantibodies present in the plasma of O blood. The titer of the isoantibodies before and after the addition of group specific substances was determined and the activity and harmlessness of the group specific substances investigated. No reactions ascribable to the combination of the transfused isoantibodies with the A and B specific substances of the patient were observed. Rise in temperature, chills and other reactions which did occur were analysed. Pyrogens are considered as the main cause for those reactions that cannot be counteracted by the addition of group specific substances. There are several advantages of using "conditioned" universal blood in the operation of blood banks, especially in emergency cases as well as in small blood banks.

ANURIA FOLLOWING HEMOLYTIC REACTION TO BLOOD TRANSFUSION

H. R. PETERS presented a case in the *Annals of Internal Medicine*, 1942, in which a hemolytic reaction and nine days anuria followed transfusion of blood of the homologous group. The role of the Rh agglutinin involved and its causal mechanism in hemolytic transfusion reactions was first reported by A. S. Wiener and the author in 1940. Accrued evidence is offered in favour of a vaso-constrictive renal element in transfusion anurias similar to that of reflex anurias. Splachnic block, variously reported as successful in reflex anurias, was performed in this case with immediate institution of diuresis and eventual recovery of the patient. While offered as an adjunct to therapy of transfusion anurias the author stresses the importance of carefully checking patient's chemical balance, including fluid intake, blood N. proteins, chlorides, Na and CO₂ combining power. These values need judicious therapeutic adjustment even after diuresis is established.

WAR AND TUBERCULOSIS

S. N. SEN

THE various problems associated with public health and the prevention of diseases have assumed such proportions all over the world in varying degrees of intensity during the four years of this global war that medical men and health authorities have rightly begun to feel deeply concerned for the future health of the population, civil as well as military, for which they have taken responsibilities. Temporary arrest of unfettered progress in medicine and public health, as in various other branches of pure research, characteristic of peace time, is, however, inevitable during war when the only *prima facie* consideration before a country is an efficient and successful prosecution of the war. This happened in the last World War, and the present war has not formed any exception. But whether the peoples of the world decide from time to time to be involved in a mortal struggle with their own kinsmen or not, the tragedy lies in the fact that human beings are apparently ever destined to wage a protracted war with morbid diseases that have challenged the security of our life ever since its appearance on this planet. In proposing to fight and annihilate human enemies we may be losing another battle of far greater importance and inviting a defeat

far more inglorious at the hand of common enemies to humanity, with which we have nothing in common.

In the period intervening between the two World Wars there was a progressive decrease in the mortality rate due to various diseases. The progress in sanitation, in provision of medical help, in fundamental research in chemotherapy and bacteriology and various other branches of medical science made such satisfactory strides that the average expectation of life in Great Britain and the United States of America has been raised as high as 55 years. Such achievements were possible as a result of a determined campaign launched by the medical men and the scientists presenting a united front. To give an indication as to the extent to which war has aggravated the problems of public health we propose to consider the case of tuberculosis as a typical disease and England as a typical country which has borne her share of the brunt of this total war. The choice of tuberculosis as the theme of the present article has special significance inasmuch as India herself is perhaps one of the worst sufferers from this scourge which takes away a heavy toll of life every year even in normal times. We are not aware

whether any list has been prepared with details of statistics relating to tubercular infection and mortality in this country since the outbreak of the war to bear out the effect of war on the progress of this fateful disease. Such a report, when prepared, is likely, we are afraid, to reveal a picture which will be hardly pleasant.

THE NATIONAL TUBERCULOSIS SERVICE

The National Tuberculosis Service is one of the most important organisations in Great Britain which has played a central part in promoting the public health of that country since its establishment in 1912. The outbreak of the last World War shortly after it had started on its programme arrested the activities of the Tuberculosis Service which could not be resumed until after the cessation of the hostilities in 1918. The rapid deterioration of the tuberculosis situation in England during the five years of the operation of the war is clearly reflected in the Malcolm Morris Memorial Chadwick Lecture recently delivered by Sir Arthur MacNalty (*Nature*, Vol. 150, No. 3815). The death rate per million owing to pulmonary tuberculosis in England and Wales, taken together, was 988 in 1914, which increased to 1,498 in 1918. Such swelling of the death rate due to tuberculosis was mainly attributed to malnutrition, overcrowding, systematic loss of body resistance to infection, arising from over-work, mental strain and some intercurrent infections such as influenza, from which war hardly offers an escape. The spread of the tuberculosis infection was, in fact, as active among the military as in the civilian population. The total number of ex-Service men of the last war invalided out of the Services by tubercular infection was as large as 35,000 in England alone, as Sir Arthur reveals.

THE POST-WAR ANTI-TUBERCULOSIS CAMPAIGN

During the post-war period the National Tuberculosis Service was actively engaged in working out the scheme of the anti-tuberculosis campaign, and succeeded in keeping the mortality rate due to tuberculosis at a constantly decreasing rate. Substantial diminution in death-rate due to all forms of tuberculosis was recorded. Thus in 1911 the number of deaths from pulmonary tuberculosis in England and Wales was 38,422. By 1938 this figure came down to 21,950. The progress in this direction so far as other forms of tuberculosis was concerned was more remarkable. During the same period the number of deaths fell from 14,698 to 4,246 in England and Wales, a diminution which unmistakably reflects the magnitude of post-war anti-tuberculosis activities in England. The following represents some of the im-

portant features in connection with her anti tuberculosis campaign during the post-war period:

- (1) The improvement in the surgical treatment of tuberculosis.
- (2) The successful application of artificial pneumothorax to many intermediate and advanced cases of pulmonary tuberculosis, formerly regarded as hopeless or questionable.
- (3) The development of X-ray technique in the diagnosis of pulmonary tuberculosis and in the control of collapse therapy.
- (4) The prevention of contact infection and increased pasteurization of milk.
- (5) The local Government Act of 1929 which has provided for proper treatment being available to all necessitous cases of tuberculosis under the tuberculosis schemes of local authorities.
- (6) Stimulation of research work in tuberculosis.

TUBERCULOSIS IN THIS WAR

There has been a considerable slowing down of the activities in the direction of prevention and treatment of the disease since the outbreak of the present war. Several places witnessed almost complete dislocation of the tuberculosis services. During the early months of the war when the fear of invasion was acute many advanced and infective patients were sent home. The problem was considerably intensified by the destruction of many tuberculosis wards and general hospitals in the series of air-raids which England had to experience. The emergency of the war-wound patients further required the conversion of a number of sanatoria into casualty hospitals, which meant a serious shortage of residential accommodation. To this was added a serious shortage of nurses for tuberculosis services. In this way the normal activities of the Ministry of Health in its anti-tuberculosis campaign received a setback from which it has not yet recovered, though it has become fully conscious of the growing menace of the rapid spread of tuberculosis.

Such dislocation of the tuberculosis services at once manifested itself in the increased number of deaths. In 1939 there were already 26,250 cases of mortality from tuberculosis in England and Wales, which steadily increased to 28,144 in 1940 and 28,669 in 1941. Sir Arthur MacNalty has shown from the statistics of the present war that if one takes the year from the mid-1938 to mid-1939 as standard, the first year of war in England experienced an increase of 6 per cent in deaths from respiratory tuberculosis and the second year an increase of about 10 per cent. According to the same standard of comparison, the increases in the number of deaths due to other forms of tuberculosis in the first two years of the war were 2.4 and 17.6 per cent respectively. Tubercu-

lous meningitis was largely responsible for this rise in the percentage of deaths; for the numbers of deaths in the first halves of 1940 and 1941 from tuberculous meningitis alone were 1,047 and 1,422, recording an increase of 375 in the period. In Scotland the numbers of deaths per 100,000 were 70 in 1939, 82 in 1940 and 83 in 1941. Tuberculosis among men in the Fighting Services has also recorded a steady increase since the outbreak of the war. But owing to better organisation of the medical services available in the Army, the Navy and the Royal Air Force, which has an important bearing on the progress of the war, tuberculosis among the Fighting Services could not be disproportionately large. Since 1941, however, there has been much improvement in the situation, and the spread of the infection appears again to have come well within control.

The National Tuberculosis Association has recently collected some authentic figures showing a significant increase in tuberculous deaths in Paris, Canada and in some other countries since the outbreak of the war. Tuberculosis mortality in Paris during the first six months of 1941 recorded an increase of 10 per cent over the deaths in the first half of 1939. Mortality due to the same infection among one-to nine-year old children increased by as much as 28 per cent. The average number of positive results showing the presence of tubercle bacilli in the sputum increased in Paris from 59.1 per 100,000 examinations in 1939 to 112.4 per 100,000 in 1941. In Canada, tuberculosis mortality in 1941 indicates an increase of 5 per cent over that in 1940. Authoritative figures for China, Greece and the U.S. countries are not available, but it appears from whatever information the Association has been able to secure that the increase in the tuberculous mortality in these countries must be alarming.

The only fortunate country which has so far not been affected by this increase in the trend of tuberculosis incidence and mortality since the outbreak of the war is the United States of America. On the contrary, there has been a slight decline in the mortality rate. The number of deaths from tuberculosis was 45.9 per 100,000 population in 1940 and 44.4 in 1941. This decrease in the mortality rate has also continued in 1942, as the Association reports on the strength of preliminary data so far available.

MEASURE FOR THE PREVENTION AND TREATMENT OF TUBERCULOSIS DURING AND AFTER THE WAR

Great Britain, as pointed out, has already been active in devising plans and adopting measures with a view to preventing the further spread of this disabling disease. It need hardly be said that this problem is closely related to the problem of proper nutrition. People suffering from serious malnutrition

gradually lose their natural body resistance and fall easy victims to tubercle bacillus. The prevention of the spread of the disease within reasonable bounds awaits a satisfactory solution of the food and nutrition problem which has assumed no less serious magnitude during this war. The proposal from different quarters for the creation of a Nutrition Council to act as a central organisation in evolving a food policy and promoting and co-ordinating nutritional research, now under consideration, indicates England's awareness of these problems.

Wide scale pasteurization of milk appears to be another most important measure to be adopted in this anti-tuberculosis campaign. As Sir Arthur MacNalty reports, the bovine type of tuberculosis alone is responsible for about 2,000 deaths in England and Wales every year. It is imperative that henceforward milk should be subjected to a universal heat treatment.

Recent advances in chemotherapy have unfolded the very significant possibility of chemotherapeutic treatment being possible in tuberculosis with the promise of a success of no mean order.* The U.S. medical men have recently investigated the possibility of using 'Promin', the didextrose sulphate of diaminodiphenyl sulphone, a member of the sulphonamide group, as an effective chemotherapeutic agent against tuberculosis. Marked activity of promin against the tubercle bacillus both *in vitro* and *in vivo* has been shown by Feldman and Hinshaw at Rochester. These researches have raised hopes that this obdurate disease might ultimately give way to some suitable chemotherapeutic agent in the same manner as the streptococcus infections have yielded to sulphanilamide.

The question of post-war planning in connection with the prevention and treatment of tuberculosis is already receiving serious thought in Great Britain. The incidence of tuberculosis, particularly among the ex-Service men, is sure to increase after the war. As early as 1936 Sir Pendrill Varrier Jones suggested the creation of a National Board in order to co-ordinate the planning of a national rehabilitation scheme. The Medical Research Council has now also expressed its opinion in favour of an early creation of such a board to cope with this growing menace of tuberculous infection during and after the war. The importance of such a rehabilitation scheme, however, need hardly be emphasised.

THE REPORT OF THE MEDICAL RESEARCH COUNCIL

The Medical Research Council has recently prepared a very useful report and put forward some

* Chemotherapy of Tuberculosis—SCIENCE AND CULTURE, Vol. VIII, No. 10.

important suggestions worth paying attention to. The report has been framed by a Committee and published from London (H. M. Stationery Office, 1942, 9d. net) of which a short summary has appeared in a recent issue of *Nature*. The Committee has noticed a significant increase in the incidence of and mortality from tuberculosis affecting all age groups in this war, and has the following recommendations to make, which, it believes, will help to arrest the progressive deterioration so far as tuberculosis mortality is concerned.

(1) The widest possible extension of pasteurization should be undertaken to reduce the spread of bovine infection from milk.

(2) Mass-radiographic surveys should be introduced to detect pulmonary lesions at an early stage.

(3) There should be an increase in the number of available beds in sanatoria and in the amount of financial help available to the patients and their dependants, and general improvement in the care and after-care of infected persons.

(4) The working conditions of young employees should receive the closest attention in order that the resistance to the tubercle bacillus, particularly among susceptible groups of the population, can be gradually raised.

(5) There should be an investigation of tuberculosis in mental hospitals. The existing tuberculosis services should be reorganised and there should commence an extensive propaganda work among the medical profession and the public.

The Committee has laid special emphasis on the importance and necessity of mass radiographic surveys in this all-out drive to combat tuberculosis. Selected groups of the community should be subjected from time to time to such examinations. The development of the technique of miniature radiography, whose characteristic feature is speed and economy has made mass radiography practicable. This consists in taking the photographs of the fluorescent screen image produced by X-rays generally in two forms, namely (a) 5" x 4" miniature (widely used in the United States) and (b) 35 mm. cine film miniature recording. It should be noted, however, that final conclusions in any case should

be drawn from full clinical, bacteriological and radiological (full-size film) examinations.

Mass radiography, as the report suggests, may be possible in three ways: (1) examination of persons about to enter employment, (2) examination of every person in employment, irrespective of age or sex, (3) periodical examination of groups of the community; this is not possible so long as war lasts on a large scale, but it can be confined with advantage to specially selected groups, for instance, munition workers, medical students and nurses and merchant sea men.

The success of mass radiography, itself a very novel suggestion, depends on a number of factors. The whole project requires a considerable degree of organisation and planning beforehand. Besides, a very high standard of the quality of miniature radiography is necessary for correct interpretation which alone can be of some use. Expert radiologists should be employed for this work requiring the highest radiological skill. The report suggests that a central advisory or controlling board of experts acting for the Ministry of Health, which should be very carefully selected, must watch the progress of such survey work.

Tuberculosis incidence and mortality rate due to this infection in India, particularly in Bengal, are far greater than in Great Britain. Gross malnutrition and unfavourable living conditions to which people in this country are constantly condemned, the hopelessly inadequate number of clinics, sanatoria and trained medical personnel available for proper attendance, and towering ignorance among the public about this terrible disease have led to the present situation. The work done so far by the Indian Research Fund Association and the Tuberculosis Associations in this field has been quite inadequate compared to the magnitude of the problem. The present discussion has been introduced in the hope that the problems facing England and the way in which she proposes to tackle them even as the war progresses might receive the serious attention of the public, the medical profession, and above all the Government which have so far signally failed in evolving some constructive programme which can reduce the menace of tuberculosis in our country.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

TO A BROTHER IN PROFESSION

(On reading the article "Technological Revolution,"
SCIENCE AND CULTURE, VIII, 315-19, 1943)

Pride goeth before fall—

Is an adage, known almost to all.

If a Scientist chooses to forget it,

It does not at all go to his credit.

The study of Nature in outer realm

Gives him a right to the just claim:

That he can master the physical forces,

The blank-cheque of power to Man, he endorses.

From the normal and abnormal behaviour of Man

He forms an idea and chalks out a plan

Of how he might control and construct

The "Kingdom of Heaven" on the Earth's crust.

He claims that he might prevent

The diseases of Man, and give him the spent

To a "full development of personality,"

Without transgressing the limits of nationality!

Alas! my dear Brother in Profession!

You are working under an obsession.

The forces of destruction that Science let loose

Have fashioned for Man a fatal noose.

But for this, the Nazi would not think

That he might afford to hoodwink

The whole of Europe, and ever dare

To bring other people under his forceful care.

The Bolshevik in the process of evolution

Is reaping the fruits of a "Technological Revolution"!

Science gave him the power to hold high

His ideological flag under a Godless sky.

The Nazis and Bolsheviks have this much in

common

That they are determined to fight on and on,

Till one perishes or accepts the others' creed.

The militant attempt is resolute indeed!

Do they not, however, simulate the animal

In spite of all they consider as rational?

Can you help them on to an Ideological synthesis,

Or, even speed them on the way to nemesis?

The scientific game of totalitarian war

Has, at least, taught the Democracies so far

That they must adopt the same methods to

combat it

In order to win the Peace with all its profit.

What law governs the combined Will of a Nation?

What forces fashion History, or course an impulsion?

Can the mighty grip of scientific exploitation
Ever be unfastened without spiritual rejuvenation?

If China fails because she started late—

What is left for India but to depend on her fate?

As Scientists let us face a few cold facts—

Who is giving us time to exploit our own tracts?

The time for building castles in the air

Is what a Scientist can ill-afford to spare.

"Capitalistic motives" will not go,

Unless you can clearly show

How by serving "Humanity" alone

Wealthier nations may cease to groan.

Logic will never convince them

For human feelings are not so tame.

How to effect 'a change of heart'

Is India's problem at the start.

Can the Scientists give a solution?

Can they help at this hour of evolution?

If not, why this idle talk,

On spiritual gates, this unseemly knock!

Do you think you can afford to ignore

The saints and seers that India produced

by the score?

They succeeded where you fail,

Keep to your place, or with them sail.

Design machines and grind the proper tools,

So, when the call comes we don't look like fools.

Do not forget that religion in the East

Is not a mere propaganda of the priest.

If you find it difficult to reconcile,

Find time to practise awhile.

Turn the mind to Nature's inner realm,

You'll find your Self and none to blame.

The picture of personality you're depicting

Is the same with what the West is lamenting

The World is in need of a better picture

It cannot be duped with a multi-colour-mixture.

Oh, Lover of Truth! relegated though you be,

Despair not, for you are the nation's bee.

Recognize the Queen that sits within,

For Truth is not alone by senses seen.

Truth can as well be intensely felt,

There's the loose nut where the blow is to be dealt.

To be of use at present and in future

Be a Whole Man first with a Love-ly texture.

Emm Dee.

Barisal, 5-3-1943.

ASSAY OF 'ENTERO-VIOFORM' (ODOCHLORO-HYDROXY QUINOLINE)

Iodochloro hydroxy Quinoline, $C_8H_7N.OH.I.Cl$, is now recognised as a useful antidyenteric remedy and attempts have recently been made to synthesize this compound in Calcutta. Our interest was created in the assay of this compound because samples were submitted to the Biochemical Standardisation Laboratory for opinion.

The N. N. R. (New and Non-Official Remedies) 1937 and subsequent editions upto 1941 record the following method of analysis:—

"Mix about 0.5 gm. of Iodochlorohydroxy Quinoline (vioform-Ciba) accurately weighed in a nickel crucible with a mixture of powdered NaOH and KNO_3 (4:1) and heat until fusion has been completed. Cool and dissolve the fused mass in 150 c.c. of water, warming to hasten solution; filter into a 400 c.c. beaker and wash well. Add 25 c.c. of $N/10$ $AgNO_3$ (the amount of silver is k in the formula below); then add slowly, with stirring, HNO_3 until acid in reaction to litmus paper. Filter the solution through a weighed Gooch crucible, wash and titrate the excess $AgNO_3$ in the filtrate with $N/10$ KCN (the amount of silver in the filtrate is a). The precipitate in the Gooch crucible (consisting mainly of AgI with some $AgCl$) is further washed with 3 portions of alcohol, then with ether, dried at $100^\circ C$, and weighed (w). The amount of iodine can be calculated according to the formula.

$$X = \frac{0.7527w + a - k}{293}$$

where w equals combined weight of AgI and $AgCl$; k equals weight of AgI and ($w - k$) equals weight of $AgCl$. This method Iodochlorohydroxy Quinoline contains not less than 37.5 per cent. nor more than 41.5 per cent. of iodine and not less than 11.5 per cent. nor more than 12.5 per cent. of chlorine."

Several samples of Iodochlorohydroxy Quinoline were subjected to careful analyses by the N.N.R. method outlined above. The results obtained were far from the expected percentages of Iodine and Chlorine which should be present in standard samples. The following modifications therefore appear necessary to enable analysts to obtain reproducible data from the N.N.R. method and formula:—

(a) The denominator in the formula for the calculation of Iodine should read "0.293" instead of "293".

This will be evident from the theoretical calculation given below:—

Let W = wt. of $AgI + AgCl$, then total Ag in $W = (k - a)$, where K = wt. of Ag added and a = wt. of Ag in the filtrate. Also let α be the fraction of $(k - a)$, which has been converted to $AgCl$.

$$\text{Then } \alpha(k - a) \times \frac{143.5}{108} = AgCl \text{ and } (1 - \alpha)(k - a) \times \frac{108}{235} = AgI$$

$$\therefore W = (1 - \alpha) \times (k - a) \times \frac{235}{108} + \alpha(k - a) \times \frac{143.5}{108}$$

$$\text{or } \alpha = \frac{108w - 235(k - a)}{91.5(k - a)}$$

Putting the value of α , in the equation $W = X + AgCl$, where X = wt. of AgI , we get $W = X + \alpha(k - a) \times \frac{143.5}{108}$

$$\text{Or } X = w - \left[\left\{ \frac{108w - 235(k - a)}{91.5(k - a)} \right\} \times (k - a) \times \frac{143.5}{108} \right]$$

$$= W + \frac{\{108w - 235(k - a)\} \times 143.5}{91.5 \times 108} = 2.568 \{W + 1.328(k - a)\}$$

$$= 10^3 \left(\frac{0.7527w + a - k}{293} \right) = \frac{0.7527w + a - k}{0.293}$$

(b) The amount of $N/10$ $AgNO_3$ necessary to precipitate halogens from 0.5 g. of Iodochlorohydroxy Quinoline should be '50 c.c.' and not '25 c.c.', as is recommended in N.N.R. 25 c.c. $AgNO_3$ is definitely insufficient to precipitate out all the halogens.

Adopting these modifications in the formula and the method, the results of analyses of (i) a mixture of known quantities of KI and $NaCl$ and (ii) two powders of Iodochlorohydroxy Quinoline are shown below:—

I		
Nature of substance	Iodine	Chlorine
Mixture of KI (0.1 g.) and $NaCl$ (0.1 g.)	found = 0.0776g. % recovery 101.4 % (expected 0.0765g.)	found = 0.05809g. % recovery 95.7 % (expected 0.06068g.)

II				
No.	Nature of substance	Wt. of substance taken	Iodine content	Chlorine content
1	Powder	0.5 g.	43.15%	10.6%
2	do	0.5 g.	36.2%	10.7%

Recovery of Iodine and Chlorine from tablets of Iodochlorohydroxy Quinoline is however not up to N.N.R. requirements. Results obtained with two brands of locally made tablets along with tablets manufactured by 'CIBA' are given for comparison.

No.	Nature of substance	Wt. of substance taken	Iodine content	Chlorine content
1	Tablet (CIBA)	0.4155 g.	32.0%	14.2%
2	do (Local)	0.4794 g.	32.0%	9.52%
3	do (,,)	0.4553 g.	32.0%	9.55%

This may be due either to content of Iodochlorohydroxy Quinoline being lower than claim (0.25 g) or the tablet-binding material interfering with the full recovery of the halogens. Attempt is being made to find out if any other method would give yields of Iodine and Chlorine more closely approximating theoretical requirements. The 'modified method' however, appears to hold good for all rapid routine analyses.

June, 1943

LETTERS TO THE EDITOR

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Our thanks are due to Dr B. Mukerji, Director, Biochemical Standardisation Laboratory, for his interest in this work.

J. C. PAL
R. C. GUHA.

Bio-chemical Standardisation Laboratory,
(Government of India),
110, Chittaranjan Avenue,
Calcutta, 7-4-1943.

ON THE OCCURRENCE OF THE GENUS *PALLAVICINIA* (THALLOSE ANACROGYNOUS JUNGERMANNIALES) AT DACCA, EAST BENGAL

Specimen here described was collected during September–November last year by one of the writers at Dacca in East Bengal, from a marshy locality in association with grasses, Eriocaulons,



Fig. 1.—Archegonial plant (dorsal surface), showing dichotomous branching, a special branch and archegonial receptacles.
2.—Archegonial plant (ventral surface) showing rhizoids and special branches.
3.—An archegonial receptacle with the involucre enclosing a cluster of archegonia.
4.—A mature archegonium with much elongated neck.

Burmanna etc. In this region the plant is very abundant and occurs in dense mats.

There are altogether 41 species of *Pallavicinia* recorded of which the following 6 species are known from India.

1. *P. ambiguus* (Mitt) St—Khasia hills, Luzon.
2. *P. indicus* Schffn—Darjeeling, Nepal, Java, Sumatra and Tahiti.
3. *P. Himalayensis* Schffn—The Himalayas (Kurseong).
4. *P. decipiens* (Mitt) St—Ceylon.
5. *P. canarens* St—Canara, S. India.
6. *Pallavicinia* Sp.—W. Himalayas.

So far as we know, this is the first record of the genus from the plains of Bengal.

The following is a short description of the species, the identification of which, with details of the morphology will be published elsewhere later on.

Thallus 2-3 inches long, nearly linear, wholly prostrate, slender, green, once, twice or thrice dichotomously branched and is differentiated into a distinct sharply defined midrib. On either side of the midrib are relatively broad longitudinal wings with undulate margin and sometimes lobed at places (Fig. 1). Frequently special branches arise from the midrib on the ventral surface. The latter has also smooth-walled rhizoids (Fig. 2).

Archegonia occur in clusters (20 or more) in restricted areas (receptacles) along the midrib on the dorsal surface of the thallus and is surrounded by an involucre, which is deeply fimbriated at the margins (Fig. 3). These so-called 'flowers' are in abundance. The neck of the archegonium is long and there is a large number of neck canal cells (Fig. 4).

Antheridial plants and sporophytes not observed.

A. K. GHOSH
A. K. CHAKRAVORTY

Botanical Laboratory,
Calcutta University,
Calcutta, 16-4-1943

OCCURRENCE OF *BURMANNIA COELESTES* D. DON IN THE PLAINS OF E. BENGAL

Burmanna Coelestes D. Don, was collected recently from a swampy locality in Dacca in East Bengal, occurring in association with Eriocaulon, grasses, rushes, hepatics and angiospermous weeds. Hooker mentions its distribution as follows:— "Tropical Himalayas, Nepal, Khasia Mts.; Chittagong and Southward to Malacca and the Andaman islands; Central India and the Deccan peninsula, from Hazaribagh to Travancore and Ceylon". Prein records it from "Chotanagpur, Behar, Tirhut, North Bengal and Chittagong."

The species has thus not been recorded previously from the plains of East Bengal. Its occurrence in this area fills in the gap between the previous records in North Bengal and Chittagong and thus makes its distribution more or less continuous from eastern Himalayas to Chittagong and further south.

A. K. CHAKRAVARTY.

Botanical Laboratory,
Calcutta University,
Calcutta, 16-3-1943.

¹ Hooker, J. D.—*Flora of British India*, 5, 635, 1890.
² Prain, D.—*Bengal Plants*, 2, 908, 1903.

ISOLATION OF A NEW ISO-FLAVONE FROM THE BARK OF *PRUNUS PUDDUM* (N. O. ROSACEAE)

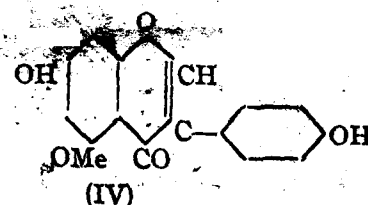
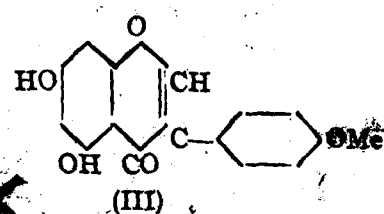
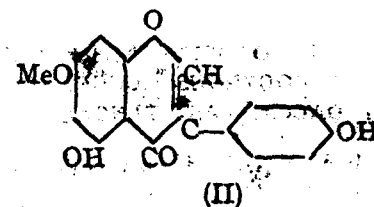
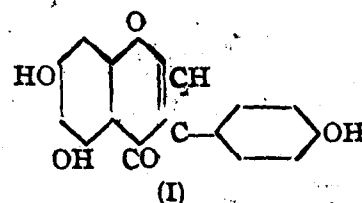
A compound, m.p. 237-238°, ($C_{15}H_{12}O_6$) has been isolated in 0.08 per cent yield from the bark of *Prunus Puddum*, collected from the district of Darjeeling. It contains one methoxyl group and two free hydroxyl groups, as it forms a dimethyl ether and a diacetyl derivative. On demethylation with hydriodic acid it forms a tri-hydroxy-derivative (m.p. 291-293°), which seems to be identical with the natural isoflavone genistein¹, the colouring matter of Dyer's Broom. The derivatives of the demethylated product are identical with the derivatives of genistein, described in literature.²

	Demethylated product	Genistein
Triacetyl derivative	m.p. 291-293°	m.p. 291-293°
Dimethyl ether	m.p. 292-293°	m.p. 197-201°
Acetylated dimethyl ether	m.p. 139-140°	m.p. 137-139°
Demethylated dimethyl ether	m.p. 201-203°	m.p. 202-204°
Triacetylated dimethyl ether	m.p. 201-202°	m.p. 200-201.5°

Hence the compound, which has been named *Prunasetin*, is a monomethoxy derivative of genistein (I) and is isomeric with the natural isoflavone prunetin³ (II or III) isolated from *Prunus serotina*. It is not, however, identical with prunetin as shown below:

	Prunetin	Prunasetin
Diacetyl derivative	m.p. 242°	m.p. 237-238°
Mono-methyl ether	m.p. 224-226°	m.p. 220-222°
(which forms an acetyl derivative, m.p. 202)	m.p. 145°	—
Dimethyl ether	—	m.p. 160-161°
(which does not form an acetyl derivative)	—	—

Since Prunasetin readily forms a dimethyl ether which does not contain a free hydroxyl group, it seems likely that it has a methoxyl group in position 5 and its probable constitution is (IV), which is unusual in view of the observations of Bose and Nath.⁴



Further experiments in support of the structure (IV) for prunasetin are in progress.

The bark of *Prunus Puddum* thus contains the flavone *Puddumetin*,⁵ an isoflavone *Prunasetin*, and also a flavanone, which is under investigation.

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¹ Perkin and Newbury, *J. Chem. Soc.*, 75, 830, 1899; Perkin and Horsfall, *ibid.*, 77, 1310, 1900; Baker and Robinson, *ibid.*, 3115, 1928.
² Baker and Robinson, *ibid.*, 127, 1961, 1925.
³ Finckh, *Pharmaceutical J.*, 31, 694, 1910; Baker, *J. Chem. Soc.*, 1022, 1928.
⁴ Bose and Nath, *J. Ind. Chem. Soc.*, 15, 141, 1938; cf. Shah, Virkar and Venkataraman, *ibid.*, 19, 135, 1942.
⁵ Chakravarty and Ghosh, *Science and Culture*, 8, 464, 1942-43.

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