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In Memoriam :

PRAFULLA CHANDRA RAY

BORN: AUGUST 2, 1861.

DIED: JUNE 16, 1944.

SIR P. C. RAY, more familiar to his countrymen as ACHARYA PRAFULLA CHANDRA RAY, is no more. He passed away after a short span of illness on Friday, the 16th June at 6-27 P.M. in his own room at the University College of Science and Technology, Calcutta, which was his home for the last 30 years of his life. With him has been severed the last link of the towering personalities of the last generation, who have made Bengal what it is to-day, culturally and intellectually, and who, by general consensus of opinion, stand in the front rank of the Makers of Modern India.

The outstanding feature of his greatness was that he loved his people and was one of them. He never thought of keeping himself above and aloof from the common man. His was a soul that disliked to dwell apart from others. He abhorred the selfish enjoyment of his own greatness, but wanted to share his feelings with all around him—great and small, rich and poor, learned and illiterate. More at home with people in humbler walks of life he used rather to say that he was afraid of great men—men of power, position, wealth and honour. In fact, he did not know how to become great in the modern sense of the word. For, though placed in power he never exercised it, holding a very high position he never felt it, possessed of wealth he never kept it, adorned with honour he could never be induced to enjoy it. Such was his greatness—a rarity by itself, which avoided all taints of vanity, scrupulously shunned all attempts to make a good impression or favourable appearance, and expressed a strong dislike for aristocratic isolation.

Though a chemist by choice, his activities were never confined within the four walls of his laboratory; and his life was far from that of a brooding scientist with an

uneventful routine of study, laboratory and rest. Within a frail and fragile frame he nurtured a virile and sympathetic spirit whose activities were many-sided and embraced almost all spheres of human interest. Intellectual, scientific and industrial regeneration, social reform, economic freedom and political advancement of this country, all made equally strong appeal to him and absorbed as much of his time and service as did his scientific researches and teaching. Above all, in times of distress and suffering, he was the first man in Bengal to respond to the call of humanity—be it a famine, a flood or any other natural visitation. Of him it may be truly said in the words of Emerson, his favourite philosopher, that he was “in this world not to get but to give; not for prosperity but to suffer for the benefit of others like the noble rock-maple tree which in all the villages bleeds for the service of man”. His life was one of pure self-immolation that could give all and take nothing, and even receive nothing.

A friend of the poor and lowly he gave away abundantly in charity, often unnoticed and unknown to others, though he never had a large income of his own. His riches, however, consisted in the fewness of his wants as he lived a single and ascetic life of Spartan simplicity. In him were harmoniously blended the lofty ideals of ancient oriental culture with the dynamic and progressive aims of the modern rationalistic western civilization.

Born in a cultured and rich family, his father being a landed proprietor with liberal western education, PRAFULLA CHANDRA imbibed from his very childhood through the latter's influence the principles of rational thinking and the value of disciplinary methods. After his first education in his father's village school up to the age of nine when the family migrated to Calcutta, he joined the Hare School and subsequently the Albert School from which later he passed the Entrance Examination in 1879. During this period a persistent attack of dysentery so shattered his health as to leave a permanent stamp of weakness upon his constitution. He then joined the Metropolitan Institution, now known as Vidyasagar College and also attended lectures on Physics and Chemistry at the Presidency College. The lectures and experiments of Prof. Pedler, at the latter institution stirred his imagination and awakened in him a spirit of enquiry and interest for natural science. In 1882, he prepared for the Gilchrist Scholarship Examination—an All-India Competition—without the knowledge of his friends and relations and was able to secure one scholarship, the other successful competitor being a Parsi gentleman, Bahadurji. This success paved the way to fulfil his long-cherished desire for further studies in Europe, for at this period there was a serious set-back to his family fortune due to his father running into heavy debts. He joined the University of Edinburgh in 1882 in the Faculty of Science. In Chemistry he came under the influence of Prof. Crum Brown and it became his favourite subject. Alexander Smith

and James Walker were his class-fellows. In 1888 he obtained his D.Sc. degree on a thesis in Inorganic Chemistry and became the recipient of several scholarships in the University.

After return to India he was appointed in 1889 Assistant Professor of Chemistry at the Presidency College, Calcutta, where in 1911, a few years before retirement, he became its Senior Professor. Here, in addition to his teaching work, he devoted himself with great enthusiasm to the pursuit of original researches. His colleague, late Sir Jagadis Chandra Bose, in Physics and he in Chemistry were the first Indian teachers to initiate research work in natural science and to inspire young minds with a spirit of enquiry, desire for knowledge and love of truth. Soon he established his reputation as a teacher of exceptional ability and his lectures wielded a great influence upon his students, illustrated as they were not only by numerous experiments but enlivened as well by his original wit, humour, examples from daily life and notably by attractive accounts from the lives of the great masters of science. His animating account of the pilgrimage of Wöhler from Germany to the great Swedish savant Berzelius, where Anna, the kitchen maid, served as a laboratory assistant, still rings in many ears. Students from other sections, both of science and arts, were attracted by his lectures and the lecture gallery was always full to the brim. Soon a body of ardent research workers gathered round him forming the nucleus of an Indian School of Chemistry. It is, therefore, no wonder that most of the eminent chemists of India to-day had their first lessons from him. In 1916 he retired from the Government service to join the University College of Science, then newly started, as Palit Professor of Chemistry at the request of that great educationist, the late Sir Asutosh Mookerjee. Here, in a more congenial and free atmosphere his research activities increased manifold and the band of devoted workers continually swelled in numbers. The total number of original papers published from his laboratories at the Presidency College and the University College on a large variety of chemical problems is likely to approach a couple of hundreds. In 1902 he published the first volume of his monumental work, the ‘History of Hindu Chemistry’ which was followed by the second volume in 1908. The work represents the result of a long and painstaking research extending over 15 years and gives us a glimpse into the achievements of the early Hindus in the domain of positive science. The book was acclaimed by competent critics and judges all over the scientific world as a valuable contribution to the history of science.

Far outweighing his reputation as a teacher and researcher, his service as the founder of a School of Chemistry will ever remain as a conspicuous landmark in the history of our national progress. The inauguration of the Indian Chemical Society in 1924, of which he was the Founder President for the first two terms, constitutes another

instance of his signal service in this line. The Society was started with a handsome donation of Rs. 12,000 from him towards its building fund.

In 1936 he retired from his position as Palit Professor of Chemistry and remained as an Emeritus Professor to the end. Long before this, at the completion of his 60th year in 1921, he wrote to the authorities of the University making a free gift of his salary from that date onward till his retirement. It was also suggested that the money accumulated thereby should be spent for further extension and development of the Department of Chemistry in the University College of Science and Technology. The University has already created two Sir P. C. Ray Research Fellowships in Chemistry to be maintained from the interests of this fund (Rs. 1,30,700). Further, an endowment of Rs. 12,000 was made in 1922 for an annual Research Prize in Chemistry, named Nagarjun Prize after his suggestion. This was followed by a second endowment of Rs. 11,000 in 1936 for a research prize in Zoology and Botany, named as Sir Asutosh Mookerjee Prize.

As a man and as a teacher his relation with his pupils was always very warm and affectionate, transcending the mere natural admiration and respect from the taught and good wishes from the teacher. There was nothing in his private or public life which was not disclosed to his pupils who regarded him as their friend, philosopher and guide. He maintained in its fullest sense the tradition of the ancient Indian Gurus with his charity extended beyond the circle of his pupils to the student community in general and to the maintenance of many schools and colleges in Bengal.

He was sent on deputation to Europe in 1904 by the Government of Bengal. In 1912 he visited England again as a representative of the Calcutta University to the Empire University Congress, and in the same year the Honorary Degree of D.Sc. was conferred on him by the University of Durham. He was also the recipient of similar Honorary Degrees from the Universities of Calcutta, Dacca and Benares. He was made a Companion of the Order of the Indian Empire in 1911 and was knighted after the last World War. In 1920 he was elected General President of the Indian Science Congress. In 1934 he was elected an Honorary Fellow of the London Chemical Society and also that of Deutsche Akademie, München, a little earlier.

At or about 1900, PRAFULLA CHANDRA founded the Bengal Chemical and Pharmaceutical Works which was converted into a limited concern in 1902, when he made a gift of his shares forming a Board of Trustees for conducting a school and promoting other benevolent activities in his native village in the district of Khulna. The Bengal Chemical and Pharmaceutical Works, now so well-known all over India, will ever remain as a glorious legacy to his countrymen and as a standing monument to his memory. He was also connected with a large number of limited companies, such as cotton mills, sugar works, chemical industries, pottery and porcelain industries, book

companies, etc., either as a Director, Promoter or Patron. Almost every industrial enterprise in Bengal had his blessings and encouragement. He never ceased to urge the Bengali youths to take to business and industries, following the example of their hard-working brethren from Marwar. The pre-eminence of Bombay and the activities of Parsis and Gujaratis in this respect were frequently referred to and stressed upon by him. No terms were considered too strong by him with which to condemn the indolence and ease of the Bengalee youths and their insane craze for university degrees.

In 1929 when the whole country was in a state of convulsion due to the Non-Co-operation Movement led by Mahatma Gandhi, he threw himself heart and soul into its constructive and economic programme. The great pioneer of chemical industries became an ardent advocate of spinning and weaving as a means of ameliorating the appalling poverty in the Indian villages. He himself took to spinning—a practice which he religiously kept up till failing vision intervened. He himself never used anything but Khadi till the end of his life. People often used to call him 'a saint of Science' and an apostle of khadi'. A number of his shares in the Bengal Chemical and Pharmaceutical Works, Ltd. (face value Rs. 17,000, at present valued at Rs. 70,000) was made over by him to a Trust in order that the profit therefrom might be utilized for the benefit of poor widows, orphans, as well as for handspinning and production of Khadi.

His services to the country as a social reformer are outstanding. Long before the Congress Movement against untouchability was initiated by Mahatma Gandhi, PRAFULLA CHANDRA by his writings and speeches uncompromisingly fought against this and many other social evils like caste system, child marriage, dowry system, communalism and orthodoxy in general. In caustic, sarcastic and almost vitriolic terms he never ceased to cast his severe strictures upon our decayed and diseased social system which exercises such a baneful effect upon individual and national progress. As early as 1917 he presided over the Indian National Social Conference in Calcutta and exhorted the people to unite and do away with untouchability, as India divided within itself could never attain independence. He was an ardent advocate of Hindu-Muslim unity and the fusion of all communities into one great Indian nation.

As a philanthropist PRAFULLA CHANDRA was ever ready to come to the rescue of suffering humanity. Whenever he appealed for funds, as in the case of Khulna famine (1921) and North-Bengal flood (1922), money came simply pouring in from all parts of India for people had an abiding confidence in him.

In politics, though never actively on the field, he belonged to the advanced school. His well-known remark on a memorable occasion, "Science can afford to wait but Swaraj cannot", gives a measure of his patriotism.

Though a scientist by profession, his love for, and knowledge of, literature and history were much above the average. Rabindranath, Madhusudhan Dutt and

Shakespeare were his favourite poets from which he could quote off-hand from memory at any time. He was also very fond of the works of Emerson and Carlyle. His interest in literature and history was so great that he was often heard to say that he became a chemist by pure accident. In 1932 the first volume of his autobiography "Life and Experiences of a Bengali Chemist" was published. It was dedicated to the youth of India with the hope of stimulating their activities. The second volume of this work was issued a few years later (1935). An idea about the value of the book is best derived from what Prof. Armstrong wrote about it in *Nature*:—

"From beginning to end the message of the book is one of the highest endeavour—pulsating with vitality and intellectual force."

As an educationist he strongly supported the use of the mother tongue as the medium of instructions, without which originality and the habit of independent thinking can never be developed, nor the standard of efficiency in our schools and colleges be raised.

On the completion of his 70th birth-day the Indian Chemical Society presented him a Commemoration Volume which contained contributions from many eminent chemists of India and Europe. A similar Commemoration Volume and an address, on behalf of the Public of Bengal, was presented to him on the same occasion. His 80th birth-day also was celebrated by the public when he received a large number of congratulatory addresses from the Calcutta University and various other educational institutions as well as from many industrial and scientific organizations.

A saint of science, a patriot, a philanthropist and a nation-builder has passed away; a truly noble soul, a kind and compassionate figure has disappeared from our midst. But PRAFULLA CHANDRA was greater than his life or work and has left behind a pattern of character for us and more specially for the student world as pointed out by Gandhiji and so aptly and beautifully delineated some time ago by Rabindranath while presiding over his 70th birth-day celebration:

"It is stated in the *Upanishads* that One said 'I shall be Many'. The beginning of creation is a move towards self-immolation. ACHARYA PRAFULLA CHANDRA has become many in his students and has made his heart alive in the hearts of many. And that could not have been at all possible had he not unreservedly made a gift of himself. The power of creation having its inception in self-sacrifice is a divine power. The glory of this power in the ACHARYA will never be worn out by decrepitude. It will extend further in time through the ever growing intelligence of youthful hearts; by steady perseverance they will win new treasures of knowledge."

He came with a great mission to serve his country and has left an imperishable example, which will serve as a light and inspiration to the present and future generations.

DEPARTMENT OF PLANNING AND DEVELOPMENT

THE recent Government of India *communiqué* announcing the creation of a new Department of Planning and Development and the appointment of Sir Ardeshir Dalal to the new port-folio have evoked widespread comments in the public press. It is possible to have a realistic outlook to the announcement. The action of the Government may at least be regarded as a "gesture admitting a tiny ray of hope in these days of bleak despondency". It is to be noticed that the Government have not declared its objective in taking the new step, but the very fact that they have offered the port-folio to one of the signatories of the Bombay Plan may be taken to show, as Sir Ardeshir has pointed out, that they have perhaps a certain amount of sympathy with the declared objective of the Bombay Plan *viz.*, the raising of the standard of living for the common man of India by a process of planned expansions in industry, agriculture, communications, and other nation building activities, perhaps in so far as that is compatible with the interests of Imperialism. A national government would not have hesitated to declare its 'objective' and such a declaration would have been hailed with acclamation by all sections of the people. Probably the Department would have been called the department of "National Planning and Development", a step we have long been advocating. But we have probably no right to expect such large promises from a government of foreign bureaucrats, and after our experience of large promises in the past, generally followed by vague excuses, or studied silence, it is better to start with no promises but reserve judgment on actual achievement.

As the newly appointed Member himself admitted in a press statement, full measures of national planning and development are possible only under a national government. We would go further, and would have no hesitation in proclaiming our firm belief that India is in urgent need of *inspiration for a national purpose*, and would respond to trusted and inspired leadership with a quickness which will surprise the world, just as the transformation of Soviet Russia from medieval feudalism to the highest form of technological civilization has surprised friends and foes alike. Such leadership can only come from national leaders like Pandit Jawaharlal Nehru and others still in confinement. Under the present system, we think that the new Member will have many hurdles to overcome and he may not have the requisite co-operation of his colleagues in the

Viceroy's Cabinet or of the officials. The course for the new Member is, therefore, likely to be neither smooth, nor promising. But like a Stein, he may have tact, and foresight enough to overcome these difficulties and lead the nation on the way to prosperity and a new life. It is in this hope that we welcome the creation of the Department and the appointment of Sir Ardeshir Dalal as its head.

But even the most gifted of men having the greatest freedom of action, and plenty of finances at his disposal cannot achieve anything substantial unless he has a suitable administrative machinery to assist him in his work, and gets the assistance of willing officials, or the co-operation of an efficient brain-trust composed of persons who will not be guided by motives of self-interest. We do not think that such a machinery exists at the present moment, but with a certain amount of reshuffling of the existing organizations, and a radically new policy in handling them, substantial progress towards the goal can be made. Prof. A. V. Hill, in his illuminating address to the Indian Science Congress at Delhi this year gave us a lucid picture of the British system, defining the fundamental principles which should be the same at every latitude and Sir J. C. Ghosh and his colleagues of the National Institute of Sciences have given their own suggestions on this subject at the symposium held by the National Institute of Sciences at Calcutta and Delhi. We consider that if the new Department is to justify the hopes aroused, it cannot ignore the existing deficiencies in organization, or the faultiness of the principles now pursued which we have criticized so frequently in these columns. It should be guided by the principles enunciated in Hill's article, and in the resolution of the National Institute of Sciences. Based on these, the following suggestions are made:

The first suggestion is that all the scientific research organizations and research institutes under the Central Government should come under the new Department. The present position is very anomalous, as these organizations are now scattered over several departments of the Central Government, and the control exercised varies from a loose, undefined connection to the fullest measures exacted by a bureaucratic system primarily devoted to interests other than national. For example:

Geological Survey: is under the Department of Labour. What 'Labour' has to do with geology is probably difficult to see for anybody.

Meteorology: is under Posts and Air but meteorological information is needed by all sections of people.

Scientific and Industrial Research: still a baby amongst scientific departments was first under the Department of Commerce but is now under the Council, a registered body of Government officials, and some representatives of science and industry nominated by the Government, and presided over by the Hon'ble Member in charge of Industries and Civil Supplies.

Medical and Agricultural Research: under two registered and semi-autonomous bodies having very cumbrous composition *viz.*, the Indian Research Fund Association and the Imperial Council of Agricultural Research are under the Chairmanship of the Hon'ble Member for E.H.L. (Department of Education, Health and Lands). The corresponding research institutes in these two subjects are, curiously enough, under the fullest bureaucratic control of the E.H.L.

Botanical and Zoological Surveys, the Survey of India: are under the E.H.L.

It will thus be seen that the existing scientific departments of the Central Government are dispersed under different Hon'ble Members of the Viceroy's Cabinet, most of them having many other serious duties and pre-occupations, and probably none of the Hon'ble Members or his secretaries being selected on account of his previous knowledge of the sciences he has to deal with, or having gained by his part played as a politician or administrator even the most casual placed under his control or even having any sympathy with its working. The amount of control exercised varies as we have pointed from the maximum measure allowed by the bureaucratic code to a varying degree of looseness, but the essential threads are always in the safehands of I.C.S. secretaries and bureaucrats who are always changing from one department to another for their, the Government's or somebody else's convenience; they* are

*In India, a civil servant may be to-day a district officer, next year an assistant secretary in the E. H. L., next year he may be attached to the food department, then he may be a sugar controller, and ultimately may revert back as Commissioner for a division. It is quite unlike the way the civil servants are utilized in England. There they are attached to a particular department, say, currency, trade, or diplomatic service, and are allowed to have sufficient time and opportunity to gain expert knowledge of his subject. Even then, they have been found slow, evasive, and generally without any spirit of initiative, and as far as scientific departments are concerned, they have been replaced by professional scientists in all key-positions. It is completely overlooked in this country that we are living in a scientific-technical civilisation. Most departments of Government in these days have to deal primarily with matters requiring the knowledge of science and technology. But people in authority are more often than not quite innocent of such knowledge. Is it any wonder that under such conditions perfect chaos prevails?

seldom kept attached to the same department long enough to acquire sympathy with the department or proficiency in its handling. It is obvious that under such a hodgepodge system, no Central plan can be, or has been evolved for national development. The Hon'ble Members and their secretaries have been content merely to carry on, and have hardly shown any initiative, nay in certain cases, they have allowed the departments to fall into decay.

For example, the Botanical and Zoological Surveys of India, which have in the past done important work have been financially starved and depleted of officers for a number of years. On account of dearth of officers, and lack of funds, field work in these two subjects has been entirely stopped. They afford examples as to how important scientific activities can be starved under a department, with little or no interest in them. The Geological Survey is still active, and has been doing good work, but it is quite inadequately staffed for the enormous task it has still to accomplish.

Probably it has never occurred to the Hon'ble Members in charge of these surveys how important they are for the development of the country's resources. They have probably never heard how Soviet Russia mobilized 10,000 geologists, and were able to discover enormous resources in petroleum, coal, iron, and other minerals—development of which by the national research institutes has enabled Soviet Russia to defeat the German onslaught. Probably they have never heard of the epic work of the Russian plant collectors who at the end of the last War, collected plant specimens from all over Soviet Russia, South America and other parts of the world, and with the aid of supplementary laboratory researches developed new kinds of wheat, potatoes, fruits and other food crops congenial to the Russian soil and thus could maintain Russia's food-front at full-strength even during the present Global War.

If the Hon'ble Members had the slightest notion of the enormous potentialities of the surveys under them, they would not have allowed these to decay, as they have done.

Such neglect of science has occurred in other countries, but being forewarned, they have taken ample measures in advance. It has been found necessary in almost all countries to place all scientific departments, surveys and research institutes necessary for the development of the country's resources, industries and agriculture and for the ensurance of public health under one responsible member of the Central Government, and in course of the current war, the existing anachronisms have been ruthlessly wiped out. In the U.K., he is called the Lord President of the Council. He has no ordinary department under

him, and can devote all his time for planning and reconstruction. Usually public men having acquaintance with *science and industry* have been selected for this highly important post. During the last war, the post was held by the Earl of Balfour, himself an amateur scientist and an intimate friend of many scientists and a lover of science, and during the present war it has been held from 1940-1943 by Sir John Anderson who, though a civil servant, is a Ph.D. in Chemistry, and has wide acquaintance with science. The post is now held by Lord Woolton, an industrialist, and lately food minister. The practice of putting civil servants at the head of administration in scientific departments has been given up, and scientists of established reputation, and sometimes not having much experience of administration have been called up straight from their laboratories to take charge of the administration of the departments, with great success.

It may be objected that the effect of removing research from the direct control of the various departments under which it is now placed would cause some harm to the work of those departments. There is hardly any logic in such arguments as the scientific sections appear to have been attached to departments without any rhyme or reason, *e.g.*, Geological Survey to Labour. But though a temporary disturbance may be caused, the final result would be that research would be done in a far better manner, that the various branches of research would be brought into closer co-operation with one another, that gaps and weaknesses now apparent would be made good, and the Hon'ble Members and their secretaries would be relieved of a charge, which, as far as our information goes, they find rather boring.

It is not realized in this country that research cannot be tied up too directly to the solution of immediate practical problems; and those who were responsible, in the Departments, for tackling the practical problems, *e.g.*, the Public Health Commissioner, are not, in general, research men, but executive officers who would be enabled, by *ex-officio* membership of the various Boards and Committees, or by contact with the various Directors of Research, to obtain the scientific information they require and to give practical bias to the directions in which research would be undertaken.

When the National Institute for Medical Research in England was started in 1914, with Sir Walter Fletcher, F.R.S. as Secretary, there was a proposal to put it under the Ministry of Health; but Fletcher opposed the idea and had his own way, and it was placed under the Medical Research Council, under the Lord President. Nobody now doubts the wisdom of the step. The same practice is followed in the other research organizations. Nobody would

think of putting the National Physical Laboratory under the Board of Trade, the Geological Survey under the Ministry of Fuel and Power, the Food Investigation Board and its Laboratories under the Ministry of Food, the Radio Research Board and its establishments under the Post Office, or the Building Research Station under the Ministry of Town and Country Planning. There was a suggestion to put the Agricultural Research Council under the Ministry of Agriculture and Fisheries, but a much better solution was arrived at by setting up an Agricultural Improvement Council in that Ministry. It is difficult to see why the same general principle of bringing research under a single separate organization and of leaving the Departments to make their own arrangements for applying the results of research to the practical problems they have to face should not apply to India, by the creation of Development Boards which will consist of representatives of the Department of Planning and Development on the one hand and those of the relevant Departments on the other hand, as has been suggested by the National Institute of Sciences of India.

As a logical sequel to our first suggestion, we would propose that the scientific departments under the Hon'ble Member for Planning and Development should be constituted into the following boards:

- (1) Surveys of Natural Resources.
- (2) Scientific and Industrial Research.
- (3) Agricultural (including Animal Husbandry) Research.
- (4) Medical and Public Health Research.
- (5) Engineering (to deal with irrigation, soil river surveys for hydro-electric power generation, soil conservation, etc.). Other boards may be added if necessary.

Each Board should have, as Chairman, an eminent person, either a non-official scientist or a professional man in the field concerned. The members of the Board should be eminent and experienced scientific and professional men in their own fields. The executive work of each Board should be in the hands of an eminent scientific man. He should have direct access to the Hon'ble Member, and should be given the status of a Joint or additional Secretary of a department of the Government of India. Each Board should work through Research Committees.

Our next suggestion is that the Hon'ble Member for Planning and Development should try to secure the co-operation of all non-official scientific talents available in this country (formation of a brain trust) and should try to foster the growth and development of such talents at the source by a liberal system of research grants and research scholarships to the universities and other research institutes, and should

help to build permanent research schools on specialized lines in the universities (training of scientific and technical personnel).

In India unfortunately there exists a fundamental antagonism between the official and the non-official, the individual and the Government. Unofficial science has been, before the establishment of the B. S. I. R., I. C. A. R., largely ignored and neglected by the Government, and promising schools of research, under distinguished scientists, were allowed to fall into decay on account of lack of financial support.

This is very unfortunate, as unofficial science of a country and fundamental researches are the backbone of all its scientific work. The National Institute of Sciences, in its Delhi session at the beginning of this year, made some suggestions which can be summarized as follows:—

(1) That the unofficial scientists of India have little means of making their views heard and respected by the Government of India.

(2) That the large number of Academies and scientific societies which have been founded by Indian men of science and above all the National Institute of Sciences which is the most representative body of senior scientists are not usually consulted by the Government of India, and are not represented by their own right in advisory councils, or other bodies of scientific experts which are frequently appointed by the Government.

(3) That the total expenditure on scientific research in this country is extremely meagre. The National Institute of Sciences recommended that 10 per cent of the national income amounting to 5 to 6 crores of rupees should be spent annually on researches of all types, surveys, maintenance of research schools and institutes, etc.

We do not know whether the Government of India will agree to the suggestion of the N. I. S. to form a National Research Council on the American model which is equivalent to handing over a large amount of planning for research and of organizing research work to a non-official body of scientists. The proposals are neither impracticable nor utopian. As a matter of fact, the system is being actually followed with great success in the U. S. A., Japan and Canada, though in the last two countries there is much more of official representation than in the U. S. A. But the points of the N. I. S. can be met to some extent and should be met, if the organization of the new Department of Planning and Development is carried out on the lines suggested above. The adoption of the proper organization and proper guiding principles right at the formative stage can alone ensure the effectiveness of the new Department.

Our third suggestion is that proposals for establishment of national scientific laboratories and research institutes should not be allowed to be put in cold storage on the usual plea "*that may stand till the war is over*". This attitude, under which the Hon'ble Members have taken shelter to cover their own inefficiency and lack of enthusiasm for positive work, is prompted by the idea that the problems of the war can be separated from those of peace, that the wants and needs of the civil population have to be completely sacrificed to military exigencies. This attitude is diametrically opposed to that followed in England and other belligerent countries where the whole population, whether actually engaged in war-work or not has to be regarded as combatants. The attitude of the Indian rulers has led to such disasters as the Great Bengal Famine of 1943, the 360 per cent rise in prices, and may lead to further disasters if not corrected in time.

Here in India, we have been talking of National Physical, Chemical, Fuel, Metallurgical Laboratories, of a Glass and Silicate Research Institute for the past three years, and the talks have hardly taken us to a report stage. Nobody knows when these important laboratories will come into existence; meanwhile commercial missions camouflaged as scientific are imported to help India out of the chaos. Contrast with this the stand taken by Canada and Australia. When the war broke out, Australia was not manufacturing a *Chhatak* of glass not to speak of optical glass; but the rulers of Australia realized that glass, particularly optical glass, was a vital war-necessity, and the Australian Department of Scientific and Industrial Research mobilized all the available scientific and technical personnel, and aided by experts lent from England, started manufacturing optical glass within 14 months of the date when the project was launched. Now she is manufacturing all her peace and war time needs in glass. The Canadian Government started a Research Enterprise Ltd. under the National Canadian Council of Research, which have been able to complete plants for the manufacture of many essential commodities for which Canada had to depend formerly on U. S. A. and the U. K.

Why turn to Australia or Canada? Even in India, huge scientific laboratories in Physics, Chemistry, and Engineering complete with equipment, apparatus and workshops have been built in Cawnpore to deal with military problems in course of the last two years.

Nay, the conclusion is inevitable that the Hon'ble Members and the secretaries in charge of the scientific departments have shown little interests in the work of the research organizations under their control, and have allowed things to remain as they were. The 'cold storage' policy is a standing monument to the defects of the existing organization.

POST-WAR EDUCATIONAL SCHEME FOR INDIA

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THE magnitude of the problem of educational reconstruction in a country with 85 per cent of the population still illiterate need hardly be over-emphasized. The present system of education obtaining in India is hopelessly inadequate, disproportionately top-heavy and grossly wasteful of the nation's time, money and energy and does not satisfy even the very minimum educational needs as accepted in every civilized country. The weakness and insufficiency of her educational system have left their mark in every sphere of her activities, social, economic and political and have caused a permanent stumbling block in her progress. The solution of her problem of educational reconstruction, colossal as it is, requires, therefore, a careful and thorough planning, the execution of which will require so much money that it will frighten the Government and so much time that it will discourage even the most ardent and enthusiastic educationists and national leaders of the country. And yet these are the two fundamental requirements of the scheme for post-war educational development in India, envisaged in the report of the Central Advisory Board of Education, recently submitted to the Reconstruction Committee of the Viceroy's Executive Council. The scheme would require for its execution, as the estimate goes, an annual expenditure of Rs. 312.6 crores, when in full working order, of which the Government would be required to spend Rs. 277 crores, and a period of 40 years before the whole plan will be in action. But it should be borne in mind that in planning for such a national system of education, 'the Board's object throughout has not been to plan an ideal system of public instruction but rather to lay down the very minimum necessary to place India on an approximate level with other civilized communities.' As to the period of operation of the scheme, there is hardly any escape from this, as it is entirely a problem of building anew. The problem of education in India is not one of building on the existing structure, because, as the Board has rightly diagnosed, 'the present system does not provide the foundations on which an effective structure could be erected', and 'much of the present rambling edifice will have to be scrapped in order that something better may be substituted.'

While the Central Advisory Board's scheme for post-war educational development in this country is not certainly above criticism, and there may be disagreement on minor details and issues, the general

principles and the main educational structure laid down in the scheme will doubtless be found acceptable to all sections of Indian people, vitally interested in the educational uplift of the country. The problems and the proposed measures for reform have been discussed in the report under the following items, viz., (1) Basic (Primary and Middle) Education; (2) Pre-Primary Education; (3) High School Education; (4) University Education; (5) Technical, Commercial and Art Education; (6) Adult Education; (7) the Training of Teachers; (8) the Health of the School Child; (9) the Education of the Handicapped; (10) Recreative and Social Activities; (11) Employment Bureaus and (12) Administration.

The purpose of this article is to present to the reader the different stages of education contemplated in the scheme, through which the future children of the land should pass as they grow to manhood before they are in a position to enter professions suited to their training and attainments. The problems of adult education, the training of teachers, the health of the school children, recreative and social activities, etc., will not, however, be included within the scope of the present discussion for which the original report may be consulted.

The different stages of education will be best understood with reference to the adjoining chart (Fig. 1) prepared by the writer, which, although not complete in all respects, indicates sufficiently clearly the main features of the proposed stages.

PRE-PRIMARY EDUCATION (NURSERY SCHOOLS AND CLASSES).

The need for pre-primary education in this country has not been sufficiently realized, as is clearly evidenced from the utter lack of provision for the same in the present educational system. An efficient national system of education cannot afford to do without a liberal provision for pre-primary education to prepare children for compulsory basic education. Since the Board has recommended universal and compulsory education for all boys and girls between the ages of six and fourteen, pre-primary education refers to the education of children who have not attained the compulsory school age of six. The education during these formative years of the growing child should receive careful consideration and should aim at catering, among other things, to mental, physical and social needs. The importance

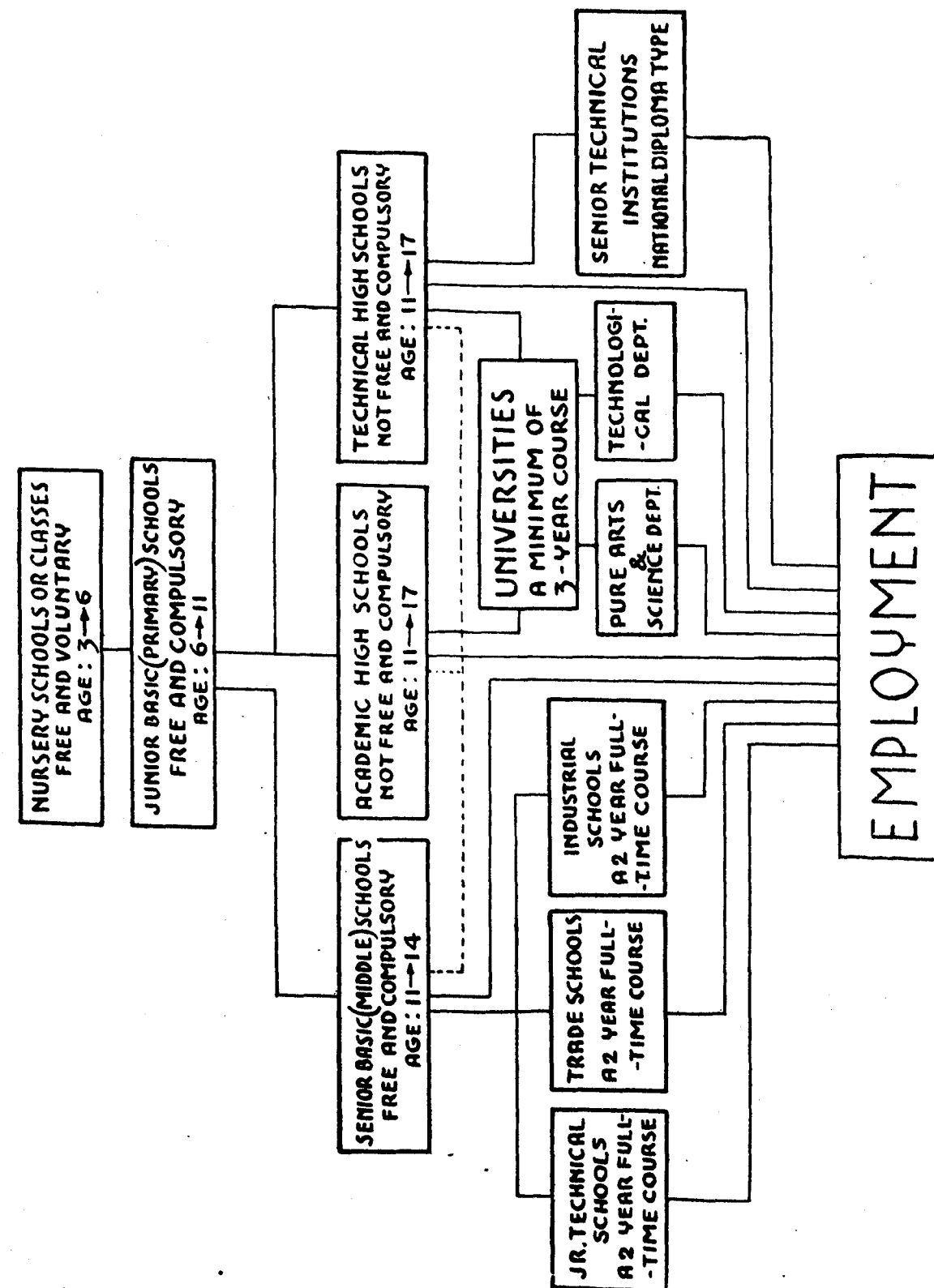


FIG. 1. Chart showing the Post-war Educational Scheme in India.

of nursery schools in urban and industrial areas where mothers go out on work has been specially emphasized. For these, sufficient number of nursery schools and nursery classes attached to the Junior Basic (Primary) Schools should be set up in urban and rural areas. The Board recommends that the nursery school age should be fixed at three to six. Attendance to nursery schools or classes should be voluntary, as in England, but the parents should be persuaded to send their children to receive this important stage of education. The organization of post-war education should secure that about 1 child in 7 attends nursery schools or classes, and on that basis arrangement should be made for 35,00,000 places. However, to start with the scheme it will be sufficient to provide for one-third the number, i.e., about 10,00,000 places. Pre-Primary education should be in all cases free and women teachers should be employed as a rule. The net cost for pre-primary education in full operation has been estimated at Rs. 3,18,40,000.

JUNIOR BASIC (PRIMARY) SCHOOLS.

A national system of education must recognize and make ample provisions for compulsory education which should be free and universal. The Board has laid all emphasis on this stage as a *prima facie* requirement in the proposed educational system. The case for introducing free, universal and compulsory education has been made out in the Board's report in the following fitting words: "In the first place, therefore, a national system can hardly be other than universal. Secondly, it must also be compulsory, if the grave wastage which exists today under a voluntary system is not to be perpetuated and even aggravated. And thirdly, if education is to be universal and compulsory, equity requires that it should be free and common sense demands that it should last long enough to secure its fundamental objective." Opinion is, however, divided on the question of the compulsory school age limits, but the age-range from six to fourteen i.e., a period of eight years, has been recommended in pursuance of the American and European pre-war practice of fixing the period for compulsory education at five or six to fourteen or fifteen.

The education received in this period has been termed "Basic Education" of which the Board has recognized two distinct stages, viz., (a) the Junior Basic stage and (b) the Senior Basic* stage. The need for such differentiation of the Basic Education arises principally out of two reasons; (1) at about the age of eleven or twelve, boys and girls step into adolescence with certain mental and physical changes

which require an adjustment both of the contents of the curriculum as well as of the methods of teaching; (2) a certain stage should be fixed at which capable boys and girls may be diverted to the high schools. Accordingly the age-range of pupils receiving Junior Basic (Primary) education has been decided to be from 6 to 11. The provision for this stage of education will be made in the Junior Basic Schools where boys and girls of all ages between 6 and 11 will be accommodated. On completion of the course prescribed for Junior Basic Schools the majority of the pupils, both boys and girls (80 per cent) will proceed to the Senior Basic (Middle) Schools, while the remaining 20 per cent of pupils who show greater capability and promise will be admitted to the High Schools. This has been clearly indicated in the chart. Under no circumstances will a boy's or a girl's education be allowed to terminate at the Junior Basic stage where a pupil is not expected to learn enough to ensure the minimum preparation for life, far less for citizenship. For late bloomers, i.e., those who show promise later (i.e., after 11), there is provision for transfer to High Schools at 13.

The number of pupils of age-groups between 6 to 11 at the Junior Basic Schools has been estimated at 3,60,00,000, according to the statistics provided by the Public Health Commissioner's Report (1940). This would require about 12,00,000 teachers, of which three-fifths should be preferably women, on the basis of one teacher per 30 pupils. Vernacular should be the medium of instruction. English as an optional subject in the Basic Schools should be eliminated; but replaced by a common language, such as Hindustani. The total gross expenditure per annum for Junior Basic Education, when in full operation, has been estimated at Rs. 114,29,00,000.

SENIOR BASIC (MIDDLE) SCHOOLS.

As already pointed out, 80 per cent or four-fifths of the pupils leaving Junior Basic Schools will proceed to the Senior Basic Schools to complete the remaining three years of their period of free and compulsory education. In view of the fact that the school education of the large population of the future citizens of India will come to an end on completion of the course provided in the Senior Basic Schools, the education in the Middle Schools should be carefully planned and devised so that it may be sufficiently complete in itself. The pupil leaving the Senior Basic School should be prepared to enter into professions and take his place in the community as a worker and as a future citizen. The demand for the great mass of semi-skilled and unskilled labour in agriculture as well as in industry will generally be met by these pupils. It is, moreover, suggested that

* Some have suggested 'Primary' for Junior Basic and 'Middle' for Senior Basic.

as the agricultural needs must always remain by far the most important factor in India's economy the Senior Basic Schools in rural areas should have an agricultural bias.

As already noted, among the pupils attending the Senior Basic Schools there may be cases of late development of proficiency, and as such their claim to be admitted to the High Schools from the Middle Schools has also been given due consideration (indicated by the broken line in the chart). A small percentage of the Middle School leavers seeking further training for better employment may proceed to Junior Technical, Trade or Industrial Schools whose function and scope will appear in what follows. The Senior Basic Schools will be required to look after about 156,00,000 pupils and the services of about 6,00,000 teachers, of which half should be women, will be necessary. The total annual cost has been estimated at Rs. 86,50,00,000.

JUNIOR TECHNICAL, TRADE AND INDUSTRIAL SCHOOLS

Organized industry requires a steady supply of trained and semi-skilled craftsmen. In the Senior Basic Schools the pupils will learn only the rudiments of craft work. To acquire the necessary skill further training is essential. Hence the necessity of such schools as the Junior Technical, Trade and Industrial Schools to which pupils aspiring for better vocation in life may proceed for further training in various crafts, after completing the Senior Basic education. Education in such schools will be voluntary and not free, though the State will be required to provide adequate grants. A provision for 2,00,000 places in these schools has been suggested.

HIGH SCHOOLS

Adequate provision for higher and more thorough education for those who are much above the average level in capabilities has been recognized in every civilized country. The High Schools represent the first stage in an educational system where the process of selection of the cream of future citizens of a country begins. In planning for a nation's minimum educational needs, High School education cannot be made compulsory if only for financial reasons and has to be restricted to the few more capable who are expected to make the most of it. If the experience of other countries is to be depended upon, the choice should fall on one out of every four or five pupils leaving Junior Basic Schools, and accordingly the Board has recommended the diversion of 20 per cent of the Primary School leavers to High Schools. At first it will not be possible to make High School education free, though desirable; but adequate financial

measures should be provided to enable poor but capable pupils to derive the full benefit of High School education. The total number of places to be arranged for in the High Schools on the above selection basis has been calculated to be 72,52,920, boys and girls taken together, which would require about 3,62,640 teachers (one teacher per 20 pupils). The net annual cost of High School system, which the Government will be called upon to bear, has been calculated on the basis that only 50 per cent of the students will produce fees (Rs. 6/- per mensem) amounting to 30 per cent of the gross expenditure and that private grants will produce another 5 per cent. It will roughly amount to Rs. 50 crores. Total gross expenditure per annum will, however, amount to about Rs. 79 crores. It is to be noted that the admission of the pupils failing to attend the required standard of proficiency to the High Schools, though discouraged in the nation's interest, will not be made impossible if their parents are prepared to defray all of their educational expenses. Here we may do well to glance at the Table I,* showing the age-range, number of pupils and teachers, average salary of teacher, total gross cost etc., for the Primary, Middle and High Schools.

The period of High School education, according to the recommendation of the Board, will be 6 years from the age of 11 to 17. Here again, as in the Senior Basic Schools, the majority of pupils will finish their career as students on completing the six year course and will seek employment. So High School education should be more or less complete in itself and should not be looked upon merely as a preliminary to University education as it is now being done erroneously. At the same time the fact that the flow of the most able pupils to the Universities will take place from the High Schools should not be lost sight of. In view of the Board's recommendation in favour of the abolition of the Intermediate stage from the University education, the present first year course will be included into the High School course. The High School education will be divided into junior and senior departments to facilitate the transfer of students from the Senior Basic to the High Schools. The High Schools should be of two main types, (a) the Academic High Schools and (b) the Technical High Schools. The transfer of students from the Academic to Technical High Schools and vice versa will also be made possible. The scope and function of these two types of schools will now be briefly treated in two separate sections.

* Taken from Mr John Sargent's paper on 'The Practical Aspect of Educational Reconstruction', being his presidential address for the Section of Psychology and Educational Science at the 31st Session of the Indian Science Congress, 1944.

(a) THE ACADEMIC HIGH SCHOOLS

The main object of the Academic High Schools will be to impart education in the arts and pure sciences. The following subjects have been recommended to be included in the curriculum, viz., the Mother Tongue, English, History (Indian and World), Geography (Indian and World), Mathematics, Science (Physics, Chemistry, Biology, Physiology and Hygiene), Economics, Agriculture, Civics, Art, Music, and Physical Training. On leaving the Academic High Schools, the student will generally enter into professions, and only a small fraction, say one in every fifteen pupils, will proceed to the Universities for higher studies. Students from the Academic High Schools will, however, be accommodated in the departments of Pure Arts and Science. All these are indicated in the chart.

TABLE I

	Age range	*Estimated No. of pupils (lakhs)	†No. of teachers required	‡Average salary per teacher per mensem	§ Total salary bill per annum (lakhs)	Other expenditure (lakhs)	Total gross cost per annum (Lakhs)	Cost per pupil per annum
	1	2	3	4	5	6	7	8
Primary Schools ..	6-11	3.60	12,00,000	Rs. 42-8	Rs. 80,00	Rs. 34,29	Rs. 114,29	Rs. 31-84
Middle Schools ..	11-14	1.56	6,00,000	Rs. 61-8	Rs. 60,55	Rs. 25,95	Rs. 86,50	Rs. 55-31
High Schools ..	11-17	72	3,60,000	½ at Rs. 61-8 ½ at Rs. 120-0	Rs. 18,69 Rs. 36,47	Rs. 23,64	Rs. 78,80	Rs. 109-44
		5.88	21,60,000		Rs. 195,71	Rs. 83,88	Rs. 279,59	

(b) THE TECHNICAL HIGH SCHOOLS

Technical Education represents the most important aspect of a national system of education in this age of industry and technology. Hitherto, there has been little or no development of this phase of education. This is not to be wondered at if the industrial backwardness of India be considered. In fact, the Board has attributed it to the limited number of openings available in industry, to the practice of filling the more remunerative posts with imported technicians and to the disinclination of the young Indians of the middle and upper classes to enter into

pansion of industry, though its extent is yet unpredictable, under pressure of events in India and abroad requiring an ever increasing number of trained personnel. The plan for a comprehensive system of technical education should be worked out and made ready while the guns are still thundering. The strong emphasis which the Board has laid on technical education in the scheme for post-war educational development has been, therefore, most welcome. The scheme is largely based on the report of Messrs Abbott and Wood, the two British experts on technical education, who visited this country in 1936-37, surveyed the position of India with regard to techni-

* The estimate is based on Public Health Commissioner's Report of 1940. Of the 11-14 age group four-fifths are shown in Middle Schools, one-fifth in the middle section of High Schools.

† One teacher to 30 pupils in Primary Schools, one to 25 in Middle Schools, one to 20 in High Schools.

‡ Average salary on the basic scales in accordance with Government's actuarial calculation.

§ Additions have been made for head teachers, higher scales in urban areas, house allowances, Government contribution to pensions or provident funds, etc. Teachers' salaries are taken as accounting for 70 per cent of the total gross cost.

|| This includes expenditure on (a) loan charges, (b) special services, including school medical service, special schools, etc., (c) administration, (d) books, stationery, apparatus and equipment, (e) maintenance and repair of buildings and furniture and miscellaneous charges. Other expenditure is taken as accounting for 30 per cent. of the total gross cost.

cal education and submitted a very valuable report which was published some years ago. Speaking of the necessity of technical education Mr Abbott remarked :

"No country can initiate and carry on industries on a large scale, unless it has an adequate supply of men specially trained for the direction and management of large industrial concerns as well as of others qualified for the minor but very important supervisory posts in them. On the other hand it cannot be expected that capable and ambitious men will devote themselves to acquiring this special knowledge and skill unless they see a reasonable prospect of exercising it and gaining a decent livelihood thereby."

Significant as the remark is, particular attention should be drawn to its latter part which is suggestive of the high status the technical education should enjoy in the community.

The primary function of technical education will be to meet the needs of industry and commerce for (1) skilled craftsmen, (2) intelligent executives, foremen, charge hands, etc. and (3) research workers. Technical education should on no account be regarded inferior to the academic type of education, and while students must be taught to be practical, their interest in academic subjects should also be maintained to a reasonable extent.

The Technical High Schools, to which reference has already been made, represent the most important stage of technical education in the proposed scheme. On completing the course in the Junior Basic Schools, capable pupils liking technical subjects or aspiring for technical occupations later in life may proceed to such schools where, as in Academic High School, a six-year course will be provided. The Board recommends that wherever circumstances permit, polytechnics should be preferred to monotecnics. The following subjects will be taught in the Technical High Schools : (1) the Mother Tongue (2) English, (3) Modern Languages, (4) History (Indian and World), (5) Geography (Indian and World), (6) Mathematics, (7) Physics, (8) Chemistry, (9) Biology, (10) Economics, (11) Technical subjects (wood and metal work, elementary engineering, measured drawing, etc.), (12) Commerce (book-keeping, shorthand, type-writing, accountancy, commercial practice, etc.), (13) Agriculture, (14) Art (including designs for industrial and commercial purposes), (15) Music and (16) Physical Training. The total number of places for which arrangement should be made in Technical High Schools has not been clearly indicated, though the total number of places in the High Schools, both types considered, has been estimated at about 72.53 lakhs. This will largely be determined by the demand and growth of Indian industries in future.

Many will complete their educational career at the Technical High Schools like those proceeding to Academic High Schools or Senior Basic Schools and will seek employment. Demand for skilled craftsmen

in industry will be met generally by Technical High School pupils. The more ambitious and capable pupils may, however, proceed to Senior Technical Institutions or to the technological department of the Universities for higher studies.

SENIOR TECHNICAL INSTITUTIONS

A full-time course of the National Diploma type will be provided in these institutions. The first diploma course will cover a period of 3 years. Successful pupils may prepare for another two-year full-time advanced diploma course. Students receiving such higher technical course will be eligible for the important posts of minor executives, foremen, charge-hands, etc. Creation of about 75,000 places in Senior Technical Institutions has been recommended.

UNIVERSITIES

The Board has made a scathing criticism of the university education obtained in this country at present. The alarming number of unemployed graduates, the large number of failures in the University examinations, unrestricted admission of students to the University classes etc. points unmistakably to the urgent need of a thorough reorganization of University education in India. The report reveals that only a limited number, say 30 per cent of the graduates, is absorbed in employment of a type commensurate with their attainments or with the time and money spent on such education. The percentage of failures at the B.A. and B.Sc. examinations of all the British Indian Universities in 1940-41 has been calculated to be 46 per cent. Such high percentage of failure is unique and characteristic of Indian Universities and is nowhere to be found outside India. This is largely the outcome of unrestricted admission without any consideration of the ability of the students for higher education. It has been found that, if Intermediate students are included in the University, one in three or, if they are not included, one in five of the High School leavers goes to University. In England, Germany and the United States one out of seven High School pupils seeks admission to Universities. The ill-conceived examination system is also no less responsible. The passing of the examination is more a matter of chance than of real education and scholarship. Speaking of the Universities, Mr. Sargent remarked that 'their examination system does not encourage original thinking and real scholarship and that their general organization does not secure that close personal contact between students and teachers from which greatest benefits of University life are usually derived.'

However, this high admission may create the wrong impression that Indian Universities are highly

developed and that their number is more than sufficient for this country. The illusion will, however, disappear if these statistics are judged against the background of the entire population of India. Thus before the war, the proportion of University students to the total population was 1 to 690 in Germany, 1 to 837 in Great Britain, 1 to 225 in the United States, 1 to 300 in Russia, and 1 to 2,206 in India. Again, while there are 12 Universities in England for a population of 41 millions and 13 in Canada for a population of 8½ millions, there are only 18 Universities in India for a population of 400 millions. Thus here in the University education also, India finds herself the most backward of all principal countries of the world. The high proportion of students in Indian Universities as compared to the school-going population indicates, as the Board has pointed out, that the super structure of the educational system was allowed to develop before the main edifice could be erected on broad and sound foundations.

In view of these drawbacks and difficulties, the Board has suggested that admission to Universities should be carefully controlled by introducing a proper selection basis, whereby only the students with reasonable promise may be given the scope of University education. For this purpose, it is proposed to introduce a standard of proficiency which at least one out of fifteen High School leavers may be expected to attain. On this basis, the Universities will be called upon to admit annually about 74,000 matriculates.

The next recommendation concerns the abolition of the present intermediate stage. Intermediate classes are now provided in many Indian Universities, but the students completing this stage are neither regarded as under-graduates, nor are they given any special consideration at the time of appointment. Further the course now followed does not also mark any definite stage of education. Some years back the C. A. B., the Inter-University Board and some other bodies suggested reorganization of the University education by abolishing the Intermediate stage. The Board now approves of this recommendation and accordingly suggests a three-year degree course as the minimum duration of a University course of study—a practice which is being successfully followed by European and American Universities.

Granting, therefore, that about one out of fifteen High School leavers should prosecute further studies in the Universities and that Universities should make provisions for a three-year degree course, post-graduate classes and adequate research work, it has been calculated that about 2,40,000 places will be needed in Universities throughout British India. At

present there are about 1,21,484 students in all stages in the University course so that the proposed expansion of Indian universities should be sufficient to handle successfully double the existing number. The total annual cost, on the basis that Rs. 400/- will have to be spent on each student (excluding maintenance), has been estimated at Rs. 9,60,00,000. 30 per cent of this expenditure will be realized from tuition fees (only half the number will produce tuition fees) and private grants, leaving the Government to provide 70 per cent of the total expenditure, i.e., Rs. 6,72,00,000 annually, from public fund.

FINANCING THE SCHEME

Any discussion of the post-war educational scheme will be incomplete without any reference to

TABLE 2

	Estimated gross annual expenditure	Estimated income from sources other than public funds	Estimated net expenditure to be met from public funds
	Rs. in lakhs	Rs. in lakhs	Rs. in lakhs
1. Basic (Primary and Middle) Education	200.00	—	200.00
2. Pre-Primary Education	3.20	—	3.20
3. High School Education	79.00	29.00	50.00
4. University Education	9.60	2.90	6.70
5. Technical, Commercial and Art Education	10.00	2.00	8.00
6. Adult Education	3.00	—	3.00
7. Training of Teachers	6.20	1.70	4.50
8. School Medical Service*	—	—	—
9. Education of the Handicapped*	—	—	—
10. Recreative and Social Activities	1.00	—	1.00
11. Employment Bureaux†	60	—	60
12. Administration‡	—	—	—
Total ..	312.60	35.60	277.00

* An amount equal to 10 per cent of the gross expenditure at the appropriate stages has been provided to meet the cost of the School Medical Service and Education of the Handicapped.

† Special provision has been made for this service in the beginning; ultimately it should be absorbed in Administration.

‡ Provision to cover the cost of Administration has been included at all stages. It is assumed that this will approximate to 5 per cent of the gross expenditure.

the financial issues involved in implementing the scheme. While dealing with the different stages of the educational structure, we have already quoted figures of annual expenditure for each stage. The adjoining table [Table 2] containing the estimated annual cost of the various branches of education, when in full working order, including those not discussed in this article, will be useful. These figures have, however, been worked out on pre-war standards and are liable to modification in the event of any future change in the standard of living or increase in population, whose extent is at present unpredictable.

Thus we find that the Government will be required to spend annually about Rs. 277 crores, when the scheme is in full working order. The extent of the educational development which the scheme seeks to introduce in the post-war period will now be apparent from the fact that the present total expenditure on education, so far as the figures for the year 1940-41 go, amounts to about Rs. 30 crores, of which about Rs. 17½ crores come from public funds. The scheme will be gradually introduced in the form of eight five year plans covering a period of 40 years and the peak gross expenditure of Rs. 312 crores will not be reached until the 40th year after its introduction. The incidence of the increased cost of education as the five year programmes are successively introduced has been roughly calculated and is indicated as follows:—

5th year	...	Rs. 10,00 lakhs.
10th year	...	Rs. 23,80 "
15th year	...	Rs. 37,40 "
20th year	...	Rs. 61,45 "
25th year	...	Rs. 106,00 "
30th year	...	Rs. 165,00 "
35th year	...	Rs. 250,00 "
40th year	...	Rs. 312,00 "

The main activities during the first five years will be in the direction of planning, propaganda, training of teachers, administration and organization of personnel. The required number of schools and colleges in different areas will also be established during this period. The remaining seven five-year programmes will be devoted to the actual carrying out of the scheme.

It is to be noted that a very large percentage of the estimated gross annual expenditure accounts for teachers' salary. Let us only consider the Primary, Middle and the High School education. Largest amounts of expenditure are involved in these three stages of education, whose combined gross annual expenditure has been estimated at about Rs. 279 crores out of the total expenditure of Rs. 312 crores.

As indicated in Table I, Rs. 196 crores, i.e., about 70 per cent. of this expenditure, will account for the payment of the teachers' salary bill. This sum by no means represents a very liberal financial provision for the teachers who are at present hopelessly ill-paid, as the detailed statement of the teachers' grade in different stages of education (Table 3)

TABLE 3

Schools	Classification of Teachers	Scale per mensem*
Junior Basic (Primary) Schools (including Infants & Nursery Schools)	Assistant Teachers ..	Rs. 3-1-35-3 (biennially) 750 p.m.
	Head Teachers of schools having (a) 1 or 2 class section	Rs. 10 above scale for assistants.
	(b) 3, 4 or 5 class section	Rs. 50-4-70.
Senior Basic (Middle) Schools (Vernacular and Anglo-Vernacular)	(c) 5 or 6 to 8 or 10 class section	Rs. 60-4-80
	Assistant Teachers ..	Rs. 40-2-80
	Head Teachers of schools having (a) 3 or 4 class section	Rs. 80-4-100
High Schools	(b) 4 or 5 to 6 or 8 class section	Rs. 90-4-110
	(c) Over 6 or 8 class section	Rs. 100-4-130
	Non-graduate Teachers	Rs. 40-2-80
	Graduate Trained Teachers	Rs. 70-5-150
	Head Masters and Head Mistresses of schools up to 250 pupils on roll	Rs. 175-10-255
	Up to 500 pupils on roll	Rs. 250-10-350
	Of over 500 pupils on roll	Rs. 350-15-500

clearly indicates. The Board has rightly realized that the success of the national system of education depends entirely on the availability of the right type of teachers. Unless the pay and the status of the teachers are reasonably improved, it is futile to expect right type of men, with proper training and attainments to join the teaching profession which is now

- * (1) Same scale for men and women.
 (2) Teachers of village schools should have free house. Where this is not possible 10 per cent. should be added to their salaries.
 (3) This scale which has been framed for what may be described as normal rural areas may be increased up to 50 per cent. to meet the needs of areas where the cost of living or other factors necessitate a more generous scale.

scarcely regarded as a service of any real public importance. Even after setting forth the scales, as enumerated in the table, the Board has expressed doubts whether such a salary scheme is attractive enough to secure the services of men and women with real teaching abilities.

The Board has suggested that this increased cost of education has to be met out of current revenues. This means a pressure on revenue which can only be reduced by simultaneously adopting a plan of industrialization of this country. With the return of peace, a large fraction of the sum now spent on defense can and should be diverted to finance the scheme. Further, during the initial period, recourse should be had to loan. These suggestions for solving the financial difficulties have been summarized as follows:—

"In regard to the large financial issues raised by these proposals the Board realize that the cost of education like that of other essential services must ultimately be met out of current revenues and that this will not be possible unless the taxable capacity of the country is increased many times. For this they can only look to an all-out development of the national resources through a rational expansion of industry on the one hand and the improvement of agriculture on the other. They believe, however, that neither of these will be possible without a wider extension of educational facilities and the spread of enlightenment and expert knowledge which this will promote. Indeed they are convinced that the development of India's economic resources and the expansion of her social services are inseparably connected and must proceed side by side. To enable a start to be made some risk, perhaps even a great risk, must be taken and the Board recommend that for this purpose the early stages of development will have to be financed out of loan or out of such capital balances as may be available. In no other way can a vicious circle be broken. It is true that some diversion to the social services of sums now devoted to defence may be possible in the post-war period and there is reason to believe that a Government prepared to face difficulties might succeed in releasing for these services substantial sums now in the possession of religious bodies after fully safeguarding the legitimate claims of the bodies concerned."

This financial issue has, however, proved disquieting to many; but this is inevitable and unavoidable. For a national system of education

planned on an All-India basis to meet the educational needs of four hundred million people, the estimated expenditure is far from liberal. Then again it has been a planning not for the attainment of the highest educational level, but for the securing of the very minimum educational needs as recognized in any civilized country of the world. If this sum appears colossal, it is because India has so far spent little or nothing on education. India's present expenditure for war effort is far more colossal. Her poverty and economic condition can hardly allow her to undertake such a vast expenditure for a cause whose issues distantly affect India, if at all. But there has been so far no difficulty in securing this money and it has flowed in any amount from the Government exchequer. India's poverty has not proved any bar to this flow. Fighting the evils of mass illiteracy in India is no less important, if not greater, than fighting the Axis enemy. The money required to execute the scheme for post-war educational development can be secured without difficulty if the Government has the will to do it. It is over the question of this will that grave doubts have been expressed. In a leading article in *SCIENCE AND CULTURE*, April 1944, it has been rightly recognized that "a national system of education can be built up only by a free National Government". India is neither free, nor is governed by a National Government. This is the main obstacle in the way of implementing the scheme which has ultimately every chance of being no more useful than a mere decoration for the archives of the Imperial Secretariat.

There is a Chinese saying:

"If you are planning for one year, plant grain;
 If you are planning for ten years, plant trees;
 If you are planning for a hundred years, plant men."

Trees may mature more slowly and men more quickly in India than in China but the moral applies to both. (*Report by the Central Advisory Board of Education*)

PLANNING FOR THE DAMODAR VALLEY

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READERS of SCIENCE AND CULTURE are aware of the problems of the Damodar river basin from the various articles which have appeared from time to time¹, and also from articles appearing in the daily press. To evolve proper measures for a radical solution of a problem of this type requires intensive study, and investigation by a large scientific and engineering staff. In the case of the Damodar, a large amount of such material already exists, of which the most important one is comprised in the report of Mr E. L. Glass. From this, and other materials and from a close study of the measures adopted in other countries, particularly the U.S.A. within the last few decades^{2,3}, we have tried to evolve a tentative scheme for the solution of the Damodar problems which we present to our readers, and to the public. The plan requires elucidation on many points and we have indicated what further work will be needed to bring it to perfection. But in spite of these shortcomings we have no doubt in our mind that the general outline is correct and may form the basis of far-reaching constructive work.

Though it is only the people of Bihar and Bengal who are directly concerned in this problem, our studies should prove of interest to the whole of India. Human life in India, from times immemorial, have developed in the valleys of the great rivers which have served as natural highways, as arteries for supply of water essential for agriculture and other essential human purposes. But for ages past, rivers have been interfered with in an unscientific way by different parties, producing very injurious effects on agriculture, public health and river communications. But modern scientific developments have enabled the advanced countries of the West and America not only to retard such evil effects, but to develop the rivers to the fullest extent for the above purposes and further to develop hydro-electric power, wherever possible, and thus enhance the nation's industrial capacity.

Huge reclamation works of such type have been undertaken and completed particularly in Soviet Russia and America, and one of the best known example is the Tennessee Valley reclamation scheme.³ The underlying idea is to take the whole river valley as one unit, and explore the fullest possibilities of the river system for purposes of agriculture, naviga-

tion and power-generation, and then take wholesale measures for reclamation.

In India, unfortunately, this unitary point of view has not been accepted, and the fullest possibilities of not a single river system has yet been completely explored. Piecemeal measures have been undertaken, with sometimes very disastrous results. Generally, but not always, irrigation has improved, but public health and communications have been impaired. No river has yet been fully explored from the standpoint of hydro-electric power development and use of this power for industrial purpose. It is time that we clearly comprehend the possibilities. In our studies we have tried to show that it is possible to treat the Damodar river basin, at no great cost, to full measures of planned reclamation, and thus convert a destructive river system into a beneficial agency, producing large amount of electrical power, ensuring water for irrigation and flushing of the lower basins throughout the year, removing the eternal menace to rail and road communication, and guaranteeing public health. *Nature, vested interests and thoughtless managements made a once prosperous valley a wilderness, but Nature, Man and Science can again make it a smiling garden.*

The source of trouble comes out of the mal-distribution of water,—the rainfall coming in abrupt surges and lasting only for a short period in the year during the monsoon months. The solution of the problem lies in scientific storage and adequate management and distribution of the water resources of the basin, combined with land reclamation measures.

The mean annual precipitation in the Damodar catchment (upper and lower) is, according to Mr Glass, 24 million acre-ft.* in normal years of water which is 1/5 the corresponding amount in the Tennessee Valley. Of this amount 19 million acre ft. is precipitated in the upper reaches where the run-off is large. According to Mr Glass the run-off may vary in this region from 55 to 85 per cent. of the precipitation. In the lower valley which comprises the low flat alluvial soil of Bengal, the run-off may be as low as 15 to 20 per cent. If we take 50 per cent. as the mean run-off for the upper valley, it

* 23 Acre ft. = 1 million cu. ft.

would not probably be a high estimate. We may therefore suppose that about 9.5 million acre ft. of water reaches the two rivers Damodar and Barakar, in the approximate ratio of 3:2 (Selection p. 40). If this amount of water be averaged throughout the year, it will give us a flow of 14,000 cusecs at Raniganj due to the precipitation in the upper valley.

The flow is however very unevenly distributed. The average flow during the five rainy months (from middle of June to middle of November) is some 30,000 cusecs; for the remaining seven months, the average is about 1600 cusecs. The actual flow, it is well known, is extremely fluctuating and during the major part of the dry season, the river is almost dry. It is obvious that if a large percentage of the total run-off water is detained by dams the fluctuations can be smoothed off and a large even flow can be attained, as will be shown, for the greater part of the year.

We can also easily see that we have vast resources in power which now rolls down the river doing no useful work, but only occasional large scale mischief. The river descends from a height of 2000 ft. at the source to 285 ft. at Raniganj. Almost the whole of the descent can be utilised for the production of electrical power if a number of storage dams are erected at suitable sites on the main rivers and their tributaries.

Let us now calculate roughly the average amount of energy which the river dissipates in course of its descent from the hills to the sea. It is obviously an extremely difficult task. The river descends from a height of 2000 ft. to 285 ft. at Raniganj. We shall not be far wrong if we take the average utilizable descent to be 300 ft. for power generation, though it appears to the writers that the figure may be as large as 400 ft. A simple calculation shows that in the former case the total energy dissipated is nearly 3000 million kwh. (units), in the latter case 4000 million kwh. This is about 1/5 of the potential energy of the Tennessee River minus its affluents. In the calculation for the Damodar, all affluents excepting the Barakar have been left out, as there are practically no data about them. We shall presently see that about one-third of the river energy can be tapped, i.e., about 1000 to 1200 million kwh. can be actually harnessed, and many suitable dam sites are available on the main rivers and their tributaries.

Whether for flood retardation, water control or power production, the core of the constructive work lies in the erection of a series of dams in the upper Damodar and Barakar regions, and a series of barrages in the lower reaches for distribution of water for irrigation and flushing. The plan for the multipurpose dams are indicated in the diagram (Fig. 1), which we now proceed to explain. The

dams should be designed for flood-detention, irrigation, generation of hydro-electric power, and possibly also for navigation on, at least, a certain stretch of its length. There are references in the old records of the Calcutta Port-Commissioners, in the reports of the early coal miners, that the Damodar was navigable from its mouth up to the Raniganj area, and coal used to be transported to Calcutta in barges in the pre-railway days. Picture of ruins of the old wharves in the coal area are given in the Geological publications (see Fig. 2). But unfortunately no details are to be found anywhere as to the size of the barges, minimum draft and the season during which the river was navigable. At the present times the river stage is so low during the dry months that navigation is impossible, while during monsoons the stream is too furious to permit safe navigation.

The construction of dams on the Damodar river and its tributaries like the Barakar, Usri and others was suggested by Lt. Garnault as early as 1863 for the mitigation of the annual flood of the river. More detailed survey was undertaken by Mr Horn, Superintending Engineer, in 1901. After the devastating flood of 1913, first Mr B. L. Subarwal, then Mr Addams-Williams and later Mr E. L. Glass were deputed to recommend fuller remedial measures, after a scientific study of the problem. The results of these studies were presented in the form of four volumes of reports. Volume IV, and henceforward called the Glass Report, contains a summary and discussion of the recommendations, others contain tables and charts. We have drawn freely from these reports, and practically all our technical informations have been obtained from them.

Mr Glass, after survey, recommended the construction of flood detention dams on the main river and its tributaries. A large number of dam sites were surveyed, the details of which are summarised below. We shall consider the sites in two broad divisions, the Upper Damodar river and the tributaries, which lies above the confluence of the Barakar river. The other on the Barakar river and its tributaries. The map of the region is shown in fig. 4.

DAM SITES ON THE DAMODAR SYSTEM

1. *Parjori Site.*—The most promising dam site on the Upper Damodar River is found near the village of Parjori which is 50 miles above the confluence of Damodar and Barakar, and 5 miles below the Jamunia mouth on the Damodar. This site commands a catchment area of 3,000 sq. miles which includes all the important tributaries except the Gowai river. The bed consists of thick layers of rock suitable for dam foundation, sluices and spillways.

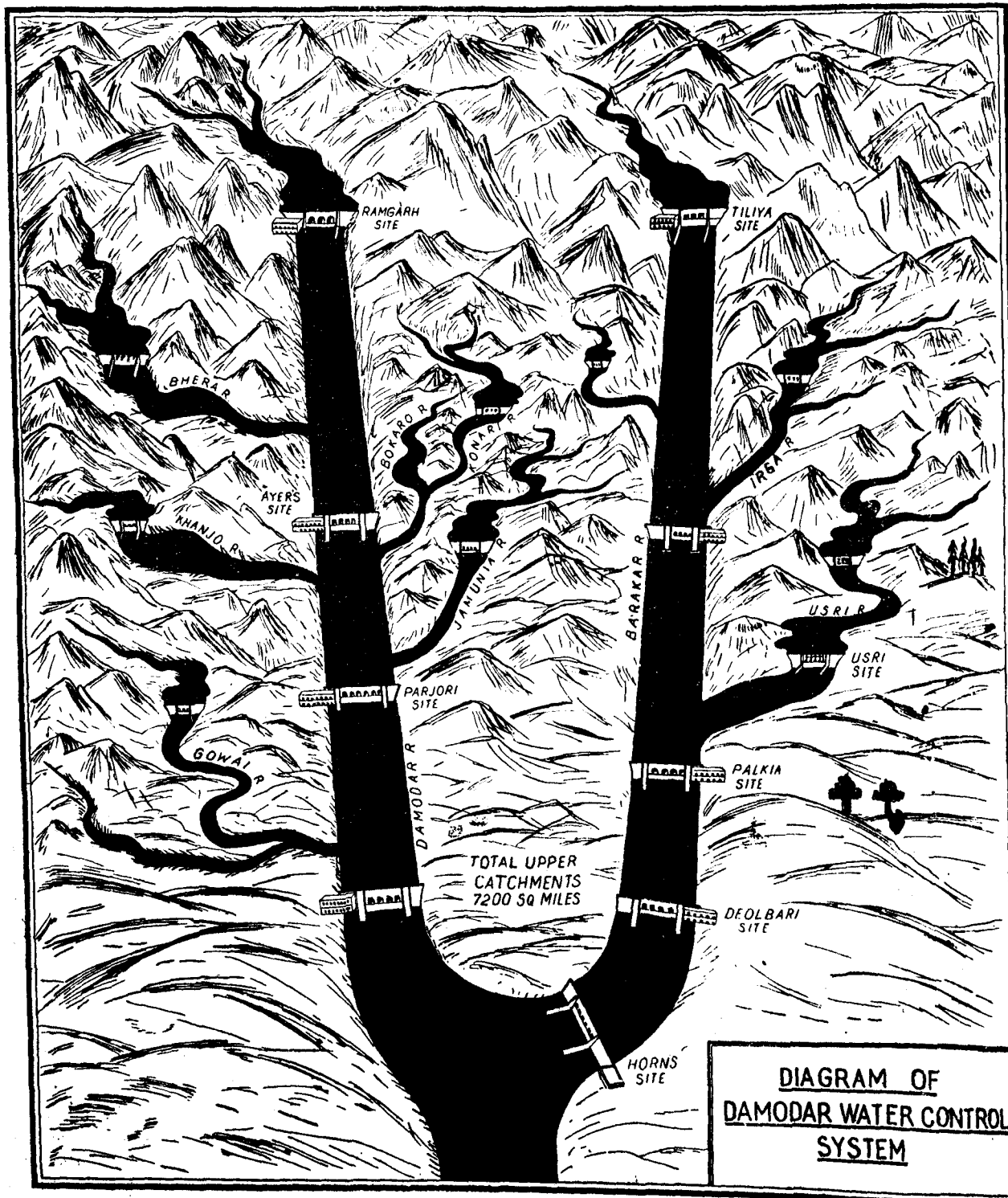


FIG. 1. Damodar Water Control System (Schematic) showing how the Dams should be constructed to conserve water resources for the purposes of adequate distribution and hydro-electric power generation.

The proposed 110 ft. high Parjori dam on the Damodar river will head up the reservoir water in the Jamunia also, but will not affect the railway bridge even at the full reservoir strength and although a small area on the western edge of the Jharia coalfield will be touched at high floods, no working pitheads will be submerged. The proposed reservoir will have a storage capacity of 15,000 m.c. ft. or 0.345 million acre ft.

It may be remembered that objection was raised by the Mining Association against the project of the construction of flood dam at Parjori (by Mr E. L. Glass in 1919) on the Upper Damodar river on the apprehension that there might be seepage of water along the faults or fractures in the rock bed at the reservoir site and might affect the working in the Jharia coal fields. Dr C. S. Fox (now Sir), of the Geological Survey, investigated the project in 1919 and was then of the same opinion as that of the Mining Association, but his opinion was not assertive to any great extent. But he has now completely changed his opinion.

"But since 1919, the Jharia coal field had been carefully re-surveyed (1926-29) and the geological structure of the coal field is now fairly accurately known and Dr Fox is of the opinion that there is little danger of such leakage into the mines. The only objection to the scheme was thus removed."

"It must be mentioned that the structure of the Jharia coal field was not fully known in 1919, and that as a result of his own (Dr Fox's) detailed geological survey of this coal field between 1926-29 he was able to say with confidence that due to the presence of dolerite dykes, which will act as underground groynes, and to the Dungri fault, which will draw off percolating water from the basin to the river above Amlabad, as well as to the destruction of the deeper coal seams by mica peridotites—percolation into the coal measures from a flood dam holding up 35 ft. of water (position of the sluices, in the proposed dam, above bed level) need not be taken too seriously. He then drew the attention of the Irrigation Department to this fact now so that they may revive the Parjori Retarding Basin project if they still felt any danger to the Burdwan district from high floods in the Damodar. Dr Fox considered such a potential danger still existed. If such a flood dam was now constructed the 35 ft. of water held up in the basin above the dam would ultimately silt up and, in the Jessop's bridge reach under construction, an additional 32 to 36 million tons of sand would be trapped. This additional sand would be nearly 20 ft. above the present river bed at the bridge, i.e., almost half way up the piers. Dr Fox was unable, in the absence of more data, to say how soon such a basin would silt up, but he thought that 5 to 6 years could be taken as an approximate guess if no sand was removed for hydraulic stowing." (*Transaction of the Mining and Geological Institute of India*, 33, 1937).

It may be mentioned that the Mining Association was then thinking of 'stowing' up their pits, which entails the packing of the voids or caves, formed by the extraction of coal, by some other material, and sand is very suitable for this purpose. It may, however, be noted to the interest of the life of the proposed dam, that if sand is removed from time to time from the bed of the reservoir for the stowing

purposes, the life of the dam will be greatly increased. The Jharia collieries raise at the rate of about 10 million tons of coal per year, which means that about 270 million cu. ft. of cavities are formed per year to be filled up by stowing. The quantity of sand required is about 20 million tons.

The 3,000 sq. miles of the catchment area have an average monsoon precipitation of 43 inches. If we assume that the run-off is 50 per cent. the total volume of water reaching the Parjori reservoir is about 3.4 million acre ft. Taking the average 'head' as 60 ft. for power generation, the total energy poured down across the site is found equivalent to about 200 million units (kwh.) of electrical energy. Under actual operating condition, however, the available energy would be much less, depending upon the overall efficiency of the plant, which includes utilization factor for the total resources of water, turbine efficiency, power factor and other details. If the efficiency factor is taken to be 75 per cent. the total energy production will be 150 million units, but probably the height of the dam can be further increased.

Much of this power will be 'secondary' i.e., available only during the rainy seasons, unless the total storage capacity of the reservoirs is large enough. If a number of reservoirs is built up in the upper valley and on the tributaries, a large fraction of it can be converted into 'primary' power i.e., it will be available throughout the year. On account of the proximity of the coal fields it will be possible to have auxiliary thermal generators for the dry seasons at no great cost.

The Parjori sites, we find, is very much similar to the Sherman Island power stations on the Hudson River, New York, in 1924. There the head was 66 ft. drainage basin 2,782 sq. miles, discharge rate 6,280 cusecs, and electrical energy obtained was 81 million units in a year. This quantity must have been increased within the last twenty years.

If the run-off water of the entire basin is released uniformly for six months it will give an average flow of 10,000 cusecs. With this flow and a head of 60 ft. it gives a power output of 50,000 kw. or 67,000 h.p.

2. *Ayar Site*.—About 17 miles above the Parjori site, there exists another dam site opposite the village of Ayar where a rocky rapid of 3 to 4 ft. height occurs. At the head of this rapid there is hard gneiss rock exposed right across the bed, a small hill on the right bank and the left bank slopes up at about one-in-fifty over 100 ft. above the bed. A dam, 100 ft. high would be about 4,000 ft. long (less than a mile) at crest level. The valley is deep and narrow. The storage capacity of the reservoir is



FIG. 2. Old coal-exporting ghat, near Egara, Raniganj coal-field. This view illustrates that coal used to be exported to Calcutta down the Damodar river during the monsoon period, previous to R. I. Railway constructed at Raniganj in 1815. (Reproduced from *Memoirs Geol. Surv. Ind.*, Vol. 61).

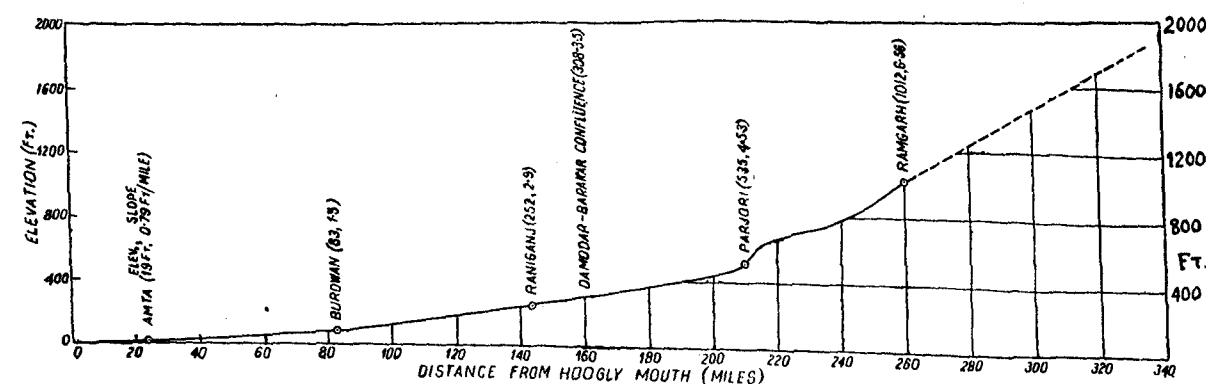


FIG. 3. Profile of the Damodar River (based on Lieut. Garnault's slope data, 1864).

therefore quite small. The catchment above the dam site is 2,000 sq. miles.

It appears therefore that this site would be suitable for a power dam provided a larger storage and regulating reservoir can be built above it. It may be noted with interest that there is a site near Ramgarh about 15 miles above Ayar. It is also possible, as Mr Glass noted, to control the head waters at the Bhera Nadi by a dam which would feed the main river above Ayar site.

Assuming 50 per cent. run-off of the 43 inches of rainfall, and 60 ft. available head, the energy which will be handled by the proposed Ayar dam calculates out to be some 133 million units in a year.

3. *Ramgarh Site.*—According to Mr Glass, Ramgarh is the uppermost site available for the construction of a dam. The site has a catchment area of about 1,000 sq. miles, and the proposed reservoir will have a storage capacity of 9,000 million cu. ft.

The water resources of this valley is about 1.1 million acre ft. in the monsoons, and assuming a head of 50 ft., the total energy dissipated by the river during this period is some 55 million units.

4. *Control of the Tributary Rivers.*—The possibilities of the head waters control in the tributaries of the Damodar river has not been properly investigated but their possibilities were not overlooked by Mr Glass.⁵ The following affluents are of importance for flood detention and power projects:

Tributary River	Catchment area
Jamunia River	350 sq. miles
Konari River	730 sq. miles
Gowai River	450 sq. miles
Total	1530 sq. miles

Thus these three tributaries control more than half of the Parjori catchment. But Mr Glass was not much interested in these sites as he observed that none of these would have large storage capacity for flood detention. He writes:

"I have considered the alternative of two or more dams on branches such as the Gowai, Jamunia and Konaree with a total catchment of say 1,000 sq. miles, but from what I have seen of the valleys of these affluents and know of the steep slopes of their beds, I am not at all hopeful of obtaining sufficient capacity at reasonable cost and much prefer to have a larger catchment under control."

These tributaries, as noted above, individually command catchment areas which are much larger than the Usri and Tiliya catchments. It will be discussed later that the Usri dam has been proposed as a power site.—The steep slope and deep valley which were mentioned by Mr Glass for the Gowai, Jamunia and Konaree rivers, might prove on further survey

to be excellent dam sites with large available head for hydro-electric power generation. Mr Glass, however, was not so much interested in power projects as in flood control for which his service was specially requisitioned by the Government of Bengal. His valuable reports, however, gives us sufficient indication and guide for future survey on the modern ideas of dam construction for power generation as well as headwaters control for flood.

5. *Site between Parjori and Barakar junction.*—The river level at Parjori is 540 ft. and that at the junction is 285 ft., the distance between them being 50 miles. If dam sites can be found in this region, the tail waters from the Parjori can be used over again to generate electrical power. This would give us almost the same or a larger amount e.g., 200 million units, as obtainable at Parjori.

No attempt was however, made to discover any dam site in this stretch because

- (1) the Parjori site alone was thought to be sufficient for flood detention, and
- (2) the depth of sand layer over the bed rock was considered to be too great for the construction of earthen or masonry dams.

According to Mr Gee,¹² the sand layer at this region is nearly 50 feet, and the average depth of the Damodar bed of sand may be taken to be 40 ft., although at places the thickness may be as great as 80 ft.

A few points should, however, be noted in this connection. It would be very lucky to get bare rock for dam foundation, but the engineers seldom have such luck. Where the overlying sand is deep, the construction of dam on such sites becomes more expensive. In the U.S.A. dam sites which were otherwise good have not been rejected even when the overlying layer of sand was as much as 100 ft. deep. For instance, the river bed at the Chickamauga dam on the Tennessee River is overlaid with 40 to 50 feet of sand clay and gravel,¹⁴ and the Arrow rock Dam on the Boise River, Idaho State, U.S.A., has its foundation 91 ft. below the sand layer.¹⁵ (p. 1066.)

TABLE 1
TOTAL ENERGY RESOURCES AT THE UPPER DAMODAR VALLEY
OUT OF THE MONSOON WATERS

Parjori site	200 million units (kwh.)
Ayar	133
Ramgarh	55
Tributary sites (Total approx.)	100
Site between Parjori and Barakar junction	200
Total	688 million units.

THE BARAKAR BASIN

The Barakar River is the largest tributary of the Damodar, and contributes about 40 per cent. of the total flow in the Lower Damodar River. The control of the Barakar river is therefore equally important for flood control or other projects.

1. *Horn's Site.*—After the disastrous flood of 1900, Mr D. B. Horn, Superintending Engineer, was put on special duty to find out remedial measures to mitigate Damodar floods. Mr Horn selected a dam site on the Barakar river in 1902 at a place just above its confluence with the Damodar River, near the village of Durgapur. The location has been named Horn's site.

which will be impounded in this reservoir is about 8,640 million cu. ft. or 0.2 million acre ft. (1 million cu. ft. = 23 acre ft.).

Boring on the site showed that the bed rock is to be found 40–50 ft. below the overlying layer of sand. The site was discarded by Mr Addams-Williams because he thought that the depth of sand was too great. But as mentioned before, in America, dams are constructed even when the bed rock has been found a hundred feet below the surface.

This site will command practically the whole of the Barakar catchment. The amount of water running through the Barakar river in the year is

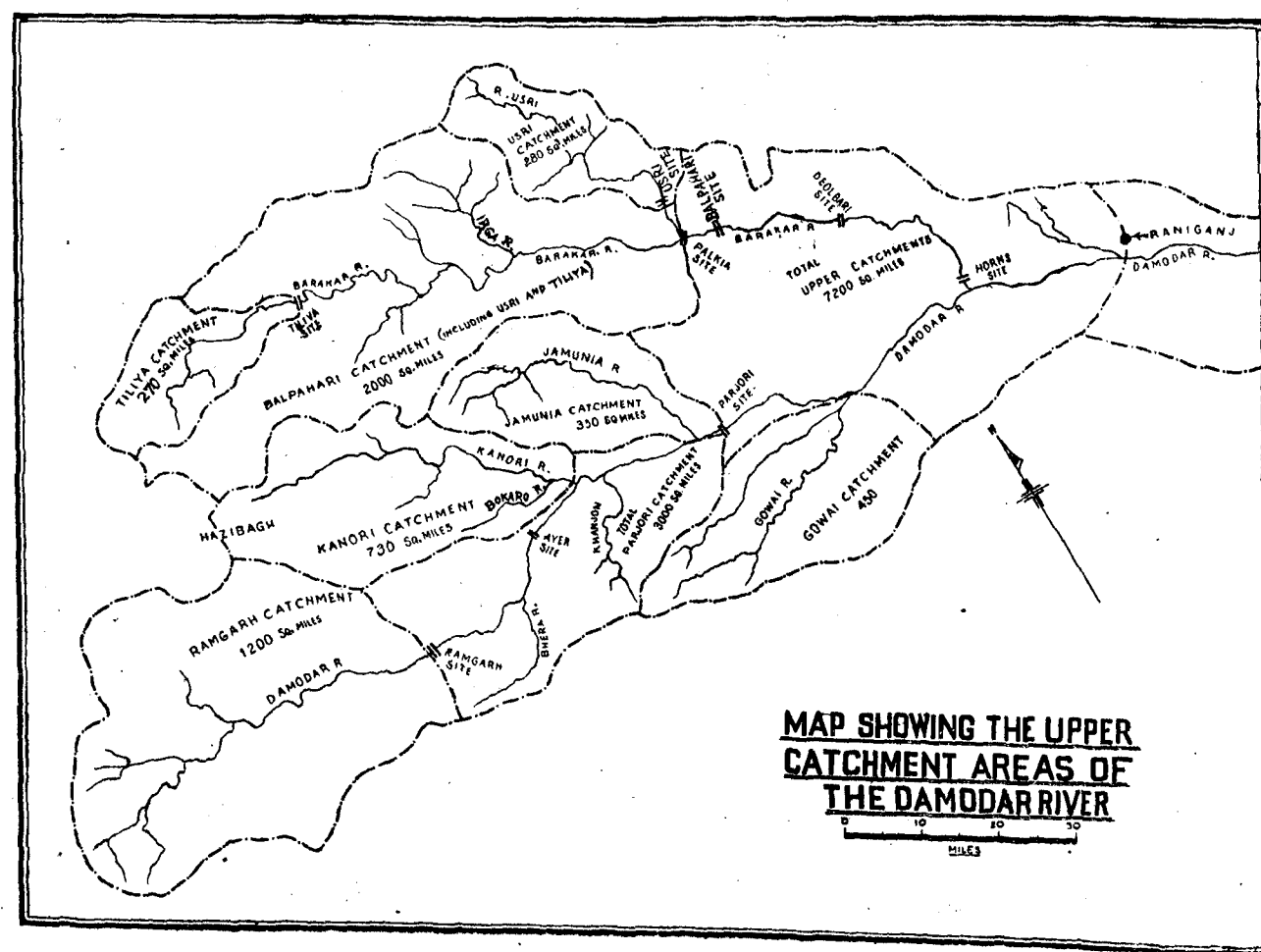


FIG. 4.

The dam site is quite suitable and Mr Horn found that it is situated among the hills, where building material is plentiful. The gorge is fairly narrow and the slope of the bed is not more than 6 ft. per mile. A masonry dam of 70 ft. height will back up its water up to about 12 miles. The volume of water

some 3.8 million acre ft. which will pass down the Horn's site. Taking the available head to be 35 ft. the power resources at the dam site is about 133 million units.

2. *Deolbari Site.*—22 miles above Horn's site there is another dam site near the village of Deolbari.

The right bank of the Barakar river at this place rises steeply out of the river bed, and the left bank attains a height of over 90 ft., at a distance of 3,200 ft. from the river. The slope of the river bed is about 7 ft. per mile. A dam of 130 ft. in height can be constructed, impounding 17,000 million cu. ft. of water.

The bed rocks lies about 30 ft. below the sand, but the rocks themselves are not very much suitable for dam foundation, abutment and spillway.

Although the Deolbari site was rejected in 1918 due to some defects of the bed foundations, the similar experience of the Tennessee Valley Authority within the last ten years gives us ample scope for accepting such sites. To mention, the Norris Dam on the Tennessee Valley was found to have very inferior bed formation but this has been completely cured by cement grouting at the foundation rocks. Extensive grouting has also been adopted for the Guntersville and Chickamauga Dams.¹⁴ It is therefore not unlikely that the Deolbari site may, after proper treatment of the foundation rocks, be found suitable for construction of masonry dam.

Taking 3.2 million acre ft. of water passing down the site at an average head of 50 ft., the total electrical energy comes out to be 160 million units.

3. *Palkia and Balpahari Sites.*—The best dam site on the Barakar river is near the village of Palkia about 16 miles above Deolbari or some 40 miles above the junction of the Barakar with Damodar. The proposed Palkia dam 125 ft. high will head up water in the Usri river also which has joined the Barakar river just at this site. The Palkia site commands a catchment area of 2,000 sq. miles with a monsoon resources of about 2.3 million acre ft. of flow water. The storage capacity of the reservoir would be about 20,000 m.c. ft. (or 0.46 million acre ft.) of water. Taking the available head to be 60 ft., the energy handled by the river is 138 million units during the monsoon. There is a site at Balpahari about 3 miles down the river, which is in certain respects better than Palkia, and the choice has to be made between these two sites.

4. *Tiliya Site.*—This is the uppermost dam site on the Barakar river, some 50 miles above the Usri junction, controlling 270 sq. miles of catchment area. Near the village of Tiliya, two ranges of low hills which hem in the river for about 7¾ miles approach within 1,600 ft. of one another. The slope of the bed being only 4.13 ft. per mile and the height of the hills more than 130 ft., a dam of at least 130 ft. could be adopted which would set back the water about 31½ miles. But the proximity of the Upper Barakar

Bridge limits the size to 54 ft. This will pound up water about 13 miles.⁶

It may however be noted in this connection that in the TVA operations in the U.S.A., hundreds of miles of roads and railways had to be rearranged, old bridges removed, and new ones built,¹⁵ (p. 917) so that if a site is otherwise good, railway alignments and bridges may not be regarded as 'Sacrosanct'.

The water resources of this site is about 0.25 million acre ft. Although the Tiliya site has a catchment area the same as that of the Usri river, the dam will give us more hydro-electric power than from the proposed Usri power project due to the higher head of water. The proposed Tiliya dam is 130 ft. high as compared to 70 ft. for the Usri project. With a head of 60 ft. the power resources at the Tiliya is nearly 15 million kwh.

5. *Usri Site.*—The Usri river is an important tributary to the Barakar river. The catchment area is 280 sq. miles and the run-off water of the basin is about 10,000 million cu. ft. (or 0.23 million acre ft.) during the entire monsoon. The proposed dam is 70 ft. in height so that the energy resources is shown to be about 7 million units.

The Usri river has a steep gradient so that a number of dams may be planned to utilize the maximum advantage of the drop of the river across successive dams, just as in the case of the dams on the Occoee, a tributary of the Tennessee.

TABLE 2

TOTAL ENERGY RESOURCES OF THE BARAKAR BASIN			
Horn's Site	...	...	133 million kwh.
Deolbari	...	...	160
Balpahari	...	...	138
Tiliya	...	...	15
Usri	...	...	7
			453 million kwh.

With the help of these dams on the Damodar and Barakar we have the possibility of harnessing the total energy of 1,141 million units every year. Taking that about 75 per cent. of the resources is utilizable we can get some 850 million units. The gross sale proceeds of this amount is more than 2½ crores of rupees at the average rate of ½ anna per unit, and 1¼ crore at the rate of one quarter anna per unit.

To consider, on the other hand, the question of the water management and control, if all the above mentioned dams are constructed, about 30 per cent. of the total run-off can be stored up.

TABLE 3
STORAGE CAPACITIES AND CATCHMENT AREAS

	Dam Site	Storage capacity (million acre ft.)	Catchment area (sq. miles)	Storage capacity per sq. mile of catchment area ft. 8C. miles.
Damodar system.	Parjori	0.35	3,000	117
	Ayar	0.10	2,000	50
	Ramgarh	0.20	1,000	200
	3 Tributaries ..	0.30*	1,530	190
	Site below Parjori	0.40*	3,500	116
Barakar system.	Horn's site ..	0.20	2,500	80
	Deolbari	0.39	2,250	173
	Palkia	0.46	2,000	230
	Tiliya	0.15*	280	535
	Usri	0.12	270	440

* These figures are tentative.

It is difficult to give our readers any accurate figure for the cost of construction of the dams in absence of any detailed plan. But so far roughly estimated by Messrs Glass and Addams-Williams, in 1922, the three dams viz., Parjori, Palkia and Usri would cost about two crores of rupees. But according to more recent ideas it seems that the cost would go up to 8-9 crores of rupees for the total storage of 1.5 million acre-ft. of water, which means about 60 rupees per acre-ft. To compare this figure with those of other countries we find that the Mississippi dams, designed only for flood detention, were planned with an average of about 40 rupees per acre-ft.², and for the Tennessee dams of the multi-purpose type (flood detention, irrigation, navigation and hydro-electric power generation), the average goes above 100 rupees per acre ft. of storage³. Thus the rough costing for the Damodar dams is well within reasonable limits, and they are by all means economically practicable. The dams on our plan have a storage capacity of 2½ million acre-ft. (Table 3) and may cost between 25-30 crores of rupees at the average rate within 100 rupees per acre-ft. A direct income of about 2 crores of rupees would be turned out of hydro-electricity alone. The indirect income, due to all-round improvement of the upper and lower basins cannot be estimated.

We have not included, within this article, any plans for dealing with the lower basin below Raniganj. This region suffers from lack of water during the winter season, and hence no winter crop can be grown in about a million acres of excellent soil. Further, the part to the north and east of the river, on the left bank, suffers from malaria due to water starvation caused by embankments, and the region on the right bank from chronic water logging. It is obvious that the

construction of reservoirs according to our plan will conserve about 30% of the total run off, i.e., about 2.50 million acre ft., which can give us an average flow of about 5,000 cusecs during seven months of the dry season, and this will be great help for the reclamation of the lower basin. Detailed plans will be published later.

TREATMENT OF THE UPPER CATCHMENT AREAS

The Chota-Nagpur plateau from which the Damodar river and its tributaries emerge are mostly bare and denuded. About 3,500 sq. miles of the upper Damodar reaches are waste land or covered with meagre forests, while, about another 2,000 sq. miles are under cultivation. In the north Barakar basin, as reported by Mr Sabharwal⁷, Bihar Conservator of Forests, there are extensive areas where all forests have entirely disappeared by repeated cutting, firing and uncontrolled grazing.

The bare areas are readily washed off and the rivers have to carry a heavy load of sand and silt. This deteriorates the channels of flow, and form sand bars and deltas near the mouth. The original soil gets more and more barren and has less power to soak and retain the rain waters.

It is highly desirable that the Government should take up the problem immediately and enforce laws for forest preservation and erosion control as suggested by Mr Sabharwal. The erosion control management will lie in regulation of cutting of forests, of grazing and pasture land, afforestation and planting, terracing, dyking, gully plugging, etc.⁷

AFFORESTATION AND WATER CONTROL

Afforestation in the upper catchment areas of the Damodar and Barakar rivers are strongly recommended for preventing erosion of soil, to improve the channel and lengthen the life of dams. Claims from certain quarters have been made that afforestation on the Damodar catchment areas would also be sufficient for prevention of floods, and no detention dams would be necessary, or if the dams are to be made they are only of secondary importance. We widely differ from this view and hold that *afforestation can, under no circumstances whatsoever, prevent catastrophic floods of the type that frequently ravage the Damodar Valley*. As their arguments are confusing and misleading it is necessary to examine them in a true scientific spirit. The claims of the afforestation enthusiasts are as follows:

(1) *Effect on Rainfall*.—They claim that afforestation somehow affects the rainfall in a basin.

There is, however, not a single iota of positive proof in support of this claim, although some have fancied that humidity of the sky in the area is to some extent increased by the presence of forests. Such effects, even if they exist, must be extremely small compared to the huge monsoon currents which are responsible for the precipitation on the Damodar Valley and the plains of India. These currents are due to atmospheric conditions in the Bay of Bengal, and these conditions cannot be modified by land conditions, and there is apparently no physical reason why these currents, which generally are thousands of feet in depth would be affected materially by the growth of forest in any area. *There has not yet been evolved any method by means of which man can control rainfall.*

(2) *Reduction of Flood Crests*.—It is generally found that vegetal cover of a tract reduces run-off of water by increasing the absorptive power of the soil for water. But the magnitude of the retardation of stream-flow is neither guaranteed nor has any generalised value. The problem has remained for long extremely controversial,—opinions going to extremes, on one hand some are of the opinion that the vegetal cover greatly reduces the stream flow, while others contend that afforestation increases flood tendencies.¹¹ On the Tennessee Valley, for example, the flood has generally decreased due to the deforestation of the catchment areas as analysed by S. M. Woodward, Chief Planner of the Tennessee Valley, at the Upstream Engineering Conference.¹⁰

Mr E. L. Glass considered this phase of hydrology in preparing his flood control project for the Damodar river, and remarked—

"Large expenditure on afforestation seems inadvisable as heavy floods are caused entirely by prolonged heavy rainfall, when the soil is saturated and the absorption in forest humus is no more than in open country, though forests do no doubt reduce the smaller floods and the scouring of soil." (p. 157).

This statement of Mr Glass requires some elucidation. The great flood of 1913 was due to precipitation of 12 inches of rainfall in course of 5 days in the catchment area above Raniganj. When such continuous heavy precipitation takes place, the ground is completely soaked, and can absorb no more water. In fact, the run-off was found by Glass to increase from 30 per cent. at the beginning to 85 per cent. at the end of this period of 5 days. The resistance offered by trees, dykes, or terracing would be quite useless, and they generally break down in the face of such heavy rush of water, and such measures can never prevent a catastrophic flood. In fact, the crest of the flood reached in 1913 was 6½ lacs of cusecs, and Mr Glass has shown by his illuminating analysis that every catastrophic flood occurring before this

date was due to similar heavy and continuous precipitation extending over 72 hours or more in the catchment area.

So even admitting that afforestation can prevent the crest of floods due to normal, or slightly abnormal precipitation, it is obvious that such measure are quite ineffective against conditions which give rise to catastrophic floods. But it is these catastrophic floods which generally burst the embankments, and destroy communication lines, cities and villages, and preventive measures have to be devised against them. Against normal floods no prevention measures need be taken.

Certain isolated laboratory and controlled field experiments, are however cited to show that the vegetal cover of a tract may lead to an absorption of the rainfall up to even 99 per cent. But can large natural river basins comprising millions of acres and containing thousands of hills and mounds be treated in the same way as controlled field experiments? In order, therefore, to get a constructive idea of any real significance of afforestation and other land treatment measures, it would be safer to learn from the statistical informations of the natural field conditions on different treatment. Mr H. H. Bennett, Chief of the U. S. Civilian Conservation Corps says,

"Our work in the last two years in 141 watersheds throughout the country (U. S. A.) indicates that the volume of run-off water can be reduced 20 to 25 per cent through the use of erosion control methods."¹²

This figure therefore may be taken as the average maximum for the retardation of the run-off water, when complete afforestation, and erosion control measures, as far as practicable, are undertaken.

(3) *Ground Water*.—Any water soaked into the soil, will either be evaporated, utilized by plants, or find out its way by seepage as underground water. Does a vegetal cover increase or decrease the ground water? Evidence on this point is conflicting, though some are of opinion that a vegetal cover increases ground water. We see, however, that a part of the ground water is sucked up by the plants and ultimately evaporated off through the leaves. So there is a considerable transpiration loss of water due to forestation,

The seepage feed of the channels, it may be noted, does not necessarily increase with vegetal cover of the tract, for, we read:

"The best ground water supply is found in regions of ample precipitation where both soil and subsoil are of fine sandy character and forest cover is absent" (p. 211).

Professor Barrows¹¹ has cautioned very emphatically against the indiscriminate statements of the afforestation enthusiasts in the following words:

"Unfortunately, too, advocates of forestry in their zeal for forest preservation often make broad and unqualified statements characterising all forests as water conservators and using this often erroneous statement as their chief argument to justify continued forestation, instead of allowing the worthy objective to stand, as it should, on its own merits"¹¹ (p. 84).

We can thus sum up:—

- (1) The chief utility of afforestation and other land treatment measures is in soil conservation, lengthening of the life of dams, retardation of normal flood crests to about a maximum of 20 per cent.
- (2) The claim that afforestation and other allied treatments affect rainfall is absurd; the claim that they increase ground water is debatable.
- (3) Catastrophic floods are due to a combination of physical conditions against which afforestation and land treatment measures are useless.

PROBLEMS OF SILTING OF THE PROPOSED RESERVOIRS

Under the conditions prevailing in 1918 the Damodar waters carry, according to Mr Glass, a silt load of 1/100 by volume during heavy surges of flood, but during average floods the proportion is 1/200, and for the entire monsoon, the average silt ratio is 1/500.

Let us now try to visualise how the deposition of the sand ensues in the reservoir. The load of sand and silt moves on in the stream when it runs with fairly large velocity. When the stream enters the reservoir its speed is retarded to a great extent so that the suspended particles begins to settle freely to the bottom of the reservoir. The supernatant water passes down the spillway of the dam, free of sand, but may be charged only with the finest silt which still remains in suspension and passes on.

It is evident that if the catchment area above the dam is large it will supply erodable debris of soil in the stream proportional to its area. Thus, larger the catchment area, the larger the silt deposition for which the reservoir capacity should be increased in order to allow for the sedimentation without impairing the useful storage.

It is however difficult to assign a definite storage capacity of the reservoirs per sq. mile of the catchment area above it, unless the erodability of the basin

is fully known. According to Mr Brown¹⁶ it is important that a suitable minimum ratio of reservoir capacity to watershed area be provided. "This minimum ratio varies from 75 acre ft. per sq. mile in the Southern States to 250 acre ft. per sq. mile in the Texas-Oklahoma region (desert), it depends on the rate of erosion, which is determined in part by vegetal cover on the watershed."¹⁷ The Damodar-Barakar basin is obviously not as bad as Texas-Oklahoma which is abnormally erodable. Table 3 shows the storage capacity, catchment area and their ratio for the proposed reservoirs on the Damodar river and its tributaries.

The problems of silting of the Damodar reservoirs were considered by Mr Glass (1919) and by Mr Kanwar Sain⁸ (1944), the results of which is extremely hopeful and satisfactory. It would be illuminating to quote the relevant portions of the discussions to elucidate the points.

"Considering the average monsoon rainfall as 43 inches and assuming 40 per cent run-off, the total volume of monsoon flow per year per 100 sq. miles of catchment area would be $100 \times 2,323,200 \times 43 \times 0.4 = 3,995,904,000$ cu. ft. or nearly 4,000 million cu. ft.

"Taking the average silt ratio as 1/500 the total volume of silt carried during 50 years from a catchment area of 3,000 sq. miles (Parjori catchment) would be 12,000 million cu. ft. or nearly 60 per cent of the reservoir capacity (Parjori Reservoir 15,000 m. cu. ft.).

"Mr Glass has added that some of this silt would pass out directly through the conduits, while the remainder would drop in the basins, some to remain and some to pass out through the conduits later on with ordinary monsoon flow. It is evident from the above consideration that it would be an extremely long time before the basins silted up sufficiently to impair their usefulness and the safety of the dams.

"This was for Palkia and Parjori basins. For Usri, assuming the same average silt ratio of 1/500, Mr Glass worked out the annual volume of silt deposited in the reservoir as about 20 million cu. ft. or 0.8 per cent of the total capacity. Mr Glass concluded 'This need not cause apprehension as it would take over 30 years to reduce the capacity by 25 per cent and this period would be extended by the passage of some fine silt through the sluices and over the spillway, while some of the deposit would be above spillway crest level in the upper basin provided for flood detention'."

The observation in the silt-ratio of the Damodar river as given by Mr Glass is not very accurate. Mr Kanwar Sain points out "Mr Glass' estimate given above is based on one season's observations only. The actual solid matter according to observations come to 1/828 by volume. Mr Glass increased it to 1/663 by applying specific gravity of clay and silt. This correction is open to question. Captain Garnault found the proportion to be 1/590. These observations were for small floods. In heavier floods the silt concentration may be heavier. According to Faris the maximum silt percentage usually occurs prior to the maximum stream discharge."

We collect the following comparative silt loads in different streams, from Mr Kanwar Sain's note⁸:

TABLE 4
COMPARATIVE SILT LOADS

River.	Silt ratio by volume		Remarks.
	Ratio	Percentage	
Damodar	1/500	0.20	Mr Glass' one season's obsn.
"	1/828	0.12	Average of obsns.
"	1/663	0.15	Correction with Sp. Gr. of clay by Mr Glass.
"	1/590	0.17	Capt. Garnault.
Bhakra (Punjab)		0.084 to 0.186	All seasons between 1916-33.
"		0.15 to 0.45	During monsoon.
Rio Grande (U.S.A.)		0.25 to 0.5*	Spring floods.
"		2.0 to 5*	Flashy summer floods.

* Figures are originally given as 0.5 to 1 per cent and 4 to 10 per cent by weight. We have taken sp. gr. of soil roughly 2 to get these figures.

"After examining a large number of cases varying from 181 to 167,000 sq. miles of catchment areas and scattered over America, South Africa, Burma and the Punjab which catchments giving rise to heavy silt charged streams, Khosla arrived at the following conclusions:

"(a) The rate of silting falls off with years.

"(b) The annual rate of silting per 100 sq. miles of catchment has an upper average limit of 75 acre ft. for arid catchments which give rise to heavily silt laden streams. The absolute maximum rate for any major catchment will, perhaps, not exceed 90 acre ft."

That the life of the proposed dams on the Damodar and Barakar rivers will be about 200-

years even under the existing silt-load conditions of the streams has been shown by Mr Kanwar Sain by more detailed calculations:

"The probable silting of the Damodar reservoirs may be roughly estimated by comparing the silting rates of other reservoirs exposed to similar conditions as prevailed on the Damodar.

"The Soil Conservation Service (U.S.A.) has made considerable studies of sediment surveys in existing reservoirs. From this data Berard J. Witzig⁸ has evolved the following formula:

$$\Delta S_R = I(S_R)^x$$

in which ΔS_R = annual silting rate of depletion or depletion of storage—in acre ft. per 100 sq. miles of drainage area; I = Coefficient, called the 'regional index'; S_R = original storage, in acre ft. per sq. mile of drainage area; $x = 0.83$ = graphic slope of the plot on logarithmic paper.

"The regional indices for Elephant Butte Dam on Rio Grande River, New Mexico, and Roosevelt Dam on the Salt River, Arizona, in Witzig's formula work out to be 1.51 and 0.69 respectively. Applying the mean ($=1.2$) of the two indices to the three proposed reservoirs on the Damodar system, the following results are obtained." See Table 5.

We have thus been assured that even the existing condition of silt load of the Damodar is not so dangerous as it has often been apprehended on merely looking at the thing. The life of the proposed dams would be further enhanced by the adoption of erosion control measures on the upper catchment areas as mentioned before.

A number of desilting measures and engineering devices have now evolved owing to the increasing

* Proc. Am. Soc. Civil Engineers, June 1943.

TABLE 5
CALCULATION OF LIFE OF DAMS BY WITZIG'S FORMULA

Site	Original storate (acre ft.)	Catchment area (sq. mile)	$S_R = \frac{\text{col. 2}}{\text{col. 3}}$	$(S_R)^{0.83}$	$\Delta S_R = I(S_R)^{0.83}$ $I = 1.2$	Life of Dam $\frac{\text{col. 2}}{\text{col. 6} \times \frac{\text{col. 3}}{100}}$
1	2	3	4	5	6	7
1. Parjori on Damodar river ...	345,000	3,000	115.0	51.3	62	185 years
2. Hazaribad or Palkia on Barakar river ...	463,000	1,665	278.1	106.8	128	228 years
3. Usri on Usri river ...	59,800	280	213.6	85.8	103	208 years

demand of dams and reservoirs which prove to be great national assets for a country. Mr Brown says

"Since 1900 there has been a phenomenal increase in the number and the scale of such reservoirs in this country (U. S. A.), with an acceleration in construction that was halted abruptly by the war. In 1941 there were on record about 8,900 dams and reservoirs, representing an investment of nearly four and a half billions of dollars. Many of these expensive works were constructed with little or no consideration of the silting problem, and there has been enormous loss of value as a consequence. . . . Fortunately there is a growing consciousness of the need for sounder engineering practice in designing and maintaining reservoirs. The need to conserve this resource is especially urgent during the war, since we do not have materials and labour for constructing new dams, and yet the demands on existing reservoirs are greater than ever before."

In order to prevent rapid silting up of the reservoirs the following measures are generally recommended:

- (i) Afforestation and putting selective vegetation at suitable regions of the catchment areas.
- (ii) Terracing, dyking, etc.
- (iii) Providing settling basins for smaller streams at the headwaters.
- (iv) Hydraulic dredging or purging of the reservoir water through the bottom sluices, which scours away much of the sand deposits. This is an old and efficient practice.
- (v) Mechanical dredging or removal of the debris. This is expensive but becomes more profitable when the deposits can be used elsewhere economically. On the Damodar basin, for example, there is a great demand of sand for stowing the colliery pits: about 20 million tons of sand being required per year in the Jharia coal mine alone. The sand is also used as a building material.

There is already a large traffic on the Damodar for sand required for building purposes at Calcutta and neighbourhood. This already amount to several million tons; but if navigation by barges can be developed in the Damodar and the Barakar, the traffic in sand can be very extensively developed as in the Ohio river below Pittsburgh (U.S.A.).

"Silt and Sand" have proved 'nightmares' to irrigation engineers, but we are fortunate to live at a time when the large scale experience of thousands of dams constructed in the U.S.A. since 1915 are at our disposal. If we take advantage of this experience, it will be possible to construct reservoir dams which will give service for hundreds of years.

USE OF THE POWER

We have indicated above how about 850 million kwh of the electrical energy may be obtained in a year on the Damodar and Barakar systems. People have often asked "Supposing that the power is developed, what can you do with it?" This is like asking the question "What will you do with a gold mine if you can discover it?"

India has so far developed only 9 units of electrical energy per capita per year, while the figure in the U.S.A. is nearly 1500 units. Even a country like Mexico which people regard as a backward country, has developed 180 units per head. This shows the extreme backwardness of India in power-development and this backwardness is the root cause of India's poverty. It can be confidently assumed that if sufficient power is developed, use can always be found for it, and the power will increase the prosperity of the country in the ratio in which it is developed.

As far as Damodar Valley is concerned we can at once indicate immediate use for the power:

At the Coal Mines.—The Jharia coal mines and cities now use about 15,000 kw., or 60 million units a year. This may be obtained from the hydro-electric grid system. This will conserve coal which is a very necessary but exhaustible national asset, and should be reserved for other purpose.

Aluminium.—Chota-Nagpur and other districts of Bihar has the richest deposits of Bauxite. Aluminium can be extracted from this ore if sufficient electrical power is available. The pre-war requirements of India in aluminium was 12,000 tons, and a factory capacity of 4000 tons of aluminium yield per year is an economic proposition. One pound of the metal requires 13 units if electricity for its extraction. A factory 4000 tons will consume $4000 \times 2240 \times 13$ or 120 million units of electricity per year. It is very probable that the consumption of aluminium will go up rapidly after the War and many such factories will be needed. Dr Dunn writes,

"There is no doubt that the bauxite deposit of Bihar will be a valuable asset in future. Although information as to their distribution is well enough, there is no exact knowledge of the actual reserves available. However, the minimum reserves calculated in some of the localities are sufficient to warrant the establishment of industries to utilise this bauxite, and it can be safely left to the companies concerned to determine their own reserves. Further prospecting in these western plateau will undoubtedly bring to light new deposits of bauxite. It is doubtful whether prospecting of laterite in other parts of Bihar will result in finding bauxite deposits elsewhere, but it is certain that high alumina laterites would be found which could be used for certain purposes. The actual development within the province of industries based on these bauxites should be encouraged. All the facilities of coal supply and cheap power are available." (p. 87).

Calcium Carbide.—India needs at present 1000 tons of calcium carbide. Each pound of the gas carbide requires 8 units of electrical energy for its manufacture. The quantity at present is imported from U.S.A., Australia and South Africa. The use of the carbide is increasing with the industrialisation of India. A 500 ton factory will consume $500 \times 2240 \times 8$ or about 9 million units of electricity.

Calcium Nitrate.—Anhydrous Calcium Nitrate is a fertilizer which is extremely good on acid soils like laterites. The raw materials required for the manufacture of the nitrate fertilizer are lime and atmospheric nitrogen which are synthesised with the aid of electricity. There is practically no limit to the demand for the fertilizer. A 35,000 ton plant will require an installed power of 12,000 kw or nearly 90 million kwh. units of total energy in a year, and India's need of nitrate of lime fertilisers is so enormous that even a dozen such factories will not be found too large.

Synthetic Ammonia.—The root cause of famine and permanent malnutrition in India is the low productivity of Indian soil. This appears to be due to depletion of Nitrogen and Phosphorus from the soil of India on account of thousands of years of continuous cultivation without any counterbalancing operation. This subject has been dealt with in an editorial article in SCIENCE AND CULTURE, June 1944, and a subsequent article on "Need and Possibilities for the Production of Synthetic Fertilisers" in the same number.

According to these articles, India needs two to eight million tons of nitrogen annually if her soil is to be raised to the same standard of productivity in paddy and wheat as Spain or Italy. Now, one kilogram of synthetic ammonia requires for its manufacture, according to the latest modification of the Haber Bosch process, 3.6 units (kwh.) of electricity, and two million tons will need 7200 million units, which is double the present output of electrical energy in the whole of India.

A factory producing 24,000 tons of synthetic ammonia may in the first instance be installed in the Damodar Valley, and this will consume nearly 90 million units of electricity. After its usefulness has been tested, more factories may be multiplied.

Smelting of Iron.—The coking coal needed for the smelting of iron in India is limited, and according to experts, the coal will be all exhausted at the present rate of consumption within 30 years, if no fresh source of coking coal is discovered. India will have to fall back upon electricity for smelting of iron, for the production of steel as in Sweden, or San

Paulo, Brazil. One ton of iron requires 300—400 units of electricity and if in future, a programme for the production of ten million tons be decided, this will require 3000 to 4000 million units of electricity. Electrical energy is also ideal for the production of alloy steel of all kinds, and there is an immense scope in India for such production.

We have thus indicated that we can not only usefully employ all the electricity which can be produced in the Damodar Valley (1200 million units), but the reader will perceive that this amount is a drop in the ocean compared to the needs of India. Further, coal is an exhaustible asset and should be kept reserved for such purposes for which there is no substitute for it (e.g., preparation of synthetic materials etc.)

Though Indian reserves of coal are rather limited, and quite insufficient for the needs of a country like India, she has got enormous and inexhaustible reserves of power in her rivers. Many of these can be harnessed for the development of hydro-electric power, as we have sketched out for the Damodar, and we understand plans are on foot for the development of similar projects in the Rihand Valley (a tributary of the Son River in the Rewa State, and the Mirzapur district of U.P.), in the Sutleg Valley, and in Mysore or the Koyna Valley in the southern part of Bombay Presidency. Scores of river valleys in India remain still to be surveyed from the point of view of all development, and plans have to be prepared.

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SIR DAVID PRAIN, F.R.S., (1857—1944)

SURGEON-MAJOR, afterwards Lieutenant-Colonel, Sir David Prain, C.M.G., C.I.E., M.A., M.B., I.M.S., D.Sc., LL.D., F.R.S., F.R.S.E., F.L.S., was born on the 11th July, 1857. Sir David took his M.A. degree in 1878, M.B.C.H. (Hons.) in 1883, and F.R.C.S. (Edin.) in the same year and became the demonstrator in anatomy at the Edinburgh University. He then joined the Indian Medical Service in 1884 and officiated for L. J. K. Bruce as Curator of the Herbarium, Royal Botanic Garden, Sibpur, during 1885-86 and subsequently succeeded Bruce as a permanent Curator of the Herbarium in 1886, but his military service prevented him from joining this appointment for about 8 months. He took over charge of the post of the Curator of the Herbarium on the 24th January, 1887. He officiated as Superintendent of the Royal Botanic Garden, Calcutta, during the absence on leave of Sir George



SIR DAVID PRAIN, F.R.S.

King, M.D., K.C.I.E., F.R.S. in 1887. He again officiated as Superintendent, Royal Botanic Garden, Calcutta in 1888 and became Surgeon in October, 1889.

During 1889-91 he undertook hazardous botanical expeditions in some of the botanically unknown islands of the Indian Ocean and during his voyage he visited Port Blair in the Andaman Islands, Diamond Island, the Great Cocos and Table Islands in the Bay of Bengal. He voyaged also in H.M.S. *Investigator* and made botanical exploration in the Great Cocos Island, Little Cocos, the Rutland Islands, Narcondam, Barren Island, Little Andaman, Car Nicobar, Batti-malo and other coral islands. In

November, 1891, he explored the Pareshnath Hills in Chota Nagpur and in the spring of 1892 he studied the flora of the Khasia and Jaintia Hills in connection with his botanical survey of Assam and Burma.

He acted again as Superintendent of the Royal Botanic Garden, Calcutta from 15th of July to October, 1892 and again for a period of 7 months from 1892 to 1893. At this time for a period of 3 months from 1893-94, he was engaged in an enquiry on the cultivation and use of Ganja—*Cannabis sativa*. On the 1st of July in 1895, Sir David Prain was appointed Professor of Botany in the Medical College, Calcutta in the place of Sir George King and rose to the rank of Surgeon-Major in 1896 and was the foundation lecturer from 1895-96 of the Agricultural Class which was opened at the Bengal Engineering College in 1895. He succeeded in 1897 Sir George King as the permanent Superintendent of the Royal Botanic Garden, Calcutta, who retired after rendering 26 years of devoted and meritorious service. Soon after his appointment as Superintendent of the Royal Botanic Garden, Calcutta, in which post he was confirmed on the 1st March, 1898, he undertook investigation on the cultivation of mustard and wheat and was lucky to discover the host of the wheat rust. He continued his researches on economic plants as well and carried on investigations on the pulses and other leguminous crops by experimental cultivation in the economic section of the Royal Botanic Garden, at Sibpur.

In 1898, Sir David assumed charges of the posts of the Director, Botanical Survey of India and the Superintendent, Cinchona Cultivation, Bengal. He was also appointed a Trustee of the Indian Museum and elected a Fellow of the Calcutta University. He was awarded the degree of LL.D. of the Aberdeen University in 1900. Sir David was a member of the Council of the Asiatic Society of Bengal in 1897 and Vice-President with the late Sir Ashutosh Mukherjee and Sir Thomas Holland in 1904.

Sir David served in the Lhasa Mission and thus got an opportunity of studying the vegetation of the Tibetan frontier during September-October, 1903, and brought back a large collections of valuable specimens. On his return he paid special attention to the improvement of the Royal Botanic Garden, Calcutta, Lloyd Botanic Garden, Darjeeling and the Calcutta Gardens under his charge. Much of the present expansion and improvement of the cultivation of the cinchona plants at Mungpoo is due to

Sir David's care and attention to this section of his work.

After the expiry of his leave on the 15th December, 1905, he was appointed Director of the Royal Botanic Garden, in place of Sir William Thiselton Dyer, another botanist of world-wide fame.

Sir David served as the President of the Botanical Section of the British Association which met at Winnipeg, as President of the Linnean Society from 1916-1919 and as Vice-President and Treasurer of the Royal Society of London from 1919-1929. He was elected as Honorary Foundation Fellow of the Royal Asiatic Society in 1920. Sir David was a active member of numerous Boards and Committees of biological associations and many other scientific bodies where his well-balanced judgment and mature experience made him welcome. He was appointed a member of Tropical Agricultural College Committee by Lord Milner in 1919 and had been the Vice-Chairman of the Imperial College of Agriculture from its foundation in 1921 until 1937.

He was appointed a corresponding member of the Botanical Society of America in 1934 and 1936 and President for life of the Imperial College of Tropical Agriculture in 1938. Sir David became the Chairman of the Plant and Animal Products Council of the Imperial Institute, London in 1936. He sat on the International Committee of Plant Nomenclature that met in 1930 and 1935 at Cambridge and Amsterdam respectively.

Sir David was elected Fellow the Royal Society of London in 1905. He was recipient of C.I.E. in 1906. He received the degree of LL.D. of St. Andrew's

University in 1911; C.M.G. was conferred upon him on the 1st January, 1912 and was knighted on the 14th July, 1912. He was awarded Barclay Memorial Medal in 1909, the Albert Medal of the Royal Society of Arts for 1925 for the application of Botany to the development of the raw materials of the Empire; the Linnean Gold Medal in 1936 and the Paul Johamer Bruhl Memorial Medal in 1938 and the Barclay Medal again in 1941.

Sir David Prain gained world-wide fame as one of the most active and brilliant botanists by his valuable botanical publications and his scientific investigations which were of considerable value to the State. The total number of his contributions from 1889 to 1944 published in the *Annals of the Royal Botanic Garden, Calcutta* and many other journals and periodicals in India and abroad comes to about, as far as can be traced, 105 of which about 40 papers were published in the journals and *proceedings* of the Royal Asiatic Society of Bengal. Sir David Prain even before his death was still actively engaged in botanical work and was able to finish his monumental monograph on *Dioscoreas* in collaboration with Mr I. H. Burkill, M.A., F.L.S., formerly an officer of the Botanical Survey of India. This work entitled "An Account of the Genus *Dioscorea* in the East" has just been published in the *Annals of the Royal Botanic Garden, Calcutta*, Parts I and II, Volume XIV.

The death of Sir David is an irreplaceable loss to the botanical science.

K. Biswas.

Notes and News

OBITUARY

JAMES McKEEN CATTELL

THE death of James McKeen Cattell on January 20, 1944, has deprived America of one of the great organizers of American science and scientists. He occupied a unique position among American men of science and there were few who exerted so profound an influence on American scholarship for a period of about half a century.

J. McKeen Cattell graduated in 1880. He was a student of psychology in which he was deeply interested in the early part of his career. For ten years from 1885 to 1895, he was engaged in research on experimental psychology and published a number of papers which immediately attracted attention. Particular mention may be made of his paper on "Mental Tests and Measurements" (1890) and of the systematic collection of measurements of individuals which won early recognition in the form of a professorship in the University of Pennsylvania at the age of 28. Soon at the age of 31 he became head of the department of psychology at Columbia University. At 35 he was President of the American Psychological Association.

Although a successful professor of psychology, Cattell's fame was made as editor and publisher of scientific journals and organizer of American science in general. He was one of the first American scientists to realize the great power of the press, which he successfully demonstrated throughout his life. In 1894, he acquired the weekly journal *Science* which, under his ownership and editorial management, came to play an important role in the organization of science in America. In the same year he founded, jointly with J. Mark Baldwin, the *Psychological Review*. His success with *Science* led him to take over in 1900 the ownership and editorial supervision of the *Popular Science Monthly* founded by E. L. Youmans in 1872. Later in 1915, he changed its title to *The Scientific Monthly*. In 1907, he assumed control of *The American Naturalist* and in 1905 founded the weekly journal *School and Society*. The latter was one of the leading journals of education, which was afterwards sold to the appropriate body, the Society for the Advancement of Education. He was also a founder of the *Archives of Psychology* and the *Journal of Philosophy, Psychology and Scientific Methods*. He was a trustee of Science Service from its foundation until his death and was president of its board of trustees from 1928

to 1937. "American Men of Science" published in 1906 under his editorship and general directions and followed so far by six editions constitutes his lasting contribution towards the advancement of science in America.

Cattell was made president of the International Congress of Psychology held in America in 1929. In 1921, he founded the Psychological Corporation, a unique organization, to promote applied psychology. He was its president for many years and later the chairman of its board of directors.

THE PERSECUTION OF SCIENTISTS IN ARGENTINA

THE recent persecution of Argentine scientists, teachers and professional men for having participated in issuing a 'declaration for effective democracy and American solidarity' has elicited widespread resentment and protest. The declaration was jointly made by one hundred and fifty distinguished citizens of Argentina to give expression to their strong feeling that democracy and human freedom are indispensable for the welfare of mankind and for the progress of science. Among the signatories were some eminent scientists, such as Professors Houssay, Castex, Romano and others. Bernard A. Houssay, Latin America's greatest scientist, is a professor of physiology at the University of Buenos Aires and was awarded the Nobel Prize.

The President of Argentina has found the declaration libellous, although it 'simply approves the principles of democracy and calls for the co-operation of free men in its preservation', and has issued order by which the signatories have been censored and dismissed from their posts in the universities and public services. Medical men have been forbidden to practice. Professors Houssay, Castex and Romano are reported to have taken refuge in Uruguay, on the other side of the La Plata estuary.

Protest against such anti-democratic decree on the part of the Government of Argentina has been made by a number of distinguished scientific organizations of the United States of America, including the American Association of Scientific Workers. In a letter recently addressed to Cordell Hull, Secretary of State, the American Association of Scientific Workers has voiced its protest through the following lines:

"The American Association of Scientific Workers affirms that the existence of such an anti-democratic policy in one of the great countries of the Western hemisphere is a

menace to the welfare of all the peoples in this hemisphere. Recent events confirm our view. Our Association further asserts that the failure of the democratic nations of this hemisphere to condemn officially and to exert pressure to rectify this action of the Argentine Government would be a serious error, first because great injustice has been done, and second because the cause of democratic nations is weakened by ignoring the suppression of liberty and democracy.

Therefore, the American Association of Scientific Workers respectfully but urgently suggests that the Government of the United States of America, in concert with other nations of this hemisphere, take whatever actions may be most effective to the end that the Government of Argentina rescind its undemocratic decrees."

ELECTRICITY SUPPLY INDUSTRY IN GREAT BRITAIN

THE Incorporated Association of Electric Power Companies has recently issued a memorandum with regard to the Electricity Supply Industry in Great Britain. The memorandum refers to the progress of, and development and legislation in, the supply of industry, to the Electricity Commission, and to the work and recommendations of the McGowan, Cooper and Scott Committees, and further contains proposals of reform and improvement with regard to the electricity distribution and the Electricity Commission. The following account of the essential features of the proposals is based on a summary report of the memorandum, published in *Nature*, March 25, 1944.

The memorandum recommends the suspension, through legislation before the war, of the exercise of the rights of purchase by local authorities and others of any electricity undertaking without, however, preventing the completion of negotiations for the voluntary acquisition or amalgamation of such undertakings. The proposed legislation should prescribe the basis of the purchase price to be paid for acquisition of any undertaking. Tariff forms throughout Great Britain should be standardized and the uniformity of charges for the whole country secured as far as it is economically feasible. Legislation should provide in the case of retained undertakers for the application of an effective sliding scale relating prices to costs and charges, including a reasonable return on capital.

Electricity Commissioners should delimit suitable electricity districts and appoint a scheme committee for each district to prepare and submit to the Commissioners a draft scheme for the improvement of distribution in the district. The scheme committee should consist of representatives of the authorized undertakers in each electricity district. Further the Electricity Commissioners should be empowered to make schemes which the Minister of Fuel and Power will have the power to confirm. Any scheme thus confirmed should, however, be subject to the approval of the Parliament.

All retained undertakers should be obliged to submit periodically to the Electricity Commissioners proposals for the development of the supply of electricity for general domestic purposes, including lighting in any part of their area where there is a demand for such a supply and a prospect of a reasonable return from such supply. The Electricity Commissioners should appoint in each area a local committee representative of local authorities and consumers to consult with the retained undertakers on matters affecting development of supplies and prices.

It is considered that the present system of valuation and rating, which has recently excited adverse criticism, should be reviewed. The Association further advocates that the proposed legislation should include various provisions recommended by the McGowan Committee on matters such as the procedure for obtaining wayleaves, fixing wayleave rentals and compensation, public supply of electricity by unauthorized undertakers, and the consolidation of the numerous Electricity Acts into one up-to-date enactment.

The memorandum further recommends the establishment of Electricity Commission whose necessity has become acute in recent years. The Commission should consist of five Commissioners to be drawn from among men of long and wide experience in the industry. The Commissioners should be enabled to appoint an experienced and well-paid staff. The Minister should have the widest choice in appointing suitable men to the Commission. The members of the Commission should not be governed by civil service conditions and rates of pay. An advisory committee should be appointed by the Minister of Fuel and Power to assist the Electricity Commissioners on matters relating to the delimitation of electricity districts and other proposals.

REPORT OF THE INSTITUTION OF ELECTRICAL ENGINEERS

ALMOST simultaneously with the memorandum issued by the Incorporated Association of Electric Power Companies has been published another report prepared by the Post-War Planning Committee for the Council of the Institution of Electrical Engineers. This report has also come forward with a series of important proposals and recommendations concerning the technical aspects of the problems of electricity supply, distribution and installation in Great Britain (*Nature*, March 25, 1944).

The four-wire, three-phase, 400/230-volt system being the national standard for low-voltage distribution, its extension throughout Great Britain has been

suggested as an urgent post-war national industrial plan. The report contains relevant data to show clearly that the problem of complete standardization of low-voltage distribution systems does not present any technical difficulties and assures that this standardization, if undertaken, can be completed within five years. Detailed estimate of the cost, drawn up on the basis of 1939 conditions and price levels, indicates that about £17.5 millions will be required for the purpose.

The report reveals that in 1939, 7.9 million urban dwellings out of 10.7 million, 1.1 million rural dwellings out of 2.25 million and at least 35,000 farms were supplied with electricity. The report recommends that rural electrification should be completed and that financial aid should be provided. Agreement by undertakings on a standard length of underground service cable laid free is recommended. A free overhead service line to a total cost not exceeding that of installing the agreed length of underground service cable is suggested. Simplified and less expensive constructions for high-voltage spur lines are proposed, and agreed standards are recommended. It is to be noted that, unless the consumer is prepared to contribute to the first cost or a subsidy is available, revenue must be adequate enough to justify expenditure on such overhead lines.

The report has made some proposals regarding the establishment of uniformity of tariff forms. Consumers are classified into groups, such as domestic, farm, industrial and commercial, and recommendations are made for the equitable assessment of the fixed or primary charge component of the tariffs appropriate to each group. It is suggested that the Electricity Commissioners should be authorized to permit any undertaking to offer a two-part tariff only, with no alternative flat rate subject to certain safeguards to the consumer.

The report proposes basic changes in the Regulations for the Electrical Equipment of Buildings. Although the need for compulsory registration of contractors and operatives or for the exactment of compulsory wiring regulations is not at present imperative, extension of inspection of installations by supply undertakings, more general observance of wiring regulations, wider use of the voluntary system of registration of installation contractors, insistence on the use of non-kinkable cords for portable apparatus and the manufacture of accessories and apparatus according to more recent British Standard specifications appear highly desirable.

The memorandum and the report indicate that supply and distribution of electricity have not yet been completely nationalized in Great Britain. The foregoing proposals have been made with a view to

introducing more thorough and effective state control of electricity supply and distribution. Much as we appreciate such attempts on the part of distinguished British associations to set their own house in order, we cannot help referring to the hopeless situation in which India now finds herself with regard to electricity supply. Electric companies in India enjoy the privilege of almost unrestricted monopoly and have never cared for consumer's interest which is a superfluous talk in this country. On several occasions the Government was urged upon to introduce effective State control over the production, supply and distribution of electricity, but each time such proposals have been whittled down in favour of the vested interest. The ill-conceived electricity legislations still remain a permanent stumbling block to the natural growth of power and electricity industry in India. In the matter of power consumption India is still as backward a country as Abyssinia or China, despite her abundant power resources in the form of coal and running water. The rate charged per unit of electricity is unusually high, being 3.75 annas (in Allahabad) against 1.25d. in England for domestic use. The extent of profiteering is adequately reflected from the amount of dividend the companies declare, which is sometimes as high as 13 per cent. All these are largely due to the unnational policy of the Government and, we are convinced, the evils of monopoly cannot be satisfactorily combated until power production and supply are nationalized.

CENTRAL GLASS INSTITUTE

SIR S. S. BHATNAGAR, Director of Scientific and Industrial Research, has announced, at a luncheon given by Mr D. N. Sen, President, Bengal Glass Manufacturers' Association in Calcutta, the decision of the Central Glass and Silicate Research Institute Committee to recommend that the Central Glass and Silicate Research Institute should be located at Calcutta. We learn with satisfaction that the Government of India has sanctioned a sum of Rs. 4,00,000 for the establishment of the Institute. Further, Sir U. N. Brahmachari, Mr I. D. Varshney, of the Central Glass and Silicate Research Institute Committee, and the Bengal Glass Manufacturers' Association have promised to donate a sum of Rs. 10,000 each towards the setting up of the Institute.

THE NATIONAL RESEARCH COUNCIL OF CANADA

CONSIDERABLE attention has recently been focussed on Canada for her remarkable contribution to the United Nation's war effort and her enviable record of accomplishment in the application of science to

war needs. The credit for this uniquely goes to the National Research Council of Canada, which is acting as the central co-ordinating body directing scientific research in the Dominion. A brief account of the way in which the Council has planned, co-ordinated and conducted scientific research in Canada on problems having a direct bearing on the prosecution of the war has appeared in a recent issue of *Science* (February 4, 1944), to which the attention of our readers may be drawn.

The work of the Council is generally planned along two main lines, (1) the conduct of fundamental and applied research, including essential test work in the National Research Laboratories, Ottawa, and (2) the promotion, co-ordination and support of research in other centres throughout the Dominion by grants-in-aid, award of scholarships and the direction of research investigations under the guidance of committees of specialists appointed by the Council. All investigations, either in its own laboratories or in the laboratories of the universities and industry, are at present directed to the solution of urgent war problems. In fact, the Council is now the official research station of the Army, Navy and Air Force. Scientific problems referred to the Council in connection with the activities of the Armed Forces are studied jointly by officers from Defense Headquarters and civilian personnel on the Council staff.

There are now some forty committees in active operation under the auspices of the Council, through which much of the Council's work is carried on. The Committees on medical research deserve special attention because of their important contributions to the health and well-being of both civilians and members of the fighting services. The Associate Committee on Medical Research co-ordinates medical research in Canadian institutions and assists in its development. Three Service Committees, e.g., Aviation Medical Research, Naval Medical Research and Army Medical Research, have been brought into existence. Mention may also be made of another important committee which is responsible for the direction and co-ordination of research in Canadian universities on sixty projects dealing with problems on the production of explosives now in use, and the development of new explosives.

The National Research Council of Canada further maintains an effective liaison with the scientific organizations in Great Britain, the United States and other Dominions through the exchange of publications and the interchange of research workers.

THE ROYAL OBSERVATORY AT GREENWICH

NEED has been felt of late for the removal of the Royal Observatory, Greenwich, to a safer and

better place where useful work may be carried on under more advantageous conditions. The removal of the Observatory from its present site has been under consideration for the last few years and has now become urgent owing to the damage it has sustained through aerial bombing. The reasons for its removal have recently been discussed in *The Times*, London, by its naval correspondent.

The Royal observatory was established in 1675 and located at Greenwich, a country village well clear of London smoke. For over a period of two and a half centuries it has been responsible for advancement of the science of navigation and nautical astronomy. The meridian passing through its transit instrument has provided the standard of reference in the measurement of longitudes. But Greenwich is no longer situated in a sequestered rural corner suitable for astronomical observations. London has to-day engulfed it and smoke from the chimneys of the newly constructed power stations and the vibration of its reciprocating engines have increasingly come to interfere with its work. The great development of electrical machinery already proved a serious obstacle to accurate magnetic observations, and as such the magnetic observatory was removed some years ago to a country site in Surrey. Such disturbances to-day seriously interfere with the work of the observatory in general. It is strongly felt that unless the observatory is removed to a suitable site, it will be destined to deteriorate into a second rate institution and will fail to play the significant part it did for so long a period. It may be noted that the need for the change of site was stressed by the Astronomer Royal, Dr H. Spencer Jones in 1939 when he submitted his annual report for the year ending April 30. [*Vide SCIENCE AND CULTURE*, Vol. 5, No. 2.]

THE ROCKEFELLER GRANT TO THE NATIONAL INSTITUTE OF SCIENCES, INDIA

Indian scientists will cordially welcome the Rockefeller Grant of Rs. 16,000/- annually to the National Institute of Sciences, India, for financial assistance in scientific publications by the different scientific societies of India. International science owes a great debt to this philanthropic organization for financial assistance in matters of maintenance of research institutes and for grants to scientific societies, an account of which will be found in *SCIENCE AND CULTURE* (Vol. VII, No. 1 and Vol. VIII, No. 5). But so far, except in medical matters, Indian science has not received any attention from the Rockefeller Foundation. The present grant which we can trace to the influence of Prof. A. N.

Hill indicates that the foundation has been persuaded to include India within her sphere of operations.

The Royal Society of London receives a grant of £8,000/- from the British Treasury for assistance in scientific publications and distributes this grant through its committees to the different scientific societies of England. In India, we have now national societies in almost every scientific subject, e.g., Geology (1906), Mathematics (1907), Botany (1921), Chemistry (1924), Physics (1934), Soil Science (1934) and Physiology. Some of these have nation-wide membership and scope; others have as yet only a small membership and influence. But all these societies suffer from paucity of funds and often fail to undertake useful scientific publications for sheer lack of money. Regularity in the publication of periodicals devoted to original articles and papers has often become difficult. Clearly, the scientific societies in India are badly in need of financial assistance and more liberal grants. By making this grant the

Rockefeller Foundation has earned the gratitude of the scientists of India.

A NEW PUNJAB OIL FIELD

A cable from London to Mr D. N. Wadia from Mr F. S. Pinfold, Chief Geologist of the Attock Oil Co., announces the successful results of the boring tests proving the existence of natural oil (petroleum) at Joya-Mair village, near Chakwal, in North-West Punjab. This area was geologically surveyed in course of his Potwar Survey by Mr Wadia who discovered this favourable oil-storage structure at Joya-Mair and reported it to the Government in 1926, suggesting this area as a possible oil-field in a paper published in the *Records of the Geological Survey of India* in 1929. For fourteen years this discovery remained untested by actual drilling trails.

AN ERRATUM

In line 22 of the left column on page 550 of the June, 1944 issue read 0'86 acre for 6'86 acre.

SCIENCE IN INDUSTRY

GAS TURBINES

THE recent progress in the design of gas turbines has generated the sincere hope that gas turbines are destined to revolutionize power generation in near future. Their great operational simplicity already bears a promise that they will eventually outdo other forms of engines now in use.

At present the reciprocating steam engine, the Diesel and the gasoline engine are generally used for all purposes of power generation. Each of these three different types of engines has its own special advantages and limitations and has accordingly found application in different fields. The reciprocating steam engine is the most inefficient of all these machines, having an efficiency of only 8 to 12 per cent. It also involves a complex and bulky arrangement inasmuch as it requires an auxiliary steam-generator plant. For these reasons steam turbines have so far been exclusively used for the production of large units of power such as are required in ships and central-station electric generators. The Diesel and the gasoline engines are, however, more efficient, so far as power output is concerned, but involve great mechanical complexity. The Diesel engines have an efficiency of about 20 to 25 per cent, while

gasoline engines command an efficiency of about 35 per cent. But this advantage in higher efficiency has almost been negated by the higher cost of fuels and by the extremely complicated designs of the engines. The Diesel has been found suitable for heavier transportation equipment and stationary power generators, but the gasoline engine burning the most expensive 100-octane fuel has so far been applied to drive only light automobiles and aircraft where the saving of weight in engine and fuel is imperative.

The principle of gas turbine was, however, known for several years, but its application was delayed by the absence of a suitable metal or an alloy capable of withstanding high temperatures. The development of gas turbines followed the successful manufacture of alloy steels and other temperature-resistant metals.

The gas turbine is a special type of enclosed multiple wind-mill operated at high speed by hot wind. The hot wind may be directly produced by burning a fuel in a stream of air or may be available as a bye-product, such as the aircraft engine exhaust gases to run turbo-superchargers which compress thin, high-altitude air for aircraft engine. As a bye-

product, the wind may also be obtained in the recovery of power from the burning of deposited carbon from catalysts used in gasoline production. Though considerable progress has been made in the design of turbines driven by hot wind obtained as a bye-product from the above sources, further researches are necessary before such turbines can be used as a primary power generator. Design of turbines driven by hot wind and directly produced by burning a fuel has, however, been successfully developed.

In point of efficiency the gas turbine, it appears, will remain inferior to gasoline engine. But its other advantages far outweigh its comparatively low efficiency. The gas turbine presents a far simpler mechanism; it eliminates the steam turbine's steam generating and condensing system and the gasoline engine's cooling system. Furthermore, the problem of lubricating hot, sliding surfaces does not arise in such turbines. According to a report in *Scientific American*, March 1944, a Swiss oil-burning gas turbine locomotive constructed before the war commanded an over-all efficiency of 15-18 per cent. This is a satisfactory percentage compared with 8 to 12 per cent for a steam locomotive and about 28 per cent for a good stationary steam turbine. Furthermore, as is well-known, the efficiency of gas turbine is proportional to the operating temperature, and as such it increases with the temperature. Thus the turbine which indicates an efficiency of 18 per cent at 1000°F will have an efficiency of 23 per cent at 1200°F. The operating temperature cannot, however, be increased indefinitely and the limit is soon reached. The use of new, non-machineable and non-ferrous metals for the construction of rotor blades has made possible the operation of the turbines at a temperature of 1500°F and higher with the consequent increase in efficiency.

Gas turbines have so far been successfully applied to large power installations. In fact, the technical difficulties in the construction of large gas turbines have been overcome; but the manufacture of small gas turbines suitable for automobile and aircraft is still fraught with several difficulties. Investigations in this direction are, however, on the way and would have been completed but for the war. Recently a committee on gas-turbine-powered locomotives, in its report to the American Society of Mechanical Engineers (*Science*, January 21, 1944), indicated the possibility of constructing a high-powered locomotive in one unit with the prime mover and all accessories in one cab. It appears that this type of power will be used in countries enjoying a reasonable supply of fuel oil. Countries rich in coal but deficient in fuel oils need not be disheartened, as more economic production of fuel oil from coal in future holds out a fair chance

of gas turbine locomotives being also used in those countries.

ALUMINIUM FROM CLAY

ECONOMIC production of aluminium from sources other than bauxite has recently occupied the attention of scientists. According to a report in *Science*, March 17, 1944, F. R. Archibald and C. F. Jackson, scientific consultants of the Ancor Corporation, speaking at the meeting of the American Institute of Mining and Metallurgical Engineers, expressed their opinion that aluminium may be economically extracted from clay. High-alumina clay, limestone and coal are three materials required in large quantities for this purpose. Each ton of clay would require about two tons of limestone. Further where coal is not available, other types of fuel may be used. The success of the process has already been demonstrated by a pilot plant in South Carolina, U. S. A., which utilized the Kaolin-type clay available in that State. It is further reported that a commercial plant is now under construction in that State.

Production of aluminium from clay is a significant development. There are regions where all the raw materials needed for the extraction of aluminium from clay are available in plenty and in a high degree of purity, and henceforward production of aluminium may profitably be undertaken in those regions.

COKE FROM PEAT

The Chemical Age, in its issue of February 12, 1944, reported the perfection of a process of making coke from peat at the Central Experimental Station, Moscow. It is claimed that this coke can be used to replace coal-coke in iron and steel manufacture and that it is also a substitute for charcoal. Referring to this report, Fritz Frank, Director of Franks Laboratories, Ltd., has now supplied further information about this process in a letter to the editor of *The Chemical Age*, March 4, 1944.

According to Director Frank, experiments on the process of making coke from peat were successfully conducted in Russia exactly sixteen years ago. The coke was good and firm enough to be used in medium high furnaces for the reduction of iron ore. The iron produced compared favourably with the Swedish charcoal iron in quality. The treatment process in which bog-iron ore was washed and formed with peat was particularly interesting. The peat-iron briquettes thus obtained were very firm. They also dried very rapidly and stood after coking in the tallest furnace available in Russia at that time.

Owing to the war, it is stated, the work could not be further pursued; but good results were reported from time to time from Russia.

The writer further observes that in the metal industry peat-coke has proved superior to charcoal in almost every case because it possesses greater density and an equally high capability of reaction in all cases of metal treatment.

RECENT DEVELOPMENTS IN THE ELECTRON MICROSCOPE

A note on the recent developments in the electron microscope, appearing in *Physics News Letter* issued by the U. S. Office of War Information, draws attention to a paper by V. K. Zworykin and J. Hillier in *The Physical Review*, November, 1943 on this subject.

During the past year, considerable development work has been done on the various optical components of the electron microscope. The effect on the

specimen illumination of the electron gun focussing has been calculated. The results show that for some adjustments of the electron gun, the condenser of a conventional microscope exerts practically no control over the illuminating beam. The resolving power of an electron microscope objective has been investigated thoroughly with and without a physical limiting aperture. It was found that for heavy specimen particles the resolving power was roughly twice as good with a limiting aperture as it was without. The best resolving power obtained was 24A. The distortion of the final image caused by the projection lens errors has been investigated, and methods for greatly reducing this distortion have been found. A small magnetic electron microscope has been developed. The resolving power obtained at present exceeds 50A. This instrument uses no condenser lens, while the objective and projection lenses are incorporated in a single magnetic circuit excited by a single regulated current supply. Internal photography is used although, because of the small volume, no air locks are necessary.

INSTANTANEOUS RECORDING

NIRODE BANNERJEE,

RECORDIST, THE HINDUSTHAN MUSICAL PRODUCTS LTD., CALCUTTA

THE shellac prints of the standard gramophone records, the technique of which has been described in a previous article (*Vide SCIENCE AND CULTURE*, June, 1943), are the outcome of a very elaborate and expensive process. It is desirable, for certain purposes, to evolve easier methods by which sound recording can be done in a way such that it may be reproduced immediately. The process for such purpose should be simple enough to be operated by any layman,—it must be quick, inexpensive and sufficiently accurate in the representation of one's voice. It should also be durable enough to be played back a number of times without any loss of the recording quality.

Those who have witnessed the commercial process of recording on wax have marked the fact that recordists usually take a few lines of test of the voice of the artists before final recording. The test cut is reproduced immediately to show how the things will be finally recorded. Thus it is seen that the soft wax discs may be instantaneously played back but it differs in an important matter from instantaneous recording. In the wax, the recorded lines are

readily damaged, but in the latter a good many playbacks can be obtained without any damage to the line and loss of recording quality.

DEMAND AND SCOPE OF INSTANTANEOUS RECORDING

There has been an increasing demand for instantaneous recording for various purposes, as noted below:—

(1) *Preservation of voice.*—Many people have the desire to preserve their voice just like their own photograph, and would like to hear the voice of their dear and near ones who have passed away. With the invention of instantaneous recording on discs it has now become quite inexpensive to get a copy of one's recorded voice.

(2) *Use in Schools and Universities.*—Instantaneous recording machines can be easily installed in universities and schools and can be profitably utilized for education. With this machine we can record down pieces of lectures delivered by eminent professors of the day, and these may be reproduced later on at any time we like, to the great pleasures of those who

have missed the lectures directly. Moreover, the exchange of lectures is possible between colleges and universities to the great encouragement of the students. A great demand of instantaneous recording would be found in Blind Schools as well.

(3) *Use in Music Schools.*—Instantaneous Recording has been utilized now-a-days by many music schools in other countries. They are employed both for imparting lessons to the pupils and to save the unnecessary straining of the teachers by repetition and also for demonstrating the defects and merits of the students. This is also an excellent aid to train the voice for any aspiring musician.

(4) *As a tool of research.*—Instantaneous recording is an essential aid to the acoustical researches in the laboratory. Any sound under investigation can be recorded first, and analyzed later on. It may also be employed to record and generate standard sounds and notes for comparison.

(5) *Use in broadcasting stations.*—It is well-known to the readers that all the broadcasting studios have the equipment for instantaneous recording. These are employed either for recording the music of eminent musicians or the lectures of eminent persons or for holding an important broadcasting from abroad which can be played back and rebroadcast from the local stations at convenient hours.

HISTORY OF DEVELOPMENT

The history of instantaneous recording begins with Edison's phonograph which employed wax-drum. The voice was recorded on the rotating drum by the hill-and-dale dentations of the needle attached to the diaphragm at the back of the horn, and reproduced by the same needle and horn. But the lines would not keep intact for sufficient times just like the flat wax discs on our standard gramophones owing to the softness of the material.

Although instantaneous recording on wax and plastics have covered a wide field, attention has been considerably drawn in recent times on the development of the process of recording sound on steel tape by the process of magnetization.

In this type of recording, the steel-tape is the recording medium. The principle consists in magnetizing the tape which runs between the chisel shaped pole-pieces of an electro-magnet. This electro-magnet is energized by the current which is modulated by the pressure of the sound wave at the microphone and later on increased or amplified by the amplifier. With the vibration of the voice at the mike, the strength of the electro-magnet varies, and the passing steel tape is impressed with the corresponding magnetization. This may be called instantaneous magnetic record-

ing. When the steel tape is again drawn between the pole-pieces of the electro-magnet in the reproducing machine, the current in the coil of the electro-magnet receives back the variations which work on a earpiece or loud speaker. The reproduction was poor previously, but by using a film coated with a deposit of iron (as devised by A.E.G.) or steel tapes having a large coercive force (as developed by Lorenz Company), the quality of reproduction has now been greatly improved. The tapes are usually run at a speed of a meter per second and a 50 minutes' recording is now quite possible on tapes. The tape may be demagnetized and used again for a fresh recording. Its principal application is in commercial firms where a busy *entrepreneur* may leave his message to his secretary which may be reproduced later. Some broadcasting stations are also using this type of recording machine.

But modern developments in instantaneous recording are directed towards the disc type which may be electrically recorded and played back immediately on an ordinary gramophone. Pre-grooved metal discs were first tried about the year 1926. The metal was an alloy of aluminium and zinc. The recording quality was very poor and it was suggested to coat the discs with such material as would ensure a soft cut like that on wax with an added advantage of harder lines and grooves.

Since 1928 great advances have been made in instantaneous recording which uses plastics. A large varieties of natural as well as synthetic plastics were tried over metal discs as the record base. The plastics coated metal discs are no longer pre-grooved, but the grooves are cut in the spiral way by some feed mechanism attached with the driving spindle of the recording machine. At first gelatine was tried which produced more or less satisfactory recording quality. But it was rejected as it is soluble in water, dries up quickly and cracks after some time. Celluloid discs were also tried but were rejected as this material is highly inflammable and flexible.

RECENT DEVELOPMENTS IN ACETATE DISCS

The invention of the coated discs commercially known as acetate discs is the outcome of a great deal of experiment and research. This consists of an aluminium or glass base sprayed with smooth coating of cellulose and other high boiling plasticizers. These coated discs have the following advantages:—

- (1) They are non-breakable (when the base is aluminium) and non-inflammable.
- (2) They can be played back several times without making any damage to the recorded grooves.
- (3) They can be cut by steel as well as by sapphire needles.

(4) They can be used for making masters in the processing work for producing hard commercial records which are usually done through wax discs.

After the recording is done the discs are swabbed with a chemical solution to make the grooves harder. The solution consists of 50 parts of a 50 per cent solution of acetic acid to which is added 25 parts of pure alcohol (absolute) and 25 parts of light machine oil. The dope should be applied by means of clean soft rag and rubbed well on the surface after which the disc should be polished with another clean rag. The discs hardened by the dope may be played back at least 70 times in an ordinary gramophone with steel needles.

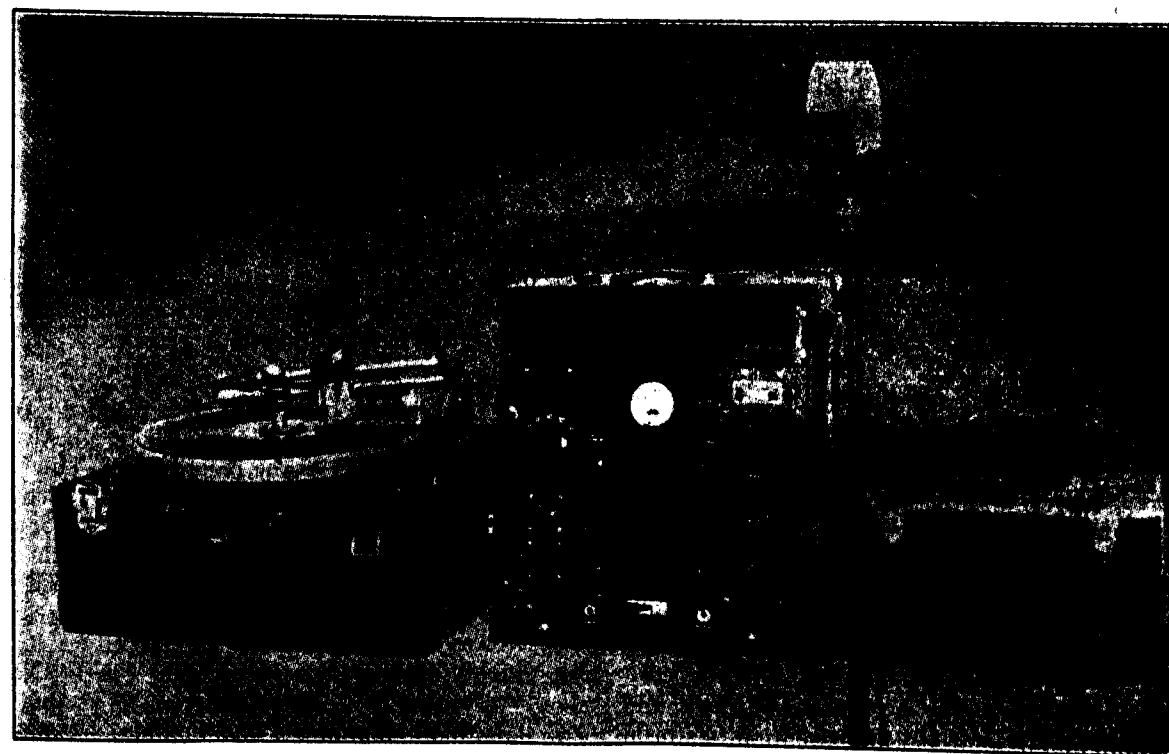


FIG. 1. Presto complete 16" portable recording equipment used the world over by radio stations, advertising agencies, and recording studios for making phonograph records and electrical transcriptions. The equipment is suitable for both studio and field work.

A complete standard instantaneous recording equipment consists of the following items:—

- (1) A heavy turn-table driven by an electric motor connected with a flexible coupling device with the turn-table.
- (2) A feed mechanism which cuts the spiral lines.
- (3) A magnetic recording head and a play-back pick-up.
- (4) A high-fidelity type microphone for transferring the sound impulses into electric current and

a high-gained amplifier capable of amplifying that small current into sufficient strength as to work the recording head.

The technique of recording is identically equal to wax recording except the speed of the turn-table which is $33\frac{1}{3}$ usually, in place of 78 r.p.m. for standard recording. In addition to this, instantaneous recording is done from inside to outside in place of from outside to inside of standard wax recording.

The question of popularizing instantaneous recording was felt in India few years ago. Production of coated disc at a cheaper cost is one of the important factors in making this type of recording

popular. The standard synthetic discs contain some percentage of nitrocellulose, and the research work which was carried on at the Indian Lac Research Institute under the direction of Dr H. K. Sen was directed to utilize shellac plastics as the chief ingredient. Discs that have been produced at Namkum Laboratory are the same in quality with the other standard discs of the market. The principle adopted in the manufacture of these discs will be described now.

3 lbs. of linseed oil fatty acids are heated with efficient mechanical stirring in a tin-lined copper or enamel kettle to 150°C and 10 lbs. of powdered dewaxed lac (flow not more than 140-150 seconds) added in small lots till intimately mixed. The temperature is then quickly raised to $175-180$ degrees and 1.2 lbs. of glycerine is added in a thin stream. The cooking is continued at the same temperature till the acid value comes down to about 40-45 ($2\frac{1}{2}$ hours). The mass is now allowed to cool down to about 100°C and dissolved in 1.0 gallon of rectified spirit or redistilled denatured alcohol, and the alcoholic solution run in a thin stream into 2 gallons of distilled water containing 0.8 lbs. of liquor ammonia, (d. 0.88) or its equivalent amount of dilute ammonia.

As freedom from dust and suspended matter is an absolute necessity, the varnish so obtained may first be filtered through finest muslin and then run through Sharple's super-centrifuge. The coating and baking of the blanks must be performed in a dust-free and, if possible, air-conditioned room.

Application to the aluminium of other bases is effected best by spinning on a mechanically driven vertical spindle and flowing the varnish on to the disc from inside to outside. After air drying the disc is baked at $90-95^{\circ}\text{C}$ for an hour.

The discs are best recorded at least a fortnight after the coating is given, and with a fresh steel needle the surface noise is very little being of the order of about 22 to 24 db below the programme level at 78 r.p.m. and about 20 to 22 db at $33\frac{1}{3}$ r.p.m. as against 40 and 36 respectively for other commercial discs under the same condition. With sapphire needles the results are still better. The quality of the reproduction compares very favourably with the best imported acetate discs, and the life may be increased considerably by baking the recorded discs at $90-95^{\circ}\text{C}$ for a few hours.

The discs are usually made of aluminium or glass, and glass gives the best surface to be coated with the recording plastics. Discs have also been manufactured out of shellac—formaldehyde-urea moulding powder. The lac moulded disc has to be baked first at 80°C for about 8 to 10 hours and then at 120°C for about 24 hours, cooled and polished and then used for the coating. (The discs manufactured under this process have been patented under the Indian patent number 29193).

Another improved composition for which patent is being applied for is making use of lac and metallic soaps. Discs produced of this composition has less surface noise and better keeping qualities.

CONCLUSION

Instantaneous recording represents a further stage of development of recording technique and has the following distinct advantages over wax recording.

(a) A commercial wax record has the maximum capacity for accommodating 3 minutes 30 seconds recording, whereas a 16" instantaneous disc operated at $33\frac{1}{3}$ r.p.m. can safely contain 15 minutes' recording.

(b) In technical experiments for judging the recording quality of a recording equipment under different recording conditions where a number of playbacks are necessary, an instantaneous disc is more suitable than a wax record as the latter is more easily spoiled with playback.

The instantaneous recording has now become almost as durable, noiseless and accurate as the commercial records, yet added with many other advantages as detailed previously. The technique has received wide attention and is expected to be more widely used in future in various fields.

To popularize instantaneous recordings two things are of primary importance:

(1) Production of cheaper type of discs which may be prepared from some products easily available locally and (2) production of cheaper type of recording machines. Instantaneous recording may be utilized by some enterprising smaller concerns as a source of income by installing a cheaper type of complete recording equipment (at pre-war period a complete recording equipment was available at approximately Rs. 1,000/-) and organizing recording centres where any one can come and record his voice or music at a reasonable fee.

Instantaneous recording on discs has become so popular in U. S. A. and Europe that even the same is done at home, and for its wide circulation it is termed as 'home recording.'*

* The writer acknowledges his indebtedness to Dr H. K. Sen, Director of Indian Lac Research Institute, Namkum, for his very kind encouragement by giving the writer the data and principles of manufacturing these discs and by allowing him to publish the same in the present article. His thanks are due to Mr A. Banerjee, Chief Engineer and Director of Hindustan Musical Products Ltd., Calcutta for affording him all the facilities to carry on recording works with Instantaneous Recording Machine. He also conveys his thanks to Mr Kamalash Ray of the Physics Laboratory, University College of Science, Calcutta, for giving his valuable suggestions in preparing the present article.

MEDICINE AND PUBLIC HEALTH

RADIO-ACTIVE ELEMENTS FOR CANCER

CURE of leukemia, lymphosarcoma, plasma cell myeloma, Hodgkin's disease and polycythemia vera by a treatment involving the combined use of X-rays and radio-active elements such as phosphorus, iodine etc. has been reported in a recent issue of *Science News Letter*. Such a combination treatment has been tried on about 100 patients at Memorial Hospital, U. S. A. Chronic lymphatic leukemia is markedly improved as shown by a pronounced diminution in the number of white blood cells whose overproduction is a feature of this cancer-like disease. The quality of the red blood cells also improves under the treatment. In cases of lymphosarcoma, there is a reduction in the size of the masses or tumours. Improvement has also been noted in cases of polycythemia vera. Radio-active phosphorus may be given orally or by intravenous injection.

Further, the use of radio-active elements has opened up a new field for the diagnosis of cancer. Radio-activity is induced to elements, ordinarily non-radio-active, by the cyclotron. In one set of interesting experiments, radio-active iodine was used to treat both cancer and benign tumours of the thyroid gland. One of the patients so treated later complained of pain in a small area of his skull. With the help of a Geiger counter the doctor was soon able to detect marked activity at the area where pain was reported, and thus demonstrated the presence of radio-active iodine in that region. It is evident that cancer must have spread from the neck to the head.

The fact that certain tissues are susceptible to specific substances has revealed new clues not only for diagnosis, but also for treatment. Thus, irradiated zinc is deposited in the pancreas, irradiated sulphur in the skin and irradiated strontium in the cortex of bones. Further investigations are, however, necessary before these new evidences can be turned to good use.

CONTROL OF LEUKEMIA

LEUKEMIA is a fatal malignant disease characterized by increased number of white cells in the blood. Dr James B. Murphy and Dr Ernest Strum, of the Rockefeller Institute for Medical Research, have recently made some important studies regarding the possibilities of bringing leukemia under complete control, according to a report in *Science News Letter*.

Their studies indicate that resistance to leukemia is apparently related to the glands of internal secretion. These glands include the pituitary, thyroid, thymus, adrenals and sex glands. It is as yet unknown which of these glands are involved. Knowledge as to the exact nature of this relation is also lacking. Their evidence, however, implicates both the thymus and adrenal glands.

The studies have so far been made with rats. Removal of the adrenal glands greatly reduced the resistance of these animals to a highly malignant form of transplantable lymphatic leukemia. Less than half, 46.9 per cent, of a group of these animals from a strain very receptive to this transplantable leukemia developed the disease upon inoculation, but almost all, 90.3 per cent, of a group of animals of the same receptive strain developed it when inoculated after their adrenal glands had been removed.

The disease in these animals is characterized by extensive invasion of the thymus gland, which, as other scientists have found, is greatly stimulated by loss of the adrenal glands. Lack of these glands and their hormones apparently upsets the normal balance between the various endocrine glands in such a way as to make the animals more susceptible to this form of leukemia.

It is hoped that further work along this line will show what specific glandular imbalance may be responsible for lack of resistance to leukemia. If this can be learned, and if the rat findings apply also to men, it may be possible to find a way of stimulating leukemia resistance so as to prevent or cure the disease.

AWARDS OF LADY TATA MEMORIAL TRUST

THE Trustees of the Lady Tata Memorial Trust announce the awards of the following scholarships and grants for the year 1944-1945.

International Awards for research in diseases of the blood with special reference to Leukaemias have been made to the following workers:

(1) Prof. L. Doljanski, of Jerusalem, to continue studies on (a) leucotic cells and agent of fowl leucosis in vitro; (b) the X-ray susceptibility of leucotic agent; (c) the cell affinities of oncogenic viruses and the mutual relationship between Rous Sarcoma agent and agent of fowl leucosis; (2) Dr Jacob Furth, of American nationality, Cornell Uni-

versity Medical College, New York, to continue the work in progress upon the leucaemias like diseases of fowls and their relation to neoplasms and to determine the nature of viruses producing leucaemias and associated neoplasms, lymphomatosis, myelomatosis, endothelioma, sarcomas, etc., etc.; (3) Dr P. A. Gorer, Guys Hospital, London, to continue the studies in the genetics of mouse leucaemia; (4) Dr A. H. T. Robb-Smith, Nuffield Reader in Pathology and Morbid Anatomy, Oxford University, to continue the aid to the establishment of a "Lymphonode Registry" in the School of Pathology at Oxford to aim at better classification and follow up of human cases showing progressive hyperplasias and neoplasms of the lymphoreticular tissues including cases of the leucaemias, lymphadenoma, lympho sarcoma, etc.; (5) Dr Werner Jacobson, part-time Sir Hailey Stewart Fellowship at the Strangeways Research Laboratory, Cambridge, to continue the study of making a histo-chemical study of the argentaffine cells of the gut epithelium, with a view to determining whether they are the source of the intrinsic factor of Castle, and hence their bearing on the problem of pernicious anaemia and other blood diseases; (6) provisional grant of £400 to the worker under Prof. Witts to confirm Dr Jacobson's research.

Indian Scholarships of Rs. 150/- per month each for one year from 1st July, 1944 for the following scientific investigations having a bearing on the alleviation of human suffering have been granted to the following workers:

(1) Mrs Alamela Venkataraman, Haffkine Institute, Bombay:—Synthesis of sulphanilamide derivatives; (2) Mr Arobinda Roy, University College of Science, Calcutta: The absorption rate of different edible oils used in India and the effect of Vitamin A and D and hydrogenation; (3) Miss Violet DeSouza, Indian Institute of Science, Bangalore: The investigation of strains of yeast and other hybrids as sources of the Vitamin B complex; (4) Mr Narayan Gopal Joshi, Tata Memorial Hospital, Bombay: Vitamin Metabolism in Cancer with special reference to Ascorbic acid and Glutathione; (5) Mr P. K. Bhattacharyya, University College of Science, Calcutta: Investigations on anti-bacterial substances produced by moulds; (6) Mr S. Dattatreya Rao, Indian Institute of Science, Bangalore: Investigations on the influence of tocopherol and fat on the absorption and utilization of Carotene and the function of Carotene in the animal system.

PENICILLIN IN INDIA

WE learn with satisfaction that penicillin, the new drug which is one of the major discoveries of this war, is now being produced in Bombay. Working in close collaboration with British and American scientists, the staff of the Haffkine Institute, Bombay, under the supervision of Col. Sokhey, Director of the Institute, are growing small cultures of penicillin mould under low temperature. From these penicillin in its pure state will later be extracted.

PENICILLIN

A. C. UKIL
CALCUTTA

THOUGH immediate credit for the discovery and development of Penicillin as a powerful therapeutic remedy against certain bacterial infections goes to a batch of British workers, the clues were obtained much earlier. As early as 1877, Pasteur and Joubert noticed the inhibiting action of some bacteria on the growth of others, which led them to hope that some day important therapeutic applications might ensue from these phenomena. Since then workers had noticed these phenomena while studying bacterial cultures and even tried to apply them clinically in certain groups of cases.

In 1929, Prof. A. Fleming noticed a green mould growing as a contaminant on an agar plate which he had used for the cultivation of staphylococci. He noticed that in the neighbourhood of the mould the

colonies of staphylococci were dissolving. The contaminant was identified as *Penicillium Notatum*, belonging to the genus *Penicillium*, so called from the resemblance of its fruiting body to a pencil or brush. On growing this mould in a liquid medium (peptone broth), Fleming noticed that it secreted something into the medium which inhibited the growth of many pathogenic bacteria even in high dilutions. Fleming gave the name Penicillin to this antibacterial agent. He also noticed that it was not toxic when injected into animals and that leucocytes were very little affected by it. The crude penicillin was, however, found to be very unstable and was too weak and too crude for injection. Early attempts at concentration were not successful and attempts at clinical trial were not pursued.

In 1932, Clutterbuck, Lovell and Raistrick found that penicillin was formed when grown on a synthetic culture medium, that it was a very labile substance, that concentration of the culture medium at 40°C. *in vacuo* inactivated penicillin, that it could be ex-

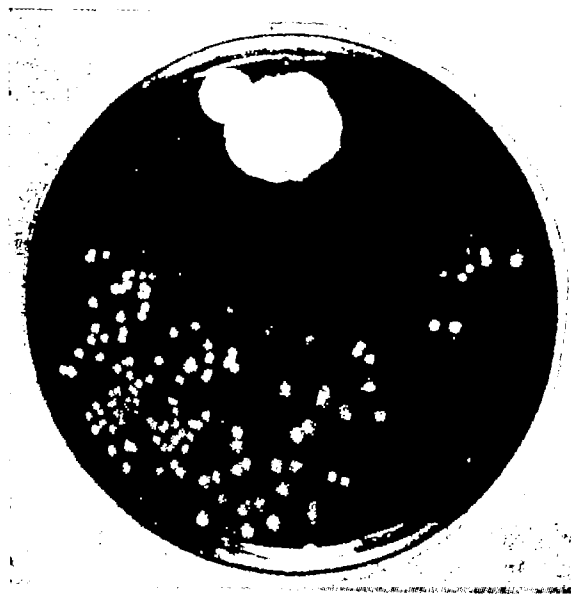


FIG. 1. The picture shows the original culture plate on which Prof. Fleming, in 1929, observed the mould *Penicillium Notatum* growing. The bacterial colonies round the mould can be seen in a state of advanced disintegration owing to the presence of Penicillin, while the colonies furthest away are still flourishing.

tracted from the culture medium with ether after acidification and that the greater part of its activity was lost on evaporation of the ether solution in a stream of air.

In 1938, E. Chain and H. W. Florey became interested in a study of the chemical and biological properties of anti-bacterial substances produced by microbes, and luckily one of the first of such substances to be taken up for study was penicillin. They attempted to find out the chemical nature of the biologically active agent. It was soon established that penicillin was an acid of low molecular weight, soluble and stable in various organic solvents, but stable in water only between pH 5 and 7. It was found that penicillin could be extracted into ether at an acid pH and that it could be re-extracted from the ether solution into water in the form of its salts by adjusting the pH to neutrality. It was also found that during these operations no loss of anti-bacterial activity occurred as long as the solutions were kept cold. Chloroform and amyl acetate are now used for the extraction and purification of penicillin on a large scale. On evaporation of the watery solution *in vacuo* from the frozen state, a dry penicillin salt

preparation was obtained which retained its activity for a long period. The initial crude preparations contained only about 1 per cent of pure penicillin, but even these inhibited the growth of staphylococci and other bacteria in a dilution of 1:500,000, an effect similar to that of powerful antiseptics like acriflavin.

The anti-bacterial activity of penicillin is expressed as the amount of penicillin which is contained in 1 ml. of a certain purely arbitrary stock solution. This is known as the "Oxford Unit". A rough indication of the size of the unit will be had when it is stated that pure penicillin contains about 1,000 units per milligram and that most strains of staphylococci are usually inhibited by a concentration of 0.01 to 0.05 units per millilitre, or with highly purified preparations of penicillin, the growth of staphylococci and streptococci is prevented at dilutions between 1:50,000,000 and 1:100,000,000.

It was evident that with such an anti-bacterial substance having low toxicity and high bacteriostatic action, further studies should be directed (1) to arrange for large-scale preparation, as the culture contained only small quantities of the product, (2) to purify penicillin and to study its chemical nature, and (3) to make a study of its biological properties. This was made possible by a team of workers, chemists, bacteriologists, pharmacologists, technologists and clinicians, prominent among whom were like E. Chain, H. W. Florey, M. E. Florey, N. G. Heatly, A. D. Gardener, E. P. Abraham, R. V. Christie, H. V. Morgan, R. Mowlen, L. P. Garrod, C. M. Fletcher, G. Glistler, K. Callow, Mahony, Arnold, Harris, Herrell, Keefer and others.

A synthetic medium to which yeast has been added was used for large-scale preparation at 24°C. As different strains vary in their potency, special care is needed to select a non-toxic strain which will yield the largest yield. The yield of penicillin from a 20-litre culture fluid is only one gramme. In 10-14 days, the fungus grows rapidly and covers the surface of the liquid medium. The liquid substance of the medium turns yellow and contains penicillin. The crude penicillin, although fairly stable, contains mixtures of very many different substances. The isolation of penicillin from this mixture proved to be a difficult problem, because of its instability towards many chemical reagents and of the unfavourable solubilities of the free acid and its salts. By a suitable combination of distribution between solvents, chromatographic methods and a reduction process by aluminium amalgam, it has been found possible to obtain barium salts possessing an activity of about 1,000 Oxford Units per milligram. Recently, it has been possible to obtain crystalline preparations of salts of penicillin. Work has also been done to determine the constitution of the breakdown pro-

ducts of penicillin, and this may open the way to its eventual synthesis. Workers in America and other countries are actively engaged in pursuing the subject. Chemists are expected to play an important part in the next phase by grouping its molecules, as has been the case with sulphanilamide.

The purest preparations of penicillin have been found to inhibit the growth of staphylococci at a dilution of 1 part in 50 millions. Gonococci and meningococci were found to be twice as sensitive as staphylococci. Among other bacteria which have been found to be sensitive are streptococcus, pneumococcus, anthrax bacillus, diphtheria bacillus, some strains of *actinomyces* and the important group of gas gangrene organisms like *cl. tetani*, *cl. welchi*, *cl. vibron septique* and *cl. oedematiens*. Recent work done in the U. S. A. shows that intensive treatment with penicillin cures the primary sore of syphilis. The typhoid-dysentery group of bacilli is among those which are less sensitive. The coliform group of organisms, *B. Proteus*, *B. pyocyaneus*, the genera *Haemophilus* and *Brucella*, *Streptococcus faecalis* and tubercle bacillus are insensitive.

The body deals with infecting organisms largely by means of the leucocytes—mobile agents which ingest and kill the bacteria. With increasing purification of the penicillin, its low toxicity has been further reduced and it has been found by tissue culture and leucocyte suspension experiments that the tissue cells retain their activity with fairly high doses and that no toxic effect is observed on the blood-pressure, heart-beat, or respiration of cats, when doses sufficient to produce anti-bacterial concentration in the blood are given to them. It could be injected directly into the brain and cerebrospinal fluid of rabbits without toxic symptoms. The anti-bacterial activity, which is not influenced within wide limits by the number of bacteria present, is in no way diminished by blood, pus, tissue autolysates, or protein hydrolysates. Very little destruction takes place inside the body as it is largely excreted by the kidneys. Penicillin, even in strong dilutions, does not kill the bacteria immediately, but inhibits their growth. These facts and its insensitivity to the products of tissue decomposition give penicillin important advantages over the sulphonamide group of drugs, which do not act effectively in the presence of protein breakdown products or if large numbers of bacteria are present. As with sulphonamides, the action of penicillin is bacteriostatic rather than bactericidal, the actual destruction of the bacteria being done by the body cells. The best results are observed in cases with good phagocytosis and high immunity, *i.e.* where the blood supply in the infected tissue is good and tissue metabolism efficient. With most new drugs, the upper limit or

tolerance is determined by the occurrence of toxic symptoms. With penicillin, striking therapeutic effect is produced by doses far below the toxic level. These facts combined together would make penicillin a chemo-therapeutic remedy of first-rate importance. Penicillin has been found to be rapidly absorbed after intramuscular or subcutaneous injection, but

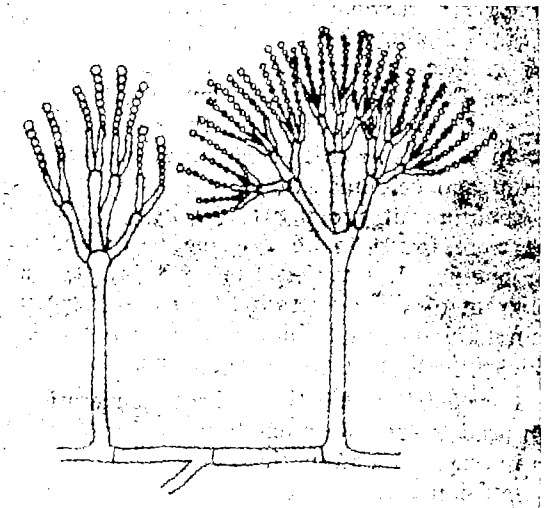


FIG. 2. The above is a drawing of the mould penicillium. The bluish-green colour of this common mould, which occurs on almost every sort of organic matter, is due to a dust of the asexual spores by which it is propagated. A branched mycelium penetrates the substratum, and sends up reproduction branches into the air, on the tips of which are chains of small rounded spores that are freed by the faintest touch of air.

not after oral administration, since it is destroyed by the hydrochloric acid of the gastric juice. It is, however, absorbed from the small intestine, but enzymes from the coliform bacilli present in the large bowel destroy it. It is excreted into the saliva, urine and bile, but does not pass freely from the blood-stream into the tears and pancreatic juice and cerebro-spinal fluid. It can also be safely administered in severe cases of generalized sepsis, by the intravenous route. It is destroyed by acids and alkalies, by boiling, by heavy metals such as copper and lead, by oxidizing agents and by enzymes from many common bacteria, including some air bacteria and some members of the coliform group. Many organisms which become sulphonamide-resistant are penicillin-sensitive, although experiments have shown that certain organisms may become penicillin-resistant. Local application has also proved to be effective in lesions caused by penicillin-sensitive organisms, provided penicillin in sufficient concentration gets access to all infected areas caused by injury or otherwise.

The potentialities of a remedy with a great anti-bacterial power combined with low toxicity are

indeed great. The only difficulty militating against its widespread application at the present moment seems to be the low yield of the material. This will perhaps remain so until chemists can help in the synthesis of the active material. This development is urgent, particularly because penicillin and its preparations cannot be stored without loss of potency for more than 3-6 weeks.

Having reached this stage, British workers of the Sir William Dunn School of Pathology at Oxford, field workers in the various war zones and American workers devoted their attention to finding out the routes of administration and the minimum effective dose in various groups of cases. A reasonably stable sodium and calcium salt of penicillin was prepared, the sodium salt proving to be hygroscopic. These salts were found to be extremely soluble in water. The potency has varied from 6.8 to 160 units per milligram of different samples of the product. The calcium salt is unsuitable for intramuscular or intravenous injection in strong solutions.

For local application, three preparations have been used to treat different types of lesions: (1) solution in water in a strength of 250-500 units per c.c.; (2) emulsion cream, made of lanette wax SX-33 per cent, vaseline-33 per cent and water to 100 per cent making a final strength of 100 units per gram; (3) powder, in base made of 95 per cent of sulphani-lamide and 5 per cent of light magnesium oxide, which are sterilizable by autoclaving. For a successful result, it is necessary that the primary infecting organisms must be penicillin-sensitive, it must reach all parts of the wound in an effective concentration throughout the period of treatment and that treatment must be continued until organisms cease to be cultivated or sometime after apparent clinical cure. It has been tried successfully in infections of the eye, skin, mastoid process, chronic wound sinuses, abscesses, empyema, burns and miscellaneous local septic conditions. In infections contaminated with *B. pyocyaneus*, *Proteus* and *B. coli*, penicillin does not act well until the pus is drained. The accessibility of tissues to the action of penicillin is an important consideration in treatment. Much smaller doses are needed for the treatment of local conditions than in systemic infections where injections are imperative.

For reasons stated above, unlike sulphonamides, penicillin cannot be administered orally.

The most practicable method of administration is by the intramuscular route at 3-hourly intervals of a dose of 15,000 Oxford units, although it may vary according to the type of case. Owing to the rapid elimination of the drug by the kidneys, repeated injections are needed. At the end of the 3-hour period after injection, a careful examination

of the serum should be made to see that the serum is still fully bacteriostatic. The pain caused by the injections can be minimized by adding novocain to penicillin solution at the time of injection. A total dosage of 5,000,000 to 1,000,000 units may be needed in severe cases. In estimating clinical progress, the temperature chart is a poor guide. Attention should be focussed to other criteria, such as lessening of pain, reduction of swelling and pus, improvement of appetite and sense of well-being, in addition to the data obtained from bacteriological examinations. The most striking result, however, has been the rapid restoration of function and the completeness with which function is regained, as compared with cases which have not received the benefit of penicillin therapy.

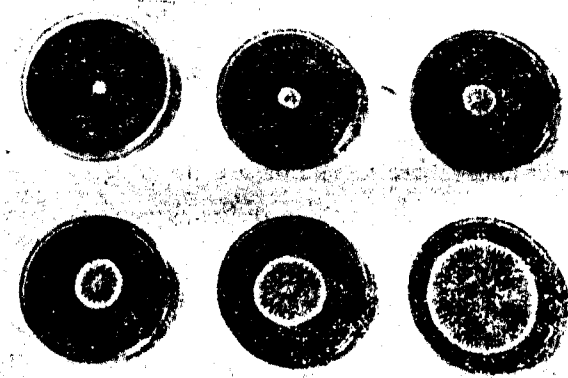


FIG. 3. The white crinkled part is the mould which exudes Penicillin into the broth (the black part), in which it grows. From left to bottom right the rate of growth is shown from one to ten days.

Apart from the conditions described above, penicillin therapy has been found to produce good results in generalized or localized staphylococcal or streptococcal infections, chronic sinuses, abscesses, empyema, cellulitis, arthritis, acute mastoiditis, acute, subacute or chronic osteomyelitis, sulphonamide-resistant streptococcal meningitis, cavernous sinus thrombosis, carbuncle, anthrax infections and some cases of actinomycosis. Penicillin is the chemotherapeutic agent of choice in the treatment of gas gangrene, when given as an auxiliary to radical surgery and gas gangrene anti-toxin, the latter helping to neutralize the toxin from gangrenous muscle where penicillin cannot act. It has also been found in America to bring about a radical cure of sulfa-resistant gonorrhoea and gonorrhoeal arthritis. Endocarditis caused by *streptococcus viridans* was, however, found to be ineffective. Recent work in America indicates that a radical cure of primary chancre in syphilis may be obtained by intensive treatment with penicillin.

In cases of staphylococcus septicaemia and pyaemia, intravenous administration, along with intramuscular introduction, a complete cure has been reported even in very severe cases. No toxic symptoms due to the drug have yet been met with.

For intravenous administration in serious cases, drip transfusion has been found to be useful. For this purpose, 30,000 units of sodium penicillin are dissolved in 1 pint of 4 per cent dextrose in 0.18 per cent saline, taking 6 hours for transfusing this quantity. The advantage of continuous intravenous transfusion have been found to be continuous maintenance of adequate blood titre and the disadvantage is frequent and painful thrombophlebitis, rendering many of the veins useless for further injections.

The advantage of intermittent intramuscular injection is its simplicity but its disadvantages are (1) pain, and (2) disturbance of the patient every 3 hours. Its administration by drip transfusion into bone marrow has been tried with a certain degree of success. A continuous intramuscular drip transfusion of penicillin has been tried with success in some cases. This has the advantage of maintaining an adequate blood titre, avoiding repeated punctures and comparative freedom from pain, but it has a tendency to local infection and abscess formation. In conducting successful treatment, it is necessary to have adequate laboratory control in not only making the initial correct bacteriological diagnosis but also in checking the results of treatment by estimating the

penicillin content of blood and of exudates. A recent issue of the *British Medical Journal* (April 15, 1944) contains as many as 8 papers on therapeutic trials in various types of cases carried out under the guidance of the Medical Research Council in England.

From what has been said above, it will appear that the application of penicillin sufficiently early in a large number of diseases where the infective organism is sensitive to penicillin may dramatically alter the whole picture. It is striking that such a remedy has been obtained from an initial accidental discovery. The chief difficulty at present is its production in sufficient quantities. It is desirable that strains of *Penicillium notatum* should be obtained from Oxford and work started in India in accredited laboratories. Extensive investigations should also be carried out to see if any other mould produces a similar or better remedy. Chemists should also get themselves busy with chemical work with a view to eventual synthesis. Unfortunately the tubercle bacillus still remains outside the fold of chemotherapy.

It is gratifying to note that the Rockefeller Foundation offered its help to the British workers to conduct their researches. In conformity with the Foundation's traditions, it is hoped that it will now stimulate the production and control of penicillin in other countries of the world. By so doing, the Foundation will help in reducing unnecessary human suffering from many infections in different parts of the world.

BOOK REVIEWS

British Dramatists—By Graham Greene. Published by William Collins & Co. Ltd., London. Pp. 48.

The book under review belongs to the brilliant series known as "Britain in Pictures". It tells within a very short compass and in a singularly lucid and graceful style the story of the growth and development of British drama from the *Mystery* and *Miracle Plays* to Eliot's *Murder in the Cathedral*. It is indeed amazing that the author has been able to mention all the important phases and characteristics of English dramatic literature in a small book of forty-eight pages. The transition from one form of drama to another has been very clearly shown. The author has also pointed out the anticipations of later drama in the mediaeval plays. The need of utmost compression has not prevented Mr Greene from putting a few words about stage-craft and theatre houses.

The fine critical acumen of the author which is manifest in his pithy observations on the genius and achievements of the different dramatists is likely to form and influence the taste of the readers. The book is, as such books ought to be, something more than a mere chronicle of literary events. It expresses the impressions of a sensitive and critical mind which make it very pleasant reading. It does not raise any controversy, nor does it simply repeat the common place formula of standard criticism. The statements of Mr Greene have a freshness and vigour which would surely create in his readers a strong desire for studying the dramatists for themselves. The book contains eight plates in colour and twenty-six illustrations in black and white which are very excellently produced. This double attraction of the brilliant essay and a nice album have made the book

an invaluable possession for those who are interested in the subject.

R. K. D. G.

Art of Discipline and Leadership or How to maintain Discipline and attain Leadership.—

By ABUL HASANAT (Indian Police), Pp. 1-306, published by the Standard Library, Dacca. Price 3s. 6d. or Rs. 2/4.

The subject matter is dealt with under the following chapter heads (1) Discipline—Why necessary? (2) What is discipline? (3) Sphere of Discipline—Whose and When? (4) A deep driving desire, (5) The right disciplinarian, (6) Self-confidence, (7) Fearlessness, (8) "Obey-me" attitude, (9) Manner—How to conduct oneself, (10 and 11) Tone—How to order others, (12) Sense of proportion, (13) Supervision, test and inspection, (14) Justice and discrimination, (15) The magic appreciation, (16) Appropriate handling of human nature, (17) Chart Index, besides a very large number of sub-headings. The author's delineations though made in popular style are fully comprehensive and are to the point. The performance reflects great credit to the author who has displayed a very wide reading and critical aptitude and vast experience. It is really a good book on a very important topic of Social and Industrial Psychology, which is claiming the attention of the military authorities and managers of big workshops and factories who are in search of people endowed with some amount of leadership. Any one concerned with the maintenance of discipline and retentions of leadership is likely to derive much benefit from a perusal of the book. The author has relied principally on biography of great men and has discussed some psycho-analytic complexes with a view to emphasize the primary wishes to achieve one's ends. He would have done well to have discussed the importance of tests of temperament and character traits of a personality with a view to the selection of leaders for different tasks. Though much can be done to evolve leadership where it is inherent yet modern psychology does not believe in creating leadership in one where it is lacking. Leadership is really inborn and thrives in proper environment. Discipline can be taught and maintained by training proper methods.

M. N. B.

Soviet Russia—Edited by K. S. HIRLEKAR. Published by Avanti Prakashan, Bombay. Price Rs. 6/8.

The book under review is a collection of articles by Academicians, members of the Supreme Soviet and prominent Soviet workers engaged in active work

in various branches of science, industry, agriculture, education, transport and communication and such other fields of human activity. The articles, written as they are by men who have first hand knowledge of men and things in Soviet Russia, have a stamp of authority and an importance which need hardly be overestimated. Some of these articles were written in 1939 for the visitors of the Soviet Pavilion at the New York World Fair and already published in various foreign papers, while others appeared at different times in Soviet daily newspapers, such as *Moscow* and *Soviet Russia Today*. Mr Hirlekar to whom goes the credit of editing and compiling these articles has shown real skill and knowledge of affairs in Soviet Russia in his selection of articles. There are far too numerous writings on Soviet Russia to indicate in superlative terms the colossal progress U.S.S.R. has made in every sphere of national development, but few have sought to corroborate the real extent of this progress by reliable statistical data which alone make the statement of any use. Mr Hirlekar has taken particular care in choosing articles replete with statistical information and has himself supplemented it by a series of useful appendices.

The book has been divided into five parts devoted to (1) Soviet Russia—Economic Power and Resources, (2) Soviet Industry and Communications, (3) Soviet Agriculture, (4) All-round Contribution to Industrialization and General Uplift, and (5) Soviet Russia, 1940-43. It is satisfactory to note that logical sequence in the arrangement of articles has been maintained throughout. Through these articles the story of the phenomenal development of natural resources, their utilization through the establishment of light and heavy industries, the growth of an admirable system of transport and communications on land, through air and along waterways, connecting the far-flung and hitherto inaccessible parts of Russia, the spectacular success of Soviet agriculture through the institution of State and collective farms and application of modern methods of science, the cultural revolution through the liquidation of mass illiteracy, the remarkable increase in the workers' efficiency through the Stakhanov movement and such other Soviet developments during the last two decades has been told in a lucid, accurate and fascinating style characteristic of the Soviet writers. The incorporation of four maps showing the Constituent Union Republics, the location of basic heavy industries, and of paper and saw mills and the chief air lines has further increased the usefulness of the book. Mr Hirlekar must be congratulated for having edited such a book which, we hope, will be cordially welcomed by every one interested in Soviet Russia as well as by general readers.

S. N. S.

Habit and Heritage—By Frederick Wood Jones, D.Sc., F.R.S., Professor of Anatomy, University of Manchester. Published by Kegan Paul, Trench, Trubner & Co., Ltd., London, 1943. Pages 100 with 17 illustrations. Price 5s. net.

In this well written book Prof. Wood Jones has advocated the idea of inheritance of acquired character, which has remained since Lamarch postulated his doctrine about a century ago, a subject matter of heated controversies. It is a vital question in the complex problem of heredity and biologists all the world over have tried to solve it. Heckel, de Vries, Buffon, Darwin, Wallace, Weismann, Herbert Spencer, Roux, Doncaster, Bergson, Arthur Thompson, Haldane to name a few, have all put forward evidences and discussed the problem, whether a character or modification acquired by an individual in its life time, can be transmitted to its progeny, and thus become a factor in evolution. It is an important factor, as the acquired character may be either beneficial or detrimental to him and his race and thus contribute largely to its evolution.

The genes within the chromosomes are the bearers of almost the whole hereditary constitution, which is fixed for the race and are handed over from parents to offsprings. But it is also an undoubted fact that mutants or "fricks" (with actual alteration in some of the genes and not mere shifting of the old ones) appear, having characters different from the parents and that these mutations are inheritable.

An equally important question is whether environment to which living objects react and adjust themselves to its changes, play any part in evolution. Are the modifications acquired by an individual in its life time in response to environmental changes inheritable?

A considerable amount of controversies have taken place to explain what is meant by "Acquired Characters", which have only caused confusion and Prof. Wood Jones has devoted an entire chapter to it.

The modifications are acquired or developed by actual use or disuse in response to physiological adjustment to the environmental changes and not a mere accidental injury and "several generations must be subjected to changed habits for any appreciable result. The incorporation of these changes in the physiological or anatomical make up of the race, the inheritance of which has a physical basis in the germ plasm, must necessarily be a slowly developing process. The author has set to answer the question: May a feature developed repeatedly during the successive lives of a long series of generations be ultimately incorporated in the heritage of the Species as a permanent feature?

It is difficult to demonstrate such inheritance by experimental methods but Nature with unlimited time at its disposal may furnish evidences of its actual happening. The author has considered in detail several instances from Nature, where some particular modification developed in response to some special condition has become permanent in the race.

The special facets on the ilia and astragalus in some of the squatting races (the Punjabis), who for generations have habitually taken up a peculiar squatting posture, is quite different from the facets developed in the Australian aborigines who assume quite a different squatting posture. These facets have become permanent and are present in the embryo as an inherited characteristic. The same story is found in the peculiar spinal curvature in the seal embryo and in the reversal of the hair slopes in some of the marsupials. In the chapter on the highly interesting method of reproduction in the marsupial the author has tried to demonstrate the gradual incorporation, as an inherited adult permanent structure in the higher order of these animals, the better elaborate primitive birth passage, which is just a very temporary arrangement in those of the lower order.

B. B. S.

LETTERS TO THE EDITOR

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

SPACING RATIO OF ATMOSPHERIC STREETS

In a slow moving stream two rows of vortices appear in the wake behind a moving bluff obstacle. All the vortices are equally spaced and equally strong, so that a clockwise (negative) vortex, for example, is symmetrically placed between two anti-clockwise (positive) vortices. There is an 'axis of symmetry', directed downstream, between the row of negative and of positive vortices. The vortices to the right of the axis are negative and to the left, positive. The line cuts symmetrically the sinuous stream of circulating fluid between the two rows of vortices. This is the wellknown Kármán street which is a vortex street with two rows of vortices. The spacing ratio of a street is the ratio of the distance b separating the two rows of vortices to the spacing a of two consecutive vortices of the same sign or, the wave length of the street.

The method of forecasting by fields and streets is based on the 'theory of free streamlines' of Helmholtz, Kirchhoff and Rayleigh. In the spacing ratio, the theory provides an index of the aerodynamical stability of a street, and, therefore, indirectly of that of a 'cyclic field' which may appear between two streets from opposite directions. The stability criterion of a street has been fully worked out in treatises on aerodynamics and a Kármán street is found to be stable for all disturbances when the spacing ratio is 0.3.

The spacing ratio of an atmospheric street is of considerable help to the forecaster in deciding such issues as the persistency of a type of weather, the potentialities of cyclonic and anticyclonic disturbances and the formation of cols and squall fields. The cols are often responsible for sudden and unexpected weather, generally of a 'sporadic' nature and sometimes of great intensity.

The earth, in the 'general circulation' of the atmosphere, resembles a sphere rotating about a crosswind axis. The orographic reliefs are the fixed, three-dimensional bluff obstacles. As to the analogy of an undisturbed stream striking an obstacle, the dominant orographic relief of the American continents, stretching from one hemisphere into another, are ideally placed in the (undisturbed) primary easterlies U_E and westerlies U_W , of the 'general circulation'.

The streets, associated with the normal positions of the two primary streams in each hemisphere, pro-

duce the two great families of anticyclogenesis fields, viz., the field A echelons in the northern hemisphere and field B echelons in the southern hemisphere. The anticyclogenesis fields are therefore the normal fields of the 'general circulation'.

Incidentally, it is the local and short-lived reversal of the normal positions of the easterly and westerly streets in the same hemisphere that brings the cyclogenesis field into existence. In the monsoon, however, the reversal is long-lived and represents persistent interactions between two hemispheres. Consequently, the highest frequency of cyclones in the Bay of Bengal is registered in this season.

Rockies in the northern hemisphere are approximately parallel to the dilatation axes of the field B family echelon, whilst Andes in the southern hemisphere are parallel to the dilatation axes of the field A family echelon. These are the two great cyclogenesis fields in the respective hemispheres. In other words, the orographic reliefs act as dilatation axes and promote transport of heat between high and low latitudes.

The average layer of the atmosphere affected by the mountain ranges is at least 5-6 km. in thickness. It is noteworthy that the thickness of the 'generative shell' in the Indian area is also of this order in the monsoon. Anticyclogenesis commences at the top and cyclogenesis at the bottom of the generative shell.

The bluff obstacles, Rockies and Andes placed in U_W , deflect the current and thus shed high pressure vortices to their west in both the hemispheres. During the monsoon, the anticyclone to the west of the Western Ghats illustrates the bluff obstacle effect in the Indian region. Similarly, low pressure vortices are shed by orographic relief suitably placed in U_E or U_W . It is between these high and low pressure vortices of the same undisturbed stream that the sinuous stream runs.

The analogy of the Kármán street with the atmospheric vortex street seems irresistible. The distinguishing features of the latter are:—(i) the mode of formation, (ii) the appreciable solid rotation cores of the vortices of the street and (iii) the geographical scale of the bluff obstacles.

The isobaric charts and the streamlines aloft demonstrate that the atmosphere consists of two types of vortex streets, viz., (a) single row of vortices and (b) double row of vortices. It is apparent that, with

the weakening of the undisturbed streams, a diffusion of an anticyclogenesis field echelon will leave only the 'sources' (which are the high pressure vortices) prominent and, as is to be expected from the normal dispositions of U_W and U_E , this feature is emphasised in the average charts.

For example, the annual average isobars at sea level over the globe show a row of marked source vortices (subtropical anticyclones) with diffused low pressure areas on either side in the subpolar and equatorial regions. The prevalence of convective instability in these regions is well-known. The streamlines in the average wind fields in the directive shell over the Indian region² also bring out the same features.

In the determination of the spacing ratio of a street of double row of vortices, both a and b have to be measured from the weather charts. The former, taken as the wave length of the street, is easily estimated from the weather charts. It is of interest to note in passing that air masses may often be identified by the wave length of an undistorted and simple street of a spacing ratio of 0.3.

In actual practice, the streets are often distorted and complex and especially so in the transition months. Some of the disturbing factors are:—(i) orographic relief, (ii) periodic motions which displace the vortices at right angles to the streets, (iii) fluctuations or weakening of the undisturbed streams, (iv) anticyclogenesis and cyclogenesis in the

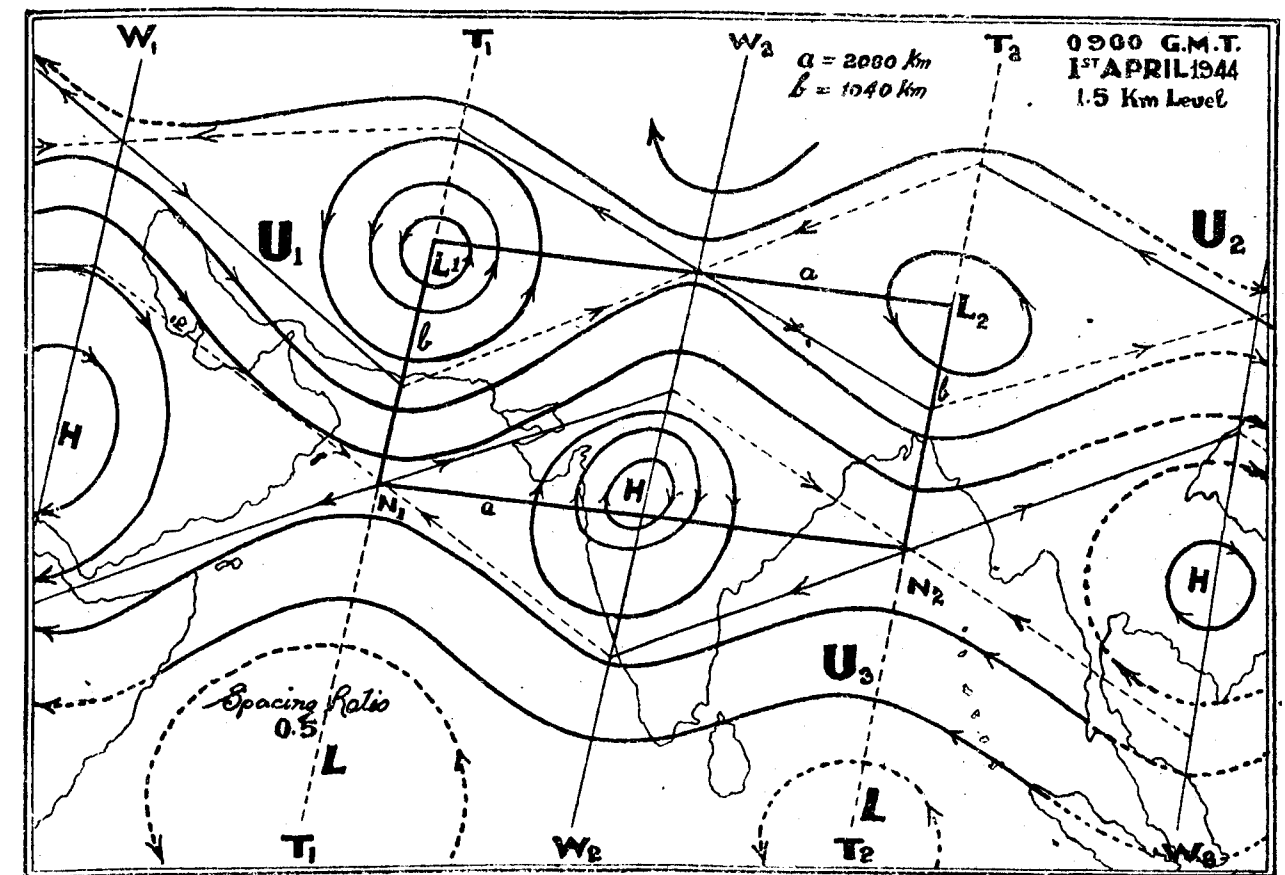


FIG. 1

From a study of the outstanding orographic relief of the globe, it is found that a grid of wedge lines, as shown in the annexed diagram may be extended right round the globe. An atmospheric street of one row of vortices may thus be built up from the more or less evenly spaced wedge lines WW. The trough lines joining the 'sinks' on the other hand, are blurred in this type of street. It has, therefore, no spacing ratio.

field, introducing longitudinal expansions or contractions in the cyclic fields, (v) unequal turbulence over land and sea, and (vi) fracture in the col field, etc.

For the measurement of b , a line has to be drawn through the centres of the solid rotation cores of the negative vortices and another line through those of the positive vortices, as shown in the diagram. The average perpendicular distance between these two lines may be taken to be b .

The intercept, L_1L_2 or N_1N_2 , between the trough lines, T_1T_1 and T_2T_2 , is the wave length a , and L_1N_1 or L_2N_2 is b .

The centre of a solid rotation core may be called the 'no wind' or calm centre. The rule of fixing of 'no wind' centre, if there is one, of a cyclone for example, is based on the assumption of the establishment of an equiangular spiral (simple vortex plus translation) round a solid rotation core. The spiral is of diminishing radius in the case of a low pressure field or 'sink' ('spiral convergence') and of increasing radius ('spiral divergence') in the case of a high pressure field or 'source.' This rule, however, does not always lead to a satisfactory location of the calm centre for reasons explained in the following paragraphs.

The calm centre may be the centre of a cluster of forced vortices of the same sign, brought together by 'belting' or by translatory motion. By 'belting' is meant the fastening of solid rotations with closed streamlines of U_0 , the neutral air. (U_0 is air without vorticity, in a uniform pressure field, inert because straight streamlines acquire solid rotation only, perhaps similar to the S-air of the Americans, losing vorticity while subsiding in a warm anticyclone). Incidentally, 'belting' brings distant air masses together. There can thus be 'cementing' or 'fusion' of adjacent solid rotation cores, when an undisturbed stream strengthens first and then weakens. These processes eventually produce 'col fields' or a conglomeration of forced vortices.

A diffusing A family echelon produces a single row of vortices or negative col fields. Similarly, a diffusing B family echelon produces positive col fields. These may be taken to be 'discs', more or less oval. Let there be an easterly street U_2 to the north of the westerly street U_1 and another easterly street U_3 to the south of U_1 . With proper spacings of the positive and negative discs, an undisturbed stream U_1 strengthening again gives rise to a new street which, however, is necessarily complex and unstable. Thus the growth of a street from simple to complex is usually followed by subdivision of vortices. The life history of a coal field, therefore, is an important consideration in forecasting.

The significant facts gathered from the charts are (a) forced vortices of the same sign may diffuse into each other but never combine, (b) a cyclic field, which encloses forced vortices of opposite signs, is unstable. A coal field has an unstable structure, and a cleavage in the 'disc' initiates coal activity. Thus 'cleavage' follows 'belting'.

The determination of b is often difficult. For example, the evidence from the surface charts is that the 'discs' may have a number of so called 'no wind centres', appreciably separated from each other. The distribution of upper winds in a horizontal section

of the generative shell, on the other hand, may not show more than two vortices of the same sign and only one of the opposite sign inside the Indian region. One of the two lines through the centres of vortices of the same sign, cannot therefore be drawn with confidence. In a case like this, the axis of symmetry of the streets has to be drawn before spacing ratio can be determined. With the axis tangential to the cores of the vortices, a determination of their diameter gives b . In the charts, however, either the 'sinuous wake' is broad or the cores are often displaced, owing to the development of a circulation round them, or on account of the presence of extraneous simple harmonic motions.

Despite all the imperfections and limitations explained in the preceding paragraphs, actual measurements from weather charts show that the spacing ratio of streets varies from 0.2 to 0.7. The winter cyclones often have a spacing ratio of about 0.3. A type of monsoon cyclones, which forms between a composite easterly street to the north and a composite westerly street to the south, has a spacing ratio of 0.5. This is equivalent to a spacing ratio of 0.3 in the case of a cyclone between two 'simple streets'. A complex street has also a spacing ratio of 0.5 and above. It is interesting to recall the stability criterion of the Kármán street in this connection.

In conclusion, it may be pointed out that a forecaster should ordinarily expect (a) an intensification of a depression into a cyclone, if the spacing ratios of the participating streets are likely to approach 0.3 in a contracting positive cyclic field, (b) a spacing ratio of 0.5 and above in a complex street is generally followed by col activity in both the negative and positive col fields, (c) ordinarily, a spacing ratio of 0.2 and less indicates a dissipating cyclic field and change of weather type, (d) col activity (which may be equivalent to anticyclolysis or cyclolysis) may give rise to dustdevils or tornadoes or simply to squall fields. In these phenomena, the direction of motion of air along z axis at the edge of a cyclic field is determined by abnormal thermodynamic and aerodynamic instabilities and may be directed upwards or downwards, according to the low or high pressure field locally set up, irrespective of the sign of rotation of the cyclic fields. The squall field will be discussed in another note.

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5-4-1944.

¹ This note is to be read along with the diagram on page 454 of SCIENCE AND CULTURE, 9, 454, 1944.
² Unpublished Atlas of Normal Vortex Streets.

EXTENSION OF THE DIFFERENCE THEOREMS OF SINGER AND BOSE

(1) Singer¹ (1938), by using the properties of the finite projective 2 dimensional geometry PG (2, m), has established the existence of a set of $(m+1)$ integers

$$d_0, d_1, \dots, d_m$$

such that the $m(m+1)$ differences $d_i - d_j$ ($i \neq j$) reduced modulo $(m^2 + m + 1)$ contain all integers 1, 2, $\dots, m(m+1)$ once and once only, whenever m is a prime or a prime power. The affine analogue of Singer's theorem is given by Bose² (1943) who has shown, by using the properties of the finite Euclidean geometry EG (2, m), that given an integer $m = p^n$ (where p is a prime) it is possible to find m integers

$$d_0, d_1, \dots, d_{m-1}$$

such that among the $m(m-1)$ differences $d_i - d_j$ ($i \neq j$) reduced modulo $(m^2 - 1)$ all integers less than $(m^2 - 1)$ and not divisible by $(m+1)$ occur once and once only. These theorems enable us to represent PG (2, m) and EG (2, m) of a certain type compactly by difference sets which give the geometrical configurations by cyclic substitutions. Both the theorems are also useful in representing the incomplete balanced block designs of the *Design of Experiments*³ (1943) as derivable from difference sets given by Bose⁴ (1939).

(2) By using the properties of the t dimensional geometries PG (t , m) and EG (t , m), where m is a prime or prime power, the above theorems have been extended and their utility in the compact representation of PG (t , m) and EG (t , m) and the incomplete block designs derived from them have been studied.

(3) Theorem 1. Given an integer $m = p^n$, (p is a prime) it is possible to find $k = (m^t - 1)/(m - 1)$ integers

$$d_0, d_1, \dots, d_{k-1}$$

such that the $k(k-1)$ differences $d_i - d_j$ ($i \neq j$) reduced modulo $v = (m^{t-1} - 1)/(m - 1)$ contain each of the integers less than v , $\lambda = (m^{t-1} - 1)/(m - 1)$ times. The method of obtaining the difference set is as follows. If x is a primitive element of the Galois field GF (m^{t+1}) and if we do not distinguish between x^0 and px^0 where p is an element of GF (m), then there are v distinct powers of x , $x^0, x^1, \dots, x^{v-1}$ in GF (m^{t+1}). The difference set is given by the distinct powers of the x 's obtained from the expression $ax^0 + a_1 x^1 + \dots + a_{t-1} x^{t-1}$ by allowing the a 's to assume all possible values of GF (m). For example, the difference sets in the cases, $t=3$, $m=2$ and $t=3$, $m=3$ are given by

$$0, 1, 2, 7, 9, 12, 13 \pmod{15}$$

and

$$0, 1, 2, 5, 12, 18, 22, 24, 26, 27, 29, 32, 33 \pmod{40}$$

Theorem 11. Given an integer $m = p^n$ (p is a prime) it is possible to find $k = m^{t-1}$ integers

$$d_0, d_1, \dots, d_{k-1}$$

such that the differences $d_i - d_j$ ($i \neq j$) reduced modulo $v = (m^t - 1)$ contain all integers less than v and not divisible by $w = (m^t - 1)/(m - 1)$, $\lambda = m^{t-2}$ times each. The difference set, in this case, is obtained from the powers of x , the primitive element of GF (m^t) obtained from the expression $(a_0 + a_1 x + \dots + a_{t-1} x^{t-1})$ by allowing the a 's to assume all possible values of GF (m) subject to the restriction $\sum a = 1$. The geometry EG (t , m) can be represented by the above difference set and the set of integers obtained from the powers of x given by the expression $(a_0 + a_1 x + a_2 x^2 + \dots + a_{t-2} x^{t-2})$ by allowing the a 's to assume all possible values of GF (m) together with a symbol ∞ which remains invariant under any addition of the elements of the modul to it. These theorems also give the compact representation of the balanced incomplete block designs defined by v , k and λ given above. For example the corresponding sets in the cases $t=3$, $m=2$ and $t=3$, $m=3$ are given by

$$\begin{matrix} 0, 1, 2, 4 \\ \infty, 5, 6, 3 \end{matrix} \pmod{7}$$

and

$$\begin{matrix} 0, 1, 2, 8, 11, 18, 20, 22, 23 \\ \infty, 0, 1, 3, 9, 13, 14, 16, 22 \end{matrix} \pmod{26}$$

(4) The theorems, given above, supply the results of Singer and Bose when $t=2$ and hence constitute suitable extensions. The detailed proofs of these theorems together with some examples will be given in a full paper to be published elsewhere.

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Statistical Laboratory,
Calcutta, 25-4-1944.

¹ Singer, Trans. Am. Math. Soc., 43, 377-85, 1938.

² Bose, Ind. Jour. of Math., 2, 15, 1943.

³ Fisher and Yates, "Stat. Tables", p. 15, 1943.

⁴ Bose, Ann. of Eugen., 9, 353-399, 1939.

PREPARATION OF VIOFORM FROM 8-HYDROXY-QUINOLINE

VIOFORM (5-chloro-7-iodo-8-hydroxy-quinoline) is now used as a powerful antidiysenteric remedy. 8-hydroxyquinoline is the starting material for the preparation of Chinosol and Yatren, both of which are useful antiseptics.

In order to obtain vioform directly from 8-hydroxyquinoline, the action of iodine trichloride on 8-hydroxyquinoline has been tried in different organic solvents (acetic acid, alcohol, chloroform, carbon tetrachloride) under various conditions. In each case, a mixture of vioform (m.p. 177-178°) and 5:7-di-iodo-8-hydroxyquinoline¹ (m.p. 200-201°) has been invariably obtained, and from this mixture vioform has been separated by treatment with chloroform in which it is much more soluble than the di-iodo compound, or by fractional crystallisations from acetic acid.

The formation of vioform in the above reaction suggested the introduction of chlorine and iodine atoms into 8-hydroxyquinoline in two stages, so as to yield vioform finally. But, the chlorination (by chlorine gas) or iodination (by iodine or iodine monochloride) of 8-hydroxyquinoline has yielded the corresponding 5:7-dichloro- (m.p. 178-179°) or 5:7-di-iodo-derivative.

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2-5-1944.

¹ Papesch and Burtner, *J. Amer. Chem. Soc.*, 58, 1314, 1936.

HISTOPATHOLOGY OF BETEL VINE LEAVES ATTACKED BY A BACTERIUM

THE writer published a short note¹ on a bacterial disease of the cut betel vine leaves in storage. The work has been in progress since then and the histopathology has now been fully worked out. Though the betel vine is subject to a number of fungal and a few bacterial diseases, this disease of the betel vine leaves has not so far been reported from anywhere else. Ragunathan^{2, 3} has described a bacterial disease of the betel vines in the field, which, however, is quite different from the present one.

This disease as was pointed out generally starts at the cut end of the petiole which affords a very suitable place for the entrance of the bacterium, though occasionally the disease may begin at any place on the lamina leading to the formation of localised brown or black spots. The progress of the disease is more or less similar in all cases. To begin with, water soaked area appears and this is followed by browning and later by blackening along the veins. In the earlier stages of the disease, the bacteria in-

vade phloem tissues which being very rich in stored materials afford excellent source of nutrition to the parasite. Though the bacteria from the point of infection spread out in all directions, the progress, however, is most rapid along the phloem, with the result that sometimes in the course of a few hours, the phloem along a considerable length of the petiole, midrib and the veins, becomes completely destroyed. This can be seen by the naked eye since the dorsal part of the midrib and some of the veins in the earlier stage of the infection becomes soft and pulpy. The disease now advances from the phloem to the xylem vessels and through these or most probably directly, to the mesophyll cells. The phloem elements now become dead and disorganised and the xylem vessels are now packed with bacteria. In a number of preparations the bacteria were seen filling the xylem vessels and the cells of the mesophylls. This indicates that the spread of the disease to the xylem and mesophyll takes place more or less simultaneously. From the cells of the mesophyll the bacteria get into the intercellular spaces and finally the mesophyll cells are killed and disorganised.

The writer is indebted to Prof. H. Chaudhuri of the Punjab University for kindly going through the manuscript and making some useful suggestions.

College of Science,
Nagpur, 5-5-1944.

R. L. NIRULA

¹ Nirula, R., *Proc. Ind. Sc. Congr.*, 1931.
^{2, 3} Ragunathan, C., *Ceylon Dep't. Agric. Leaflet* 39, 1926;
Ann. Roy. Botanic Garden, Peradeniya, 1928.

A PRELIMINARY NOTE ON THE MICROFLORAL CORRELATIONS OF SATPUKHURIYA, GHUSICK AND ASSOCIATED SEAMS

IN recent years there has been a sharp controversy about the proper correlation of Satpukhuriya, Ghusick and some other associated seams of the Raniganj coal fields.^{1, 2, 3} This portion of the field is variously disturbed by cross-faults, dykes etc. Hence, correct correlation from stratigraphical data has become difficult. So it is necessary to approach the problem from altogether a different point of view. The recent development of the study of microfossils in the correlation of coal seams in England and America has been found to be very helpful in the solution of the present anomaly.

A large number of samples from Ghusick, Kushadanga and Nega seams on the eastern side of

the Bonbishtopore-Mohshilla cross-fault, and upper Dhadka, Satpukhuriya and lower Dhadka seams on its other side were analysed following Raistrick and Simpson's method⁴ modified. The spores and cuticles were artificially classified into several formed types and sub-types. Occurrence of each spore type is expressed in percentage and only the dominant types are represented graphically in a general spore diagram. Only one typical spore diagram from each seam is given in the correlation chart (fig. 1).

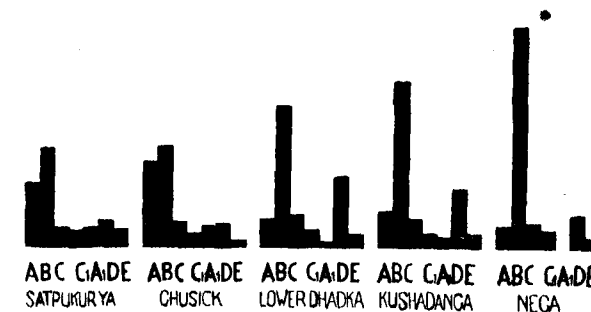


FIG. 1. Graphical representations of the spore contents of five coal seams in the Raniganj coalfield. A-E, the types of spore whose frequencies are represented by the heights of the black columns.

In a particular seam some general spore types (A, B and D) show a constant frequency of occurrence, which is, however, different from seam to seam. But the rest are present in more or less same proportion in all the seams examined. Hence, the latter group of spores may not be of much correlative value. Without entering into the details of correlation the author likes to point out that the spore diagrams of Ghusick and Kushadanga resemble those of Satpukhuriya and lower Dhadka respectively. Nega resembles none. There are, however, some points of difference between the spore diagrams of Ghusick and Satpukhuriya. The following correlations are provisionally suggested:—

- (1) Ghusick and Satpukhuriya.
- (2) Kushadanga and Lower Dhadka.
- (3) Nega.

Studies on rare type spores (used as zone fossils) and cuticular structures tend to confirm the above correlations.

The details of correlation and points of palaeobotanical interest of the work together with descriptions and drawings of spores etc. will be published elsewhere later on.

My thanks are due to Mr N. N. Chatterjee, Geology Department, Calcutta University, Mr M. M. Mukherjee, General Manager, Martin & Co.'s Collieries and several other colliery officials, who have facilitated the work by helping me in obtaining the material, Mr A. K. Ghosh of the Botany Department,

Calcutta University, for helpful criticism and advice and Prof. S. P. Agharkar, head of the Department of Botany, Calcutta University for giving laboratory facilities.

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Calcutta, 11-5-1944.

¹ Gee, E. R., *Mem. Geol. Sur. Ind.*, 61, 256, 1932.
² Mukherjee, M. M., *Trans. Min. Geol. and Met. Inst., India*, 35, part 3, 314, 1939.
³ Mukherjee, M. M., *Ibid.*, 38, part 1, 29, 1942.
⁴ Raistrick, A. and Simpson, J., *Trans. Inst. Min. Engineers*, 85, 225, 1932.

SYNTHESIS OF ATEBRIN

I find in an article entitled "Malaria—from the treatment point of view" by Dr K. V. Krishnan in the August number (1943) of the *SCIENCE AND CULTURE* that he refers to the synthesis of a substitute of Atebrin by Sir U. N. Brahmachari called "Acridine X". This reference is probably taken from Sir U. N. Brahmachari's Presidential address to the Medical Section of the Indian Science Congress at Calcutta in 1938. No paper seems, however, to have been published by Dr Brahmachari in subsequent years either on the synthesis of this substitute or its pharmacological and clinical tests. It may on the other hand be pointed out that quite a number of papers have been published on this subject by other authors in India^{1, 2, 3, 4, 5} which have completely established the identity of the product and its therapeutic value. Several Indian firms, in fact, are manufacturing this product on the basis of this work and the limitation is only that of raw materials. It would have been desirable if Dr Krishnan had made some suitable reference to these detailed published papers and thus given credit where credit was due.

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Calcutta, 17-5-1944.

¹ S. J. Das Gupta and U. P. Basu, *SCIENCE AND CULTURE*, 2, 585, 654, 1937.
² S. J. Das Gupta and U. P. Basu, *J. Ind. Chem. Soc.*, 14, 468, 1937; 15, 160, 1938; 16, 100, 1939.
³ S. J. Das Gupta, *J. Ind. Chem. Soc.*, 20, 1937, 1943.
⁴ B. M. Das Gupta and L. B. Siddons, *Ind. Med. Gaz.*, 78, 42, 141, 291, 1943.
⁵ U. P. Basu and A. N. Bose, *Ann. Biochem. Emp. Med.*, 1, 317, 1941.

ESTIMATION OF CARBON IN COAL BY THE CHROMIC ACID REDUCTION METHOD

ESTIMATION of carbon in coal is carried out by the Standard Furnace Combustion Method but for the routine analytical work this method is a long and laborious one although the results obtained are accurate. It has been found that the Chromic Acid Reduction Method as modified by Allison¹ can be successfully extended to the estimation of carbon in coal for the routine analytical work. This method is a very rapid one and can be done within 20 minutes. When compared with Standard Furnace Combustion Method, the percentage recovery of carbon is 90.90% and by the use of a Factor 1.10 almost identical results may be obtained.

Briefly stated, the Chromic Acid Reduction Method consists in oxidising the organic carbon in a small sample of coal (passed through 100 mesh seive)

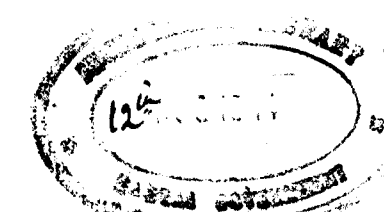
with a known quantity of N Potassium Dichromate in conc. Sulphuric Acid by raising the temperature 175°C in 90 seconds. Then the extent of reduction is measured by titration with Ferrous Ammonium Sulphate using Diphenylamine as indicator.

The details of the paper will be published elsewhere.

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30-5-1944.

¹ Allison, L. E., *Soil Science*, 40, 311, 1935.



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INDIA'S NEED FOR POWER-DEVELOPMENT*

THE modern age is fundamentally different from medieval times, and there are many ways of describing the difference. We sometimes say that we are in the age of steam or electricity. Another writer describes the modern age as 'neotechnic' (production in factories by industrialists with the aid of large machineries) as distinguished from 'paleo-technic' (production in cottages by artisans working with small tools). The third definition, though accurate, is pedantic. But probably nothing brings out the characteristic difference so vividly as the "Energy-Index"—by which term we mean *the output of energy or work per capita of the population per year from all sources*. Probably it will surprise some of our readers to learn that the energy-index† in medieval times was not more than 80, while in modern times it is nearly 2000 in a moderately advanced country and in the neighbourhood of 3000 in some of the go-ahead countries like U. S. A. or Canada.

What do these figures indicate? It shows that an average citizen of an advanced country, like Sweden, is today nearly 25 times richer than he was in medieval times, for wealth is directly proportional

to the output of work. True, the total national wealth in most countries is not equitably distributed, but that is a different topic. If the country as a whole gets richer everybody shares in the benefit, though there is no denying the fact that an equitable distribution is far more beneficial and desirable. But the question at any rate is of secondary importance, for unless there be production there would be nothing to distribute. Countries, like Iran or China, which have till recently clung to medievalism, can never attain in spite of the traditions of a great past, or prevalence of saints or wise men, the prosperity, or material happiness of modern Sweden.

How has this profound revolution been brought about?

In medieval times, work was done almost entirely by manual labour aided by animal power (cattle and horse) and to a small extent by powers of nature (wind power or water power as used in water wheels first invented in Iran). In modern times work is done by power derived from coal (steam engines) and oil (oil engines) and by electricity generated from coal (thermal stations), oil (Diesel engine) or water power (hydro-electricity). For a country it is now possible to calculate, almost with mathematical precision, the whole amount of energy output from coal or oil consumed for this purpose, or from the records of electrical power companies. The total energy output divided by the population gives us the "Energy-Index."

Countries, like Sweden and Switzerland, which have very little coal and oil have to depend on electrical power generated almost entirely from water. In 1942, Sweden's output of work per capita per year was nearly 1700 units. In a country where steam power is very largely used, such as England, calculations are more difficult to carry out. In 1938,

* Based on a lecture delivered by Prof. M. N. Saha before the Calcutta Rotary Club on July 10, 1944.

† Note for the non-technical reader: The 'unit of energy' used here is the 'kilowatt-hour' i.e., the work done by a machine having a power of one kilowatt for one hour. This is equal to one and one-third horse-power hour. The man-power hour is just one tenth of one horse-power hour i.e., an average adult working for 8 hours produces only 6/10th of a unit (kilowatt-hour). The price of a kw. hr. charged by an electrical power company for industrial use is about an anna, so that a man working for 8 hours does work, whose normal value is 2½ pice. But generally man's work, even if it be entirely manual, is intelligent, hence the value is higher. For very unintelligent or mechanical work, like spinning or digging or drawing water the rating will be lower, say at twice the minimum.

the per capita electrical energy derived from coal was 650 in England. The per capita energy derived from steam and other sources has been calculated to be about 1400 units (this figure is given with a certain amount of reserve) so that the energy index for the U. K. amounted to about 2100 units. The figures for Canada and U. S. A. are higher, probably in the neighbourhood of 3000 units. The U. S. A. and Canada have enormous resources of water power and have developed a very large percentage of that, with the result that they are now ahead of the whole world in the production of work and in material prosperity.

Where do man power and animal power come in this picture? A man's output of work in the whole working year of 300 days is only $6 \times 300 = 180$ units, and since we have to leave out old men, children, most of women and the idle rich for purposes of productive work, we can take the active worker as one in three. The average annual output by man power is therefore only 60. The output from animal power could not have been more than 20, so that in medieval times, the energy-index could not have been larger than 80. The output of work by man's physical exertions can now be entirely neglected in comparison to the energy output from other sources; his work is now mainly directive.

If we arrange the countries of the World according to the energy-index, at the bottom amongst the countries which claim to be civilized would be found India and China, and pre-Bolshevik Russia whose position in 1918 was no better than that of India in 1944. India's energy-index in 1944 cannot be much larger than 90 units even on the most liberal estimate; this is made up of 60 units derived from manual labour, 15 from animals, 9 from electricity in 1942, (the total production was 3500 million units) and about 10 units from steam and oil—the exact figures being not available. So the energy-index cannot be larger than 90 units, as against the Euro-American figure of 2000 or more.

The average annual income of an Indian was calculated by the National Planning Committee to be Rs. 65. The average income of a Swedish was about 1800 Kroners in 1938, or about Rs. 1300. He earns 20 times more than an Indian. The reason is quite clear; he uses about 20 times more energy. In fact we can assume that the average income of the citizen of any country from all sources would be directly proportional to the energy-index.

We can put the facts in more figurative language. In Europe and America forces of nature have been harnessed so effectively that an European or an American has literally 10–15 slaves working

constantly for him. In India, the number is $1\frac{1}{2}$, one being himself and $\frac{1}{2}$ derived from the harnessing of forces of nature and from animal power. We may say that in India the energy output is equivalent to $1\frac{1}{2}$ slaves, of which 1 is the man himself and $\frac{1}{2}$ derived from other sources. This is probably just equal to half a donkey-power.

UTILIZATION OF ENERGY

How is the large amount of energy utilized in Europe and America? A substantial fraction is utilized in communication and transport which include rail and road travel, telegraphy, telephony, navigation, air travel, and radio and for domestic purposes; but the larger fraction is utilized in producing fertilizers, both phosphatic and nitrogenous, which have increased the productivity of the soil nearly four times; in extracting metals from ores producing alloys and chemicals, both heavy and fine, textiles, machinery, engineering goods, and miscellaneous consumers' goods and in the processing of forest products (wood and chemical pulp used for the manufacture of paper and rayon).

It is this large production with the help of natural power which has enabled men in advanced countries to attain a standard of living far beyond the dreams of medieval philosophers, a fact which is reflected by the rise in average longevity from 25 in about 1870 to over 55 in 1938 in Europe and America.* This is the result of better food, shelter and better conditions of public health rendered possible by greater wealth. Let us contrast conditions of public health in the two ages.

PUBLIC HEALTH IN MODERN AND MEDIEVAL TIMES CONTRASTED

It could be said that the child-bearing and child-burying were the chief occupations of women in the medieval age. Queen Anne of England lost all her fourteen children due to diseases which are now considered preventable; if any labourer's family at the present times has to suffer a fraction of the child mortality suffered by Queen Anne, probably the Ministry of Health would not last for two days. Conditions of public health, which are directly connected to income, are in India only slightly better than what it was in England in Queen Anne's time. We are told that there was no domestic running water in those days. Queen Elizabeth could afford only two baths in the month, and that was considered a luxury (*Westaway: The Endless Quest*). Probably, even the poorest man in England now takes at least 8 baths in the month.

* According to a report in *Science*, May 19, 1944, the longevity in the U. S. A. reached a peak of 64.82 years in 1942.

It is known to everybody that 90 per cent. of the people of India still lives in the sixteenth century,—a life of chronic malnutrition amounting in times to famine, disease and indescribable wretchedness. The amenities of modern life are available only to a small fraction of people living in the cities. Yet India has all the resources in power and materials which, if they were properly exploited, could raise her to the standard of the average European countries. The paradox is, as Dr Vera Anstey succinctly puts it, that the soil of India is extremely rich, but her people is extremely poor.

In the past, there has been much loose thinking regarding the methods by which the material condition of the average Indian can be improved, but it is only recently that there has been some objective thinking. The first step towards this was taken by the National Planning Committee of the Indian National Congress which sat during the years 1939 to 1941 at Bombay under the Chairmanship of Pt. Jawaharlal Nehru. It is pleasing to note that the Committee in its work secured ready and helpful co-operation from the Provincial Governments including those, like Bengal, which were not run by Congress Ministry. This shows the popularity of the idea of national planning. The Committee found that if the material condition of the average Indian were to be substantially raised within the next ten years, her production of energy should be raised by 40,000 million units per year (above the present figure). This may sound to be a very large figure, but a little reflection will show that the estimate is extremely modest. Even Mexico which is considered to be a rather backward country produces 180 units of electrical energy per capita per year contrasted to India's nine in spite of the chronic revolutions for which she had acquired a notoriety. The National Planning Committee's figure gives only 100 units per head, which is $1/20$ th of the per capita production in the U. S. A.

This energy can be generated by burning 20 million tons of coal, but India is markedly deficient in coal, and as an exhaustible national resource on which many essential needs of the nation depend it should be conserved for other purposes as far as practicable. It is desirable that most of this energy should come from electricity derived from hydro-electric sources* which exist in

* India's hydel power resources were estimated or rather guessed by Mears in 1922 to be 20 million kilowatts, so that even on this estimate up to this time, barely 1 per cent. of the resources has been harnessed. But Mears' figure is most probably glaring underestimation, for he was asked to do things hurriedly and he had neither the time, nor the proper resource to make an accurate survey. A parallel is afforded by Soviet Russia which before 1918 was reported to have hydel power resources amounting to 20 million kilowatts; but accurate survey carried out by the

plenty. Further only a small part of India has coal; other parts, such as the Punjab, Bombay and the whole of South India, have to depend on longhaul coal. It is not only desirable, but almost imperative that the water power resources of these parts be properly developed. The hydro-electric survey commission should now be revived, if we really wish to pass out of the present axis combination of poverty, disease and malnutrition.

In the reforms of 1933, development of electrical power was made a 'Provincial Obligation'. The Government of India thus divested itself by one stroke of pen of one of the most important obligations of Central Governments of all countries, and the befuddled Provincial Governments mostly talked vociferously about industrialization which sometimes in their minds was identical with the manufacture of tooth-pastes and matchsticks without achieving anything, and with one or two exceptions did practically nothing useful.

We turn to a pleasant picture afforded by the progressive State of Mysore. Even before the first World War, the Mysore State, thanks to the far-sightedness of Dewan Sheshadri Iyer, had harnessed the Cauvery falls at Shivasamudram, and after the World War, the work was further extended during the regime of Sir M. Visvesvaraya leading to an installed capacity of 48,000 kw., and production of nearly 300 million units of electrical energy. This gave the average of Mysorean nearly 50 units per capita. Encouraged by this success, the Mysore Government during the regime of Sir Mirza Ismail launched another great project calling for an expenditure of rupees seven crores for harnessing the waters of the Jog Fall in the Western Ghats. This is calculated to produce an installed capacity of 120,000 kilowatts, which is expected to yield nearly 720 million units, so that when these installations are in full working the production of electrical energy in the Mysore State would be nearly 200 per capita, or nearly double of the figure contemplated by us for the rest of India.

Amongst the provinces†, Bombay has shown the greatest amount of progress due to the enterprise of the Tatas who installed three power projects in the Western Ghats and thus ensured power-supply to

Soviets showed that the figure was 280 million kilowatts or 14 times higher. After the last War the Government of India had a plan for largescale development of hydel power in India, but this was dropped in 1923.

† The development of electric power in India has taken place mainly through three different types of projects, namely (1) Government or State projects, such as the U. P. Ganges scheme, the Punjab Government's Mundi scheme, the Mysore Government's Shivasamudram and the Madras Government's Pykara schemes; (2) the schemes undertaken by the great joint-stock concerns, such as the Tata Hydro-electric scheme, the Andhra valley scheme etc.; and (3) small projects for thermal stations undertaken and operated by a host of private companies all over India.

the industries of Bombay. After Bombay comes Madras in importance, which province during the Congress regime has also made significant progress in the development of power through the initiation of such projects as the Pykara Scheme. The Punjab and the United Provinces had had some very unfortunate experience with their schemes of hydel development. But the experience, though sad, had at least some educative value, for the Punjab has become alive to the needs of power development and is reported to have embarked on some very ambitious projects planned by her *own engineers* in the Sutlej and other river valleys. These works, when completed, are expected to yield nearly 2000 million units. *Let us hope that the past mistakes would not be repeated.*

In India, we have many populous river valleys which are subject to violent floods and which, on account of thoughtless handling in the past, have gone down in prosperity and public health. The most glaring examples are the Damodar Valley in Bengal and the Mahanadi Valley which is practically the whole of Orissa. How these rivers can be turned into beneficial agencies is afforded by the example of the Tennessee Valley in the U. S. A. This area, comprising about 40,000 square miles was going down continuously, and in 1931, it was estimated that for a large part the income had dwindled to 100 dollars per capita in the year. In 1933, due to the personal initiative of President Roosevelt, the Tennessee Valley Authority (shortly called TVA) was created and within ten years the whole face of the country has been changed. The core of the whole work has been the construction of about 20 multipurpose dams built for flood prevention, irrigation and soil conservation, navigation and power generation. In 1943 according to the annual report of the Authority 9000 million units of electricity have been generated, (a summary of the report appears elsewhere in this issue), and about a stretch of 650 miles of the river had been rendered navigable. Agriculture and industry have been in a flourishing state. Jacks and Whyte put it:

"Nature and vested interests turned a virgin country into a wilderness; but nature and man have again combined to make it a smiling garden".

It has been shown that the Damodar River Valley which is now notorious for its floods and malaria can be treated in the same way as the Tennessee and be turned into a beneficial agency yielding nearly 1,200 million units of hydel energy. Other valleys which can be treated in a similar way are the Mahanadi in Orissa, the Son and its tributaries in U. P., the Sutlej and other rivers in the Punjab, and the Koyna Valley in the Southern Bombay Presidency. In fact, if a plan of expansion is decided on, we do not see why India should not produce 200 units of electrical energy per capita within the next ten years.

We have tried to impress upon the reader the basic fact that the root cause of poverty of India is the hopelessly inadequate use of natural power. This is self-evident. Because, wealth can only be created by doing work. And, the work necessary for creating wealth of amount approaching that of the western countries cannot be done by man and animal power alone as is often held in this country. India must, therefore, develop and utilize to a vastly greater extent her natural power resources than she has been doing till now. Lenin, the Father of new Russia, realized the supreme necessity of developing power. One of his first acts on assumption of power was the appointment of a commission under Prof. Krzhizhanovsky to enquire into the power resources of the country. In fact, Russia began the development of power long before she launched her Five Year Plans. The Great Dnieper Dam was nearing completion when she started her First Five Year Plan in 1928. It is, therefore, imperative that the Central Government should at once set up a committee to make a thorough survey of the power resources of the country as a whole and establish suitable educational institutions to train a proper personnel. The survey is of basic importance and should be started immediately without waiting for the full formulation of the reconstruction plans.

The present global war has ruthlessly destroyed the normal tenor of life in every country by bringing ruin, desolation and disaster on an unprecedented scale. Out of these travails humanity is eagerly expecting the birth of a new age,—an age which will usher security and good living for the common man and good will and co-operation amongst the different nations. This has been the dream of founders of religions and of philosophers; but in the past ages all altruistic philosophy has been negated by severe limitations on the powers of man to obtain sufficient material (food, clothing, shelter, and other essential necessities of life) out of Mother Earth, which will provide plenty for all. The result has been the robbing and the enslavement of the weak by the strong all over the world and in all ages, and the situation thus created still continues. But the scientific discoveries of the past and present centuries have so far increased man's power over Nature that production of all essential commodities can now be multiplied many times leaving a margin of plenty for all. Though the potentiality of development is apparent to the scientific man, those who rule are still obsessed by the lust for power, domination and exploitation of weaker peoples.

Would India enter on a period of planned development and prosperity, or would all the mistakes which were committed after the first World War be repeated?

ON MISGIVINGS ABOUT SCIENCE AND SCIENTIFIC RESEARCH IN INDIA

BIJUPENDRA NATH MUKHOPADHYAYA

"WE do our best when we work under urgent stress"—the epigram, if true, would by implication put all of us on the level of the naughty child who refuses to work unless threatened by the "rod". Or, perhaps the epigram raises Newton's conception of "the external force" from the physical to the psychological world. That an external force is often necessary to break through our inertia is abundantly proven by the incidents of Narvik and Dunkirk. Whatever may be the psychological implications or philosophic background of such a contention, humanity marches forward through struggle.

The establishment of the Board of Scientific and Industrial Research in April, 1940 is only a reminder that India has entered within the threshold of a hard, long struggle. The Board has so far more than justified its existence and will no doubt continue, with other scientific and industrial research organizations, to render invaluable services to the community during the war period. But what concerns the thinking person of today most is the coming post-war period of still harder struggle, especially for us in India. It is easy to grasp the war-aim; even the politicians of the world have grasped it: they say that their war-aim is to beat the enemy. I do not think anybody would seriously doubt their sincerity—it would be rather strange if people should fight with a view to let their enemy win! What the politicians cannot grasp or cannot agree upon is the peace-aim. It is difficult to grasp not only because it is fundamental (fundamental things are often the most difficult things to grasp), but because it is not yet the same for all peoples. For the people of India the problem is straightforward enough. Our principle has always been "to live and let live" and there cannot be any deviation from this golden rule. Our first and foremost duty is therefore to feed, clothe, and house our people; and the scientists must do their utmost to secure these essentials. Some of our younger generation—the progressive thinkers—may be thinking in terms of internationalism; but it must at all cost be realized that national weakness does not contribute to international strength. The stupendous energy of the U. S. S. R., which held the avalanche of blitzkrieg, is but the galvanized strength of the highly developed individual autonomous States.

"The aim of every post-war reconstruction in India", said Sir J. C. Ghosh in his opening address on the occasion of the Symposium on Post-war Organization of Scientific Research in India, "should be

the removal of these two weaknesses. . . . 'A low national income and limited industrial development'. And we are met together today to discuss how science should be organized in India so that this object may be achieved." This is a clear statement of the aim of the scientists in post-war India; and there is no cogent reason—moral, ethical, economic or political—why science should not be pushed forward to achieve this end. There, however, seems to be, as pointed out by Sir Jnan at least two schools of thought in the country who view any prospect of scientific and industrial research with apprehension. Sir Jnan would have been more effective in putting forward the case for the scientists had he, instead of trying to persuade his opponents into his belief, pointed out the fallacies of their process of thinking. Firstly, there are those who do not favour scientific research or industrialization in India because of their disgust of the accompanying evils they have witnessed in the West; and secondly, those who favour industrial development but consider scientific research for this purpose to be unnecessary—they think that by importing foreign machinery and experts we can develop our industries; "they are in favour of providing such technical education in the country which will enable the industry to be run by indigenous talent after a period of probation under foreign experts."

I should like to deal with the second opposing thought first; as the consideration of the first would involve graver and more fundamental issues.

Those of us who believe that we can profitably employ and utilize the results of foreign research in our industry are not only thinking in terms of parasitic existence but also in terms of permanent economic dependence and political servitude. The chief error of this type of thinking lies in the failure to realize two basic facts of our modern world. In the first place, we are living in a highly dynamic world where everything is changing, and changing fast; the ancient sword has given place to the modern gun; the modern Hurricane is now making room for the ultra-modern jet-propelled aircraft; and the time-honoured peaceful occupation of growing paddy and potato in the field is now a "home front"! Yesterday is being outdated by today, and today by tomorrow, at a speed unknown in human history. Secondly, side by side with this tremendous change is the tendency of our world to get progressively smaller in the sense that its inhabitants are being

brought closer together. So, what one does now in one corner of the world is bound to have repercussions in all four corners. When science has abolished natural barriers between people and people, and country and country, what chance is there for our artificial barriers to survive? We must adapt ourselves to the changing circumstances of the day in the light of facts or else perish. If we, therefore, dispense with research and depend on others for our industrial development we shall not only live under conditions that were good only in the out-dated past, but advances made elsewhere are bound directly to affect our industries with adverse consequences. We shall keep on importing foreign machinery and foreign experts *ad infinitum* only to find ourselves permanently settled in the degenerating past.

On the other hand, the opinion of those of us who, to quote Sir J. C. Ghosh again, "have been so impressed by the evils of the modern world, that they do not hesitate to declare that the introduction of Western methods for increasing our national income should be resisted," is based on more fundamental ground. They have seen the Western civilization crumble under its own power of science and industry; they have seen how women and children are being slaughtered with lightning speed by the monstrous technique of science: to them the abstract concept of "science" takes the concrete forms of bombs and torpedoes, tanks and guns, mines and mortars—instruments of misery and destruction. It is but natural that they should forget all the good that science has done and is still doing to humanity—Penicillin, Patulin and M. & B. are a poor match for the High Explosives. Human mind does not measure good and evil by balancing one against the other and ticking them off, but by the quality of impression that is left behind: and impressions of fear and horror outlast pleasurable impressions both in intensity and in time.

How, then, are we going to answer those who maintain that science is responsible for the two major catastrophes in Europe, and that it would bring only disaster to India? Sir J. C. Ghosh's suggestion that these people should be educated out of their conservatism, and that the men of science in India should preach that science is capable of doing immense good to humanity and that the evil results are due only to evil men, does not appear to me to be adequate. For, in the first place, the distrust for science on the part of a large section of our public is not due entirely to conservatism; and secondly, preaching the virtues of science without convincing argument would merely betray intellectual lethargy on the part of our men of science and would ultimately defeat its own purpose. The case for science is strong enough to allow itself to be established by the dispassionate array of

facts and logical arguments, without appealing to human emotion and sentiment.

The outstanding feature of the Western civilization of today is, as it appears to me, not the enormous scientific and industrial power, but the colossal gap between this power and the power of man to control and direct it for the benefit of mankind. Science is progressing every day, but man has so far been unable to keep pace and adapt himself to the new environment. In other words, human wisdom is sadly lagging behind scientific knowledge. The advancement of science in all its branches has given man an immense opportunity to improve his physical existence, so that he may be better able to progress along the path of higher values; but he, being blinded by the chimerical brilliance of his own material achievement, has shifted the emphasis from the moral to the material aspect of things and in the process has completely lost his aim. Lin Yutang, the noted Chinese writer, has, at a recent interview with a representative of a London newspaper, said "... but I think when the West talks of culture it often means civilization. Bath-tubs, wireless, telephones are civilization. Culture is another thing. It lies, for instance, in the manners, the attitude to life of the Chinese peasant—kindness and tolerance and the ability to live side by side."

Another feature—a very significant feature especially in the light of modern psychological researches—of the present day Europe, is the lack of serious faith. Even Newton had his God; but the man-in-the-street today is largely impelled by the motives of day to day affairs. Science has usurped the place of God in the ordinary man's heart but has not been able to give anything in its place. The light of scientific knowledge has, it is true, dispelled the darkness of ignorance and superstition; but the need for faith is a human need and must find its expression elsewhere. This explains the authority of the Führer and the belief in blood and soil in Germany. The initial triumph of the Fascist forces is in no small measure due to this implicit faith upon their respective lords. But the authority of a man is bound one day to be questioned—that of God is unquestionable and hence permanent. The gallantry of the Soviet peoples who draw their inspiration from their faith in their Fatherland and the ideals it stands for, illustrates the dimension of the human power, which with the help of science could successfully withstand the greatest pressure the human race has yet been called upon to bear. The recent steps that are being taken towards decentralization within the U. S. S. R. show how strong are their love and faith for their local territory—the Fatherland.

It may be argued that if the human mind has been unable to adapt itself to the changing environ-

ment introduced by science in the West, what is the guarantee that it would be different in the East? Taking human nature as it is, is it not better that science with its potential danger be kept out of its reach? The answer to this is fairly simple: We do not stop using fire because its misuse or abuse may burn us. The best course is to train ourselves to use it in the proper way. Moreover, science has come to stay; and if we do not care for it in India we would, it is true, have to go without its benefit; but we are sure to share its evil effects through its misuse by others—we are sharing it now. As regards faith, we have enough—if not too much—in India now; any advancement of science in our country would in effect help to re-establish and strengthen the genuine faith by disentangling it from the myriad adventitious beliefs based on ignorant superstitions.

In conclusion I may emphasize that the real cause of the disastrous result of the present European civilization is not so much the introduction of scientific knowledge as the failure to introduce structural changes in the society to meet the new social functions which this knowledge has imposed. The industrial revolution brought about a sudden and violent change in the function of the society; but the social structure was allowed to remain practically medieval in character: the feudal lords handed over their

power and position to the shrewd businessmen with capital, and the labourer left the land and came to serve his new master in the factory. Not only were the business magnates able to take complete control of the nation's wealth and productive power, they were, with the help of the new tools which science had placed in their hands, better able than the noblemen to exploit the resources of the nation to their sectional interest. This concentration of power and wealth in the hands of the few is the ultimate source of the present-day trouble. It is, therefore, not surprising that the peoples of the Soviet Union should be able to strike a better balance between the structure and function of the social body with their much altered social condition.

The present unfortunate results of the European experiment with science need not, therefore, frighten us; for, not only we ought to learn our lesson from this experiment, but if we pin our faith to our vastly different tradition, where the realm of facts has always been subordinated to the realm of values, we shall not fail to combine scientific knowledge with human virtues. If Pasteur were alive today, he would, instead of saying "Science is the soul of all progress and the source of all prosperity", have said "Science is the soul of progress of all and the source of prosperity for all."

LOUIS PASTEUR AND HIS WORK

JUGAL BEHARI LAL,
LATE DIRECTOR OF PUBLIC INSTRUCTIONS, BHARATPUR STATE

[This One Act Play was written by Mr Jugal Behari Lal, M.A., Late Director of Public Instructions, Bharatpur State, to be staged by the pupils of the State College. Several plays and dialogues have been written by the author; and science, health and diet campaigns were conducted in the State and the neighbouring provinces.]

Ed.—*Science & Culture.*

SCENE I.

A STREET IN PARIS. Enter Chappuis, Pasteur's friend and Biot, a famous scientist and admirer of Pasteur.

Biot. Well met Chappuis, I was coming to you. You alone have influence over Pasteur and can shift him to Arbois from Paris which is being evacuated. If we save Pasteur, we save France and the world; there is that promise in the youth. An old chemist like me, after thirty years' effort, could not produce pure racemic from tartaric acid, which he has effected. From vision to vision, this prodigy further detects the ferments, when experimenting on the tartaric acid. Pasteur's quest for the racemic acid takes him from the illusory boundary that separates

life processes from purely inorganic reactions. Grappling with the manufacture of alcohol from beet sugar, he discovers the tartaric acid fermentations, which fixes the date of "New Learning".

Chappuis. Who could be more proud than I—his bosom friend, when he defeated the Liebig group of molecular physicists after 20 years of struggle? He could hardly ever be induced to leave his laboratory even for a walk when performing one experiment after another to confirm that fermentation, decomposition and putrefication all "are acts of life", and in the absence of life do not take place. Germs also have parents.

Biot. This has led him to discover that the various infectious diseases are originated by germs.

Chappuis. He has discovered both the diseases of the silk-worms and their cure and proved that they are contagious and hereditary. France has gained millions and millions. During these four years he lost father and three of his daughters—Camille, Cecil and Jeanne. The tenderest heart in the world is carried by the world's greatest living scientist—Pasteur. The microscope almost blinded him when he looked for the invisible typhoid germs which had carried off his three babies and made his home desolate.

Sounds of shells bursting.

Biot. Here are the Germans shelling our Paris. Run, run and save Pasteur and his laboratory.
[Both run away].

SCENE II.

PASTEUR'S LABORATORY. *Pasteur and his two laboratory assistants working on a table full of apparatus, chemicals and cultures.*

Pasteur. Life in the midst of danger is the life, the real life, the life of sacrifice, of example and of fruitfulness. Both the silk-worm diseases—Pebrine and Flachery, are conquered, and the Chicken-Cholera germs have got cultured by chance.

1st Asst. In the field of observation, Master, chance only favours the mind which is prepared.

Enter Biot and Chappuis, running and breathless.

Chappuis. Pasteur, pack up, run. Metz, the strongest fort of the world has surrendered without a struggle to General Moltke and this great Paris is surrounded. Evacuation is ordered. There is still a way out of Paris. A moment after, it would be too late. A shell at any moment may smash you and your laboratory to atoms.

Pasteur. I leave my Paris at this crisis? My father was a soldier before he was a tanner. He fought in the battle-fields of Europe in the valiant Third Regiment—the brave among the brave, and earned the cross of the Legion of Honour. I will die before I leave Paris.

Biot. Can you fight? You will be the worst soldier of France. But you can discover things to defeat Germany. Why not do what you are capable of, if your patriotism is genuine?

Pasteur. My beloved France is defeated, dishonoured and humiliated. We must end and let things go their own way.

Biot. It is not for a hero of Science like you to lose heart. Live and win by your Science. As a force you count for nothing, as a wisdom you

are the highest in the world. Fight with your own weapons and not with those of the enemies'.

Chappuis. You have no right to stay; you would be a useless mouth in the siege.

Pasteur. It is a cruel-kind argument and I yield to you. I would raise my beloved France above Germany by improving the wines, vinegar and the brewing of France. I would save my wounded countrymen by the Listerian antiseptic dressing and sterilizing wounds. For the memory of my diseased children and for the honour of France, I would give the heart its share in the progress of science.

Bursting of shells increasing.

Chappuis. Run, run. [All run away with the laboratory tables].

SCENE III.

Bombardment of Paris.

SCENE IV.

Enter Pasteur and his two assistants.

Pasteur. Blessed is he who carries within himself a God, an ideal and who obeys it: ideal of art, ideal of science and the ideal of the gospel of virtues. Therein lie the springs of great thoughts and great actions; they all reflect light from the Infinite. Let us do our bit. Five per cent of the cattle and ten per cent of the sheep in France die of anthrax. Davaine and Koch have isolated the bacilli but could not effect the cure. I have taken up the problem. I had taken 50 sheep and 25 were inoculated with the anti-anthrax serum, while the other 25 were not so inoculated. I have since infected all with the virulent disease. If the inoculated ones survive, the principle of inoculation will be established. In the case of Chicken-Cholera culture I have found that it loses strength merely by keeping, and a fowl inoculated with this weak culture suffered only a passing indisposition and afterwards was immune from the attack of this virulent disease itself. The principle of inoculation should apply to anthrax and all the infectious and germinal diseases.

Noise without.

1st Asst. Master, there is a crowd of farmers who wish to see you.

Pasteur. Let them come in.

Enter Farmers.

Farmers. Saved, saved, our cattle are saved. Hail Pasteur! Long live Pasteur!

2nd Asst. Quiet, quiet. There is an old woman with two children, wailing and crying and wishing to see you.

Pasteur. Now friends, leave me. I have to attend to other business. [The farmers leave, saying "Long live Pasteur. Pasteur for ever."]

Pasteur. Jenner, Jenner, you have discovered the vaccination against small-pox. How can the world ever forget you? Working so far apart we are guided by the same human spirit. I have discovered the anti-rabic serum. But what can this woman and the children want?

Enter an old woman and two children.

Mother. Monsieur Pasteur, my children Meister and Jupille are bitten by a mad dog. Nothing, except you, on earth can save them from the suffocating mad struggles of hydrophobia and the most painful death. O! save them, save them. [Cries bitterly, while the children cling to him and cry. Pasteur also cries out of sympathy.]

Pasteur. Lady, I have succeeded in curing mad dogs but I have not yet tried the inoculation on human beings. I cannot bear to see the reaction and the possible pain resulting in death and cannot apply the treatment without being sure of the result.

Mother. O! Try this desperate remedy.

Pasteur. I cannot unless Vulpian can assure me of its success.

Mother. We will call Vulpian here. [Mother and the children depart.]

Pasteur. The anthrax bacilli are isolated by Davaine and Koch but I have not been able to detect or

isolate the raby germs, yet the disease is of germinal origin, as the inoculation has proved. Is it a virus like the small-pox germs, too small to be detected by a microscope? I have submitted my anti-rabic treatment to the Government who have appointed a Rabies' Commission under Vulpian. Vulpian will tell the result if he comes. I rely on Vulpian, the greatest physician of the age.

Enter Vulpian.

Vulpian. Good morning, Monsieur Pasteur.

Pasteur. The same to you.

Vulpian. The year 1885 will be memorable in the history of the world. Your anti-rabic treatment and inoculation have been proved and confirmed by the Commission. The Government have ordered Pasteur Institutes to be opened throughout France to perpetuate your great memory. A time will come when every big centre in the world will have a Pasteur Institute. I have treated the two children strictly according to your method and they are cured. You are a benefactor of mankind, you have solved the problem of "Man or the Microbe" in favour of mankind!

Enter the mother and the two children cured. They jump and kiss Pasteur.

Pasteur. Hallo my children you are cured. In you I see my Camille, Cecil and Jeanne resurrected. It is one touch of Nature that makes the whole world kin. Live France, live all mankind and prosper!

All. Hail Pasteur! Immortal Pasteur!. [Lift up hands.]

D R O P

A. FUEL RESEARCH PROGRAMME FOR INDIA

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A FUEL Research Institute is to be established by the Government of India. This is the time to discuss as to what would be the best programme for such an institute. Any such national institute should obviously have two fundamental issues to deal with; firstly, the maximum economic utilization of the nation's fuel resources and secondly, the production of substitutes for those natural fuels that are not available in the country. From both these points of view, India can be compared with Britain, which country had established a fuel research institute as early as 1917, to find out ways and means for optimum economic utilization of British coals which have been showing a steady rise in price since long, and also to develop methods for the production of liquid fuels—substitutes of petroleum products—for internal combustion engines. It is thus interesting to know how the British Fuel Research Board proceeded to formulate their programme. The following is an extract from the first report (1917) of the Board of Fuel Research* to the Lord President, Privy Council for Scientific and Industrial Research.

"The field to be covered by Fuel Research is admittedly a very wide one. It embraces inquiries into the sources and qualities of coals, oil shales, natural oil and gas, and peat; into the methods of preparation of manufactured fuels from these natural raw materials and into the methods of consumption of the various forms of natural and manufactured forms of fuel for the production of light, heat and power. The underlying motives in these inquiries must be the securing of greater health, comfort and convenience for the community, combined with the more economical use and development of the natural resources of this country.

"It is proposed that two main lines of inquiry should be followed, but should opportunities present themselves for the effective pursuit of other lines, they have to be able to utilize them.

"The first of these lines of inquiry originated in proposals from the Coal Conservation Sub-committee of the Reconstruction Committee for a complete Survey of the Coal Resources of Great Britain. The part of this inquiry with which the Board is more immediately concerned is the examination and classification of the coal seams of the various coal mining districts by means of chemical and physical examination in the laboratory. At the discussion, which have taken place at the Coal Conservation Sub-Committee it has emerged, that the inquiry is intended to cover two aspects of the subject, the immediately practical, and the theoretical and more remotely practical.

"On the immediately practical side, it is proposed to take stock of the coal resources of each district, as these are already known to exist, to classify according to their qualities the seams which are being worked or which might, under certain circumstances, be worked and to ascertain broadly the industrial uses to which the different kinds of coal are being put. The classification for practical purposes involves the formulation of standard methods of sampling and testing. The testing would be done primarily in the laboratory and would be so carried out that standard values related to the purposes for which each kind of coal would be most suitable might be assigned to the various seams, e.g., for carbonisation for metallurgical purposes or for illuminating gas making, for steam raising in land or marine boilers, for the production of heating or power gas or for domestic use. The formulation of a complete testing scheme and the establishment of standard methods of testing will need to be carefully discussed by laboratory and manufacturing experts.

"On the more theoretical side of the inquiry investigations will be required as to the nature and origin of the various types of coal and into the chemical and physical behaviours of their constituents under the action of heat and other agents. These investigations would be systematized and followed up energetically and every reasonable resources should be put at the disposal of the scientific workers who are prepared to take up the work. (Italics are ours). By concentrating scientific investigations in the first instance on those coals which are widely known and used in industry the work on this side of the enquiry would be most readily kept in touch with that on the more immediately practical side, and the new knowledge acquired by the scientific worker would at once be available for the use of his practical colleagues.

"The second of the proposed lines of enquiry has been led up to by a variety of influences. Amongst these influences have been the demands for cheaper and more ample supplies of electrical energy, for home supplies of fuel oil for the navy and of motor spirit for the transport and air services, and last, though by no means least, a definite demand for a smokeless domestic fuel brought about mainly by the growth of public and municipal opinion as to the great evils due to atmospheric pollution caused by the smoke and corrosive gases emitted by industrial and domestic fires. The only development which would satisfy these needs simultaneously, is the replacement of a large proportion of the raw coal which is at present burned in boilers, furnaces and domestic fires by manufactured fuels prepared from raw coal by submitting it to the distillation.

"These problems can only be solved by carefully organized experiments on a working scale carried out under the conditions likely to arise in practice."

The above extract gives a precise idea of the fundamental considerations involved in the formulation of the research programme that was to be followed by His Majesty's Fuel Research Board. The actual programme, which was subsequently decided upon and which was followed for the first decade,

by the British Fuel Research Institute, was as follows:—

"(1) The organisation and development of the Physical and Chemical Survey of the National Coal Resources with a view to ascertaining the most suitable method of utilizing the various seams and in particular their suitability for treatment by carbonization or otherwise.

(2) The obtaining of data of unquestionable accuracy for the preparation of thermal balance sheets for various methods of coal carbonization and the gasification of coal and in connection with the use of gaseous fuels in industrial furnaces.

(3) The obtaining of data for the preparation of economic balance sheets for carbonization, gasification and furnacing operations.

(4) The obtaining of similar thermal and economic data in connection with the use of peat as fuel.

(5) Experimental work on carbonization at temperature up to 650°C and on various types of apparatus for this purpose.

(6) The study of the coke produced under (5) from various types of coal as a smokeless fuel for domestic and industrial purposes, either directly or in the form of briquettes.

(7) The study of the oils produced under (5) as a source of fuel oil for use by the Navy in steam boilers or in Diesel engines.

(8) The study of the gases produced under (5) with a view to their utilization directly as a high grade fuel or as a source of fuel alcohol.

(9) Experiments in the carbonization of coal at high temperature to ascertain the influence of temperature, rate of heating and other variables on the quality of coke and gas produced, and other yield of by-products.

(10) The use of pulverized fuels in operations of various kinds.

(11) Steam-boiler tests of various fuels including the products of the carbonization of coal.

(12) The production of oil from natural fuels by processes other than that of carbonization.

(13) The production of light oil from heavy fractions or residues.

(14) The use of various types of liquid and gaseous fuels in internal combustion engines.

(15) Investigation into the production of light spirits other than those produced from natural oils, coals, etc.

(16) Investigation of instruments and devices suggested as aids to economy in fuel.

(17) Investigation into the use of fuels for domestic purposes and similar applications.

(18) General investigation into the chemistry of fuels and the processes for fuel applications."

It is clear that whatever other items might be included in the research programme for India, the above investigations will also have to be carried out here, as they are equally significant for all country's rational fuel utilization. A good part of the above programme involves work in Low Temperature Carbonization. This is to be explained, perhaps, not only by Britain's urgent necessity for production of petroleum-product substitutes, but also because of high

hopes entertained during the decade 1914-1924, on the possibility of production of liquid fuel from coal by Low Temperature Carbonization. With the development of the processes of Hydrogenation of coal and Fischer-Tropsch synthesis, however, there is a growing opinion that work on Low Temperature Carbonization is futile. It has to be submitted however that both the latter processes involve intricate chemical engineering operations, especially in the realm of high pressure technology. The cost of petrol obtained by the two processes is also very high. Low Temperature Carbonization has a further significance for India, as the vast reserves of Indian coal are mostly non-caking and can thus hardly be profitably processed by High Temperature Carbonization. One great offset in Low Temperature Carbonization has been the disposal of the heavier fraction of tar which is obtained in much greater yield. It has been reported,¹ however, that a process has been developed by His Majesty's Government in Britain to utilize this tar for road construction. If this works successfully, India will need primary tar for her innumerable roads still to be constructed. The last word on Low Temperature Carbonization, it appears, has not yet been said and for obvious technological, chemical and economic reasons, it can hardly be advised not to follow up Low Temperature Carbonization. One word more need be said as regards this process. Unsaturated gases constitute today the raw materials for the production of innumerable basic synthetic organic chemicals. Whilst America obtains the supply of these gases from the petroleum industries, others will have to develop processes for their production from coal. Britain has already established a Gas Research Institute, with Dr J. C. King, as its first Director.² Here, it seems, investigations will have to be made on the possibility of production of olefines from Low Temperature Gas.

Certain inherent peculiarities of Indian coals demand research in some other directions also. For Indian coals are sadly characterized by a higher content of ash, which is again believed to be intrinsically bound with the main mass of coal. Secondly, there are coals with high percentages of moisture and sulphur. Russia has done wonderful works towards the utilization of this type of coals and some of Russia's super-pressure steam boilers are running with coals of very high contents of moisture, sulphur and ash.³ Surely we can also use our inferior coals and it will be the responsibility of the future Fuel Research Institute to develop processes for the purpose. The non-caking nature of the majority of coals necessitates urgent and energetic work on the items 6 and 10 of the above programme.

¹ Chemical Age, Annual Number, 1942.

² Chemical Age, Annual Number, 1942.

³ Soviet Science, J. Crowther, Kegan Paul, London, 1936.

* The members of the Board were Sir George Beilby, F.R.S., Hon'ble Sir Charles Parsons, K.C.B., F.R.S., Sir Richard Redmayne, K.C.B., and Sir Richard Threlfall, F.R.S.

As regards liquid fuels for internal combustion engines, India is decidedly at an advantageous position, as compared to Britain. Petroleum and even coal may get exhausted. But vegetation is perennial. We must use alcohol and wood charcoal in spontaneous ignition engines and vegetable oils, like groundnut oil, in compression ignition engines. All modifications necessary in engines for using these substitute fuels should be investigated and standardized. This deserves, in our opinion, the immediate attention of the Fuel Research Institute to be established.

In view of the above considerations, it appears, the programme for India should include the follow-

ing items as well, in addition to the eighteen detailed above.

(1) Investigations on the methods of washing and cleaning Indian coals.

(2) Investigations on the processes for production of olefinic gases from Low Temperature Carbonization gas to produce the basic materials for production of synthetic organic chemicals.

(3) Investigations on alcohol-burning engines.

(4) Investigations on the use of vegetable oils in Diesel Engines.

(5) Investigations on producer-gas engines and charcoal for use in these engines.

PRIMITIVE PRODUCTION IN NORTH EAST AND CENTRAL INDIA*

NABENDU DATTA MAJUMDER

THIS paper is an attempt to study the productive activities of the Mongoloid Indo-Chinese tribes of Assam, e.g., the Khasi, Garo, Naga and Lushai Kuki etc., and the Pre-Dravidian tribes of Santal Parganas, Chota Nagpur, Central Provinces, and the Eastern Ghats between the Godavari and the Mahanadi, e.g., the Santal, Munda, Gond, Kond etc. The problems discussed here include (i) the different ways of exploiting natural resources to satisfy needs, (ii) the relative importance of the different types of production, (iii) the relation between the physical environment and production, (iv) the principles of the division of labour, (v) co-operative labour, (vi) slave labour, (vii) the organization of production, and others.

The conditions of material life exercise an enormous influence on the spiritual or ideological life of society. These conditions of material life of society include geographical environment, growth and density of population, and economy. It is true that each one of this complex of conditions influences the development of society, but the degree of influence is not the same in every case. Of all such conditions it is the economy that has the greatest influence on social development. Of the various factors that go to make up the economy of society—production, exchange, distribution, and consumption—it is the method of procuring the means of livelihood, the mode of production of such material values as food,

clothing, houses, fuel, foot-wear, instruments of production etc., that constitutes the chief force in determining the physiognomy of society, the character of the social system, the development of society from one system to another.

The importance of production in the development of society was recognised as early as the 4th century B.C. when Dihaerchus spoke about the three stages of hunting, pasturing and agriculture in attempting to discover the principal land-marks in social development. I am not here trying to prove the validity or otherwise of the classical theory of the three stages, but my sole object is to show that the exponents of the classical theory, at least, realised the determining part played by production in the course of human development. Whether or not it is possible to discover all the stages through which mankind has passed, and if so, what these stages are, is another question.

According to the school of historical materialism, founded by Karl Marx and Frederick Engels, the mode of production may be analysed into two aspects: (1) the productive forces, and (2) men's relations of production, or economics relations. The first aspect expresses the relation of men to the objects and forces of nature which they make use of for the production of material values, while the second is the relation of men to each other in the process of production.

The productive forces are, again, divided into three elements: (1) the instruments of production

with which material values are produced, (2) the people who operate these instruments and carry on production, and (3) production experience and labour skill.

The above-mentioned school holds that the noble of production is a mobile and changeable factor, and that any change in the mode of production is bound to lead to changes in the whole social system, social ideas, political views and political institutions. They further maintain that of the two aspects of the mode of production the productive forces are more mobile, and that of the three elements of the productive forces the instruments of production are the most mobile. So, changes and development of the instruments of production are bound to initiate a whole series of changes and development—first of the productive forces, then of men's relations of production, and finally of the physiognomy of society, of the whole social system.

It is regrettable that very little has been done by anthropologists to study the role and significance of the mode of production in social development, the effects of changes in the mode of production on the physiognomy of society. I am, mentioning this here in the hope that future investigators will tackle this problem.

The various ways in which the primitive tribes of India exploit their natural resources to satisfy their needs, in other words, the different types of economic activities prevailing among them, are: (1) collection of edible fruits, roots, plants etc. from the forests, (2) hunting, (3) fishing, (4) domestication of animals, (5) cultivation, and (6) arts and crafts. Though the relative importance of the different forms of production vary in different tribes, all of them agree in having cultivation as the most important form of production. The production of food is the chief pre-occupation of all these tribes.

The collection of forest products has always been of great importance to these tribes as a subsidiary source of food. In seasons of scarcity, they fall back on the edible fruits, roots, and plants of the forests to keep body and soul together. For example, among the Konds, the summer, which is a season of scarcity, is known as *sukki kalo* or hungry season. Products of the jungles, e.g., yams and other edible roots, dry *mohua* fruits, mangoes and mango stones ground to a sort of flour etc., pull them through the *sukki kalo*. In 1868, there was a widespread famine in Central India, during which the Gonds and other aboriginal tribes were but slightly affected, because (i) they could rely on the products of the jungles, and (ii) the light millet crops, *Kodon* and *Kutki*, were not so badly affected by the failure of rain. Among the Lushai Kukis, in times of scarcity, whatever rice can be had is reserved for the young

children, while the rest of the people live on wild yams, vegetables, and the pith of the sago palm. But the importance of the collection of forest products, as a method of securing food in primitive tribal life has been greatly reduced by the reservation of forests by the Government. I am informed by Mr T. C. Das of Calcutta University that he has come across one small tribe, the Chiru, belonging to the Kuki group and inhabiting the eastern fringe of the hills bordering the western side of the Manipur plain, who, when questioned about what they would do in case of a failure of crops, did not say anything suggesting the importance of the collection of forest produce in scarce times. On being given a broad hint about wild fruits and roots, they mentioned only a few wild roots that could be collected. This may be explained on two grounds,—(i) their natural environment is not rich in wild edibles, and (ii) the possibility of borrowing from the plains people with whom they are in contact.

In former times hunting and fishing played a very important part in the economic life of the primitive tribes of India. They were once the primary occupation of many of these tribes, e.g., the Mundas, Santals and Gonds. To-day all of them are concentrating on cultivation. But till recently the contribution, made by hunting and fishing, to the food-supply of the primitive tribes has been considerable. Now-a-days, however, the reservation of forests has diminished the importance of hunting to a very great extent. For example, the Konds, Gonds and Baigas have been deprived of one of their main sources of livelihood. In connection with hunting it should be noted that the ancient bow and arrow is being replaced by flint-lock guns wherever the tribes have come into possession of a few of them. This is the case with the Gonds, Lushai Kukis, Angami Nagas etc.

Cultivation, which is the main source of food-supply to the primitive tribes under consideration, is of two kinds, shifting and fixed, or dry and wet. The shifting system of cultivation is known by different names among different tribes. It is called 'jhum' by the Assam tribes, 'bewar' by the Baigas, 'dahia' by the Gonds, 'podu' or 'kumeri' by the Konds, and 'kurao' by the Maler in the Rajmahal Hills. The fixed cultivation is like the usual plough cultivation of the Hindus of the surrounding plains. The two systems of cultivation play different roles in the economic life of different tribes.

The Maliah Konds, Maria Gonds, Hill Garos, Lushai Kukis and Lhota, Sema and Ao Nagas practise only the shifting system of cultivation. In this system a patch of jungle on the hill slopes is cut down in the winter, and left to dry in the sun. In the summer the dried logs and branches are set on

* Read at a meeting of the Anthropological Society, University of Calcutta.

fire, and the ashes scattered all over the ground. When the rains commence, the seeds are sown broadcast in the ashes with or without hoeing. These patches are cultivated for 2 or 3 years, and then left to lie fallow till they are recovered with jungles. The number of years for which these patches are left fallow also depends on the availability of jungle land and the density of population.

The tribes living in or near the plains, and in contact with the plains-dwelling Hindus, are adopting the fixed system of cultivation. Such are the Konds of the lower slopes, the majority of the Gonds, the Mundas, Santals, Garos of the plains, Khasis and Angami Nagas. It may be mentioned here that the Chakroma Angamis, though they live nearer to the plains than other Angamis, have so much good *jhum* land, that they depend only on 'jhumming' for their livelihood.

The fixed cultivation of these tribes may be sub-divided into dry and wet cultivation. The former is practised by the Gonds, Mundas and Khasis; and the latter by the Konds of the lower slopes, Santals, Mundas, Angamis, Plains Garos, and Khasis. The Mundas and Khasis practise both dry and wet system of fixed cultivation.

The dry cultivation is carried on by the Gonds in hilly and jungle tracts of poor quality, consisting of *barra* or gravel soil disintegrated from the rock of the hill-sides, by the Mundas in their *danr* or *lanr* (uplands), and by the Khasis in their *Ka ri lum* or *Ka ri phlang* (high grass land). The wet cultivation is carried on in terraced low lands and valley bottoms, which are called *don* by the Mundas, and *hali* or *pynthor* by the Khasis.

All the primitive tribes under consideration, with only three exceptions, use the plough in their fixed cultivation of both dry and wet kinds. The Kutiah Konds, i.e., the Hill Konds of Kalahandi, a State in Orissa, in rare instances, grow a little wet rice. When they do so, they use neither the hoe nor the plough in preparing the field, but manual and pedal labour of men, women and children. The Angamis dig their terraced fields with a spade which has the shape of an inverted V and a flat spoonlike blade 6 to 8 inches broad in the broadest part. The Khasis use a hoe for the purpose, though the Syntengs, one of the Khasi tribes, in the neighbouring Jaintia Hills employ the plough.

The cultivation of these tribes is mainly dependent on rainfall. But the Angamis, Khasis, Mundas, Santals, and Konds of Ganjam supplement rainfall by artificial irrigation, which takes the form of *bandhs* or embankments across ravines, hollows or other natural depressions to retain natural moisture. The Santals exhibit much ingenuity and co-operative effort

in constructing *bandhs*. The Angamis and Khasis are more ingenious in artificial irrigation. They irrigate their terraced fields by skilfully contrived channels drawn from streams, sometimes at a distance of a few miles.

The crops cultivated are usually cereals, pulses, oil seeds, and vegetables. Rice is the staple crop among the tribes of Assam, Chota Nagpur and Santal Parganas. The Gonds, Baigas, and Kutiah or Maliah Konds depend on small millets called *kodon* and *kutki*. It is not long since the cultivation of potatoes was introduced among the Khasis, but they already excel in it. Among fruit crops, the cultivation of oranges by the Khasis is noteworthy. The export of Khasi orange, under the name of Chhatak or Sylhet orange, to the markets of Bengal has been going on for generations. According to Sir George Birdwood, the orange and lemon of Garhwal, Sikkim and Khasis have been carried by Arab traders into Syria, "Whence the Crusaders helped to gradually propagate them throughout Southern Europe."¹

The domestic animals found among these tribes are cows, buffaloes, mithans, pigs, goats, fowls, dogs, cats etc. The chief animal among the Angamis and Lushai Kukis is the mithan, while that among the Mundas, Santals, and Konds is cows and buffaloes. The main economic importance of the domestication of animals among the primitive tribes of India consists in supplying them with their protein requirements in the form of meat. Other economic uses of domestic animals are ploughing, trading, hunting and scavenging. A number of Syntengs in the Jaintia Hills depend on cattle-breeding for their livelihood. The Angamis sometimes rear mithan for sale. The Mundas, Santals and Konds use oxen and buffaloes in ploughing. Dogs are reared by the Angamis and Lushai Kukis for hunting purposes. Pigs are the first-class scavengers of the villages of the hill tribes of Assam, and contribute much to their sanitation. Dogs also play their part in scavenging the villages. Apiculture or the rearing of bees is found among the Khasis and the Angami Nagas.

The arts and crafts found among these primitive tribes are spinning, weaving, basketry, pottery, carpentry, blacksmithy, iron-work, brass-work, oil-pressing, salt industry, and dyeing. The majority of the above arts and crafts are practised by the Mongoloid tribes, whereas the Pre-Dravidian tribes are very poor in this respect. The Gonds and Konds have no handicrafts, their industrial requirements being supplied by low-caste Hindus settled in their villages. The Mundas have only spinning and oil-pressing. It should be noted that the art of oil-pressing is present among the Pre-Dravidian tribes,

¹ Sir George Birdwood—Introduction to the "First Letter Book of the East India Company", p. 36.

but absent among the Mongoloid Indo-Chinese tribes, except the Kacharis. I am indebted to Prof K. P. Chattopadhyay of Calcutta University for the information regarding oil-press.² The Mundas have a strong prejudice against weaving, which they regard as a degrading occupation, only fit for the Panos (a Hindu caste) of the village. The efforts of the Roman Catholic Mission to introduce weaving among the Mundas have proved a failure. The Santals have no specialized crafts, and buy their industrial requirements from the Hindu artisans. According to Man, writing in 1867, the Santals "have weavers from their own tribe", and "each man is his own carpenter."³ But according to Dalton, writing in 1872, "They have no weavers among their own people."⁴

Of the Mongoloid tribes, the Garos and the Khasis (proper) are rather poor in arts and crafts; but the Angami Nagas and Lushai Kukis are richer in this respect. The Khasis proper are entirely unacquainted with the art of weaving, though it is known in the neighbouring Jaintia Hills where the spinning and weaving of both cotton and silk are found in a few villages. The Khasis knew the art of excavating and smelting iron ore, and the forging of iron implements therefrom. But this industry, together with the cotton-spinning industries at Mynso and Suhtnga in the Jaintia Hills are dying out, as a result of competition from cheap British goods of iron and cotton. The Angami Nagas, before their conquest by the Government used to manufacture salt from brine wells. This salt industry has now almost gone out of use. The moulding of brass and the forging of simple iron implements, found among the Lushai Kukis, has been introduced, according to Shakespeare, by the raid captives from the plains of India or Burma.

The influence of the physical environment on the economic life of these tribes in general, and the method of procuring food in particular is obvious. All these tribes live in well-wooded hilly tracts rich in all kinds of forest products and game. Consequently they show similarity in the method of procuring food. For, they are mainly collectors of wild edible fruits and roots, hunters and shifting cultivators. But where there are open plateaus, as in Chota Nagpur and the central plateau of the Khasi Hills, we find fixed cultivation. This is the case with the *danr* and *don* lands of the Mundas, and high grass land (*ka ri lum*) of the Khasis. But in the forest tracts of the Khasi and Jaintia Hills the

Bhois, Lalungs and Lyngngams still practise *jhum* or shifting cultivation.

The influence of the physical environment is also to be observed in the details of technique. For example, the Mundas and Khasis practise dry cultivation in their highlands, and wet cultivation in lowlands. This influence may be noticed even in the method of sowing. For instance, the Mundas have *buna* or sowing broadcast for their *danr* lands, and *ropa* or transplantation for their *don* lands in the bottoms of valleys.

But the influence of the physical environment is not omnipotent and determining. It sets certain limits within which there is scope for variations. For example, in the fixed cultivation of the wet type, the Mundas and Santals use the plough, whereas the Khasis and Angamis have no plough and employ the hoe, though the physical environment is about the same. Again, though the Khasis proper do not use the plough, the Syntengs in the neighbouring Jaintia Hills use it in their wet cultivation. (I am told by Mr. T. C. Das of Calcutta University that nowadays the Khasis also are adopting plough cultivation in the lower valleys). It seems that these variations are due to separate cultural traditions. The point may be further illustrated by the fact that while the Angami Nagas and Lushai Kukis build their villages on tops of hills, the Khasis choose sites a little below the tops, and the Garos prefer the valleys or depressions between hills for their village sites. In the case of the first two tribes, living in the midst of peoples fond of raiding each other, the consideration of security determined their selection of the hill tops. But the choice of the Garos was influenced by the proximity of the source of water-supply.

Now, I shall consider the question of labour. There are some ill-informed people who seem to think that the primitive tribes are very lazy and that most of their miseries are due to that fact. This is very far from the truth. The primitive tribes are by no means averse to hard work. As a matter of fact, they have to work very hard, in the face of serious dangers of attacks by wild animals infesting the dense forests, merely to keep their body and soul together. The cutting of a *jhum* or *bewar* or *podu* is a difficult as well as dangerous task. The reclaiming of land from jungles for plough cultivation is a very hard job, and the Santals have acquired great skill and fame in that work. The terracing of hill-sides, embanking and irrigating them, to make them fit for wet rice cultivation, requires an enormous expenditure of energy, and the Mundas, Santals, Khasis, and Angamis have been performing this arduous work for generations.

² K. P. Chattopadhyay—"Indian Oil Presses and Oil Extraction". *Journal of the Indian Anthropological Institute*, Vol. I, Nos. 1 & 2, 1938.

³ E. G. Man—Sonthalia and the Sonthals, Calcutta, 1867.

⁴ E. T. Dalton—Descriptive Ethnology of Bengal, Calcutta, 1872.

Work among the primitive tribes is not undertaken indiscriminately. There are certain traditional principles according to which labour is divided. The main basis for the division of labour among these tribes is sex. The functions usually reserved for women are the collection of edible fruits, roots and plants from the forests, cooking and other domestic work, ginning cotton, spinning, weaving, and pottery by hand. Among the Sema Nagas and Changs pottery is done exclusively by women, though among the Angami Nagas both men and women take part in it. The functions usually reserved for men are hunting, fishing, warfare, basketry, carpentry, house-building, and metal work. Cultivation is usually shared between the two sexes. Heavier tasks like jhum-cutting, ploughing, constructing *bandhs* and irrigation channels are left to men, whereas women participate in transplanting seedlings, sowing, weeding, harvesting and threshing. (I am indebted to Mr. T. C. Das for the information that jhum-cutting among the Naga and Kuki tribes is shared between the two sexes; big trees are cut by men, and small brushes by women). Among the Mundas, who use bullocks in threshing, it is done by men. Munda women watch the ripening crops in day time, while men keep watch at night. Sometimes women take part in hunting and fishing. Among the Garos, in big hunting drives, women line the outside of the V-shaped stockade, and by beating it with sticks and uttering shrill cries, help in preventing the animals from escaping except through the openings made for them. Garo women also fish with the *chekke*, a scoop-like basket. In the excavation of iron ore by the Khasis, women do the washing of the ore in a trough.

The principle of sex division is sometimes extended to the field of fine arts. The Jew's harp is practically the only musical instrument that women can play among the Angami, Sema and Lhota Nagas. Among the Semas, the flute is a taboo to the women, and is played exclusively by men. Incidentally, it may be interesting to note here that the Hindu womenfolk of Bengal have a prejudice against the flute, and that if they (married women) hear the sound of a flute while having a meal they would immediately stop eating and go without anything till the next meal.

The principle of dividing labour on the basis of age is not much in evidence. A few cases may be noticed. Among the Gonds the task of watching the ripening crops is left to the old men and children. Among the Kutiah Konds, the children along with their mothers, puddle their wet fields with hands and feet. The Lushai Kukis are assisted in their cultivation by the children. Little Lushai girls help their mothers in bringing up water in bamboo tubes from

the springs. Among the Angami Nagas, only old men are entitled to manufacture wooden dolls.

Division of labour according to crafts or occupation is absent among the Pre-Dravidian tribes. Only rudiments of such division are found among the Mongoloid tribes. For example, among the Angamis, every large village has at least two or three individuals who live either entirely or mainly by blacksmithy. Among the Lushai Kukis, every village has a blacksmith who is also one of the village officials, and is paid at the rate of one basket of rice from each householder whose tools he repairs. Some Angami villages keep a regular cowherd who is to look after the cattle of the village, and who is paid at the rate of two baskets of paddy per annum per cow by the owners of the cattle under his charge.

The principle of specialization according to locality, though in a rather elementary form, is found among the Khasis. For instance, among the Syntengs in the Jaintia Hills, the Khyrwang and Nongtung villages specialize in the manufacture of Eri silk cloths, Mynso in spinning cotton thread, and Sulhnga in weaving the *ingki* or sleeveless coat from Mynso thread.

The division of labour according to ethnic groups is present among some Pre-Dravidian tribes. For example, the Gonds and Konds devote themselves to collecting, hunting, fishing and cultivation, while low-caste Hindu artisans, resident in their villages, supply them with their industrial requirements. The Sitrans are the metal-workers of the Konds. They make their battle-axes, brass ornaments, etc. The Panos are the weavers of the Konds, sometimes work for them as agricultural labourers, and provide them with salt and many other necessities.

Primitive labour in India presents another feature, and that is co-operative work. All forms of economic activity among the primitive tribes provide ample instances of the principle of co-operation in labour. Let me take a few cases. Among the Konds, in the hot weather when food-supply gets low, and people have to depend more on food-gathering for subsistence, young men and women form parties for fishing and the collection of mahua fruits and other jungle berries. In the collection of wild honey from the bee-hives in the crevices of precipitous rocks, the Khasis form working parties of six or seven persons. An excellent example of co-operative labour is supplied by the institution of age gangs among the Sema Nagas. Every member of a village, old enough to be independent of the care of the mother, belongs to a gang consisting of persons of about the same age. Gangs of unmarried persons are usually mixed, whereas a married person belongs to a gang of his or her own sex. The cultivation of the fields is done by these gangs, whose membership usually lasts for

life. Each gang elects its own leader who decides what fields are to be cultivated each day. Every member of a village can depend on his gang for the cultivation of his fields, the conventional remuneration of gang labour being rice and liquor.

Co-operation in hunting is very well-illustrated by the Santals, Angamis, Lushai Kukis and Garos, who organize large hunting parties where whole villages take part. During the hot weather, from the middle of April, the Santals organize big hunts in which every able-bodied man in a *pargana* or a group of villages, tries to participate. These hunts are very well organized. A common Santal is democratically elected to be the priest, sacrificer and master of the hunt, and is called *dihri*. The *dihri* fixes the time and place of the hunt, and also the place where the whole party is to assemble and spend the night. These hunts are of great importance not only economically, but also socially and politically. For, in the night, these hunting parties form a hunt-council under the presidency of the *dihri*, which is the supreme authority in the *pargana*, and where all important issues concerning the life of the people are raised, discussed and decided upon. It is in these councils that *manjhis* (village headmen) and *parganais* (heads of *parganas*), who abuse their position in their selfish interest, can be brought to justice. It is through these hunt-councils that the voice of the people speaks, and democracy is translated in vigorous action.

The principle of co-operation in cultivation, shifting as well as fixed, can be illustrated by the practice of the Angamis and Santals. In those Angami villages where jhuming is practised, it is the custom for the whole village or at any rate the clan to jhum collectively. There is no case of an individual household jhuming an isolated patch. Again, in digging and puddling wet terraced fields, an Angami receives help from his friends or kindred, each going to work in the fields of those who helped him. In such cases of co-operative labour, payment is made, in the form of a mid-day meal, by the owner of the field on which work is being done at the moment. A very good example of co-operation in cultivation is given by the Santals. The enormous task of constructing, maintaining and repairing large *bandhs* or embankments for irrigation purposes, which is far beyond the means and enterprise of the individual, is performed by the entire village community, and every member of the community shares in the resultant benefit.

The next question to be discussed here is whether the institution of slavery exists among the primitive tribes of India. Before I answer this question, I would explain the socio-economic significance of the institution. Slavery is a quantitative division

of labour where some people are compelled to labour for others, and the whole personality of the forced labourer is completely absorbed. This is the sense in which the term slavery has been used by Fuchta and Nieboer among others. Nieboer defines the slave as "a man who is the property or possession of another man, and forced to work for him".⁵

The institution of slavery exists among the Mongoloid Indo-Chinese tribes, though it is conspicuous by its absence among the Pre-Dravidian tribes. For example, the Angamis enslave the prisoners of war. Among the Lushai Kukis, persons captured in raids who are called *sal*, are the property of the captors. The *inpuichhung boi* of the Lushai Kukis, i.e., widows, children and others incapable of maintaining themselves, who take refuge in the chief's house, and do all sorts of manual work for him, e.g., domestic work, jhuming, fetching wood and water, making cloths etc., in exchange for food, clothing and shelter, can be classed as slaves with two limitations. The first limitation is that they are free to move from one chief's house to another, and the second is that they can purchase their personal freedom by paying one mithan or its equivalent in cash or goods. Even when they purchase their freedom they are known as *inhrang boi*, and are compelled to give the chief a hind leg of any animal they kill, and help him if he is in want of rice. An *inhrang boi* also can go to the chief for assistance when in want. Incidentally, it may be mentioned here that the custom of *inpuichhung boi* of the Lushai Kukis serves as a sort of social security for the helpless members of the community. Among the Khasis, the punishment of the convicts sometimes leads to the confiscation of their property and personal freedom, and the enslavement of the convicts and their families by the Siem or Chief. The slaves among the Garos are called *nokol* as distinguished from the *nokoba* or freemen. But the Mundas, Santals, Gonds and Konds do not show any trace of slavery. The meriah victims of the Konds cannot be regarded as slaves, as they are not forced to work.

In connection with slavery, one correlation is noteworthy, the correlation between slavery and the institution of chieftainship. These two institutions seem to go together. The Mongoloid Indo-Chinese tribes have both chieftainship and slavery, whereas the Pre-Dravidian tribes have none.

The last point to be considered in this chapter is the organization of production. Though in the final analysis the family or household is the basis of such organization, it carries on productive activities, not in isolation or as it pleases, but in the broader framework of the village organization. The basis

⁵ H. J. Nieboer—Slavery as an Industrial System, 2nd edition, Hague, 1910, p. 8.

of this village organization is, among the Mongoloid Indo-Chinese tribes, more or less authoritarian chiefs assisted by nominated village officials, while among the Pre-Dravidian tribes it is the democratic village community with elected headmen and other officials. For example, among the Lushai Kukis, each village is ruled by a *lal* or chief. He appoints one or more *upas* (elderly councillors) and a number of village officials—*ramhual* and *llangau*—to assist him. The function of the *ramhual* is to select the place for jhumming, and he has the first choice of land for the purpose. The *llangau* arranges the division and allotment of the work of the village, e.g. making a road, repairing the *Zawlbuk* (bachelors' hall) etc. The *llangau* is paid for his organizing work with a small basket of rice from each house in the village. Coming to the Pre-Dravidian tribes, the village community of the Santals, and the *parha* and *muta* organizations of the Mundas and Konds respectively

are very similar to each other, and represent excellent examples of a compact, well-organized, democratic village community. To take the case of the Santals. Every Santal village has a *manjhi* (headman) and six other elected officials. One of these officials—the *paramanik*—may be called the economic organizer of the village. His duties include attending to farming arrangements, apportioning lands, preventing the monopoly of specially fertile rice lands by any one individual or individuals, looking after the interests of new settlers, providing for guests, and levying contributions on the villagers for the last named purpose. All these officials are remunerated by *man* or rent-free land. The Santals have a tradition of an annual ceremony in the month of *Magh* when all the village officials surrender their offices and lands to the people of the village. A week later, they stand for re-election and are usually accepted.

Notes and News

TECHNICAL MISSION ON FERTILIZERS

THE Technical Mission on Fertilizers from United Kingdom, headed by Mr G. S. Gowing, has arrived in India. The purpose of the Mission, it is understood, is to advise the Government of India on the manufacture of chemical fertilizers in this country. Immediately after its arrival at Delhi, the Mission is reported to have met in a conference with members of the Reception Committee constituted by the Government to place at the Mission's disposal all available data in this connection. The discussions centered round the technical aspect of the question of soil survey, availability and utilization of raw materials and power and questions of the manufacture of ammonium sulphate and ammonium nitrate. The question of the proper location of fertilizer industry was also discussed, but no decision is reported to have been reached. We also understand that no commitment has yet been made on financial question. It appears, so far as it can be guessed, that the enterprise will be a Government one financed jointly by the Central and Provincial Governments and the States.

The Mission has left Delhi for a forty-day tour in various places of India, which include Patna, Calcutta, Cuttack, Tatanagar, Dhanbad, Madras, Mysore, Bangalore, Hyderabad and Bombay and is expected to return to Delhi on August 4.

In our editorial article of the June issue of SCIENCE AND CULTURE, we already expressed grave doubts as to the wisdom of inviting such technical missions of foreign experts for short commissions. During recent years it has become a fashion with the Government of India to invite foreign technical missions to advise us on technical matters. The activities of the U. S. Technical Mission headed by Dr Henry Grady, which visited this country during April and May, 1942, are still fresh in our memory. In fact, we object to the practice of inviting scientific, technical, or economic missions, partly or wholly composed of foreigners, on principle. No such procedure is adopted in any independent country. When a country like, say Sweden, wants to take advantage of some technical process or scientific discovery elaborated in another country, say U. S. A., it forms a scientific mission of its own scientists and sends them to the foreign country to establish contact with the parties concerned who may be Government Departments or manufacturing concerns. The scientists so chosen need not be experts on the particular subject, but such as are able to understand the processes and carry on the talks and conversations. Such a system has great advantages. The mission is guided entirely by the countries' interest, and gains an experience which is valuable for the country and may be utilized on all subsequent occasions.

This time the very technical competence of the experts, all foreign, constituting the Mission has been called into question. In India, a fertilizer plant has already been built in Mysore and is being successfully operated by Mysoreans, thanks to the initiative, foresight and zeal of her statesmen. The unpleasant fact of the exclusion of Indian experts from the Mission has been knavely concealed under cloak of of the newly created Reception Committee composed of Indian members whose chairman, Sir James Pitkeathly, is again a non-Indian. The Reception Committee, although a novel device, is a superfluous creation and was never heard of in India before.

The experts of the foreign mission have not come on philanthropic mission; they have the commercial interests of their own country or employer in view. Further, their interest is only temporary, and after they submit the report which, as in the case of most reports, will soon be forgotten by every body and probably eaten by white ants in the Delhi archives, they will have forgotten everything about their own recommendations.

LONG-RANGE WEATHER FORECASTING

DR CHARLES G. ABBOT, Secretary of the Smithsonian Institution, in course of his recent Twelfth Arthur Lecture, discussed the possibilities of long-range weather forecasting from a study of the variations in solar energy received by the earth. It is well-known that the earth, at a distance of 93,000,000 miles from the sun, is incessantly receiving solar energy equivalent to 250,000,000,000,000 horse-powers. The rate of reception of this radiation is not steady, but it fluctuates in a peculiar way of which the cause is still imperfectly understood. The variation is characterized by cycles or rhythmic curves, of which Dr Abbot has identified not less than 14. It seems highly probable that such fluctuation in solar radiation is directly related to the sun spots. Each sun spot pours out a great conical spray or jet of electrically charged particles which sweep in vast circles as the sun makes its 27-day revolutions about its axis. The radiation from the sun suffers scattering from these particles and hence a loss of intensity in a particular direction. Loss of intensity on the earth, which generally lies between 1 to 5 per cent., takes place when such a spray sweeps across the earth.

Dr Abbot has applied the knowledge of the variations in solar radiation to the study of the meteorological conditions on the surface of the earth and has made a number of successful trial forecasts during recent years. Mention may be made of his prediction that the rainfall in the Tennessee Valley during a given three-month period would be between

84 per cent. and 87 per cent. normal. Later measurements during that period, when it came, indicated a rainfall of 87 per cent. normal. In connection with his another experiment on weather forecasting for Washington, D.C., he informed the Chief of the Weather Bureau that in a certain list of dates in 1943 the average daily precipitation would be higher than on the remaining dates of the year. The selected dates were expected to show 1'66 times the average rainfall of the non-selected dates. The actual ratio, for the 175 selected dates compared to 191 non-selected ones, proved to be 1'58, which is a satisfactory agreement. Dr Abbot has made another interesting long-range forecasting that great droughts resulting in the serious lowering of water level in the Great Lakes will come to pass in the North-West in the years 1975 and 2020.

T. V. A. ELECTRO-CHEMICAL INDUSTRIES

THE great progress of the electro-chemical industries associated with the hydro-electric plants of the Tennessee Valley Authority has been outlined in the annual report of the Authority, issued recently. This progress is due mainly to the substantial increase in the output of electric power which now amounts to 9,000 million units compared to 5,556 million in 1941, as recorded in an earlier issue of our journal (Vol. IX, No. 10). Three-quarters of this power is now used for war purposes. The fertilizer plant at Muscle Shoals is now producing large quantities of ammonia and ammonium nitrate for explosives, elementary phosphorus for incendiary bombs and smoke screens and carbide for synthetic rubber. It is stated that 13,600 tons of ammonium nitrate were diverted from military allocation to civilian use as fertilizer. 60,200 tons of concentrated super phosphate and 7,300 tons of calcium metaphosphate were produced during the year ended June 30, 1943. We further understand that TVA has planned to produce 15,000 tons of dicalcium phosphate, which will be used to replace bone meal in farm animal feed. TVA fertilizers containing the optimum amount of phosphorus have been found to increase the crop yields on experimental farms by 30 per cent. It has been estimated that if the yield of crop is to be similarly increased throughout U.S.A., her present production of 1,712,000 tons a year will have to be doubled.

A TESTING LABORATORY IN SOUTH AFRICA

THE recent recommendation of the South African Standard Institution, according to a report in *Science*, for the creation of a National Standards Testing and Investigational Bureau to be set up by the Government bears testimony to the increasing recognition of the importance of science in South

Africa. Such a bureau would act as a national standardization laboratory and would carry out or arrange for investigations and tests in connection with standardization. Its functions would include the testing and calibration of precision instruments, gages and scientific apparatus, the determination of the degree of accuracy with regard to fundamental standards and finally the preparation of certificates.

Testing and investigations on behalf of the South African Standards Institution and others would be done either by delegating the work to approved institutions or by providing laboratory facilities. Such testing would include physical or chemical examination of materials and products and tests of their use and performance.

The bureau would also assist the South African Standards Institution in investigating any questions affecting the preparation of its standard specifications. It would provide facilities for testing goods, articles and materials purchased on specification to decide whether such materials comply with the specification, and would act on behalf of the Government in testing locally manufactured and imported goods with a view to determining whether the goods comply with the regulations laid down by the Merchandise Marks Act or any other act and to verify standards. It would also test manufactured products and carry out investigations and inspections to enable the South African Standards Institution and other standardizing bodies to control their marks. In addition to all this, it is suggested that the bureau would also assist the Government departments in any tests which may require to be undertaken.

BRITISH RADIO RESEARCH INSTITUTE

ACCORDING to a report of *Nature*, March 18, 1944, the British Institution of Radio Engineers has recently recommended the creation of a British Radio Research Institute. The need for such an institute is now urgently felt in that country in view of the lack of opportunity for conducting basic research in radio and electronic sciences. At present research is mainly concentrated on short-term problems with promise of immediate practical applications and early financial returns. Facilities for long term fundamental research with no such immediate prospects are now available with difficulty owing to financial limitations. Accordingly the Institution advocates the formation of a Radio Research Institute to provide facilities for the equally important basic research in radio and allied sciences. It is suggested that such an Institute, when created, should be financed jointly by the industry and the Government, the latter providing grants of at least equal amount. The board responsible for the direction of the Institute's work

should consist of the representatives of the Government, the industry, the B.B.C., the Services, the British Institution of Radio Engineers, the associated professional institutions and the universities. It should have a permanent scientific staff and should receive the co-operation of the industry and the universities in the matter of assistance and engagement of extra-mural workers. Another important suggestion is that the institute should extend to all countries within the Commonwealth opportunities for participation in its research work.

Thanks to the impetus of the war, the radio has already developed into a highly important industry. It is reasonable to expect that in the post-war period the radio industry will supply capital goods on a scale equal to many of the older industries. Benefits derived from research associations in other branches of development encourage the hope that the radio industry will be similarly benefited by the formation of a Radio Research Institute of the type contemplated. It is further stated that if the present turnover for the radio industry be assumed to be about £60, an allocation of only 0.25 per cent., with Government grants, will produce an income comparable with that of other research associations.

ALL-INDIA RADIO

THE All-India Radio has recently issued a report on the progress of broadcasting in India during the five years of existence of the war. Since its publication of the first comprehensive report in 1940, covering its activities up to April 1939, the A.I.R. has undergone several vital changes and great expansion in its activities, thanks to the exigencies of the war. Although originally designed for internal services, the A.I.R. no longer confines its activities within the borders of this country, but has extended its field of broadcasting services beyond her frontiers to the four continents of the world. Up to 1939, it maintained a basically internal service and operated from its eight stations and thirteen transmitters. The A.I.R. now controls twenty transmitters, of which the latest to be installed were two high-powered 100 k.w. short-wave transmitters capable of direct point-to-point transmission from Delhi to London.

But the setting up of the Broadcasting House in New Delhi in place of the Studios in Old Delhi marks the most significant advance in the great development of the broadcasting services with which A.I.R. is now credited. Although the construction of the House was long under contemplation, it was postponed for an indefinite time. The construction of the building became inevitable when the A.I.R.; under the pressure of war, had to take the vital decision of installing the high-powered transmitters. Architecturally and from the view point of equip-

ment, the Broadcasting House represents the latest developments in radio-engineering. Of twenty transmitters today, Delhi alone has a concentration of nine, including the high-powered 100 k.w. short-wave transmitters. All these developments at Delhi have made possible the centralization of the news service, with the result that all special facilities required for rapid and efficient broadcasting of news have been concentrated at one point.

The technical expansion has brought about a rapid growth of the A.I.R.'s activities on the programme side. Within a month of the outbreak of hostilities, the total transmission output from all A.I.R.'s stations increased from 45 hours to 75 hours daily. The extent of its expansion is further reflected from its programme contents which include, besides the normal mainstay of musical entertainment, news in nine Indian (and fifteen non-Indian) languages, news commentaries, talks—topical, informative and cultural—features, plays special programmes for schools, universities, villages and industrial areas, women's and children's hours and broadcasts for Indian, British and American forces. The relations between A.I.R. and B.B.C., always cordial—have become more closer than ever. From September 2, 1939, A.I.R. began the daily relay of B.B.C.'s 9-30 p.m. (I.S.T) news bulletin broadcast by the Central News Organization as an organic part of its news service. On request from B.B.C., special broadcasts have been prepared and transmitted for rebroadcast from London. Studio and transmission facilities are given to B.B.C.'s news correspondent in India. The report further records greater co-ordination between various stations.

While we appreciate the amount of progress made by the A.I.R. during the last five years, our attention is drawn to the significant proposal by the British Institution of Radio Engineers for the creation of a Radio Research Institute in Great Britain. The need for the creation of a similar Radio Research Institute in India is also strongly felt in India and it is high time that this problem should receive the serious attention of Indian scientists, the industrialists and the Government.

INDIAN WATERWAYS EXPERIMENT STATION

THE name of the Central Irrigation and Hydrodynamic Research Station, Poona, has been changed into "Indian Waterways Experiment Station", according to a notification published in the Gazette of India. The Station, recently put on a permanent basis by the Government of India, was originated 24 years ago under the Bombay Government at Poona by Mr C. C. Inglis, then Executive Engineer, Special Irrigation Division. In its early days, ex-

periments were conducted at Hadapsar with models designed to solve various hydrodynamic problems concerning irrigation in Bombay and Sind—specially in connection with the design of the Sukkar Barrage Scheme and the Deccan Canals, then being constructed.

In 1925, it was found that the discharge available at the Station was insufficient for carrying out several large-scale model experiments simultaneously; and, as exceptional facilities existed at Khadakwasla situated about 11 miles from Poona, where water could be drawn straight from Lake Fife, new models were constructed there. In 1934, the original Station was totally transferred to Khadakwasla, where it has been working ever since. In 1937, it was taken over by the Government of India to serve the whole of India. Mr Inglis was appointed its first Director, a position which he still holds.

The outstanding features of the Station are that there are 11 independent sources of supply, the discharge of each of which can be maintained absolutely constant; no pumping is required; water is free from sand and is normally clear except during floods in July to September, and the temperature of the water is constant throughout the day and varies very little throughout the year. The Station comprises an area of 16 acres. Twelve models are normally under investigation at the same time, in addition to some 20 demonstration models.

During the last 7 years, over 100 important investigations have been carried out at the Station. These included the protection of bridges over rivers and the prevention of excess sand entering canals. This was applied in many cases, the most important being the right bank canals at Sukkar which were rapidly going out of service due to the excessive charge of bed sand entering them. River training in tidal and non-tidal waters was another important line of research, and a number of important principles have been established in connection with the value of attracting, deflecting, and repelling spurs for controlling rivers, the factors determining the size and shape of meanders, the relation between rainfall and run off, the effect of silt washed into rivers when hill denudation occurs, and the rate of silting of reservoirs.

INDIAN INSTITUTE OF SCIENCE

At the Seventh Annual Meeting of the Court of the Indian Institute of Science, Bangalore, held on July 3, 1944, Sir M. Visvesvaraya, President of the Court, while presenting his opening address, said:

"There have been two notable developments during the past year. One is the institution of aeronautical and automobile engineering sections in

the Institute for which the Government of Mysore has sanctioned a capital grant of Rs. 1 lakh and an annual recurring grant of Rs. 15,000. An additional grant of Rs. 2 lakhs for laboratory equipment in aeronautical engineering has been sanctioned by the Government of India. The second is the sanction, also accorded by the Government of India, of a further grant of Rs. 1,30,000 for a new department of metallurgy.* * *

The estimates of income and expenditure presented to the Court appear to be satisfactory. It may be of interest to the members to note that during the interwar period, 1919 to 1930, the average income and expenditure of the Institute remained practically stationary at about Rs. 6 lakhs. The increase which began in 1939 has continued and the actuals of income and expenditure from 1st April 1943 to 31st March, 1944 stand at Rs. 15,78,617 and Rs. 16,03,451 respectively. The estimates of income and expenditure for the session 1944-1945 is shown to be Rs. 19,27,378 and Rs. 21,76,535 respectively.

The opening balance of the new academic year—beginning from 1st July, 1944 available for ordinary expenditure—stands at Rs. 4,91,799 and the closing balance on the 30th June, 1945 is likely to stand at Rs. 1,97,992. There is thus a decrease of about Rs. 3,90,000 expected in the opening balance. This decrease is due to the fact that the Institute has been financing, either wholly or partly, out of its own resources the following projects:—(1) New Departments of Aeronautical Engineering, Rs. 1,00,000; (2) Building a Dining Hall, Rs. 60,000; (3) Contribution to the Cosmic Ray Research, Rs. 40,000; (4) Air Raid Precaution Measures, Rs. 10,000; (5) Dearness Allowance during War, Rs. 40,000; (6) Financing Industrial Research as per item 14 of the Budget to the extent of Rs. 1,30,000. It may be added here that there is also a hidden reserve in the Suspense Account of the Institute to the extent of Rs. 78,000 which will eventually be transferred to the opening balance.

Several new schemes have been initiated since this Court met last year. The most notable feature of the year's history is that the Government of India which was giving only a fixed grant of Rs. 1,50,000 annually ever since the Institute was started in 1911, has this year increased the grant to Rs. 7,70,000.* * * I understand the Government of His Highness the Maharaja of Travancore has agreed to give a recurring grant of Rs. 3,000 from this year.

It is gratifying to learn that the income of the Institute from applied research is steadily on the increase. The actual income in 1943-1944 was Rs. 35,830 and the income expected from the same source in 1944-1945 is Rs. 80,000. The major part

of this income has, I learn, been derived from the activities of the Biochemistry Department of whose work in this respect I may speak with high appreciation.

The subjects chosen for applied research were mainly suggested by the Board of Scientific and Industrial Research, the Imperial Council of Agricultural Research and by the War and Supply Departments.

The total expenditure is shown under items 14 and 17 of the expenditure head and it comes to approximately Rs. 1,76,000. This is exclusive of the expenditure and income which are brought under the head "Suspense" and used for the purpose of manufacture of war chemicals. This should normally be considered as research effort which gives pilot plant experience to workers.

The Director wishes the interesting news to be made known that the Institute has been able to produce the drug 'penicillin' from raw materials available in India by a method which is far less time-consuming than the standard methods.* * *

Some nine proposals have been put forward by the Joint-Committee for future development. I understand the proposals have been carefully considered and generally approved by the Council. The proposals are:—

(1) That plans and estimates be prepared with the aid of experts for bringing into existence a department of metallurgy (a very important development), and attempts be made to secure funds for the purpose;

(2) That a department of applied mechanics with special reference to the study of internal combustion engines, with a view to their manufacture in India, be started;

(3) That the department of aeronautical engineering be equipped and staffed on an up-to-date and adequate scale;

(4) That the department of electrical technology be split into a department of electrical engineering which should progressively be converted into a purely research department, and a department of communication engineering, which will be a centre both for post-graduate teaching and research in radio communication;

(5) That the training course in chemical engineering be extended over six terms and that more adequate arrangements be made for imparting this training in the department of chemistry;

(6) That a central power distribution house

should be established in the Institute at an early date;

(7) That a first class Research Workshop of Mechanical Engineering with a suitable staff attached to it, of fuel engineers, chemical engineers, mechanical engineers, and metallography experts who by close co-operation and intimate teamwork would be able to solve the problem of design and construction necessary for the erection of industrial plants for various manufacturing processes which are now being developed in India, be created at the Institute and that this Workshop should be an integral part of the Mechanical Engineering Department;

(8) That the possibility of opening a department of fuels and refractories be kept in view; and

(9) The central services such as maintenance of lands and buildings, and maintenance of electrical installations, gas and water, and sanitary arrangements should be placed under the control of the Registrar, the Council arranging for regular supervision by experts, who may be appointed from the members of the Institute and paid suitable allowances. (The object of this last change is stated to be that professors of the Departments should be relieved of the routine administrative duties in this connection and should thus have more time to devote to their legitimate work of research and teaching.)

I understand that the recent action taken by the Council leads one to hope that all the proposals with the exception of Nos. (7) and (8) embodied in this plan will soon mature. It is hoped that the other two items which are also of paramount importance will be taken up in the coming year.* * *

In 1938, the affairs of the Institute had reached a low ebb and the stagnation was mainly due to lack of funds. A Court formed a part of the Constitution but it never met. A President had been appointed who never presided. There was a Visitor

who never visited. Now, however, although it is still war time, affairs seem to be brightening.

The chief cause which has contributed to this favourable turn is the raising of the grant of the Government of India which stood as already stated at Rs. 1.50 lakhs for over 30 years to Rs. 7.70 lakhs for the first time.

It will not be superfluous to repeat, that this has been due to the happy combination of a sympathetic Chairman and members of the Council, the members of the Joint-Committee of the Court and of the Council, and the Director Sir J. C. Ghosh. The Joint-Committee appointed for the first time in March, 1940 under the Chairmanship of Sir V. N. Chandavarkar has done much valuable work. The members of the Joint-Committee who have given a generous measure of attention to this work have been besides Sir J. C. Ghosh, Sir V. N. Chandavarkar, Professor M. N. Saha, Principal G. R. Paranjpe and last year Mr J. Mohamed Imam and Mr S. G. Sastry. In the first two years of the working of the Joint-Committee, the services of Dr Syamaprasad Mookerjee were of special value."

PROF. B. B. RAY

We deeply regret to record the death of Professor Bidhu Bhushan Ray, Khaira Professor of Physics, Calcutta University on July 29, in his Calcutta residence at the early age of 50. Prof. Ray was associated with SCIENCE AND CULTURE from its very inception and the first issue came out in June, 1935 under his editorship. A detailed account of Prof. Ray will appear in the next issue.

AN ERRATUM

On page 10, column 1, lines 33 and 34 of July, 1944 issue of SCIENCE AND CULTURE, read one per cent. for ten per cent.

SCIENCE IN INDUSTRY

SYNTHETIC DRYING OILS

THE use of tung oil as a natural drying oil is widely known. Although tung oil is the best of all natural drying oils, it suffers from a number of limitations, of which the most remarkable is its lack of uniformity. Considerable progress has recently been made in the development of synthetic drying oils which are now being increasingly used in place of tung oil with varying degrees of success. In fact, there are now strong evidences that in the post-war period paint and varnish industry will come to depend largely on synthetic drying oils, and the natural tung oil will be relegated to the background. In an able article on 'Post-War Developments in Synthetics', appearing in *Chemical and Engineering News*, January 25, 1944, J. Edmund Good, Vice-President of Woburn Chemical Corp., New Jersey, has summarized the present position with regard to synthetic drying oils, an account of which may be of interest.

It is now generally accepted that the characteristic properties of tung oil arise principally from the conjugated position of the double bonds in the tung oil molecule. This has been a most important study and has served as a guide in the development of the synthetic product in whose molecules the conjugated position of the double bonds has to be maintained. Drying oils have so far been successfully synthesized from castor oil, linseed and soyabean oils. In these three cases it has been possible to introduce the double bond characteristics in their molecules.

The first successful attempt to produce the molecular characteristics of tung oil was made with castor oil which is a non-drying oil in its natural state. This has been effected by subjecting it to a process of dehydration, which consists in abstracting a molecule of water from the castor oil molecule. The method differs from the Scheiber process in the fact that the conversion is made without first converting the oil into a fatty acid and then esterifying the fatty acid. Dehydrated castor oil has proved a successful drying oil and has been received well in the industry.

Owing to the shortage of castor beans in U.S.A., normally importing this agricultural product from Brazil and India, attempt was recently made in that country to impart the tung oil characteristics to linseed and soyabean oils. An altogether different process is, however, followed in the conversion of these oils. Glycerol is first extracted from

the molecules of both the oils. The linseed oil yields the Conjulin fatty acid and soyabean oil the Conjusoy fatty acid. These fatty acids are characterized by the presence of the conjugated position of the double bonds in their molecules. Either of these conjugated fatty acids may then be processed and esterified and the required drying oils obtained.

The Conjusoy drying oil derived from soyabean oil is as good as dehydrated castor oil in its resemblance with tung oil. It is colour-retentive to a high degree and retains the flexibility of dehydrated castor oil. Isomerized linseed oil, known as Conjulin drying oil, approaches tung oil more closely than has been possible for dehydrated castor oil or Conjusoy oil. Conjulin oil has its gel time slightly greater than that of tung oil, but has a greater water resistance, as has been indicated in numerous tests. Its film is tough and hard rather than brittle, and it retains flexibility. In the manufacture of insulating varnishes, wrinkle finishes and baked finishes of all kinds, isomerized linseed oil serves as a satisfactory substitute for tung-oil.

In addition to the dehydrated castor oil and isomerized linseed and soyabean oils which have reasonable chance of replacing natural tung oil in future, a number of less satisfactory synthetic oils have also been developed during recent years. Such synthetic drying oils include segregated fish oils, pentaerythritol esters, oils fortified with maleic anhydride and other dibasic acids, all of which have been used with satisfaction for specific purposes.

PREFABRICATED HOUSES

THE introduction of prefabricated houses marks an important advance in building construction. Made in the factory, such houses are now being increasingly used for war purposes and bid fair to offer a satisfactory solution of the serious shortage of housing accommodation, apprehended at the end of the war. Even before the war, prefabricated houses are reported to have been used in America to house the large number of workers concerned in the great Tennessee Valley hydro-electric scheme. Some important constructional details of such factory-made houses, as they have been put up by one Uni-Seco Structures, Ltd. in Great Britain, have recently appeared in a short note in *The Chemical Age* (April 1, 1944), to which the attention of our readers may be drawn.

The case of single-storey houses with three rooms has been described. Erection time of such houses is about 730 man-hours, which means that a team of eight men requires less than two weeks. Such gain in time has been possible through the use of building units considerably larger than the units of traditional construction. The building units of which the walls are made measure 7 ft. 4½ in. by 3 ft. 2 in. and consist of a rigid insulating core of wood-wool bonded with cement and faced on both sides with flat edges by a light timber frame. Such units are claimed to be as good as 11 in. non-cavity brick wall so far as heat insulation is concerned. External joints between units are treated with a mastic compound to make them weather-proof. The floor units are made of resin-bonded plywoods; the largest floor unit, with a span of 12 ft. 9 in., can be easily handled by two men, as can all other units and components in such prefabricated buildings. The standard beams, columns, and eaves are also of stressed skin construction and built up of resin-bonded plywood firmly keyed to diaphragm spacing members. The use of plywood for the construction of houses was formerly discouraged owing to the failure of the glues to resist the action of weather or the attack of fungi. But the availability of glues conforming to such specifications as D.T.D. 484 has removed the difficulty of using plywoods which are now being used with great advantage.

Electric wiring and service pipes are easily installed and concealed in the ducts provided between, and at the end of, floor units. Plumbing is effected by a prefabricated vertical duct, passing from the kitchen through the first floor and connecting with a horizontal duct carrying the service pipes. Prefabricated houses are demountable, but can be used permanently if desired. Another encouraging fact about such houses is that the wastage involved during dismantling hardly exceeds 10 per cent. It is reported that during the last two years the company referred to has erected such houses on an area of about 50 million cubic feet at over 600 places in Great Britain.

USE OF BENTONITE IN FLUID FLOW ANALYSIS

THE varied responses of a flowing fluid to variously shaped obstacles like a boat hull, a heating pipe or an aerofoil form an interesting study but not a very exact one unless the directions of flow can be actually made visible. A new method of doing this, recently developed at the Massachusetts Institute of Technology, promises a real advance in the branch of hydrodynamics of fluid flow.

The method is similar to that in which engineers use "Polarized" light produced with optical equip-

ment (analogous to that in "Polaroid" non-glare sun glasses) to render visible the strains in plastic models of solid structures like gears and other machine castings. When stressed, the plastic model deforms slightly and in so doing bends and twists the polarized light passing through it so that bends and splotches of colour show up at the points of strain. In the analysis of fluid flow, a suspension of bentonite (a non-refractory clay derived from the shale of the Fort Benton formation in the Upper Missouri Valley) in the fluid serves to modify the polarized light shining through the transparent walls of the experimental channel, just as the plastic modifies light in the analysis of strains in solids. The bentonite particles consist of platelets so small that they have no tendency to settle out of the suspension and so light that they move exactly where the fluid takes them showing substantially no inertia of their own. These physical and optical properties make bentonite superior to other substances used to trace out fluid flow, such as ink streams, smoke trails in gases or fine bubbles; for these latter materials cannot follow the paths of fine eddy motion encountered when streamline flow is broken up. The bentonite method of observation for the first time permits quantitative measurements of velocity change and other factors within the field.

In the analysis of fluids, bentonite so modifies the light passing through the stream that coloured bands or 'fringes' show up, connecting points where a particular rate of change in the fluid speed prevails. The analysis is similar to the photoelastic methods of analysis for solid bodies. Use of improved photographic techniques including high speed photography has enabled observations to be carried out for highly turbulent as well as for the semi-stream line flow by this method, while qualitatively it can be used to find out how a moving or even a stationary object of particular size and shape affects the flow. Analysis of fluid flow is important not only in such obvious applications as design of aerofoils, boat hulls, or bridge piers but also in many chemical engineering problems, such as the distribution of fluids in reaction vessels. By polarization analysis, it is even possible to calculate the rate at which heat will be transferred from a solid to a liquid.

The bentonite method has as yet received few applications. But some of the applications have already proved extremely important. One of these is providing graphic demonstrations for training aviators in flight theory. Another diverse application is reported to have served to change the design of fire-boxes in the locomotive of a railroad in a Western country and giving it greater efficiency.

S. K. G.

MODERN ENDEAVOURS OF GROWING SEEDLESS FRUIT

ATTEMPTS at growing seedless fruits by artificial means may be traced to the end of the nineteenth century. It is only recently that botanists have partly succeeded in growing them. In view of the importance of growing seedless fruits, a brief account of the process and mechanism involved in their production may be useful. It is well-known that after fertilization the ovule is changed into a seed and the ovum into an embryo. The ovary is caused to grow more and more into a fruit. The maturity of an ovary into a fruit and the change of an ovule into a seed are not one and the same process. The pollen tube in a way gives a kind of stimulation to the ovary which matures up into a fruit; on the other hand, it enters into the ovule and fertilizes it to grow into a seed. It is known that the pollen tube oozes out hormone after reaching the ovary. This hormone stimulates the ovary and changes it into a fruit. If it can be secured that the pollen tube will ooze out the hormone but will not be able to enter into the body of the ovules in order to fertilize them, seedless fruits can be grown without difficulty. The advent of the pollen tube from the stigma to the interior of the ovule takes time which is definite for

particular flowers. In some flowers like cucumber, tomato, etc., seedless fruits have been made to grow by cutting off the style, after a time of shedding of the pollen on the stigma. This proves that just before separation the pollen tube was in such a position where it gave out the hormone to stimulate the ovary to grow into a fruit, but was unable to pass through the micropyle of the ovule and fertilize it.

Few chemicals, e.g., acetic acid, alpha-naphthalene, phenyle-acetic acid, etc. also can cause an ovary to grow into a seedless fruit. These chemicals should be applied on the top of the ovary after cutting off the style. These can also be applied as spray, poured under the tree, or introduced in solid state to the trunk of the tree.

Experiments on few plants which naturally give seedless fruits showed that a kind of nutritive product, called Auxin, is already present in ample quantity in the ovaries of the flowers of those plants which causes them to mature up. In other plants where the ovary is deficient in Auxin, it is necessary to supply it from outside, either artificially or by chemical processes. In this way also growth of seedless fruit is possible.

C. R. S.

COLCHICINE TREATMENT OF JUTE

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INTRODUCTION

SINCE Blakeslee (1937) made his remarkable discovery, many successful results in inducing polyploidy by colchicine treatment have been recorded. The work has been reviewed by Fyfe (1939) and Dermen (1940), who have also discussed in detail the action and use of colchicine. In India striking results have been obtained on *Capsicum annum* L. (Pal and Ramanujam, 1939; 1941) and *Cicer arietinum* L. (Ramanujam and Joshi, 1941). In cotton (Amin, 1940) and sesamum (Richharia and Persai, 1940) also, colchicine treatment seems to have been effective in producing polyploids. But no such work on jute has been reported so far and the present study which was started at the Jute Agricultural Research Laboratories, Dacca in 1940, appears to be the first of its kind.

MATERIAL AND METHODS

Two well-known jute varieties D 154 (*Corchorus capsularis* L.) and Chinsurah Green (*C. olitorius* L.)

were at first selected for study but as the latter did not give encouraging results it was dropped.

In 1940, selected dry seeds of D 154 and Chinsurah Green were immersed in 0.4, 0.6, 0.8 and 1.0 per cent. aqueous colchicine solutions for 6, 12, 24 and 36 hours in each case, the number of treatments for each variety being sixteen. To study the effect of presoaking, a few seeds of D 154 and Chinsurah Green were first soaked in water for 30 hours and then for 12 hours in 1.0 per cent. colchicine solution. The seeds were sown in pots.

In 1942 seeds as well as growing terminal shoots of D 154 were subjected to colchicine treatment as follows:—

Seeds:—1. The seeds were first soaked in water for 18 hours and then in 0.05, 0.1, 0.5 and 1.0 per cent. aqueous colchicine solution for 12 and 24 hours the number of treatments being eight.

2. Eight treatments as in 1, but without any pre-soaking in water.

Growing shoots:—Three applications of 0.05, 0.075, 0.10, 0.15 and 0.20 per cent. aqueous colchicine solution on terminal buds of six weeks old vigorously growing plants.

Observations on vegetative characters such as leaf size and shape, size of flower, pollen and fruit, and size and frequency of stomata were taken for detecting cases of polyploidy. Acetocarmine smears of leaf-tips (Baldwin, 1940) were made at different stages to determine the stomatic number of chromosomes. Sections as well as macerated material were examined to study changes, if any, in the anatomical structure.

EFFECT OF COLCHICINE TREATMENT OF SEED FIRST GENERATION

Germination:—Seed treatment with various concentrations of colchicine was found to have a marked effect on germination. Germination was considerably checked especially in the higher concentrations, only a few plants coming out successfully (Table I). As observed by Pal and Ramanujam (1939; 1941) for Chilli, and Ramanujam and Joshi (1941) for gram, colchicine appeared to have a retarding influence on the growth of germinating seedlings. In the lower concentrations the general swelling of the hypocotyl and the radicle was more prominent than in the heavier concentrations, where growth was more effectively checked.

TABLE I

PERCENTAGE OF GERMINATION IN COLCHICINE TREATED SEEDS (1942)

Per cent. of colchicine Treatment.	0.05	0.10	0.50	1.0	Control
12 hours with 18 hours presoaking in water	27.5	22.5	...	10	100
24 hours with 18 hours presoaking in water	10	2.5	2.5	7.5	...
12 hours without presoaking	22.5	...	17.5	2.5	100
24 hours without presoaking	45	42.5	20	15	...

Morphological:—In the preliminary studies carried out in 1940 most of the surviving plants from the treated seeds showed no morphological differences from the controls. Only one D 154 plant obtained from seed treated in 1 per cent. colchicine solution for 12 hours, after 30 hours pre-soaking in water, seemed to have responded to colchicine treatment. Its leaves were rough and rounded as compared with the control and the flowers much bigger. The capsules were about double the normal size (Fig. 1) and contained only three seeds per locule (Patel, 1941).

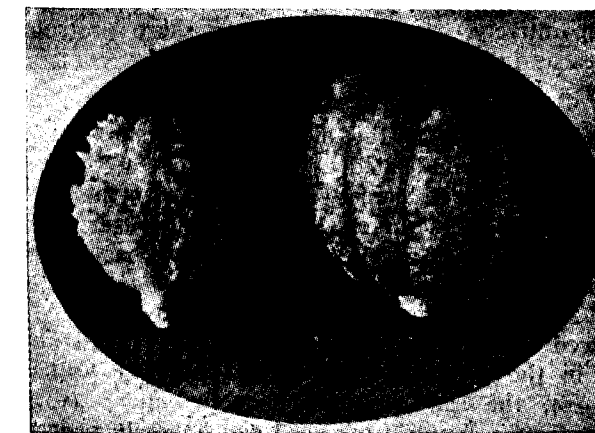


FIG. 1. Capsules from normal (left) and colchicine treated (right) plants ($\times 2\frac{1}{4}$).

indicating possible cases of polyploidy. Both were from seeds treated in 0.1 per cent. colchicine for 24 hours without any pre-soaking in water. In these plants the stem and petiole were stouter and better developed and the leaves were very much thicker, coarser and broader than in plants raised from untreated seeds. The guard cells of the stomata were 1.5 to 2 times bigger than in normal leaves and the number of stomata per unit area was about half (Table II).

TABLE II

SIZE AND DISTRIBUTION OF STOMATA
(Average of 20 observations)

Plant	Size of guard cells		Frequency (Number of stomata per unit area*)
	Length	Width	
Normal ..	24.15 μ	6.68 μ	12.75
a268 ..	42.15 μ	10.95 μ	5.7
b987 ..	39.45 μ	10.22 μ	6.2

* Unit area = 0.08 sq. mm.

The flowers too were much bigger, and the pollen grains averaged 45.08 μ in diameter in a268 as compared to 29.81 μ in normal flowers. Plant b987 which resembled a268 in almost every respect did not show any appreciable difference in the size of

the pollen from the normal, the average diameter being 31.77μ .

The capsules in both a268 and b987 were strikingly different in appearance from the normal ones. They were about 1.5 to 2 times the normal size with a thick and fleshy pericarp. The outer surface was comparatively smooth without any sharp protruberances as in normal ones and the capsules contained only a few good seeds.

Cytology:—As the morphological characters of a268 and b987 indicated polyploidy due to colchicine treatment, a cytological examination of these two plants was undertaken. Acetocarmine smears of young leaf-tips from these plants as well as controls were made at regular intervals from 9-30 A.M. to 1 P.M. Preparations made from 10-30 to 11 A.M. showed all the stages of mitosis. The diploid number in the normal plants of D 154 (*C. capsularis*) was 14, the same as reported by Banerji (1932). Chromosome counts from a268 and b987 showed that a doubling of chromosomes had occurred as a result of colchicine treatment. Associated with this doubling of chromosomes there was a marked increase in cell size. The cytological examination thus revealed that both a268, and b987, obtained from D 154 seeds treated in 0.1 per cent. colchicine were tetraploids having $4n=28$ chromosomes.

Acetocarmine smears of dividing pollen mother cells were tried without much success.

Anatomy:—To find out structural changes associated with colchicine induced polyploidy anatomical



FIGS. 2, 3. Ultimate fibres from diploid (left) and tetraploid (right) plants ($\times 220$)

examination of diploids and tetraploids was carried out. Transverse sections of both petiole and stem were examined and it was observed that the larger size and the stouter appearance of these organs in tetraploids, was due to increase in size of the cells rather than to an increase in their number. The number of fibre bundles was the same but the bundles appeared larger, the individual fibres show-

ing a large lumen in cross section. In macerated material, the length of the ultimate fibres in the tetraploids was found to be about the same as in normal plants but the fibre width was more. The lumen was very large almost twice that in normal plants, but the thickness of the wall remained the same (Figs. 2, 3 and Table III).

TABLE III

FIBRE MEASUREMENTS OF DIPLOID AND TETRAPLOID PLANTS
(Average of 100 observations)

Plant	Mean fibre length	Mean fibre width	Mean wall thickness	Lumen
Normal (diploid)	2125 μ	17.46 μ	6.21 μ	5.04 μ
Treated (Tetraploid)	2407 μ	26.52 μ	6.10 μ	14.31 μ

SECOND GENERATION

Seeds collected from tetraploids showed poor germination. Of the 120 seeds sown in pots according to pod size about half failed to germinate, the number of mature plants obtained being only 10. The morphological and cytological behaviour of these plants was studied and they were found to resemble their parents. The capsules were large, but comparatively few, some of the plants bearing only one or two capsules. Leaf tip smears showed $4n=28$ chromosomes and anatomical examination revealed the same structure as in the parent tetraploids.

COLCHICINE TREATMENT OF GROWING SHOOTS

Treatment of growing shoots with various concentrations of aqueous colchicine did not prove successful in inducing polyploidy. In some cases, especially with stronger treatments the terminal shoot withered and died. There was no appreciable difference excepting for the distortion of a few leaves and flowers in some of the plants. Plumule treatment of germinating seedlings has been recently taken on hand and it is interesting that in some cases differences in the size and distribution of the stomata have been observed.

SUMMARY AND CONCLUSIONS

Seed treatment of jute with various concentrations of colchicine seeds to be effective in artificially inducing polyploidy. Two tetraploids were obtained from seeds treated in 0.1 per cent. colchicine for 24 hours, without any pre-soaking. They showed the typical *gigas* characters, and were also structurally different from the diploids. The fact that

differences in the structure of the ultimate fibre are associated with changes in chromosomes, is of great economic importance, for the quality of jute depends primarily upon the nature of the ultimate fibres.

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MEDICINE AND PUBLIC HEALTH

THE ROCKEFELLER FOUNDATION'S WORK IN 1943

THE report of work of the Rockefeller Foundation in the year 1943 makes interesting reading. The income of the Foundation from investments during the year was \$8,079,164 and the expenditure amounted to \$7,760,186. The different items of expenditure were as follows:—public health, \$2,450,000; medical sciences, \$1,529,000; natural sciences, \$599,000; social sciences, \$1,068,000; humanities, \$1,055,000; and programme in China, \$108,000. Of the above expenditure, 69 per cent was for work in the United States and 31 per cent for work in other countries.

The Foundation took justifiable pride in helping financially the development of penicillin in England, by placing funds and facilities at the disposal of Prof. Florey and other workers. The Foundation lent its support to the Harvard Medical School for the organization of a laboratory of physics and chemistry. Its Plasma Research Section has now undertaken to produce dry plasma for civilian and military casualties during the war.

In Europe, work was financed in Sweden at the University of Upsala and at the University of Stockholm in chemical physiology, embryology, bio-chemistry, bio-physics, neuro-physiology, radiology, etc.; in Switzerland, at the Universities of Basle and Zurich for research in bio-chemistry, organic chemistry and plant physiology. In Great Britain, grants were given to the Universities of Oxford, Cambridge, Sheffield, Edinburgh and Birmingham for basic research in bio-chemistry, bio-physics, genetics, organic chemistry, psychiatry, neurology and neuro-surgery. Researches have also been made for work on the Social Sciences by the Royal Institute of International Affairs, the London School of Economics and Political Sciences, the National Institute of Economic and Social Research

in London, the Social Studies Research Committee at Oxford and Political and Economic Planning (P.E.P.).

The information that the dangerous malaria-carrying *anopheles gambiae* mosquito, whose home is in Africa, has reappeared in Brazil is upsetting. Efforts are, however, being made to control the sources of infestation. Another noteworthy fact is the reopening of the Yellow Fever Laboratory at Lagos, which was started in 1925 and abandoned in 1934, in order to study whether the jungle variety discovered in South America has its counterpart in West Africa and to conduct studies in case of positive findings. It is interesting to note that all the yellow fever vaccine which has been manufactured since 1937 comes from a South African native named Asibi who was sick with yellow fever. Studies are also being conducted on typhus. It is realized by the Foundation that science and learning are truly international and that public health can no longer be thought of exclusively in national terms.

A good deal of attention was devoted to the study of the social sciences and the protection of cultural heritage in countries overrun by the enemy during the present world conflict.

NEW TECHNIQUES FOR STERILIZATION

According to *Science News Letter*, April 8, 1944, two new methods of sterilization, one of them for liquids, the other for air in rooms, have recently been patented.

The first is by a well-known scientist, Prof. Alexander Goetz of the California Institute of Technology, who has been awarded patent 2,344,548. It is an improvement on the method of sterilizing liquids by exposing them to certain metals, notably silver, through which slight electric currents are

passed to induce them to release their charged atoms, or ions, into the liquid.

A difficulty with this method has been that the metal surfaces tend to become coated, slowing down their action. Prof. Goetz solves this problem by running an endless chain surfaced with the metal, first through the liquid to be sterilized, then through de-coating and cleansing baths, then through the liquid again. Rights in the patent are assigned to the Sunshine Mining Company of Yakima, Wash.

The second sterilizing method is the joint invention of S. C. Coey and J. W. Spiselman of Middlesex Borough, N. J., who have assigned rights in their patent, No. 2,344,536, to the Research Corporation. It consists of an apparatus to make practicable and economical the recent discovery that the compound known as triethylene glycol is an efficient means of ridding air of germs without rendering it disagreeable or toxic. The chemical is mixed with a small portion of the air at a moderately elevated temperature. This is then diluted into the main stream of the air passing into the room through the ventilating or conditioning ducts.

ON Rh CONSTITUENT OF HUMAN BLOOD*

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WHAT Rh IS

BY Rh constituent is meant that antigenic component of human rbc which is in common with the rbc of the common brown monkey of India (*Macacus rhesus*). It was first demonstrated by Landsteiner and Wiener in 1941 and named Rh after the name of the monkey Rhesus.

It is said to be antigenic because it has all the properties of an antigen, *e.g.*, (i) power of producing antibody when suitably introduced into laboratory animals, such as guineapig, rabbit or fowl, (ii) react with the antibody produced in man or animal in the form of agglutination and lysis and (iii) being a constituent of rbc is a protein chemically. Rh substance is sometimes called a factor, but there is no need to call it so, because physically substance is the better name, immunologically it should be called an antigen and genetically a character.

* Read at the Society of Biochemistry and Experimental Medicine, Calcutta.

THE TOTAL SYNTHESIS OF QUININE

IN the May issue of the *Journal of the American Chemical Society*, (66, 849, 1944), Woodward and Doering have described an outline of the method for the synthesis of quinine. This work was undertaken as a research project of Polaroid Corporation by the senior author, instructor in Chemistry at Harvard University and chemical consultant to Polaroid Corporation.

The total synthesis of quinine is a great achievement in view of the fact that all the previous attempts have been fruitless. Woodward and Doering have started with 7-hydroxy-isoquinoline, a coal-tar product, and have succeeded, through a large number of stages, in preparing *d*-quinotoxine which was converted into quinine by Rabe over twenty-five years ago. This total synthesis of quinine opens up vast possibilities and in future we might get in the market the synthetic quinine to fight out the scourge of malaria.

D. C.

guineapig Rh prepared showed a gradation from the strongest to the weakest, the possible reason of which is to be found in genetics. All these go to show the complex nature of Rh.

COMPARISON WITH ANTIGENIC CONSTITUENT OF Rh

Other accepted antigenic constituents of human rbc are A and B, M and N. Antigens A and B give rise to 4 different blood groups by their presence either singly or together and by their complete absence. Corresponding antibodies are normally present in human bloods.

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Antigen	..	O	A	B	AB
Antibody	..	ab	b	a	o

Antigens M and N give rise to 3 different types according as they are present singly or together. Both of them can never be absent. Antibodies are not normally present but may give rise to immune iso-antibodies.

Antigen Rh can give rise to two different types according as it is present or absent. As regards the positive there seem to have different variants of it, which can be proved both by the positive human and artificially produced animal sera. Like M and N substances it may give rise to immune iso-antibodies. Inheritance, like group specific substances, is, according to the Mendelian line, the presence being dominant to its absence.

The Rh antigen defied all attempts, to find any relationship with known antigens of blood groups (O, A and B) and types (M and N). Complete serological formula of a blood should represent all these antigenic systems, *e.g.* O, A, B, M, N ; and Rh.

LABORATORY PREPARATIONS

Guineapigs and rabbits were injected inter-venously and chickens intermuscularly with 1 c.c. washed 50 per cent monkey rbc thrice at an interval of 4 days and serum collected 10 days after the last injection. Higher titre was obtained with 3 injections in place of two as recommended by American workers. Guineapigs so far gave better results than rabbits. Chickens with intermuscular injections gave disappointing results. The highest titre found by this method was 1 in 300, lytic titre keeping space with the agglutinating titre.

Lately the writer has used stroma only (after the cells are lysed with distilled water) instead of cells as a whole for injection. It has the advantage

of giving intervenously in chickens without the risk of haemolytic reaction occurring. Guineapigs and rabbits were not yet tried. Chickens by this method gave the highest agglutinating titre so far available, *i.e.* 1 in 1000 which is really astonishing where as the lytic titre was very low. The very high protein content of chicken serum probably made it possible. Incidentally it also proves that Rh property like other agglutinating properties (group specific) resides into the stroma and not in haemoglobin.

MECHANISM OF ANTI-Rh FORMATION IN HUMAN SUBJECTS

This is due to the effect of inheritance. An Rh- mother mated with an Rh+ father may beget a foetus who may have inherited the Rh character from the father.

Now the Rh+ rbc of the foetus somehow gaining entrance into the mother's circulation, the rbc of which is Rh- acts as an injected blood into the mother and iso-immunizes the mother.

The immune iso-antibodies thus produced being in solution in serum gain entrance into foetal circulation. Thus incompatible reactions are produced in the foetal circulation producing Erythroblastic anaemia in the foetus called Foetal Erythroblastosis. Further transfusion with otherwise compatible but Rh+ blood will necessarily aggravate the condition.

There are, however, some contradictions. For instance, (1) how can foetal rbc enter into maternal circulation and (2) is iso-immunization possible? These contradictions have received explanation which may be referred to as follows:—

(1) According to the accepted view substances dissolved in blood (not rbc) can only pass through the membrane separating the foetal and maternal circulation. But the membrane may, at times, leak and this is perhaps the reason why mishap occurs usually in subsequent pregnancies.

(2) It was found that the serum of patients who had shown haemolytic reactions (*i.e.* incompatible reactions) after receiving repeated blood transfusions of otherwise compatible group bloods contained anti-Rh agglutinin while in the rbc the corresponding Rh agglutinogen was wanting. This showed that the Rh antigen can produce immune-iso-antibodies in human beings. M and N antigens have been found to behave similarly.

ISO-IMMUNIZATION OF THE MOTHER BY THE FOETAL ANTIGEN

Iso-immunization of the mother by the foetal rbc antigens was found to occur only when the antigen in question is Rh and not blood group specific antigens (O, A and B) or blood type specific

antigens (M and N). As for blood group iso-immunization is not possible because the corresponding antibodies are normally present in the blood and probably because the group specific antigens are distributed throughout the tissues and fluids of the body and not confined to rbc only and so the corresponding maternal antibodies become specifically bound to the tissue cells and inhibited by the body fluids, so that group specific antigens of foetal rbc are protected. Rh antigen, on the other hand, occurs in the alone and consequently is exposed to the full action of the mothers anti-Rh agglutinins that have gained entrance into the foetal circulation. Iso-immunization of the mother by the antigens M and N in foetus does not occur though they have got limited distribution (in rbc only) like Rh substance for reasons not known to us.

EXPERIMENTAL MEDICINE—PRACTICAL IMPORTANCE IN TRANSFUSION

Rh substance is a good antigen in Rh- individuals.

(1) *Re-transfusions*.—An Rh- subject received an otherwise compatible but Rh+ blood in previous transfusion. He develops an anti-Rh agglutinin. Before it is sufficient time for the disappearance of the antibody he receives another transfusion of Rh+ blood. The new Rh+ rbc will be agglutinated by the anti-Rh agglutinin and will cause haemolytic reaction.

(2) *Obstetrical cases*.—Even in the very first transfusion in subsequent pregnancies or in and after labour, an Rh- mother already iso-immunized by foetal Rh+ rbc may develop haemolytic crisis if she is transfused with an Rh+ but otherwise compatible blood. This is the reason why transfusion in some obstetrical cases with severe anaemia worsens the cases. Abortion also comes under this heading. The antibody in mother's blood was found to be present for a period of 2 years after labour in some cases.

(3) *Infant with Foetal Erythroblastosis*.—This is better named as a condition of haemolytic anaemia of the foetus and new born with either hydrops or icterus gravis. It is usually found in subsequent pregnancies and the mother also suffers from anaemia. The foetus inheriting the Rh+ property from his father when conceived by an Rh- mother iso-immunises the mother and thereby receives from the mother anti-Rh agglutinins which in turn causes haemolytic reaction. Here again transfusion with an Rh+ blood only causes to aggravate the condition.

Such difficulties can be reduced to a minimum by having regard to the following:

(1) To test routinely in all obstetrical (including abortion) and re-transfusion cases, for the pre-

sence or absence of Rh substance and select the donor accordingly, i.e., selection of Rh- donors for Rh- patients. For this purpose it is essential to have a constant supply of anti-Rh human serum from iso-immunised Rh- mothers.

(2) To observe the direct cross-matching test most scrupulously and lengthen the time limit from half an hour to one hour.

Genetics.—The character Rh is transmitted by means of a pair of genes, Rh and rh and the dominant gene Rh determines its presence (Landsteiner and Wiener, 1943).

So genotype RbRh (Homozygous father) corresponding to phenotype Rh+ must beget Rh+ children. Genotype RbRh (Heterozygous father) corresponding to phenotype rh+ may beget both Rh+ and Rh- children. Genotype RbRh (Homozygous father) corresponding to phenotype Rh- must beget Rh- children.

IMPORTANCE IN GENETICS, SOCIOLOGY, FORENSIC MEDICINE AND ANTHROPOLOGY

Sociology.—As Rh- women when mated with Rh+ husbands run the risk of being iso-immunised Rh compatibility before marriage may be rightly demanded by both the parties concerned but as the Rh negative rate is very small actual incidence of such couples (Rh+ X Rh-) is only $90 \times 10 = 9$ per cent Indians and $85 \times 15 = 13$ per cent Europeans of all random matings.

Forensic Medicine.—Exclusion of paternity will only be possible in Rh- couples (Rh- X Rh-) alleged to have given birth to Rh+ child, i.e. $15 \times 15 = 2$, 25 per cent.

Anthropology.—Relationship between the races of humanity can be shown by the presence of identical antigenic substances.

SOME SUGGESTIONS FOR FURTHER RESEARCH

This iso-immunization of mothers by foetal antigenic substances opens up the question whether or not other unknown blood constituents can play an important role in several conditions, such as unexplained anaemias of pregnancies in the tropics, stillbirths, congenital malformations, etc.

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BOOK REVIEWS

A Handbook for the Identification of Insects of Medical Importance—By John Smart with chapters on Fleas by Dr Karl Jordan and on Arachnids by R. J. Whittick. British Museum of Natural History, 1943. 269 pages, 13 full page plates and 177 text figures. Price fifteen shillings.

This book represents the first serious attempt that has been made to consolidate into one volume a taxonomic guide to the insects of medical importance throughout the Old World. Dr Smart is one of the ablest students of Diptera taxonomy and has presented the subject in a very masterful manner in this book. Such a work has been badly needed for a long time as the literature pertaining to this subject is widely scattered and not readily obtainable. To have this important information in one publication is of special significance during this time of war, since so much of the fighting must be done in tropical climates and it is essential that every possible effort be made to protect our troops from diseases. The great importance of insect taxonomy is soon realized by everyone who has intimate contact with problems in control of insect-borne diseases, especially in instances where specific control is essential. It is impossible to attack any problem scientifically until one knows the species with which he is dealing. An accurate specific determination often gives the key to the erradication of the vector concerned and saves much time and expenditures. This book will be extremely valuable to Army personnel who are working with insect-borne diseases. It provides them with a consolidation of information on the classification of the medically important insects which would otherwise be unavailable to the workers in the field.

The introduction deals with the structure of insects, development and life history, classification and nomenclature and zoogeography. This provides the general background information that is essential to the study of taxonomy so that the text would be entirely usable by any one with enough training in science to understand the system of animal classification and the working of a key. The discussion of classification and nomenclature is very well written. This is one of the best, concise presentations of this subject known to this reviewer. It briefly but clearly outlines the methods and procedures in nomenclature and emphasizes the importance of accurate identification of insect species.

The discussion on zoogeography presents a useful table of the faunistic regions and subregions of the world.

The larger portion of the book, one hundred and seventy three pages, is devoted to the Diptera. For the most part all of the medically important families are well handled. The section on structure and life histories gives a review of the important taxonomic characters and a few statements on the developmental stages. The classification of the suborders of Diptera and the keys to the families which are of medical importance is complete and simple to use. The excellent illustrations of the Diptera, as well as the other Arthropoda, clarify the keys and other subject matter.

The psychodidae are the first flies that are taken up. The discussion is very brief and inadequate. In view of the importance of these flies in most sections of the tropics it seems that a key to the Phlebotomus should have been included. Even though the species determination of Phlebotomus is a matter for the specialist, it so happens that there are many capable Dipterists working in the field who do not have access to the necessary literature.

The other families are discussed under their respective suborders and keys are given to the medically important genera. A few short statements are given on each of the more insignificant families and no keys are felt necessary. The family Muscidae is thoroughly treated, with generic keys, notes on the important genera and keys to the species of Glossina. The Calliphoridae (the Sarcophagidae of most Dipterists are included in this family) are keyed to genera and notes are given on the important ones. The Oestrides and Hippoboscidae are adequately treated although no keys are provided.

Ten pages are devoted to a comprehensive treatment of the subject of myiasis and the identification of myiasis-producing larvae. This appears to be very thorough and well worked out; it should be very useful to the medical entomologist.

The phylogenetic order is somewhat upset when the Culicidae are left out of the discussion on the Nematocera and are taken up by themselves directly after the Cyclorrhapha. Ninety-nine pages are given to this all important family and this section is perhaps the most useful portion of the entire book. Keys to the subfamilies, tribes and genera of the Culicini, adults and larvae, and to the species of Anopheles are given. The latter are divided into

keys for the Palearctic region, the Ethiopian, the Oriental and the Australian region and deal with adults and larvae. The keys have been compiled from many sources but have been brought up to date and simplified in many places. The section is very excellent and is made even more valuable by the inclusion of a table on the breeding places of Anophelines, a list of the synonyms and important misidentifications: also a list of the malaria-carrying species given under countries and a very good treatise on distribution and literature pertaining to the Anophelini.

The other insects of medical importance are dealt with in thirty two pages, with twenty one of these being devoted to an excellent discussion by Dr Jordan on the Siphonaptera. The orders Orthoptera, Anoplura, Hemiptera, Lepidoptera and Coleoptera are briefly considered. Dr Jordan's section is exceptionally well done and will be of much value to workers in Flea-borne diseases. After an introduction to the group, giving the medical importance, biology and notes on taxonomy, he has keys to the important genera, notes on the genera and a key to the species of the genus *Xenopsylla*. This section is very well illustrated and most of the figures are original.

The remaining Arthropoda are treated by R. J. Whittick of the Department of Zoology at the British Museum. Under the Scorpions he gives the structural characters of only the Buthidae and Scorpionidae and leaves out the other four, less common, genera. The Araneae and Acarina are discussed briefly but keys are given only to the families and genera of the Ixodoidea. The medically important genera and species are treated adequately. The last few pages of this section are given to short statements on the Pentastomida, Myriapoda and the Crustacea.

An eight page appendix presents very useful notes on methods for collecting and preserving insects. It discusses the materials and equipment needed, tells how to prepare killing bottles, aspirators, etc. It gives the various methods of preserving and preparing insects for study and the various formulae for preserving and mounting. Some of the more pertinent literature on insect collecting and sources of entomological supplies are given at the end of this chapter.

In conclusion the reviewer feels that this book is a very outstanding contribution to the war effort

and that it will be especially useful to entomologists and medical men of the Allied Armies. It is clearly written and very beautifully illustrated, the excellent figures demonstrate the subject matter explicitly. The bibliographies at the end of each chapter are well chosen and appear to be fairly complete. It is regrettable that the book confines itself to just the Old World, the inclusion of keys and figures to the Nearctic and Neotropical regions would have increased its value and would have given a world wide coverage of the subject in one volume.

D. N. R.

Experiment and Theory in Physics - By Max Born, Cambridge University Press. Price two shillings net.

The short monograph is an expansion of an address by Prof. Born given to the Durham Philosophical Society and the Pure Science Society in the summer of 1943. He deals with a theme that is very familiar to the physicist and his present address is directed mainly to the man-in-the-street and the philosopher rather than to the physicist. He attacks again the oft-criticised epistemologists specially the abstruse cosmological theories of Eddington and Milne. Prof. Born attempts a dig at the extreme experimentalists of the school of Lenard and Stark and finally settles down to an analysis of the growth of Relativity and Quantum Mechanics. His analyses emphasize the slowly accumulating empirical foundations on which these present elaborate theories rest. He explodes for, perhaps the nth-time the fiction of pure reason and details how the experimental discovery of the neutron could not have been foreseen by any reasonable guess of epistemology. Regarding Eddington he sums up excellently, thus, "I shall not attribute any possible success (of Eddington's Theories) to Eddington's philosophy as a doctrine which could be followed by others, but to his personal genius and intuition." Regarding Milne he is rather obscure except for the usual argument about the obvious problem of age of the universe which Milne puts at 1.5×10^9 years in his cosmology.

On the whole Prof. Born's criticism of current cosmological theories by the epistemologists is a popular and lucid exposition but he hardly says anything new or remarkable to interest astrophysicists and cosmologists.

B. D. N.

LETTERS TO THE EDITOR

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

NEW CONTINUOUS EMISSION BANDS IN THE SPECTRUM OF CHLORINE

Apart from those due to temperature radiation, continuous emission bands which can be attributed to diatomic molecules are the simplest of their type. The importance of continuous band spectra for the development of the theory of structure of molecules is clear if one realises that these afford probably the only source of information regarding the repulsive energy states of a molecule. The spectrum of chlorine suitably excited by high frequency discharge is known to possess a large number of such continuous bands an elucidation of which is expected to throw considerable light on the structure of chlorine molecule. Cameron and Elliot^{1,2} have recorded a number of bands which we have included in two main groups. Each group is composed of a strong band followed by a few weaker ones on the short wave side. In excitation by active nitrogen, only one band λ 2564, the strongest in the second group is observed which is interspersed by a diffuse-banded structure.³ On exciting pure flowing chlorine at a pressure of 1 to 2 mm. by a mild high

them on a large number of plates visually and the data pertaining to all the bands present on our plates are included in the table, where also the data of Cameron and Elliot are given. These comprise in addition to the already known group I and two bands in group II, five new bands in group II and an altogether new group III of bands headed by a band at λ 2001 and followed by two more bands upto the limit of the quartz spectrograph used. It seems very likely that the bands extend into the vacuum region. In agreement with Cameron and Elliot's observation no structure is seen either in the band at λ 2564 or in any other band.

We are very grateful to Dr R. K. Asundi for his valuable suggestions and guidance during the course of the work.

NAND LAL SINGH
K. SRINIWASA ADIGA

College of Science,
Benares Hindu University,
Benares, 21-6-1944.

¹ Elliot and Cameron, *P. R. S.*, 158, 681, 1937; 164, 531, 1938
² Cameron and Elliot, *P. R. S.*, 169, 463, 1939.
³ Strutt and Fowler, *P. R. S.*, 86, 105, 1912.

BALANCING OF CHEMICAL EQUATIONS

Students of Chemistry often find the numerical balancing of chemical equations ticklish. I devised a method for balancing them as far back as 1933 and as upto now I have not come across a like method either in books, or in the lecture-room or outside. There is nothing fundamentally new about it. It only puts algebraically the fundamental concept of indestructibility of matter and solves the equations infallibly and surely.

As an example, let us balance the well-known equation :—



We put the equation like the following, introducing unknown coefficients x, y, z etc.



The coefficient of one of the members of the equation i.e., O, has been taken unity.

Group No.	Intensity (Visual)	band in A. U.	Position of maxima		
			Authors		Cameron & Elliot
			λ in air	ν Vac.	
I	8	3160-2983	3063	32863	3063
	3	2983-2923	2954	33843	2957
	4	2923-2852	2880	34712	2881
	3	2852-2793	2818	35488	2819
	1	2793-2737	2759	36234	2758
	1	2737-2675	2718	36781	2714
II	10	2675-2473	2564	38990	2564
	8	2473-2380	2428	41174	—
	6	2380-2318	2349*	42558	—
	4	2318-2250	2287*	43712	—
	2	2250-2163	2200*	45440	—
	1	2163-2105	2139*	46736	—
III	0	2105-2055	2076*	43154	—
	2	2055-1955	2001*	49959	—
	1	1955-1892	1918*	52120	—
	0	†—	†1865*	53890	—

* New bands.
† Uncertain, confused with the intense Schumann-Runge Oxygen Absorption bands at $\lambda\lambda$ 1883, 1864.

frequency discharge (650 to 700 K. cycles per sec.) a number of additional bands are recorded on our plates (Kodak Process B 5). We have measured

We now equate the numbers of atoms of each element, occurring on each side of the equation.

From H atoms:—

$$2x = 2t \quad \dots \dots \dots (1)$$

From S atoms:—

$$x = z + s \quad \dots \dots \dots (2)$$

From O atoms:—

$$4x + 4y = 4z + 4s + t + 1 \quad \dots \dots \dots (3)$$

From K atoms:—

$$y = 2z \quad \dots \dots \dots (4)$$

From Mn atoms:—

$$y = s \quad \dots \dots \dots (5)$$

We solve the above five equations simultaneously.

From (1) and (2)

$$x = t = z + s$$

From (4) and (5) and above.

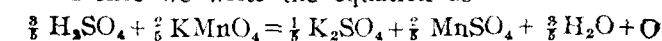
$$y = s = 2z = \frac{2x}{3} = \frac{2t}{3} \quad \dots \dots \dots (6)$$

We put the above results in (3), in terms of one unknown say, x .

$$\text{We get } 4x + \frac{8x}{3} = \frac{4x}{3} + \frac{8x}{3} + x + 1 \quad \text{or } x = \frac{3}{5}$$

and therefore $t = \frac{3}{5}, y = \frac{2}{5}, s = \frac{2}{5}, z = \frac{1}{5}$

Hence we write the equation as



Which becomes



The method becomes simpler and more brief by practice. For example, one could have written at the very outset y instead of s for MnSO_4 in the chemical equation because there are no other atoms of Mn except in KMnO_4 and MnSO_4 .

The method has indirect uses also. If some molecules were placed on the wrong side, the value of its coefficient would come out negative. Also if an equation is mathematically impossible, it is also chemically impossible.

R. PARSHAD

Irrigation Research Institute,
Lahore, 5-7-1944.

CANNIBALISM AMONG FRESH WATER FISH

Cannibalism or feeding on its own species is a frequent occurrence among carnivorous fish, such as, *Koi (Anabas testudineus)*, *Singhee (Heteropneustes fossilis)*, *Magur (Clarias batrachus)*, *Chitol (Notopterus chitala)*, *Boal (Wallagonian attu)*, etc. This sort of cannibalistic habit is not only restricted amongst adults but can be found at all stages—fry, adolescent and adult. Cannibalism aggravates with the scarcity of food and space.

It may be difficult to believe that herbivorous fish like, *Labeo rohita*, *Labeo calbasu*, *Cirrhina mrigala*, *Catla catla*, i.e., all the major carps of India, and all other smaller types have this cannibalistic habit, yet the fact remains the same. The only difference being with the carnivorous type is that such habit is restricted at a particular fry stage which we generally do not perceive due to our lack of observation.

During our investigation with the scheme of the life-history, bionomics, and development of fresh-water fish of Bengal, financed by the Imperial Council of Agricultural Research, we have frequently observed that there are four definite stages regarding food-habit of major carps. The first stage should be the hatched fry which begins to take food after its mouth opens till it attains a size of 10 mm. Soon after the mouth develops these fry begin to take unicellular algae and not any protozoon, as paramoecium even is too big for them. This stage may be called as true herbivorous condition. From 10 mm. to 20 mm. the major carps take mostly animal bodies, such as protozoon, small crustacea and almost negligible proportion of algae. Such a stage may be called a carnivorous condition. This stage is followed by a stage which can be said as omnivorous condition as they take vegetable and animal food half and half. The duration of this stage is restricted from 20 mm. to 250 mm. Finally there is the stage which may be called as the second herbivorous condition which includes even the adult form. It should be mentioned that *Catla catla* is an exception as they continue the omnivorous condition from 3rd to the adult stage.

During carnivorous stage of carps cannibalism is frequently seen. Stronger ones devour the weaker ones either partly or wholly, although people have an idea that herbivorous fish is free from such a pernicious habit and such habit is only restricted to carnivorous types. It has already been pointed out that there is no true carnivorous or true herbivorous fish.¹ Strictly speaking every fish is omnivorous. We classify fish as carnivorous or herbivorous only from its major proportion of food.

Cannibalism is one of the nature's means of restriction of over population. Mortality due to this is not so much as the mortality at the time of hatching. This is due to sudden change of environment from egg-capsule to water in which the eggs are lodged that causes the greatest mortality in the life-history of any fresh-water fish.

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Calcutta, 7-7-1944.

¹ Mookerjee, H. K., SCIENCE AND CULTURE, 9, 306, 1944

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MEDICAL EDUCATION IN INDIA

EDUCATION always presupposes an ideal and a purpose. Medical education is a specialized continuation of general education but with a definite purpose. Medical education cannot therefore be considered entirely apart from general education, as its efficiency is connected with the quality and quantity of the general, and preliminary education which a student receives, before taking up the medical course.

MEDICAL EDUCATION THROUGH AGES

The nature of the educational course has varied with the ages. In various epochs of history, the doctor has been a magic man, priest, craftsman, cleric, and in Europe in the Middle Ages, he was a pedant swearing by Hippocrates, and Galen, as in India today the indigenous medical man still swears by Charaka and Susruta. It is only with the rise of natural sciences, and after Paracelsus, Vesalius and Harvey that the medical man became a scientist. As the universities came into existence, medical education became a part of the university framework. In the process of evolution, didactic teaching was supplemented and ultimately replaced by demonstrations, practical work in the laboratory and field, and with organized investigations of the various problems confronting the cure and prevention of diseases. The evolutionary process is still in progress. The important discoveries made during the past 60 years in the basic sciences of physics, chemistry and biology have been placing in the hands of the medical man newer tools to control the incidence of diseases and to alleviate human suffering.

While medical education is thus becoming increasingly complex, and difficult to deal with, the purpose element of education is undergoing a gradual, but radical change. The Industrial Revolution which started in the 18th century transformed the complex of society in many countries, giving rise to

large urban areas based on industries, where large rural population poured in and underwent a rapid, but invariably painful process of urbanization. This not only gave rise to novel problems in public health, but opened up before the medical man large fields for practice and experimentation, but above all, a far wider scope for raising his income, which he fully utilized, taking advantage of his high and complex training in sciences. Treatment in most cases became so expensive that only the rich could afford it, while the poor man had to be left to his fate.

It is only recently that there has been a general protest against this state of affairs, and the prevention of disease and maintenance of physiological hygiene for the general mass of population, and concurrently a strong demand for social security in health matters for the community have loomed up before governments. The doctor has also to realize that he should not regard himself as a mere therapist. The public has realized that though the present day doctor may be in possession of sufficient scientific means to practise curative medicine on a large scale, the ideal should be prevention of diseases, the chief cause of which is poverty with all its dire consequences—ignorance, slums, malnutrition, prostitution etc. For a solution of the cognate problems, medicine needs to be a social science and what is needed to-day is that we produce not only a scientific physician well-trained in laboratory, clinic and field work, but a social physician who is conscious of the scientific developments, the social functions of medicine and the social maladjustments which give rise to disease. Sir George Newman has said, "the ideal of medicine is the prevention of disease, and the necessity for curative treatment is a tacit admission of its failure."

As a result of this conception the barriers between preventive and curative medicine have been

gradually breaking down during the last 30 years or so, and the medical curriculum is gradually undergoing a change. The student is being taught not only to become interested in disease but also in health. He is being taught that every case should be analyzed medically and socially as to the factors which have made it possible to produce the diseases, and as to what measures could be taken to prevent similar cases in the future. The student must be made familiar with the problems, working and living conditions of the different income groups of the population. It is being impressed upon him that medicine is not a competitive business but a service and that there is no direct relation between their work and their income. The idea of State Medicine is gaining ground, aiming to provide the physician with a decent, though modest, living on similar lines to that of other public services. Thus the objective of medical education has changed, necessitating a new curriculum adapted to the present and future needs of the society. The purpose of the curriculum should be to guide the student and to help him to develop his personality and a correct attitude towards the problems of health and to acquire knowledge and skill in the technology and sociology of medicine.

An inquiry into the curriculum and methods of training in medical education was carried out in more than one country during the early years of the present century. As a result of these inquiries certain principles have been established, the more important among them being as follows:—

(1) That a definite minimum standard of education must precede admission to a medical school or college and that this should include physics, chemistry and biology for at least 2 years. A certain number of hours should also be devoted to the history of science and introduction to medicine, languages and literature, mathematics, anthropology, sociology and economics. In order to make this pre-medical education effective, the secondary education which the student has received must be of the proper standard, as the difference between secondary and university education is as the difference between immaturity and maturity. It is widely agreed that the teaching of basic sciences should begin at school and that, in the university course of general science, stress should be laid upon physical chemistry and organic chemistry and that in the biology course more stress should be laid on such biological principles as the theory of evolution, adaptation to environment and genetics and less time should be given to memorizing of details of animal types. In choosing a student for the medical career, his or her academic record, intelligence, character and personality should be taken into account.

(2) That the main defects of the existing system of training are (i) absence of the university ideal, (ii) subordination of teaching to examination, and (iii) waste of energy in hospital schools.

Until recently the universities had confined themselves to prescribing a curriculum and in conducting examinations on a syllabus. The educational ideal fell short of broad educational objectives which

required that the basic training should include the acquisition of knowledge of the fundamentals of the medical sciences, the acquiring and understanding of certain indispensable techniques, the development of initiative, of a scientific point of view, and of proper methods of work. The intention of medical teaching institutions was not to make its students experts in all the subjects but rather to have a sound foundation for future development. The education of a physician is never completed and it has to be continued throughout his professional life. Medical education is directed towards two objectives—educational and vocational. In the former, the student is taught method so that he can collect, analyze and interpret facts for himself and observe and understand what he observes. In the latter, he is given such knowledge adapted to the requirements of the country as will enable him to ably practise medicine on his own account. In preference to the emphasis on factual knowledge, the student should be grounded in methods and principles which he can apply to the requirements of the situation. The methods of examination of students have, therefore, to be adapted to the changing objectives and curriculum.

(3) The functions of a medical teaching institution are to provide stimulus, guidance, supervision and facilities essential to its students in the acquisition of education. Contact with active research programmes or, better, actual participation in such programmes, are factors of major influence in the educational development of the student. Satisfactory stimulation and leadership is impossible in the absence of a competent, interested and active faculty.

(4) It is necessary for an institution of the modern type to address itself wholeheartedly to the advancement of knowledge, the study of problems, and the training of men at the highest level of efficiency. It is desirable that it should be affiliated with or integrated in a university, where the pursuit of science and scholarship is the ideal, even if it means some sacrifice of independence.

In an university atmosphere the students have an opportunity to work in constant association with fellow-students of their own and other faculties, where knowledge is pursued not only for the sake of information but for the attainment of truth, with the further advantage of a close association of undergraduate and post-graduate work. Integration of medical colleges in an university offers opportunities for broadening the objectives and procedures of medical education by the influence derived from wider association and the extension of the influence of medical education into many spheres of university activity. The university faculties should be properly constituted to keep a vigilant eye on the methods of teaching imparted in the medical colleges under them and all appointments should be made by the faculty. The college should be under a Dean who should have the necessary educational and administrative experience in his native country and abroad and should

possess the necessary tact and administrative ability. The university should receive an adequate block grant from the Government to keep the medical college at the required level of efficiency. In addition, it should try to secure decent endowments for expansion and research. As the cost of medical education cannot all be recovered from students' fees, it is best to keep students' fees in medical institutions at par with fees in other lines of university activity and to offer scholarships and studentships as far as funds permit.

(5) That medicine must be learnt neither from books alone nor from lectures alone but chiefly from observation of the sick, whether in the hospital or in the social milieu, and that all instruction is to be given by men actively engaged in research in their respective fields.

Medical subjects have an observational and experimental basis which is constantly changing. The student must, therefore, be trained in these methods, not merely lectured to.

(6) The first 2 years of the under-graduate curriculum in a medical college are usually devoted to the pre-clinical or basic sciences with a sprinkling of such knowledge of the human body and the human society as can be assimilated by the student, and the next 2 to 2½ years are devoted to the application of the basic sciences in the various major branches of clinical medicine. An additional half to one year is devoted to internship. This is followed by post-graduate appointments as "house officers", when the graduates receive detailed and specialized knowledge in different fields.

It has been accepted that the former text-book, drill-master courses are to be discontinued and didactic exercises to be reduced to a minimum. These are to be replaced by actual experiences in the laboratories, hospital wards, libraries, conferences, seminars, clinics and field work in the community.

It has been recognized that the student receives satisfactory guidance and supervision only through intimate and competent teacher-student relationship. The ratio between teacher and student for this purpose may vary from 1:5 to 1:10. The optimum ratio of theoretical to practical training stipulates that for every hour spent on theoretical lecture at least 2 to 3 hours should be allotted to practical instruction, whether in the laboratory, dissection room, bedside, clinic or the field. The pre-clinical course should include among its subjects history of medicine, sociology, bio-chemistry, bio-physics, and bio-statistics. The clinical course should include a training of nursing, nutrition, housing and sanitation, social medicine, industrial hygiene and occupational diseases, pediatrics and psychiatry. The course must be supplemented by clinico-pathological and medico-sociological conferences, and at least two months of field work during every year of the clinical period should be given throughout the clinical course. Teams, consisting of students of medicine, nursing, midwifery etc., shall be sent out with instructors and their work shall consist of surveys in various regions,

work in connection with public health agencies, nurseries, clinics, co-operative health associations etc., medical relief in distressed areas and similar tasks. The idea is to give the student a comprehensive view of the health situation and problems of the country both in rural and urban areas. It is expected that the student will thereby learn to identify his interests with those of the people. It is necessary that every medical college should have its own community practice fields. The teaching of preventive medicine should be organized on the same basis as the other major subjects in the clinical period.

(7) Post-graduate education should form an important part of a medical teaching institution and should consist of (i) short or refresher courses, lasting a few weeks, on various subjects; (ii) courses, lasting for several months, on broader subjects; (iii) courses, lasting for one to two years or more, for specialists; and (iv) courses for auxiliary personnel.

(9) Every medical teaching institution should be properly equipped with the necessary apparatus and an up-to-date functioning library.

MEDICAL EDUCATION IN INDIA

Viewed in the perspective given above, let us try to assess *medical education in India*. Some of the medical colleges in India were started one hundred years ago; with the establishment of universities in India in 1857 some of them were affiliated to the universities. The universities laid down the curriculum and conducted the examinations. The colleges were controlled by the Government and teaching was imparted, until lately, by Government officers belonging to the Indian and Provincial services. The appointments were not guided by the requirements of the professorial chairs, and very often teachers were transferred from one chair to the other in total disregard of the needs of education. Most of these institutions being under the medical branch of the Government administration, the universities could not take part in shaping their policy. Despite the fact that all medical colleges in India today are affiliated to one university or other, education in them is not planned according to the true principles of university education, nor does it sufficiently forcefully stress the modern trends in medical and public health education neither does it sufficiently relate to the requirements of the country. It has been laid down in other countries that only men with high academic qualifications, teaching and research experience, experience at foreign universities, originality, initiative, integrity and right outlook should be selected as teachers. There is a complete violation of these principles in the matter of appointing teachers in medical colleges and schools in India. Of late there has been a tendency to make appointments on communal basis to the detriment of academic objectives. Appointments on

communal considerations do not exist anywhere in the world.

There is nothing like a Dean, in the real sense of the word, in most of the medical colleges to manage and shape the policy of education in these institutions. Very few of the Principals have any experience with international trends in education and have made a special study of the subject. The result is that he carries on the day-to-day administration without any sustained effort to improve the quality and content of education.

While England, America and other countries have tried to level up medical education to meet the growing needs of the modern community, medical schools and colleges in India have largely remained medieval. The existence of university grade and lower grade medical schools is an anachronism in modern society. The number of institutions is not related to meet the needs of national health in the country. The institutions are ill-equipped, the curriculum badly planned, teachers inadequately trained, teaching methods old-fashioned and the staff inadequate. Teaching is still chiefly didactic and the social sciences have no place in the curriculum. There is no close correlation between the different stages of medical training—pre-medical, pre-clinical and clinical. The teaching in most subjects is not purposeful and real, and violates Abraham Flexner's dictum that "medicine is learnt; it is not taught." Many subjects which have assumed importance in medical education in various universities are noticeable by their absence in the curriculum in India. Besides, teachers hardly engage themselves in research work and students are usually taught from books written in foreign countries, which do not contain the results of investigations carried out in India.

The medical colleges, with the exception of one, are not integrated in the universities. Except three non-official medical colleges, they are controlled and run by the medical administrative departments of the Government, who rarely possess the necessary training in planning and administering medical education. As far back as 1913, the Royal Commission on University Education in London emphasized the incorporation of medical schools into the universities. But in India, the old system has been going on to the detriment of a sound system of medical education. The levelling up of medical education in India is, therefore, urgently needed.

Most Faculties of Medicine in Indian Universities have a Board of studies, formed from the members of the Faculty, one of whose important functions is to indicate how best the tools of scientific progress could be adapted to the changing needs of the community. It is sad to reflect that, instead of

attending to this more important function, it is chiefly concerned with the selection of examiners.

POST-WAR PLANNING IN MEDICAL EDUCATION

It is reported that a post-war committee of the Government of India is now engaged in studying the standards prevailing in India with a view to devising measures for improving them. It is hoped that their labours will bear early fruit. We hope the committee will realize that education is not only for today and that the methods of education that we employ today will help us to plan for the future. A poorly designed and equipped medical college is a bad investment. We should like to draw the attention of those concerned to the warning of Plato who said that "the most gifted minds, when they were ill-educated, became pre-eminently bad." India needs to hurry up if the enormous time lag is to be overtaken.

SUGGESTED MEASURES OF REFORM

The first reform that is needed is to abolish or raise the so-called medical schools in the country to the university level, and to level up the university grade medical colleges to modern types. The universities should take entire charge of the medical education through a properly constituted Faculty of Medicine, where teachers should have a predominant voice not only in laying down the curriculum but also in the selection and appointment of the proper type of personnel. If all the medical colleges cannot be raised to the high-ranking university type, at least one college should be so raised in each province or under each university. The Medical Council of India may co-ordinate medical education in the various provinces. The Government should make an adequate grant to the university to improve medical education and to run the colleges at the required level of efficiency. Teaching methods should be thoroughly revised and the proper type of teachers appointed. Less time should be devoted to textbook assignments and more to practice periods under proper supervision. Intimate and competent teacher-student relationship in medical education, which hardly exists here, should be introduced. It should be the aim of the university not only to arrange to train the necessary personnel but also to help in evolving practical methods of solving the various medical and public health problems of the country.

Hitherto the practice in medical teaching institutions has been to run the departments "on the cheap" by employing teachers whose minds and interests are bound elsewhere. So long as the staff is mainly occupied in earning a living in other ways than by teaching and research no real improvement can take place. If the standards of the teachers are poor,

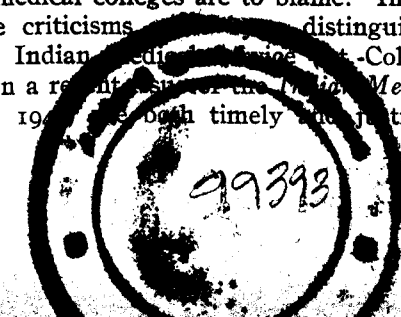
it is bound to react adversely on higher medical thought and education. The higher-ranking institutions referred to above may help in training teachers of the proper standard. It is whispered that there is a proposal for starting such an institution in the capital city of India at an estimated capital expenditure of Rs. 7 crores! Remembering that India needs about 110 university-grade medical colleges to supply the personnel necessary to execute the programme for taking up the lag and that the allocation for public health expenditure may not be unlimited, it should be considered whether a high expenditure like this should be spent in developing a new institution in which a lot of money will have to be sunk in buildings, or whether it should be distributed in raising the standard of several existing provincial institutions. Moreover, one institution in India will not be able to supply all the teachers needed for something like 110 medical colleges. It may so happen that some of these institutions may specialize in certain spheres, thus offering an opportunity of pooling the higher training facilities. No satisfactory improvement can take place unless and until all the senior teaching appointments are made full-time, with adequate emoluments to prevent them from being lured by other sources of income.

Scientific research in the universities, both for its own sake and as a background for scientific education, is the fundamental basis of all scientific progress. The unsatisfactory state of research in the Indian Medical Colleges is due to the absence of academic influence or an university atmosphere. A fair amount of medical research in India has been done at special institutes not connected with medical colleges or universities. This deprives the research workers from the stimulus obtainable from young enquiring minds in an university environment, while it hampers the growth of research centres in teaching institutions. The sooner this anomalous tendency is given up the better.

In the absence of high-ranking medical colleges in India, and in the absence of a good system of post-graduate education and research, many talents which can be brightened by polishing, do not get a chance of improvement. It has been stated that post-graduates in India find it easier to obtain qualifications in foreign countries than to secure them in their own *alma mater*. For this situation, the universities as well as the medical colleges are to blame. In this connection, the criticisms of a distinguished member of the Indian Medical Service, Col. G. R. McRobert) in a recent issue of the *Indian Medical Gazette* (April, 1944) are both timely and justified.

UNDESIRABLE COMPROMISE WITH PSEUDO-SCIENCE

Lastly, one thing requires close consideration by the people of India; it is with regard to the tendency of Provincial Governments and local bodies to set up or support separate teaching institutions for Ayurvedic, Unani and Homeopathic medicine. This is creating complications, which will be difficult to remove as time goes on. The present tendency of Provincial Governments to register practitioners of these separate systems of medicine, most of which lack systematic scientific training, is a move in the wrong direction. Science is progressive and is the same throughout the world; the basic sciences of chemistry, physics, biology, physiology, pharmacology, pathology, and bacteriology are the same all over the world. The criterion of the right of a doctor to medical practice or to the privilege of registration must depend on the basic knowledge he possesses of the fundamental sciences of chemistry, physics, anatomy, physiology, pharmacology, pathology and of medicine, surgery, midwifery and other cognate subjects. All the tools of modern science must be utilized for the early and correct diagnosis of diseases, and unless an accurate diagnosis is made no proper treatment is possible. No system of medicine, Ayurvedic, Unani or any other, can get on without the help of modern basic sciences. There should be no spirit of communalism or opportunism concerning matters of life and death of millions of the population of India. The question of prevention of communicable diseases cannot be successfully solved unless scientific methods of proved efficiency are adopted. The proper move should be to have only one medical science which has been worked out by the scientists all over the world, incorporating into it whatever good there may be in the indigenous medical sciences of the country. It is not our purpose to say that medicines in the other systems of medicine are not efficacious but that they require to be scientifically studied and the best place for doing this would be the university grade medical colleges with their attached hospitals where a separate section may be kept in the Department of Pharmacology and Therapeutics for the study of the indigenous remedies. The students of today will then get an opportunity to know what is best in the indigenous systems and to utilize it in the amelioration of human suffering, instead of the present confused state of affairs. If India is to achieve her place among the first-rank nations of the world, she must advance with the help of modern sciences and she must discourage any retrograde measures which will impede that progress.



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JOHN DALTON (1766-1844)

EXACTLY a century ago, on the 27th July, 1844, John Dalton, the founder of the atomic theory, passed away from this world, but left a legacy behind which has enriched the world of science and the entire civilization to an extent that can be said of very few other men. Though one of the greatest scientists of the world he was not less so as a man. For, he was not born with a silver spoon in his mouth; and it was by means of sheer perseverance, selfless devotion, firm determination, ceaseless labour and untiring struggle against many adverse circumstances that he rose to the high position in life—a position not of wealth, of course, but a far nobler one of benefiting mankind. Though rich in fame he always remained poor in worldly wealth. His habits were extremely simple and unassuming; he never cared for money and devoted himself unreservedly to the pursuit of knowledge for its own sake. These are the sterling qualities which constitute ingredients of a real man and enable him to stand head and shoulder above his fellow men. This was what Dalton himself said in later life:

"If I have succeeded better than many who surround me, it has been chiefly—I may say almost solely—from unwearied assiduity; this not so much from any superior genius that one man possesses over another but more from attention to study and perseverance in the objects before them that some men rise to a great eminence than others."

If genius may be defined as 'an infinite capacity for taking pains', then we may call Dalton a genius.

Dalton was born in 1766 in a thatched cottage of a humble family in the village of Eaglesfield in Cumberland. His father Joseph Dalton was a handloom weaver. Dalton thus described his own early years—"The writer of this was born at Eaglesfield, near Cockermouth in Cumberland. Attended the village school there and in the neighbourhood till 11 years of age, at which period he had gone through a course of mensuration, surveying, navigation, etc."

Between 11 and 12 years of age he opened a school in his father's barn for children of both sexes. At 15 he left his native village and walked about 40 miles to join his brother's school at Kendal where he worked as a teacher with his brother for 12 years. During this period he was also engaged in self-improvement and self-education. By hard and unremitting toil he became a good mathematician and acquainted himself with the work of Newton, as well as those of other English and Continental men of science. In 1793 he came to Manchester as a teacher in Manchester Academy (Manchester New College) and earned £80/- only for a session of 9 months. For six years he served as a tutor in this college teaching mathematics and natural philosophy. He then resigned and devoted himself to scientific enquiry

earning his bread by private tuition which provided him with sufficient means to meet his small needs. He continued with this mode of life till his death in 1844. At the same time he was always meditating and experimenting upon the composition of air and constitution of gases, which led to his discovery of the Law of Thermal Expansion of Gases with which his own name is associated with that of Gay Lussac. He also studied the absorption of gases in liquids and as a result thereof formulated the Law of Partial Pressure, also associated with the name of Henry. To him we owe further the discovery that gases are heated by compression and cooled by expansion against pressure.

In 1800, he became the Secretary of the Manchester Literary and Philosophical Society, of which he was elected President in 1817 and continued as such until his death. He had his laboratory in the house of the Society, and his diary and manuscripts still remain in their possession. The Society also published most of his scientific papers. Dalton's mind was philosophically bent, and, influenced by Newton's views, he believed in the existence of atoms long before his formulation of the Law of Combination in Multiple Proportions. It may be stated that his atomic conception of matter guided him in the discovery of this law and not, as usually believed, that the latter led him to the discovery of the Atomic Theory. The Law of Multiple Proportions resulted from his examination of the composition of marsh gas and ethylene, as well as of oxides of nitrogen. For, he found that when two substances combine they do so in simple multiples of whole numbers. He showed that atomic conception of matter could satisfactorily account for all the physical properties of gases studied by him, as well as the Law of Constant Proportion formulated by Proust and that of Multiple Proportion by him. He thus adduced experimental evidences for the first time in support of the Atomic Theory of Matter. At the end of his great paper "On the Absorption of Gases by Water and other Liquids" which was read before the Manchester Literary and Philosophical Society, Dalton gave an account of his work laying the foundation of the Atomic Theory.

The fundamental assumptions of Dalton's Atomic Theory can be stated as follows:

- (1) Every elemental substance is made up of minute indivisible homogeneous particles called atoms.
- (2) Each kind of atom possesses a definite and constant weight.
- (3) Chemical combination takes place between atoms.

Since its formulation Dalton's theory has been subjected to repeated assaults and as a result of recent advances in physical science his first two assumptions have lost their strict validity. Nevertheless Dalton's atoms still constitute the building stones of our chemical science and still serve to represent the composition of, and the reaction between, chemical substances.

It may be said that through the formulation of Atomic Theory Dalton provided the final and absolute proof regarding the conservation of matter, and that his service to chemistry is on a par with that of Newton to astronomy. The first printed account of his Atomic Theory was published by Dalton himself in 1808 in Part I of his "New System of Chemical Philosophy". He constructed a system of notation for graphically representing atoms and the composition of chemical compounds; and he also determined the values for relative atomic weights of different elements. But these never came into general use in view of better and more rational symbols subsequently introduced by Berzelius, who also supplied more exact values for the relative atomic weights.

From the beginning of his career Dalton was very fond of making meteorological observations, which he made into a great hobby and continued till the very evening before his death. Dalton died in his bed after retiring for the night at the end of his day's work. He made altogether no less than 200,000 meteorological observations.

Dalton was invited to deliver a series of lectures at the Royal Institution in London in 1803-4 when he publicly announced for the first time the discovery of the Atomic Theory and the Law of Combination in Multiple Proportions. By his unceremonious and unassuming behaviour, and notably by his use of the country dialect, he created a sensation in the polished, genteel and fashionable society of London. On his side, he, too, was shocked by the bustle and din of the great metropolitan city and wrote "London is a most surprising place, worth one's while to see once, but the most disagreeable place on earth for one of a contemplative turn to reside in." Dalton was invited to deliver lectures also at Glasgow, Edinburgh and other places, and received scientific honours from almost all parts of the world. In 1816 he was made an Associate of the French Academy—the highest dignity awarded to any foreigner. In 1822 he was elected a Fellow of the Royal Society and in 1826 the first Royal Medal of the Society was awarded to him.

With the simplest possible apparatus that can ever be imagined Dalton achieved results of far

reaching consequence. A penny ink-bottle closed by a cork with a tube fixed in it, a couple of ordinary apothecary's scale and one or two thermometers serve as typical examples of the apparatus in his stock.

His habits were very simple, methodical and uniform. He practically spent every day all his time in the laboratory except on Thursday afternoon, when he would play a game of bowls with his friends and afterwards refresh himself with a pipe of tobacco. He was a very early riser and would repair immediately to his laboratory. A lady living opposite to Dalton's laboratory in Manchester once remarked that she could know her time almost exactly to a minute from seeing the Doctor open his window for reading his thermometer.* In fact, he spent all his waking hours for the pursuit of science. Dalton lived a single life and used to say, when questioned by friends, that he had no time to marry. His holidays were few and were mostly spent in the lake districts of England ascending mountains, measuring their heights by his self-made barometer, determining dewpoint and collecting samples of air at different altitudes for analysis in his laboratory at Manchester.

Dalton was colour-blind and could not distinguish between red and green; a phenomenon discovered for the first time by him in 1794 and that in himself. It, therefore, goes by the name of Daltonism.

Dalton was a rather poor speaker. When as President of the Manchester Literary and Philosophical Society he had to make some comments on any paper read before the Society, it is reported that he would have satisfied himself simply by saying "This paper will no doubt be found interesting by those who take an interest in it."

With utter contempt for wealth Dalton lived a life of self-imposed poverty. Late in life he was relieved from the drudgery of his tuition and the worry of earning his bread by a Royal Grant of £150/-, afterwards raised to £300/- per annum.

Dalton was held in great esteem and love by his countrymen, specially by the people of Manchester who already raised in his life-time a sum of £2,000/- for his statue. After his death, on the day of his funeral many mills and shops of the city were closed. An important street of the city was named after him. Dalton Chemical Scholarship was established in 1866 in Owens College, Manchester, to perpetuate his memory. This was the first scholarship in England awarded for original research.

P. Ray

* A similar story is told of Immanuel Kant, the German philosopher, who was also a bachelor like Dalton.

THE GYROSCOPE AND ITS APPLICATION

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INTRODUCTION

THE "Gyroscope", or "Gyrostatis" as some call it, has been for a long time one of the mysterious scientific toys apparently disobeying the laws of mechanics. The gyroscope is, however, only a glorified scientific name for a spinning top. Such a top has a unique tendency for retaining its orientation in space and resents, while spinning, any change of orientation when a force is applied to do so. The size of the gyroscope varies from a few ounces to a few tons according to its use and application.

As early as 1743, Mr Serson, an ingenious mechanic took a hint from the axial rigidity of a spinning top in space and developed an instrument which was in fact a gyroscope. He took a polished metal disc provided with a spindle and set it rotating. With the help of this elementary gyroscope he wanted to establish an artificial horizon at sea and undertook experiments to that end, which he could not unfortunately complete owing to a disaster. After him, George Graham studied this instrument and tried many experiments to establish its properties. About 25 years later Admiral Fleurius constructed a gyroscope to establish the artificial horizon at sea.* His gyroscope had a rotor weighing about 175 grammes with a speed of rotation of 4800 r.p.m. and was driven by means of a jet of compressed air. Due to mechanical defects its speed did not go up very high, and the instrument did not prove to be of much use. In 1810, Bohnenberger successfully constructed a gyroscope of elementary type with a spheroid rotor.

In 1836, Edward Lang read a paper before the Royal Scottish Society of Arts, suggesting an experiment with an instrument similar to a gyroscope, by which rotation of the earth could be directly proved. After 16 years, in 1852, the French physicist Leon Foucault quite independently took up this experiment and called the instrument a "Gyroscope", a name which has persisted since then. But Foucault's experiment did not attract widespread attention, till it was repeated by the British Association in Liverpool meetings later. The gyroscope

* Due to rolling and pitching of vessel, and in fog, it is very difficult to make any observation, with reference to natural horizon. For this an artificial horizon which will maintain horizontal position in spite of rolling and pitching is needed for correct observation at sea. For instance, for sextant observation of altitude, a steady horizon may be procured by attaching a mirror to the support of the gyroscope and setting it once for all by means of a spirit level.

was utilized by Prof. Piazzzi Smyth in 1856 to stabilize astronomical telescopes at sea. Attempt was also made to couple a gyroscope to the equatorial mount of a telescope so that the latter remained fixed in space.

Until the end of the last century, the gyroscope was however an instrument of demonstration only, but since then its practical applications have increased at such leaps and bounds that gyroscope is today one of the most powerful appliances at the disposal of seamen, aviators and railway men during peace and war.

PHYSICAL PRINCIPLE OF GYROSCOPE

Before discussing the various modern applications of gyroscope, we shall do well to examine briefly the physical principles involved in its working. All rotating bodies show gyroscopic phenomenon, but its effect is observable only when the angular momentum or the moment of momentum is large. As is well known from simple principles of dynamics, the angular momentum of a rotating body depends upon three factors: (1) the massiveness of the rotating body, (2) the speed of rotation and (3) the square of the distance at which the mass is effectively situated from the axis of rotation.

These three physical factors clearly suggest that to get a pronounced gyroscopic action, the rotor must be of a heavy material, the mass should be disposed as far away from the axis of rotation as practicable, and at the same time, the speed of rotation should be appreciably high. The rotor must be well balanced and its mounting should be free to permit smooth rotation at high speed.

A simple form of gyroscope is represented diagrammatically in fig. 1. "A" is a heavy rotor in the form of a fly-wheel free to rotate about its spinning axis B-B', which is called the axle of the rotor. It is mounted on the ring which turns freely about the vertical axis V-V', which is in the plane of the wheel intersecting the spinning axis at right angle. The rotor with its new fittings is again mounted on another ring in such a way that it can rotate about the horizontal axis H-H' which intersects the vertical axis at right angle. The spinning axis and the vertical axis are always at right angles to each other; so also the vertical axis and the horizontal. But the spinning axis may make any angle with the horizontal axis i.e., it may be in any direction horizontally and, therefore, in any direction in space.

Two important physical properties of its motion guide the application of the gyroscopic phenomenon. The first property is the rigidity of the direction of its axis of rotation and plane of rotation relative to the space; this enables the gyroscope to be carried about on its support in any manner without changing the direction of its axis of rotation. The second property is what is known as "precession". When a pressure is applied against the supporting rings of the gyroscope with its rotor spinning, a peculiar phenomenon is observed. Suppose the pressure be applied so as to move the gyroscope about its horizontal axis. The supporting ring, instead of moving

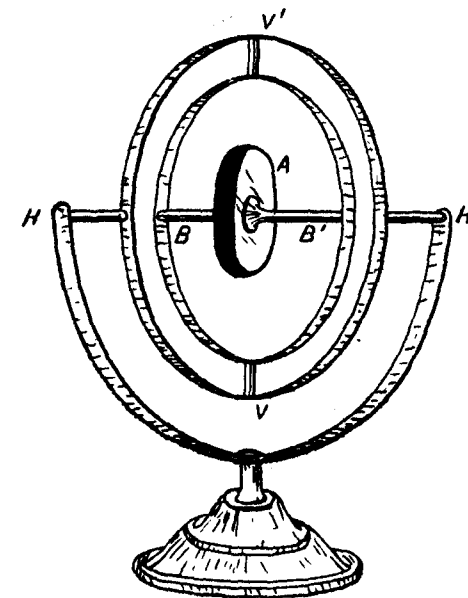


FIG. 1. Elementary Gyroscope.

in the direction of the applied pressure, will resist this pressure and move about the vertical axis of the gyroscope at right angles to the applied pressure. Similarly, if a pressure be applied about the vertical axis of the gyroscope it will resist this pressure in this direction and will move about the horizontal axis. Practical application of a gyroscope requires restraint or control of its freedom according to the need of the purposes.

APPLICATIONS OF GYROSCOPE AT SEA.

(1) *Gyro-Compass*.—In 1883 and 1884, at the meetings of the British Association at Southport and Montreal, Lord Kelvin suggested a method of constructing gyrostatic compass. Now-a-days almost all the big ships are equipped with a gyro-compass. Its advantage is well appreciated by the naval authorities all over the world. The presence of great masses of iron and steel seriously impairs the accuracy of the magnetic compass, and as such magnetic compass is not dependable where high degree of accuracy is

required for the gun-fire control. Both the properties of the gyroscope, viz., its rigidity in space and the precessional characteristics, have been utilized in the gyro-compass. The actual instrument on a big liner consists of a wheel weighing 50 lbs. and driven by an electrical motor at 5,000 revolution per minute. It is supported on horizontal bearings inside a vertical ring. This ring is in turn hung from the centre of the compass-card. The North-South axis of the compass-card is first set up in true geographical North-South axis of the earth and the gyroscope is allowed to run. Then the compass will show always the true north.

(2) *Gyro-stabilizer*.—In order to increase comfort and pleasure in ocean travel and to reduce stresses and strains imposed on a ship's frame-work during rolling in a heavy sea, different instruments have been devised to stabilize the pitching and rolling of the ship. In 1907, gyroscope was utilized by Schlick in such a device. His method proved successful. The gyroscopic stabilizer designed and developed by E. A. Sperry, however, appears to have achieved the greatest measure of success in this direction. This stabilizer is a compact unit generally located below the deck and on the centre line of the ship. It consists essentially of a rotor of special steel weighing from a few pounds to several hundreds of pounds and having a speed of rotation of about 18,000 r.p.m. It is supported in a casing which is on the horizontal 'Thwartship' (i.e., across the ship) gudgeon bearing so that the rotor axle, when central, is vertical with the ship on even keel or at perfect rest. The only apparent movement of the stabilizer other than the spinning is a precession fore and aft the 'Thwartship' bearing. In doing so the gyro-stabilizer exerts a proper force against the action of the waves as they tend to roll the ship. The gyro-stabilizer quenches the force of each wave and never allows the ship to roll more than 3 to 4 degrees. The advantage of a non-rolling ship consists not only in the physical comforts of the passengers but also in the use of less power needed to propel the ship. Sister instrument of the gyro-stabilizer is the roll and pitch recorder which records the amplitude of roll and pitch of a ship.

(3) *Gyroscope for Steering Torpedoes*.—L. Obry of Trieste, sometimes an officer of Austrian Navy, was the first man to utilize a gyroscope to steer a torpedo. The gyroscopic steering of torpedoes has now found universal use. The principal member of the torpedo's mechanical crew is a gyroscope. Its rotor is a bronze fly-wheel of the size of a tea-cup saucer which is set whirling at 18,000 revolutions a minute by means of a jet of compressed air. It is connected to a small engine which operates the directional rudder. The gyro-pilot, through the engine and the rudder, corrects instantly any deviation

of the torpedo from its aimed course. The human pilot may err but the gyro-pilot never does.

SPEERY'S GYROSCOPIC RAIL RECORDER

E. A. Sperry, pioneer of gyroscopic instruments has utilized the services of gyroscope in studying the condition of rail-road. This instrument is the only means of obtaining a stabilized vertical within a running train, uninfluenced by the disturbing effects of the movements of the train. The gyroscope, jointly with the vertical seeking tendency of a pendulum, provides a means for construction of this apparatus with which to obtain exact replica of the behaviour of the track as the heavy train passes over it. In actual practice, a pendulum is connected to a gyroscope which remains uninfluenced by the train's movement. The pendulum seeks to remain vertical and is able to record all the defects in the rail-road. With the help of this apparatus almost all the conditions of the rail bed can be determined. It is capable of recording accurately the difference of elevation of the two rails both on curve and straight sections of the railway and also the location of rail spread and rail depression. Moreover, it can record the depth of low rail joints and all the inequalities in the railroad bed at the time when the rails are actually subjected to impact of the train passing over it at normal speed.

GYROSCOPE AND MONO-RAILS

The use of gyroscope in controlling a railway car was first introduced by Louis Brennan, when he exhibited his mono-rail car model. The car was driven over a single rail and its balance was controlled by a gyroscope. In December 1909, Mr Brennan exhibited a much larger mono-rail car measuring $40 \times 13 \times 10$ feet, weighing 22 tons and carrying 40 passengers. The balance of the car was preserved by means of two gyroscopes weighing three quarters of a ton each and spinning in vacuum at the rate of 3,000 r.p.m. Both the car and the gyroscopes were run by gasoline motor and the car preserved the balance under the severest tests such as the sudden shifting of passengers from one side to the other. Precessional action due to gyroscopic motion which would have tended to over-turn the car slowly was obviated by frictional devices.

After Brennan Scherl, a German technician of Dresden, exhibited his car controlled by gyroscopes run by electric motors. The rotors revolved at 8,000 r.p.m., and the weight of the rotors was 6 per cent. to 7 per cent. of the total weight of the vehicle. Better and improved control devices have now practically eliminated accidents.

Gradually gyroscopic controlled mono-rails are being improved upon, and in future it may demand a proper place in railway organizations of the world.

GYROSCOPE IN AVIATION

It is in modern aviation that gyroscope has played by far the greatest part. Blind flying, long distance flying and flying in odd days would have been impossible, but for the gyroscope. In bad weather, in the midst of fog and cloud, gyroscope is the only hope before the pilot. In long distance flight when the pilot wants a relieving partner, he has his gyro-pilot to take the full control of the plane from him.

A man can at any time feel his attitude in space through three senses, namely, (1) his eyes, (2) his ears and (3) his deep muscular and nerve sense *i.e.*, when the pilot goes up to higher altitude he feels a peculiar nerve sensation due to low atmospheric pressure and his tilt in space. In clear days an aeroplane pilot can use his eyes to keep the aeroplane in normal flight with respect to natural horizon. But what happens in the dark night in foggy and sultry day when the visibility is extremely poor, when all the senses of the pilot are of no avail to determine the attitude of his flight with respect to horizon, and when his sense of balance is confused and his spatial orientation inaccurate? Just to relieve the pilot from his confusion and to make his position secure, the modern airplane is equipped with three blind flying instruments. These are:

(i) *Gyro-horizon or Artificial horizon*.—The chief member of these groups of instruments is the 'Gyro-horizon' better known as artificial horizon. This instrument gives the pilot a real direct reading indication of his flight attitude for bank, climb or glide. It is just a substitute for the natural horizon when it is obscured.

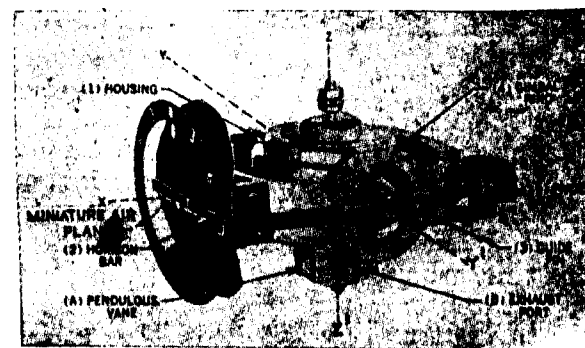


FIG. 2. Gyro-Horizon.

Figure 2 represents a Sperry's Gyro-horizon taken out of its case. The gyro-element in this is a heavy brass rotor (about 6 oz.) with 'bucket' depression round it. The rotor is capable of rotating at the speed of 12,000 r.p.m. approximately about its axis $Z-Z'$, *i.e.*, about its steel shaft. The rotor is mounted inside its housing and driven by the air

pressure (a vacuum of 3 to 4 inches of mercury is maintained in the case which causes the air to rush in the housing through an air filter and strikes the buckets of the rotor, making the later spin). The rotor with its housing is mounted in a gimbal ring (4) and is free to rotate about the "a thwartship" (*i.e.*, pitching) axis $Y-Y'$. The whole mechanism is mounted inside the case of instrument and pivoted about the longitudinal axis $X-X'$; (2) is the pointer bar carried on an arm pivoted at the rear of the gimbal ring and is controlled by the gyro through a guide pin. There is a pendulum arrangement suspended from underside of the gyro-housing. This arrangement consists of four exhaust ports and four pendulous vanes controlling the air coming out of these exhausts, the reaction of which keeps the gyro axis upright in straight flight.

When the aeroplane noses up, the plane of the gyro remains horizontal and the pointer bar goes down. Thus the pilot observes the miniature airplane of reference of the instrument above the pointer. Reverse is the case when the aeroplane glides or noses down. When the airplane banks or tilts about its horizontal axis, the gyro, by its natural tendency, remains fixed in space, but the case of the instrument with its miniature reference airplane tilts with it. Thus from the behaviour of the miniature airplane, the pilot knows his flying attitude in space, without any reference to his senses.

(ii) *Gyro-directional*.—The second member of the blind flying group of instruments is the directional gyro. Due to the rolling, pitching and turning of an aeroplane, the magnetic compass swings and takes time to come to rest. The psychology of the pilot is to turn his machine and cause more swings on the compass in order to follow the magnetic compass in its state of swing. Thus the magnetic compass alone is insufficient for steering the plane accurately, hence the necessity of coupling it with a directional gyro.

Figure 3 shows a Sperry's Directional Gyro taken out of case. The directional gyro is a horizontal axis free gyro provided with an azimuth card and setting devices. The rotor differs slightly from that of gyro-horizon in its design and is capable of spinning about its horizontal axis $H-H'$ at about 10,000 r.p.m. driven in the same principle as the gyro-horizon. The rotor is mounted in a gimbal ring which is free to

turn about the vertical axis $V-V'$; (4) is a circular card calibrated in the same way as that of a compass card, attached to the vertical ring. The card can be read through an opening of the case which is closed by a glass window and thus it gives the bearing of the instrument. Due to the rigidity of a gyro, the whole system remains fixed in azimuth, and the airplane moves around it. There is a synchronizer gear and a pinion arrangement by which the instrument can be set and reset by stopping operation and again can be made free to operate according to the will of the pilot. The rotor is kept upright with the help of two parallel air jets which drive the rotor. The instrument is set and reset from time to time with the magnetic compass.

(iii) *Turn and Bank*.—The third member or the junior partner of the blind flying group is the turn and bank indicator. It consists of an air driven gyroscope mounted in a single gimbal ring which carries the pointer and is free to turn about the fore and aft axis. Its movement is restrained by a spring adjustable for calibration, and for the prevention of violent movements, there are two dash pots. Any turning of the plane will cause the gyro to precess, and the pointer will then indicate the right turning and rate of turning of the plane. The bank indicator which indicates the lateral attitude of the flight skid, side slip etc., is a curved glass tube as shown in the Fig. 4. The tube contains a liquid (non-freezing type) and a black ball, and is sealed. On normal straight flight the ball remains between the two radium painted line; the back of the tube is also painted with a radium salt so as to make it visible in the dark. In fact it is a kind of spirit level.

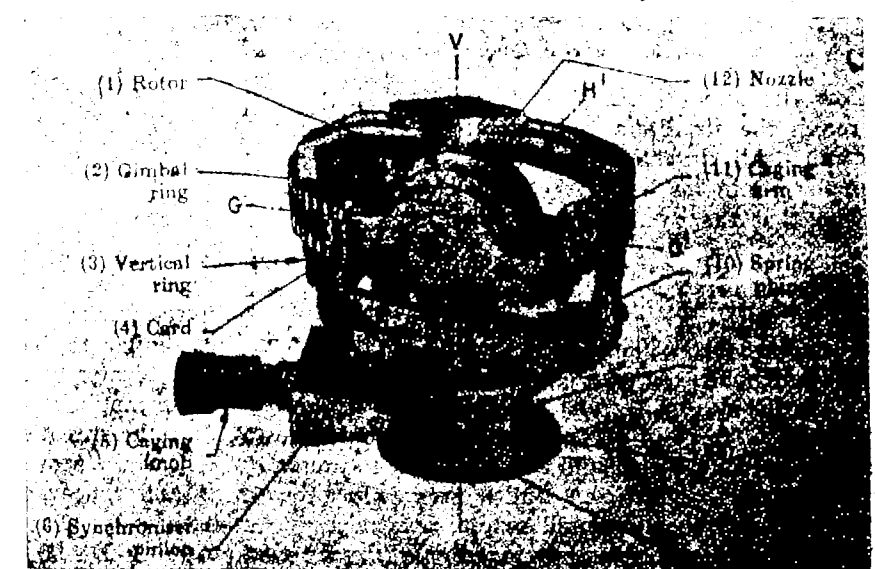


FIG. 3. Gyro-Directional.

All these blind flying instruments have their respective operating limits. These are parallelly con-

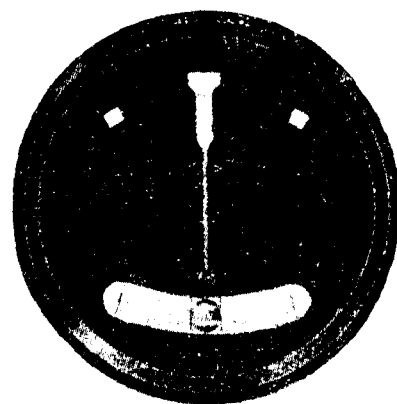


FIG. 4. Turn and Bank.

nected to a vacuum valve system connected to a vacuum pump and to the system of Venturi tubes as shown in the Fig. 5, and are installed on board the ship. Pressure inside these instruments is controlled and kept always at 3 to 4 inches of mercury

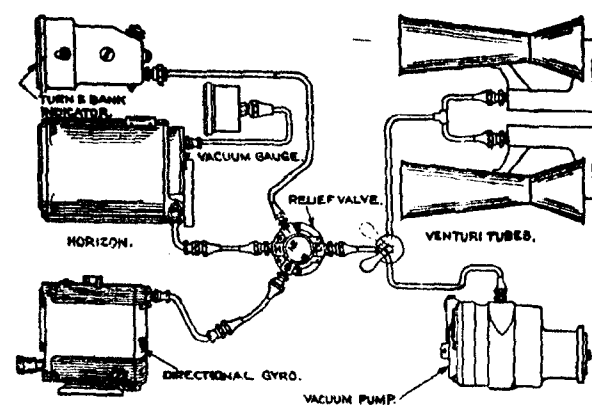


FIG. 5. General Connection.

below the atmospheric pressure so that air gets in through the air filters and forces the gyro elements to run. All these instruments must be allowed to run for 5 minutes before the plane takes off so as to assure that the gyros have attained their operating condition.

GYRO-PILOT IN AID OF LONG DISTANCE FLIGHT

The idea of stabilizing an aeroplane with the help of a gyroscope is not new. At first, inventors seemed to have the idea of keeping an airplane on its course by the sheer force of a gyroscope which would grasp the airplane in a giant hand and compel it to preserve an undeviating direction. But it was soon proved mathematically that it would require a heavier gyroscope than the aeroplane would carry. In 1914 the Sperry aeroplane stabilizer won the 'grand prix' in Paris for safety in flight. This apparatus consisted

of four gyroscopes controlling the aileron and elevator. After this, the gyropilot proved an unique instrument for mechanical control and stabilization of an aeroplane. It has been observed that a human pilot soon becomes tired and fatigued and loses his course if he is to keep to his routine task of operating the flying control and maintain its course and attitude in long flight. "Gyropilot has solved this problem as it takes the control from the human pilot and keeps the course of machine all right during long flight". Fig. 6 is a gyropilot or complete mechanical pilot.

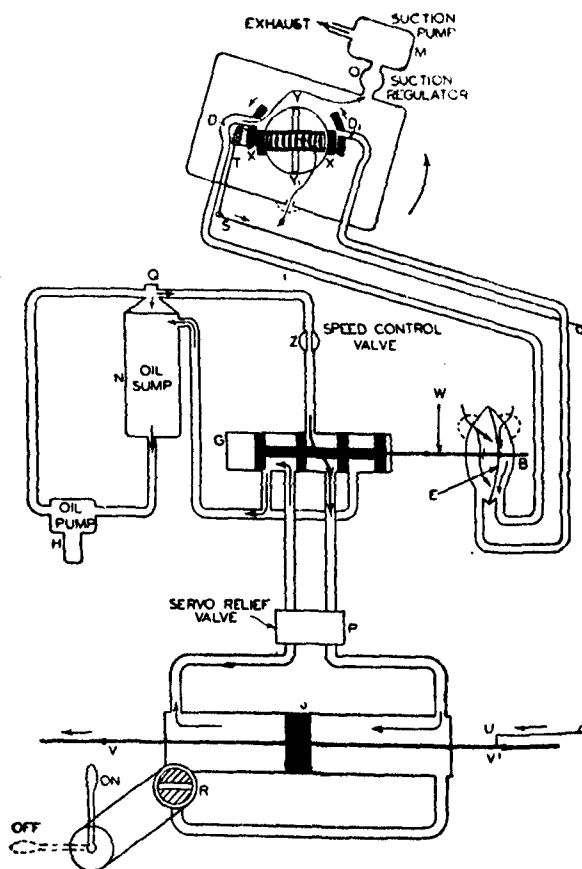


FIG. 6. Gyro-Pilot.

The "brain" of the gyropilot consists of two gyros, one similar to gyro-horizon and another to gyro-directional. The main part of the brain which is similar to gyro-horizon controls the ailerons and the elevator of the plane, while the other part of the brain similar to gyro-directional controls the rudder, i.e., the directional reference.

The "nerve" system consisting of the air relay B and the balanced oil valve, E is a diaphragm, both side of which is connected to the exhaust opening D—D₁ of the air pick off of X—X₁.

The "muscular" system of the instrument consists of three hydraulic servo-cylinders, one of

which is shown in the Fig. 6. Servo oil enters from one end of the cylinder and moves the pistons thereby exhausting the equal amount of oil from other side and takes it back to the oil sump. The piston rod V—V' is connected to one set of the control cables of the aeroplane. When the plane is piloted by a human pilot, the handle is in "off" position. The valve R opens, the oil flows through the by-pass tube and controls can be moved freely by hands.

By means of a vacuum pump the rotors of the gyros are allowed to run. O is a suction regulator which regulates the air suction inside the gyrobox and allows the rotors to run at a pressure of 4 inches of mercury below the atmosphere. The oil sump N carries the reserve servo oil; Q is a valve which regulates the oil pressure from the pump and permits it to circulate through the sump whenever the balanced oil valve cuts off the circulation to servo unit. P is one of the servo relief valves by means of which human pilot can take the charge of the aeroplane when the system is in operation; Z is a speed regulator valve which regulates the oil speed to servo unit and thus controls the speed of gyro-pilot's control operations. A cable is connected to the servo piston rod at U running to a follow-up pulley S on the gyro box which controls the gear and is ultimately connected to the air pick off, X—X₁. In normal level flight, the suction pump, draws air equally through the exhaust parts D—D₁ at the gyro. This equalizes the pressure on both sides of the diaphragm E. The arrow mark of the air relay shows how air is drawn in. When the oil valve G is in central position, the servo piston movement away from the neutral is stopped. Whenever there is a variation in the attitude of the flight the relative movement between the boxes and the gyros (gyro remains fixed in space and the gyro boxes move) make unequal suction through D—D₁, thus admitting unequal quantities of air through the relay valve. In this way unequal pressure is maintained on either side of the diaphragm E causing it to yield on one side and operate the spindle W attached to the diaphragm. The spindle in its turn opens and closes the ports of the oil pressure system G—admitting oil to either side of the piston of the servo unit. The servo-unit is connected directly to main control cables of the plane (not shown in the diagram) which prevents the deviation of the plane from the desired direction. We, therefore, see that the main energy is supplied not by the gyros but by the servo oil pump driven by the engine. The relative movement of the gyroscopes and their container controls the distribution of oil from high pressure system to the control actuating mechanism.

Flight ray.—The most recent use of gyroscope in aviation is Sperry's newly invented "Flight-Ray".

In this instrument, the combined action of gyro-horizon, direction-gyro, turn and bank and altimeter is focussed on the luminous screen of a cathode ray tube. With a single observation, the pilot can read the operations of all the members of the instruments. Thus by combining gyros with a cathode ray tube the task of the pilot has been considerably simplified by the inventors and engineers. This flight ray has undergone severe tests at Indianapolis airport and many blind landings depending solely on the indications of the flight ray have been successfully made during recent years.

This war has seen many new uses of the gyroscope. One of the most interesting use is gyro-control gun-turret of a tank. This type of tanks were first used by the Russians in the eastern front. The gun-turret is coupled with a gyroscope, the turret-gun of the tank is first aimed at a particular direction, and the control of the gun is maintained by the gyroscope. The gyroscope, by its properties, never allows the gun to change its direction, and the tanks go on as they like but the guns go on firing their shells in the aimed direction. The advantage is that the tanks, by moving in zigzag course, viciates the aim of the enemy, but its own aim at the enemies is not lost.

Another achievement of the gyroscope is the gyro-control unit of the "flying bomb". Construction of the flying bomb still remain a matter of controversy. But the out-line of this can be drawn as following. Flying bomb carries its explosives inside a chamber in its main fuselage. It is propelled by jet propulsion method of rocket system. The fuel used is petrol. The control unit with which the direction of the bomb is kept fixed, is a gyro-pilot similar to one which has been explained before. According to the distance of the target the calculated quantity of fuel is charged. On reaching the target the fuel is exhausted and a lever operates the gyro-pilot which forces the bomb to dive at an angle of 60° to the horizon and strikes the target. Explosives burst in a fraction of a second after its striking.

The use of gyroscope is more and more being appreciated by inventors, amateurs and engineers and they are using it as a means of mechanical stabilizer in space. It has so far proved its worth quite satisfactorily. In future, it may create more wonders in the field of inventions.

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PLANT BREEDING IN INDIA

DR C. D. DARLINGTON, F.R.S., has an interesting article on "Plant Breeding in India" in a recent issue of *Discovery*, wherein he has analyzed some of the causes of the failures of agriculture in India and offered suggestions of improvement through plant breeding. He referred to the systematic and unchecked deterioration in the productivity of Indian soil during the last 40 or 50 years, in which time other countries, notably U. S. S. R., U. S. A., Britain and Sweden, were busy improving their old and traditional methods of cultivation and devising fresh applications of science to the progress of agriculture. She is no longer reckoned with as the greatest storehouse of plant wealth, which she used to be in the old days.

Since then her population has increased four fold; but her land productivity has miserably failed to keep pace with this rate. During the last 50 years she could not increase her acreage under wheat by more than 50 per cent., nor could she arrest the steady decline in the average yield per acre, which has fallen from 0.38 to 0.30 ton. In course of the last 30 years, her area under oil seeds, fruits and vegetables and other vitamin crops has gone down from 5.7 to 4.8 million acres with the consequence that fruits which once grew in abundance in India have now to be imported from abroad. The recent famine which has overtaken parts of India and whose menace has not yet been lifted altogether from the country has its origin, in the opinion of Dr Darlington, in the deterioration of the land productivity and the absence of efforts on the part of the powers that be to harness science to the promotion of agriculture.

Dr Darlington traced the development of plant breeding as a science and alluded to the progress made in other countries in this respect. First steps towards plant breeding were taken some 200 years ago when private firms made their appearance in Europe with a view to raising seeds for the cultivator. Before that the farmer used to breed his own seed and did not usually make any attempt to separate the various types of the same grain and had often sown mixtures of different grains, such as wheat and rye. The advent of such private firms made possible the selection of better seeds of one particular colour, quality and time of ripening and was soon responsible for the production of improved grains, pulses and vegetables in general. Thanks to the pioneering work of Keen and Laxton, modern special straw berries were grown in England, while Vilmorin in France 'created the modern sugar-beet, raising its content of sugar from 6 to 16 per cent'.

The success of the new enterprise soon brought into existence numerous other private firms. The

gradual expansion of seed trade, all in private hands, led in course of time to unfair competition, loss of quality and other complications. Next important step was, therefore, taken when modern State Institutions responsible for the control of seed trade were created. The research centres now existing in Moscow, Washington, London and Delhi carry on scientific work relating to the control and breeding of new plants.

Dr Darlington referred to some modern practices in hybridization. Methods involving the use of drugs and X-rays are now available by which one can change the very heredity of plants and make them larger or smaller, annual or perennial. Species hitherto uncrossable have been crossed by chemical means and the sterile hybrids made fertile.

The production of quinine in India is not sufficient for millions of Indians suffering from malaria. It is not enough to say that the *cinchona* plant does not flourish in every part of India. By experiments on plant breeding 'new types must be found and new hybrids raised'. In this connection Dr Darlington mentions how in Russia, Sweden and Canada great areas have been brought under cultivation by making new plants to suit them. Thus new frost-resistant apples, hardy rye-wheat hybrids, drought resistant or sand-binding grasses and new forest trees have been successfully produced. In 1933, the United States introduced a new hybrid maize seed for cultivation, and by 1939 some 20 million acres came under hybrid maize all over U. S. A. The great thoroughness with which work on plant breeding is being carried on in U. S. S. R. is reflected from the fact that the State Agricultural Organization has a staff of over 20,000 workers to control plant breeding.

Recent work on plant breeding at the Indian research stations has clearly indicated the possibility of improving crops, such as wheat, cotton and sugarcane, already grown in this country. Despite these works, India with her rich and varied storehouse of tropical plants largely unknown has hardly made a beginning and has not certainly touched the fringe of her vast problem of plant breeding.

Dr Darlington has the following plan to offer in the direction of plant breeding if full utilization of India's rich treasure house of plants is to be effected along modern scientific lines:

(1) Collections of the main economic plants suitable for India should be assembled and tested. These should not be confined merely to the species of the systematic botanists but should also include the local varieties of the farmer.

(2) Botanic gardens should be properly organized and developed in order that they may function as places of acclimatization of new species and new varieties of useful

living plants, oil palms, citrus fruits, bananas, fibre plants and timber trees which can be sorted out by trial and experiment.

(3) New stations should be established for dealing with special crops which can be speedily turned to advantage either for home food production or for export.

(4) Elaborate plans to raise new plants by hybridization should be developed; great areas of jungle and desert are lying fallow for want of a crop suitable for these regions, and accordingly new hybrids suited to such areas will have to be created.

(5) The plant breeders should work in liaison with industrial workers, as a knowledge of the plant and its cultivation alone is not enough.

(6) The plant breeding research stations should maintain close contact with the cultivator who should be made to realize the significance of recent results of scientific research. New plants, whenever developed, should be brought to the cultivator and its success demonstrated to him.

(7) The Government must take the responsibility of distributing seed of improved varieties to the peasant, as otherwise the work in the research station will be simply wasted.

(8) Greater facilities for transport and communication should be created, and conditions of agricultural marketing should be improved. "A Government", as Dr Darlington has most aptly put, "which is paying one lot of people not to raise pigs or potatoes cannot be expected to pay another lot of people to breed bigger and better pigs and potatoes."

Plant breeding has a great future in India. Application of scientific methods has already made possible the cultivation of better sugarcane, tea, coffee and a number of other crops, and henceforward the policy of scientific plant breeding should be pursued more vigorously than has been hitherto possible. Broad vision and working according to long-term planning can alone solve India's problem of feeding her population on a reasonable basis of health and nutrition and remove the menace of recurring famines to which she has been condemned during the last one hundred years or two.

S. N. Sen.

OBITUARY: PROFESSOR BIDHUBHUSAN RAY

WE deeply regret to record the death of Dr Bidhubhusan Ray, Khaira Professor of Physics of the University College of Science and Technology, Calcutta, who passed away on July 29 at his Calcutta residence. He had a severe attack of Coronary Thrombosis in February, 1940, while working in his Laboratory, from which he never fully recovered. He was only 50 years of age at the time of his death. Professor Ray was a physicist of international fame, and Indian Science has suffered by his death an irreparable loss.

Born in July, 1894 in a respectable family in the District of Faridpur, Bengal, Prof. Ray had to struggle hard with poverty for his early education. Being endowed with great talents, and possessed of industrial habits he obtained many scholarships and distinctions during his academic career at the Ravenshaw College, Cuttack and the Presidency College, Calcutta. He took the M.Sc. degree of the Calcutta University in 1918, shortly after which he was nominated for a post in the Bengal Civil Service as being one of the most meritorious students of his year. The late Sir Asutosh, however, encouraged him in his scholarly ambition, and his personal aptitude for research led him to reject the offer in spite of the financial hardship which such a step entailed for him. His early researches were carried on under Prof. C. V. Raman. He obtained his Doctorate degree in Science in 1922 by a thesis on scattering of light which brought him great reputation. It is well known that when light passes through a medium containing small particles in suspension, it decreases in intensity due to scattering

by the medium and the nature of the transmitted light depends on the suspended particles. As the particles grow in size, the suspension refuses to



PROF. B. B. RAY

transmit, first the shorter waves, and finally, the whole visible spectrum. This is precisely what is to be expected from the theory. But in 1914, Keen and Porter discovered the remarkable fact that

after a certain stage the suspension again transmits light, the colour being at first indigo, then blue, blue green, greenish yellow and finally again white. This remarkable reappearance of the transmitted light could not be explained by any hypothesis, and naturally doubts were felt regarding the actual presence of the effect. By making elaborate and accurate experiments Prof. Ray, in collaboration with Prof. Raman, not only demonstrated the existence of this effect but also succeeded in giving a satisfactory explanation of the phenomenon by considering the interference of the direct light with the light scattered by suspended particles. His findings have an important bearing on the colouring of glasses by suspended metal particles and the axial colours exhibited by clouds.

Prof. Ray joined the University of Calcutta as a Lecturer in Physics in 1921. In 1923, he was awarded the Premchand Roychand Scholarship and also the Palit Scholarship for scientific research abroad. While in Europe he worked in the laboratories of Prof. Manne Siegbahn at Upsala in Sweden and of Prof. Niels Bohr in Copenhagen. Prof. Ray's investigations in these laboratories were of great importance and contributed significantly to a revision of a theory regarding the origin of X-ray spectra. It was previously held that X-ray absorption spectra were due to atoms alone and were not changed by chemical combination. By means of a special type of spectrograph, however, made at Prof. Siegbahn's Laboratory, Dr Ray was able to establish definitely that the spectra are actually modified by chemical combination. After his return to India in 1926, he devoted himself entirely to the investigation of how X-rays were modified when emitted by the atom. By passing monochromatic X-rays through carbon, nitrogen and oxygen he discovered in 1930 new lines emitted by these atoms on the longer wavelength side of the primary radiation. These lines were diffuse and broad and had more or less sharp edges on the short wave length side of the spectrum and appear to be something like Raman-lines in X-ray region. Though his results have not been generally confirmed it is still believed by some of the leading theoretical physicists that future experiments performed under suitable conditions, particularly at small angles, should confirm the findings.

Dr Ray went to Europe a second time in 1934 with a Ghosh Travelling Fellowship of the Calcutta University and toured extensively on the Continent, visiting all the leading centres of scientific research. The University of Calcutta offered him the Khaira Chair in Physics in 1935, when he returned to India,

in recognition of his scientific achievements. Dr Ray now applied all his time and energy to the organization and equipment of the X-ray research laboratory and also to the training up of a band of young research scholars who would be able to carry on investigations in a truly scientific spirit. It was in his own laboratory in the Science College, Calcutta, that he had the first heart-attack as a result of over work. He initiated researches in several new fields of X-ray, and before his untimely death he was engaged in important investigations on the emission and absorption spectra of elements in the soft X-ray region, which are expected to throw much light on the distribution of electrons in the solid state. He had also been conducting researches on the luminescence of solids under X-ray and similar irradiations with a view to elucidating the problem of extra energy levels in solid. Recently from the study of the fine structure of X-ray absorption edges, he attained interesting results on the nature of ions in solution.

Professor Ray was a fellow of the National Institute of Sciences and was associated with several learned societies of India. He presided over the Physics Section of the 29th Session of the Indian Science Congress held at Baroda in 1942. His presidential address was a masterly review of the work done by himself and his team and was highly appreciated.

Professor Ray was the first editor of *SCIENCE AND CULTURE* when it made its appearance in June, 1935. Jointly with Professor M. N. Saha, he was also the founder Honorary Secretary of the Indian Science News Association. Although he failed later to continue his active association with the management of the journal owing to indifferent health, he always took keen interest in the affairs of the journal.

Professor Ray had great reputation as a teacher. Always clad in *dhoti* and *punjabi*, Dr Ray was one of the most unassuming men in the University College of Science. He avoided publicity in all its forms and his numerous charities were not known even to his best friends. Prof. Ray had a charming personality, and the wit and sense of humour which he possessed did not leave him even at the last moment of his life. He was religious in temperament and was connected with the Ramkrishna Mission for the last 30 years. He has left behind him his wife, an only daughter, a brother and a sister and numerous pupils, friends and admirers to mourn his loss.

R. C. M.

PROF. B. B. RAY MEMORIAL FUND

At a meeting of condolence, held at the University College of Science and Technology, Calcutta, and attended by the colleagues, numerous friends and pupils of late Prof. Ray, it was decided to raise funds for perpetuating the memory of the departed Professor in a suitable manner. A representative Committee was constituted, to start collections for the Memorial fund. On half of the Committee we beg to approach the friends, well-wishers and pupils of late Prof. Ray as well as those who generously support every endeavour for the growth of scientific research and study in this country for their contribution to the Memorial Fund and request them to send their suggestions to us so that the task of the Committee may be fulfilled in the best manner. All contributions are to be sent to Mr S. K. Acharyya, Treasurer, Prof. B. B. Ray Memorial Committee, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

M. N. SAHA,
Chairman.

S. GUPTA,
Secretary.

Notes and News

POST-WAR INDUSTRIALIZATION OF INDIA

POST-WAR industrialization of India formed the subject of an address delivered by Mr Sankalchand G. Shah, Vice-President of the All-India Manufacturers' Organization, Bombay, at the Second Quarterly Meeting of the Central Committee, held on July 23, 1944. Mr Shah welcomed the creation of the new Department of Planning and Development by the Government of India and referred to the appointment of Sir Ardeshir R. Dalal to be in-charge of the new Department as a step in the right direction. He expressed the view that Sir Ardeshir's intimate knowledge of the state of affairs in the country, his contact with the commercial and industrial community and his association with the authorship of the Bombay Plan will enable him to pursue the plan for industrialization of India with vigour and enthusiasm.

Speaking of India's sterling balances, he referred to the bitter sense of frustration India experienced at the decision of the recent International Monetary Conference to exclude the question of abnormal war balances from the scope of the Fund. 'The amounts represented by these balances amassed out of the privations and hardships suffered by the people of India', he said, 'are very badly required for purposes of its reconstruction and of industrial development, and it is particularly from that point of view that I feel that the decision of the conference to evade this issue amounts to putting a damper on our efforts at planning and development. We require this money for enabling us to purchase the necessary capital equipment and machinery, more particularly in the post-war period.'

Mr Shah strongly criticized the Government's present policy, in the name of anti-inflationary measures, of importing large supplies of consumer's goods irrespective of the detrimental effect of such a step on the indigenous industries producing similar goods. The import policy has already placed some of the existing industries into difficulties. Although the Government have sought to justify their policy in the light of the urgent necessity of relieving the scarcity of consumers' goods in the country, the Indian public is at a loss to understand how it is easier for Government to arrange to secure the importation of finished bicycles in preference to importation of some parts and machinery required by the cycle manufacturing industry here to increase its production. Furthermore, the present import policy is utterly inconsistent with the assurances given from time to time since the outbreak of the present hostilities by such official spokesmen as Sir Ramaswami Mudaliar with regard to the protection of Indian industries started or developed during the war in the post-war period. Mr Shah referred to the assurance Sir Ramaswami gave in course of his statement in the Central Legislature on March 12, 1944, when he said, "... in case we (Government) in any form encouraged the development of industries for our war names, we shall make it clear that at the end of the war those entrepreneurs who had come to the assistance of the State and had developed industries would not be left high and dry and to take care of themselves." The import policy has engendered widespread suspicion whether the Government would really stand by Indian industries in the difficult times

likely to face them after the war. He emphasized the need at this stage for a clear declaration by the Government in regard to the fiscal policy which they propose to adopt in the post-war period.

Mr Shah expressed his firm belief in the industrialization of the country as the only possible remedy for the present deplorable state of affairs and finally referred to the following proposals put forward by the A.I.M.O. for the current year.

- (1) The establishment and development of really large scale industries for the manufacture of heavy machinery including railway and defence equipment and their ancillary industries. They should form the most important item of our immediate industrial programme.
- (2) The concentration on creating public attention on adequate naval defence of the country which when sufficiently developed should provide for the establishment of the two heavy industries of sea-transport and ship construction.
- (3) The establishment upon a permanent footing of such industries as the country has been fortunate in having as a result of the war conditions.
- (4) The establishment of a first grade institute of higher technology for training technical and executive personnel and for carrying on research in the technique of modern methods of production.
- (5) Provision of technical and scientific advice on all problems connected with the establishment and maintenance of industries by firms or panels of technical experts and advisers.
- (6) Publication of an industrial journal giving the latest information on all technical and economic problems relating to industries.
- (7) The propagation of correct and nationally beneficial ideas on tariff and other policies of Government which will have to be followed in the post-war period in the interests of our industries.
- (8) An intensified and countrywide drive by means of propaganda, lectures by eminent scientists, economists and industrialists and the establishment of personal contacts between all who are connected with industries through tours and conferences.

A. I. M. O. AND INDIAN INDUSTRIES

THE Secretary of the All-India Manufacturers' Organization, Bombay, draws our attention to a resolution passed at the recent meeting of the Central Committee of the A.I.M.O., advocating protective Government measures for essential industries, particularly those started during the war. In pursuance of this resolution the working committee now invites interested industrialists to get immediately in touch with the Secretary (address, Industrial Assurance Building, Opp. Churchgate Station, Bombay) to enable the Organization to urge upon the Government, where necessary, to adopt one or more of the safe-guarding methods which include among others, (a) protective tariffs, (b) bounties and or subsidies, (c) guarantee of interest on invested capital, (d) facilities for importation of essential raw and semi-manufactured materials, (e) provision by means of priorities of suitable equipment and technical assistance.

It is hoped that the parties interested will assist the Organization in its work by immediately forwarding complete statements including, (1) the date of the establishment of the factory, (2) the amount of capital invested, (3) the output and the value of products, (4) the nature of the difficulties experienced in detail, (5) the name of protection desired in detail.

The undernoted types of industries are specially required to supply the particulars sought for: (1) industries started or developed with further capital investments at the instance of the Government, (2) industries which are in the nature of key or defence industries, (3) industries which can be developed into or as adjuncts of heavy industries, (4) industries in respect of which it is essential for the country to be independent of foreign supplies in times of war, (5) industries providing articles serving as ancillaries for other industries, (6) industries utilizing waste products of other industries, (7) industries catering for educational and cultural developments of the country, and (8) industries manufacturing such consumers' goods as are required to raise or maintain at least the minimum standard of life of the people.

POST-WAR TRAINING OF FOREIGN ENGINEERS IN THE UNITED STATES

We learn from a report in *Science* that the General Engineering Staff of the Foreign Economic Administration in the United States has recently adopted a plan for the post-war training of foreign engineers in the American engineering colleges. The plan has made provision for about 3000 to 4000 foreign students from Europe and Asia at an estimated expense of about \$3,600 per student. The period of study has been stated to be eighteen months. The foreign governments concerned, with the advice of the educational leaders of the United States, will select the students and will be required to provide most of the money for their expenses. The Federal Government, however, proposes to contribute an unspecified percentage. All students will receive practical working experience in industry for a third of the course and, while at college, will be under the direct supervision of the college authorities.

We further learn that courses have been developed or are under preparation at the Carnegie Institute of Technology, the Massachusetts Institute of Technology, The Colorado School of Mines, the Illinois Institute of Technology, North Western University, Pennsylvania State College, the Philadelphia Textile Institute, Purdue University, the University of Detroit, the University of Illinois, the University of North Carolina, the University of Michigan, the University of Utah, the University of Wisconsin and Union College.

The plan further proposes to train up some 5000 to 10,000 American technical graduates for foreign service. For, it is the feeling in America that the rebuilding of the industrial systems in the devastated areas of Europe and Asia in the post-war period will necessitate the direct assistance of American engineers.

The American move to open their universities and centres of technical education to train up foreign students for the most difficult rehabilitation work in the post-war period is highly commendable and will doubtless inspire fresh hopes in the war-weary countries outside U. S. A. But we fail to understand on what basis the plan has sought to train only 4000 foreign graduates when it has admitted that as many as 10,000 American engineers may be required for foreign service. Needless to point out that any country outside U. S. A., which will be left with some prestige and national pride, will prefer to build her demolished industrial systems through the efforts of her own engineers and scientific men and will not be prepared to receive American engineers with much enthusiasm. We wish if the U. S. A. could give up ideas of thrusting her own engineers for such philanthropic work and concentrate on the more modest programme of giving training to more foreign graduates to rebuild the unhappy lands of their birth.

COLONIAL RESEARCH FELLOWSHIPS

THE report has filtered through the Department of Education, Health and Lands that the Secretary of State for the Colonies has instituted a number of Colonial Research Fellowships to encourage research on problems of colonial interest. The creation of the Fellowships, it is reported, particularly aims at producing a cadre of scientists with special knowledge of environmental and social issues of the colonies and encouraging research on fundamental problems in tropical regions. These Fellowships are open to graduates under 35 years of age from any part of the British Commonwealth and Empire and will carry an allowance of £400 to £600 per year. These will normally be for two years but may be extended for a year and will be tenable in any part of the British Colonial Empire. Provision for 25 Fellowships has been made within the next five years. The award will be made by the Secretary of State for the colonies on the advice of the Colonial Research Committee.

IRRIGATION RESEARCH AT POONA

THE Annual Report (Technical) of the Central Irrigation and Hydrodynamic Research Station, Poona (now renamed as Indian Waterways Experiment Station), for the year 1941-42, issued recently, contains important conclusions and notes on river and canal problems, such as protection of bridge

piers against scour, control of sand entering the Right Bank Canals at Sukkur, high efficiency siphon spillway to control water levels in reservoirs and divergence from regime in stable channels in alluvium. Experiments were conducted at the Station to control sand entering the Right Bank Canals, and as a result an approach channel was constructed upstream of the Barrage at Sukkur. The channel came into full operation in 1941 flood season and has succeeded in reducing considerably the deposit of sand in the North-Western Canal and the Rice Canal.

The problem of the protection of bridge piers against scours received investigation at the Station. It has been clearly demonstrated that the level at which the stone pitching is laid round bridge piers has a great bearing on the scour of the river bed downstream of the piers. A high level pitching which results in a great depth of the scour has often been found to be the cause of large slips of stones from the downstream ends of piers. The remedy lies, it is suggested, in the low level pitching which will reduce the depth of the scour and largely eliminate the danger of such slips of stones.

The Station also studied, among other things, the problem of erosion occurring at several points along the fore shore of the Hooghly above Calcutta and suggested either the filling of the 'scour hole' or the cutting away of the 'kunkle' as a possible remedy. The Director's observation of the westerly movement of the Kosi River at an average rate of more than a mile per year for 50 years during his deputation to Nepal is another interesting feature of the report.

WORK AT THE TATA CHEMICALS

AN account of the progress of work made at the *Tata Chemicals* has been reported in a recent issue of the *Journal of Scientific and Industrial Research*. The *Tata Chemicals*, started in 1939 at Mithapur in Okhamandal, a district in the Baroda State, with an authorized capital of Rs. 5 crores, represents a pioneering industrial venture characteristic of the *Tatas*. The plan for the establishment of this new chemical industry, now claimed as the biggest in India, was drawn up by Mr Kapilram H. Vakil, the present Technical Director of the *Tata Chemicals*, early in 1937. In the same year, the scheme was carefully scrutinized by a committee of experts at London, under the Chairmanship of Mr J. A. Reavell, the distinguished British chemical engineer, and was found to be satisfactory and workable.

The outbreak of the war within a few months of the commencement of work at Mithapur seriously interfered with the execution of the project, and the progress was slow and halting. Despite such war-time odds and difficulties the project has been carried to a successful issue, and the company has started manufacturing several important chemicals which in-

clude, among other things, alkalis, heavy chemicals and marine products. Soda ash is manufactured according to the ammonia soda process, and the plant installed for the purpose incorporates the latest practices in soda-ash manufacture. Soda-ash being the most important starting material for the manufacture of drugs and dyestuffs and of caustic soda and sodium bicarbonate required in the glass, soap and paper industries, its successful production at Mithapur has gone a long way in meeting the need of an important basic chemical in India. Further, plants have been completed for the production of caustic soda by the electrolysis of brine, and gaseous by-products are already being utilized for the manufacture of bleaching powder, liquid chlorine and hydrochloric acid. Other chemicals now being manufactured include zinc chloride, bromides, epsom salts, potassium chloride and magnesium chloride. In fact, the *Tata Chemicals* are now manufacturing all the basic chemicals essential for the production of dyestuffs, fertilizers, glass, drugs and pharmaceuticals.

The chemical works at Mithapur are fast undergoing expansion and have already come to occupy an area of about 60 acres. Some 1500 workers and about 500 skilled personnel including 200 highly qualified and trained chemists and engineers comprise the staff of the *Tata Chemicals*. The whole works have been planned, designed and equipped according to latest developments and have been provided with a well-equipped research laboratory. Moreover, the choice of site for the new chemical industry has been a suitable one from the geological point of view inasmuch as large deposits of high quality limestone in the Okhamandal area and the salt garden at Mithapur provide an abundant supply of important raw materials needed for the industry.

WELDON PRIZE TO PROF. P. C. MAHALANOBIS

We are glad and proud to learn that the University of Oxford has awarded the Weldon Prize to Prof. P. C. Mahalanobis of the Calcutta Statistical Laboratory, the first Indian to be ever chosen for such singular honour and distinction. The award has been made in recognition of his significant contributions to biometric science during the preceding six years.

The Weldon Prize to be awarded every three years was instituted in 1907 in memory of W. F. R. Weldon, professor of biology of the Oxford University. Prof. Weldon was one of the great pioneers of the new science of biometry and founded, jointly with Karl Pearson, another great pioneer, the famous journal *Biometrika* in 1911. The recipients of the Prize which is international in character include such distinguished men as Professors J. B. S. Haldane, F.R.S., R. A. Fisher, F.R.S., M. Greenwood, F.R.S., and E. S. Pearson, all of England, Prof. Johannes Schmidt of Denmark and Prof. J. A. Harris of the United States. Prof. J. B. S. Haldane was the last recipient in 1938 and the Prize was kept in abeyance in 1941.

ANNOUNCEMENT

SHORT notes on industrial topics, both technical and of news value, are invited on payment basis for publication in the "Technical Research Note", "Notes and News" sections of the Industrial and News Edition of the Journal of the Indian Chemical Society. For each note approved for publication Rs. 2/- will be paid. None of the notes, approved or unapproved, will be returned unless accompanied with requisite postage stamps. Further information can be had from the Honorary Secretary, Indian Chemical Society, Post Box 10857, Calcutta.

SCIENCE IN INDUSTRY

A NEW ORGANIC INSECTICIDE

A NEW organic insecticide identified as dichlorodiphenyl-trichloroethane and abbreviated into 'D.D.T.' has recently formed the subject of much discussion in the lay press as well as in scientific papers. According to a recent Repter news, D.D.T. is reported to be effective against typhus, malaria, dysentery, enteric, cholera and plague and against insects both as contact and as stomach poison. It works by striking at the carrier of the disease and can kill body lice, mosquitoes and flies which are responsible for the spread of dysentery, enteric fever, cholera and the plague. Further, bugs, fleas, cockroaches,

beetles, cabbage worms and aphides fall easy victim to D.D.T. It is, however, non-toxic to man and other warm-blooded animals and also does not appear to hurt plants.

The new insecticide is the result of an intensive search for a suitable synthetic organic compound for the control of pests and insects and such other carriers of diseases. Although a number of organic compounds having insecticidal properties were synthesized, few proved acceptable owing to their toxic effects on man, animals and plants. Their high cost was also no less an important factor. But despite such discouraging facts, the hope of a suitable organic

insecticide non-toxic to man, plants and animals was never given up.

Although the full story of the development of D.D.T. is lacking for obvious reasons, the new insecticide, according to a recent issue of *Scientific Monthly*, is reported to have been first used successfully in Switzerland whence the results were later communicated to the U. S. Department of Agriculture. The chemists of the Bureau of Entomology and Plant Quarantine soon analyzed the compound and described it as dichloro-diphenyl-trichloroethane. The compound is made from chlorobenzene and chloral hydrate and is crystalline in nature. The elaborate tests carried out at the testing laboratories of the Bureau of the Crop Protection Institute have corroborated all the insecticidal properties now claimed for D.D.T. The insecticide has been so far adopted by Army on an extensive scale.

THE CHEMICAL TREATMENT OF WOOD

A METHOD of hardening soft wood through chemical treatment has been reported in *Science*. Developed in the laboratories of E. I. du Pont de Nemours, the chemical process is claimed to make timber markedly harder, stronger, stiffer and more durable. The process has successfully eliminated the natural tendency of wood to swell, shrink or warp with changes in humidity. The hardness of the wood so treated remains unaffected by such varying climates as characterize the tropical jungles and the desert regions. Such woods have further been given a permanent colour throughout the material.

The chemical treatment consists in the use of the organic compound methylolurea obtained by compounding urea with dimethylolurea. Both urea and dimethylolurea are white, water-soluble solids, prepared from ammonia, carbon dioxide and methanol and available commercially at a reasonably low price. Methyl urea is impregnated into the wood to be treated in the form of a solution when the compound reacts with the wood components to form hard, water-insoluble, unmeltable resins within the piece of timber. The formation of resin inside imparts the characteristic hardness to the wood specimen. It is stated that the process may be speeded up through the application of heat, such as kiln drying.

The process may further be applied to harden the outside layers of a piece of lumber sparing the interior. Lumbars so treated have decided advantages in certain types of construction, such as trestles, bridges and towers.

RECENT PRACTICES IN BEET SUGAR CHEMISTRY

DR T. TWOMEY, of the Irish Sugar Company, during his lecture delivered recently to the Irish Chemical Association, has made an important review of some of the recent practices in beet sugar chemis-

try. He has discussed briefly the various stages of the chemical operation, involved in the extraction of sugar from raw beet juice. Such stages include lime treatment of juice, carbonatation, removal of incrustation, purification, boiling and by-products. The following summary account is based on a fuller report appearing in *The Chemical Age*, April 15, 1944.

The precipitation of non-sugars from raw beet juice is now most effectively carried out by lime milk through two stages in preference to one single operation as it used to be followed until recently. The stages are pre-defection and main liming. Pre-defection may again be conducted in two ways. According to the first, raw juice at a temperature of 40°C is treated with small doses of lime, gradually increasing the alkalinity to a maximum of 0.3 per cent. During the addition of lime, punctuated by a series of pauses, a pH equivalent to the isoelectric point of every colloid present is reached and all colloids are coagulated. The juice is then heated and made ready for the main liming. The second method consists in adding enough lime in pre-defection stage to make the juice attain a pH value of 10.9, and then wait for 10 minutes before proceeding with the main liming. It is assumed in this procedure that beet juice contains only one or two predominant colloids which will be completely coagulated when the stated pH is reached and that the tedious operation of passing through all possible isoelectric ranges is unnecessary.

The lime treatment of juice is followed by the carbonatation process which seeks to remove the excess of lime. This is effected by passing carbon dioxide gas in two stages. CO₂ is first added till the alkalinity is reduced to about pH 10.9, after which it is filtered. Gassing is then continued in the filtrate till the percentage of CaO falls to 0.015. In the second stage of gassification, dissolved calcium salts are removed, according to modern view, by their interaction with sodium carbonate. This reaction is made possible by the normal presence of sodium in beet sugar juices. The removal of calcium salts is an important stage as they lead to heavy incrustation on the heating pipes. It should be, however, noted that incrustation cannot be altogether prevented despite every precaution. The scale consists, for the most part, of calcium carbonate, sulphite, phosphate, silicate and oxalate and may be removed by boiling it first with dilute hydrochloric acid and then with 8 per cent. caustic soda solution. The descaling of pipes is sometimes effected through the use of suitable scrapers. But a more suitable chemical method of removing the scale remains yet to be developed.

The recent introduction of new synthetic ion-exchange adsorbents to purify sugar liquors has greatly increased the final sugar yield with its conse-

quent reduction in the quantity of molasses formed. The conventional lime treatment usually increases the percentage of sugar in the liquor to 93-94, whereas the ion-exchange method ensures a purity of 99 per cent. The process consists in allowing the juice having a purity of 90 per cent. to pass in succession through beds of cation and anion exchangers. The method further promises to reduce the fuel and equipment costs and simplify the several stages of operation now in use.

The boiling of the sugar solution represents another important stage in the extraction of sugar from beet juice. The success in this stage depends largely upon the effective control of the boiling. Formerly the degree of supersaturation attained during boiling used to be determined by the measurement of viscosity or conductivity of the solution. But as such measurements are made at a particular spot within the pan the results are not representative of the mass as a whole. According to the most recent development, the control of boiling is effected through the study of the boiling points of the sugar

solution. The method arose from the discovery that at all pressures encountered in the usual sugar boiling practice the graph of the boiling points of sugar solutions of any degree of supersaturation against the corresponding boiling points of water at the same absolute pressure was a straight line. A formula has been developed from this and an instrument constructed, which records the degree of supersaturation continuously.

The molasses left as a waste product in the beet sugar industry has recently been utilized for the manufacture of a series of important by-products. Yeast and ethyl alcohol were already produced from molasses. An American bio-chemist has lately expressed his view that this waste product may form the starting material of a series of products, such as glycerine, acetone and acetic, lactic and citric acids. It is reported that a motor fuel called Jeanite has been recently obtained by the polymerization of ethyl and butyl alcohols, both derived from molasses. The new synthetic motor fuel has further been claimed to be almost as good as petrol.

PRODUCTION OF RAMIE FIBRE IN INDIA

A. N. GULATI

TECHNOLOGICAL LABORATORY, MATUNGA, BOMBAY

RAMIE like cotton is an ancient heritage of India. The use of best fibres from the nettle family of plants in India, China, Central Europe, and America is a noteworthy coincidence in the history of ramie fibre. Whereas the cultivation of ramie is limited now to a handful of cultivators in India, its methods of cultivation and production are still primitive in China, and Europe has abandoned it as a costly fibre. There is, however, a definite urge for increasing its production in America and Japan in present times.

The American farmers have obtained very high yields of ramie fibre from the cultivated crop, their industry has perfected a mechanical decorticating device, has developed a suitable degumming process for the preparation of the fibre, and has also found it adaptable to the standard spinning machinery. They are thus, able to compete with the cheap production of the fibre in China. They claim the fibre not only to be an addition to the textile resources during the war but also consider it an acquisition for all times.

The ramie plant is indigenous to India. Should not India therefore, tap this source for supplementing the country's need for a long staple vegetable fibre or the textile resources of the Allied Nations during the war? In view of the enormous length of the ultimate cells of this bast fibre, its whiteness, lustre, strength and durability of the fabrics made from it, the revival of its cultivation in India de-

serves backing from Government, the financiers, and the industrialists. It may be mentioned that apart from its textile use, the ramie fibre on account of its high cellulose content which is almost as much as that of cotton, is highly suitable for paper and cellulose acetate manufacture. It is suggested that the Government of India may offer some handsome prize again just as she did in 1869 for a machine to decorticate ramie, for the development of a process to degum the fibre. Indian scientists have hardly any paying objectives for research.

It is pointed out that the cultivation of this fibre in India has no unsurmountable difficulties. While the farmers at least in Bengal and Assam know how to grow the crop, the country needs a long and strong vegetable fibre capable of producing durable cloth, and its production can materially add to the textile resources of the Allied Nations. The only thing wanting is encouragement and a ready market for the product. Under the present circumstances, Indian raw produce can supplement America's yield for war purposes.

The crop needs alluvial or light sandy soil, about 40 inches of rain well distributed throughout the year, and is adaptable to cultivation in irrigated land. India may be able to spare such land in rain-fed and irrigated tracts as well. Furthermore, India grows some surplus short staple fibres and therefore, it may be worthwhile for her to grow ramie instead, which

American industrialists have found to be admirably suited for tropical hard wear, notably for uniforms of the fighting troops.

For general information we give below a short account of the ramie plant, methods of its cultivation, and preparation of the fibre together with its properties as summarised from Robinson (1940).

THE PLANT

Ramie fibre is obtained from two species of the nettle family of plants, viz., *Boehmeria nevea* and *Boehmeria tenacissima*. They are perennial shrubs suited for cultivation in the sub-tropical regions. The fibre from the two species is indistinguishable. *B. nevea* is the more favoured of the two species in China, Japan, Philippines, and America. The plant is said to need a cool winter for inducing a resting period but not freezing cold which is likely to kill its roots. It can withstand drought after being well established, but needs abundance of moisture for high yields. Moisture at the time of harvesting however, is an unfavourable condition for storing cut stalks.

As the plant is grown for its vegetative stalks which yield the fibre, its cultivation quickly depletes the soil of its nutrients. They have therefore, to be replenished from time to time. After decorticating the stems it is good to return the waste back to the field. The level of nitrogen, phosphorus and potassium in the soil has to be maintained for successful cultivation of the crop. Nightsoil and compost are useful manures tried in other countries.

CULTURE

The ramie plant is best propagated by pieces of roots. Each piece has to be about six inches long and is planted in a slanting or upright position with the upper end one or two inches below the surface. They are set in rows three to six feet apart and spaced 18 to 24 inches in each row. The shoots grow up in one to two weeks. The root-stock breeds true to the nature of the fibre, and yields one or more cuttings in favourable circumstances even in the first year. Best results are obtained by keeping the weeds out and breaking the soil now and then for soil aeration. Crops from seed are difficult to raise, and less homogenous in fibre character. Harvesting is begun when the flowers make their appearance. A timely cutting may make it possible to have three to four cuttings in a year. A new growth of about 30 inches may follow a cutting within two weeks under suitable conditions. The productive period is for ten years. Maintenance of original fertility and the care taken can prolong the productive period and also increase the yield appreciably. On an average this crop yields 400 to 700 lbs. of prepared fibre per acre annually. The upper limit of the yield may

reach 1500 lbs. The major part of the total world production of ramie comes from China and is about 100,000 long tons.

It may be mentioned that the gross yield per acre of the stalk in the U. S. A. varies from 1 to 45 tons. The American analysis of the gross yield is given below.

Stalks and leaves	...	...	100%
Stripped stalk	...	...	52%
Air dry stalk	...	...	10.4%
Decorticated fibre	...	...	2.1%
Degummed filasse	...	...	1.2%

PREPARATION OF THE FIBRE

The harvested stalks are soaked in water for sometimes before the fibre is stripped off. At this stage the fibre consists of a brownish outer bark, adhering cortical tissue and much gum. This process known as decortication is carried out by hand in China, while it is done by machine in America and Philippines now. The manual labourers use bone or bamboo implements for scraping the fibre from the stalks. The gummy brownish fibre is then degummed by the action of anaerobic bacteria or by the action of some chemicals the formulae of which are protected by patents. After the fibre is degummed, it is perfectly white and more or less divided into ultimate cells which are flexible enough for being spun. The fibre loses about one-third its weight in the process of degumming.

PROPERTIES OF FIBRE

Ramie is stronger than any other bast fibre, cotton or silk. Cotton and silk excel it in being twistable more easily. Ultimate fibres range from $\frac{1}{2}$ to 20 inches with a diameter of 0.002 to 0.003 inches. The average length is from six to eight inches. Flax is finer than ramie, but ramie has a smoother surface and is more lustrous. It does not throw off linters and is therefore, highly recommended for surgeons overalls, and surgical bandages. It absorbs water more quickly than flax. Chinese use it in the manufacture of various fabrics which compete well with European linen. It is used in the manufacture of table-clothes, napkins, plushes, upholstery cloth, curtains, dress goods, knit goods, and notably for gas mantles. With the help of the cheap labour available in India, the cost of the fabrics made from this fibre is not likely to be more than that of cotton.

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HEAT IN CONTROLLING SEED-BORNE DISEASES OF PLANTS

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THE application of heat or temperature in the art of controlling plant diseases is a new practice dating back from the early 'eighties of the last century'. Prior to this efforts at controlling and curing diseases in plant were directed along such sanitary and hygienic operations as roguing of diseased plants, eradication of alternate host-plants near about the fields, rotation of crops, regulation of drainage, application of lime or fertilizers to the soil, propagation of disease-free stocks, seeds and setts or along such direct control measures as seed dressings and spraying (or dusting) of fields and plantations with appropriate fungicides known at the time.

But the discovery of the therapeutic value of heat in the science of plant pathology and its successful application thereto was made by the Danish school-master and agriculturist, Jens Ludvig Jensen. Working with the 'late blight' disease (*Phytophthora infestans*) of potato Jensen (1882) found that none of the control measures known at the time was effective enough to check the rot caused by the disease. But he achieved at the same time a momentous success to be able to discover that the fungus of the 'late blight' disease lives in a dormant way within the body of the tuber itself and that the disease manifests itself in the progenies when such tubers are next used for sowing or sets in rots when kept in storage for future consumption. This finding of the occurrence of the 'germ' of the disease deep within the tissues of the tuber had far-reaching consequences on the next course of his investigation. It dictated to him that surface sterilization of potato tubers with dusts or fungicides would be of no avail as the fungicide could not get in to affect the 'germ' living inside. And this set him to think how the internal dormant 'germ' (i.e., fungus) of the disease could be killed without impairing the vitality of the tuber.

Happily, it was known to him that (1) all organisms could be killed by heat and (2) this lethal temperature (i.e., the temperature that kills an organism) varied according to the organism that was sought to be killed. So, acting on this principle he first determined the lethal or death point temperature for the 'late blight' fungus as well as that of the seed potato tubers and found that a temperature of 40° C would kill the fungus within the potato tubers while a higher degree of temperature was necessary to cause the loss of viability of the potato tuber. So here Jensen got a thing which could penetrate in and destroy the fungal germ without killing the tuber itself because, as stated earlier, this temperature was much lower than that which would cause

death of the potato tubers. He therefore, treated the seed potatoes in water at 40° C for 4 hours; this completely killed the internal fungal germ without impairing the germinating capacity of the tubers. But, since continued soaking for such a period in hot water softened the tissues and made them susceptible to subsequent rotting he applied dry heat instead by suspending a water-tight cylinder containing the potatoes to be cured, in hot water raised to 42-56° C till the temperature inside the cylinder recorded 40° C for 4 hours. Seed tubers sown after this dry heat treatment gave rise to healthy offsprings but the latter's immunity was not assured as the 'late blight' fungus could and easily did spread in such a healthy cultivation through secondary infections from adjacent diseased plots. So, to avail full advantage of this method of blight control it becomes imperative that adjacent plots should contain no diseased plants and the cultivators in a said locality must act co-operatively together.

Because of the latter condition this method of combating potato blight was not adopted in any measurable scale beyond Denmark, the home of its origin. But it was soon thrown into the background by the then discovery in France a couple of years later of Bordeaux mixture, which proved so efficacious in controlling the potato blight disease by checking secondary spread of infection and which, moreover, did not call for that type of co-operation imperative for the success of the hot-water method. But to-day Jensen's method holds a special offer to be taken full advantage of by countries that have run short of copper, a cheap and invariable ingredient of Bordeaux mixture, due to the impact of war.

But the method evolved first for potato soon found a world-wide application for prevention of seed-borne diseases of cereals, and recently of other crops.

Earlier to the application of the hot-water method all efforts at controlling loose smut of cereals proved a failure; and the reason for this escaped detection so long. And this, too, was left to the investigation of Jensen to show that the loose smut fungus, as in the case of blight disease fungus of potato, was an internal parasite living in a dormant way within the body of the grain. So surface sterilization with any fungicide so long proved a total failure. Jensen, therefore, subjected loose smut infected cereals to hot water at 50-52° C for 10 minutes; the seeds then became completely free from smut 'germ'.

In later years the researches of Appel and Riehlm

(1911) have proved the accuracy of Jensen's method. They have further shown that the process could be hastened by pre-soaking the seeds for a few hours in water at ordinary temperature before putting them in hot water.

Jensen's hot-water method, despite the difficulty in maintaining accurate temperature range when treating bulks, is still considered as the only successful measure against loose smut disease of wheat, oats and barley; and moreover this principle is now being increasingly availed upon to disinfect seeds, setts, or any other plant parts that are used for vegetative propagation where the disease germ, fungus, bacterium or nematode, is carried within the body of the 'seed' and is therefore inaccessible by any other means.

Indigenous modification of Jensen's hot-water method have been devised by various workers to suit local conditions. In India Luthra and Sattar (1934) employed with equal effectiveness solar energy in place of hot-water. Here the seeds are first soaked in water at ordinary temperature (as suggested by Appel and Riehlm) in a bright day from morning to noon (1 P.M.) and are then exposed in thin layers to the full action of the sun where in the plains of the Punjab the temperature reaches as high as 129° F or more in the summer. Mitra and Taslim (1936) could employ with success Luthra and Sattar's modified method under North Bihar conditions. Similarly Lamb (1933) is reported to have successfully disinfected cotton seeds attacked with bacterium (*Bacterium malvacearum*) by exposing them in an iron dish to the full action of the sun daily for a fortnight in the month of June under Nigerian conditions where the day temperature soars as high as 60° C. Successful results have also been reported by other workers; Wager (1935) could control brown rot of tomato caused by *Phytophthora parasitica* by immersing the fruit for 1½ minutes in water at 60° C, while Ogilvie and Brain (1936) could cure rust in mint by subjecting the runners used for vegetative propagation for 10 minutes in water maintained at 105-115° F.

The *Helminthosporium* disease is known to cause a serious loss to rice cultivation. The causative *Helminthosporium* fungus lives on the glumes and on the surface and inside the tissues of the fused pericarp and seed-coat (Nisikado and Miyake, 1920). Whether on the surface or inside the tissues of the fused pericarp and seed-coat the fungus is shut off from the outside by the presence of the two tightly fitting glumes (Tisdale, 1922). Necessarily externally applied seed disinfectants will scarcely be able to get in and affect the pathogen. This is the reason which so long baffled all attempts to proper sterilization of seeds through externally applied fungicides. The seeds are now being treated as under hot-water

method at 52° C for 8-10 minutes after pre-soaking in water at ordinary temperature for 8-12 hours. This gives absolute control of the primary infections, but since the disease spreads in the field through secondary infections a foliage spray in addition is called for to get absolute control.

APPLICATION TO CONTROL VIRUS DISEASES

Jensen's hot-water method evolved for curing seed-borne diseases of plants has now found an application to kill the active principles of the virus disease that live within the body of the plant. So setts or cuttings obtained from virus infected plants are first cured of the virus germ by subjecting them to Jensen's hot-water method before planting. But the results achieved here have not been as uniform. While Miss Wilbrink (1923) claims to have destroyed the virus agent in Black Cheribon sugarcane setts by treating them in hot water at 52-55° C for 30 minutes, Brandes and Klaphaak (1923), working with G.C. 701 variety of sugarcane, came out to say that immersion at high temperatures (45-55° C) for shorter period or at low temperatures (42-48° C) for longer period (up to 96 hours) could not cure the setts of virus germs. Blodgett's investigations (1923) on leaf-roll and mosaic of potato also support Brandes and Klaphaak's contentions. But the extensive researches conducted by Kunkel (1936) on peach yellow viruses suggest that different virus has different lethal temperature and this needs to be separately studied and determined.

APPLICATION TO CONTROL NEMATODE PESTS

The hot-water method, so successful against seed-borne diseases, is now being increasingly employed to control certain of the nematode pests where the worm perpetuates, as in the case of fungal and virus diseases, from one generation to the next by being carried within the body of the bulb or other vegetatively propagated parts.

Ramsbottom was the first to try in the year 1918 the hot-water method against the nematode pest (*Anguillulina dipsaci*) of narcissus bulb. A 3-hours' treatment in hot water at 110° F is now prescribed for complete elimination of the worms from within the body of the bulb without impairing in any way the germinating capacity of the latter.

Since then and especially from the early 'thirties of this century this aspect of the nematode pest control is being increasingly studied; and encouraging results have been obtained by English and American authors on chrysanthemum, strawberry, violet, begonia, etc.

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MEDICINE AND PUBLIC HEALTH

ONION PASTE AS A DRESSING

ACCORDING to *Medical News Letter* No. 38, issued by the United States Office of War Information, promising results with onion paste used as a dressing for infected wounds have been reported by Dr I. V. Toroptsev and Dr A. G. Filatova, of the Tomsk State University and the All-Union Institute of Experimental Medicine, U.S.S.R. The experiments with onion paste followed reports by Dr B. Tokin that the essential oils of onion, garlic and certain other strong-scented vegetables contain substances that kill bacteria, protozoa and even larger organisms. These substances, or phytoncides, have not yet been identified chemically, but are extremely volatile, so that the paste has to be made immediately before use. The preparation consists simply of grinding the peeled onions or a portion of it and then placing the paste into a glass dish with a diameter equal to that of the wound. This is applied so that the paste does not come in contact with the wound, which is exposed only to the onion vapour for ten minutes. Of 11 patients treated, seven had amputations of the arm, one of the thigh and three of the foot, and all the wounds showed distinct purulent inflammation before treatment. After the first phytoncide treatment, the doctors report, all the wounds without exception became rose-coloured and the patients no longer complained of pain. After the second treatment the purulence and odour subsided. After five days all the cases showed extensive soft epithelialization. The Soviet scientists feel that phytoncides have a place in the treatment of infected wounds along with synthetic preparations such as the sulpha drugs.

PROPOSED CHANGES IN THE MEDICAL CURRICULUM

It is becoming increasingly recognized throughout the world that prevention of disease and the promotion of positive health require more emphasis than mere provision of measures for curing sickness. We understand that the Health Survey and Development Committee has had under consideration the question of revising the medical curriculum so as to shed much of the unnecessary burden that is placed on the medical student and of improving the content of the subjects taught and the method of teaching, particularly for the purpose of giving a preventive bias to the outlook of the student. The proposed

changes in the curriculum will, it is hoped, enable the doctor of the future to offer to the people of India both curative and preventive health service in an effective manner.

Other subjects considered by the Committee (which, with its sub-committees, held meetings between July 1 and 15) included the place of the indigenous systems of medicine and of homeopathy in the future programme of medical relief for the country, the health of the school population, the control of venereal diseases, prevention of small-pox, physical education, health education and publicity, the problem of nutrition and control of food adulteration.

Groups of members of the Committee will shortly undertake tours in the provinces of Delhi, the U.P., Bihar, Orissa, Bengal and the C.P. Industrial centres in Northern India will also be visited. These tours will complete the rapid survey of existing health conditions in British India by the Committee, that has been in progress for the last few months.

WORK OF THE INDIAN RESEARCH FUND ASSOCIATION FOR 1943

REPORT of the Scientific Advisory Board of the Indian Research Fund Association for the year 1943 contains an account of research work on various subjects carried out under the auspices of A.R.F.A. During the year under review, a good deal of work on the nutritive value of dehydrated vegetables has been conducted in the Association's Nutrition Research Laboratories, Coonoor, under Dr W. R. Aykroyd. Steam-blanching cabbage was found to lose vitamin C more rapidly on storage than cabbage blanched by dipping in boiling water. Loss of vitamin C in dehydrated vegetables prepared by the so-called "pre-cooking" method was more rapid than in vegetables prepared by other processes. The general conclusion arising out of a considerable amount of work on the vitamin C content of dehydrated vegetables is that these cannot be relied upon as antiscorbutics after a period of a few months' storage.

While carotene is somewhat more stable than vitamin C in dehydrated vegetables, very appreciable losses occur on storage. After 20 weeks' storage at 98°F, bitter gourd, cauliflower, carrot, pumpkin and

potato lost from 35 to 65 per cent of their original carotene content. Losses in the mineral content of dehydrated vegetables during reconstitution and cooking amounted to 60 per cent. While attending the United Nations Conference on Food and Agriculture in U. S. A., Dr Aykroyd collected considerable literature on the effect of dehydration on the nutritive value of vegetables and other foods, a subject which is being intensively studied in England, Canada, U. S. A. and Australia.

During the year investigations continued on sprays for killing adult mosquitoes, on larvicides and on various drugs considered to be useful in the treat-

ment of malaria. Investigations on the best method of treatment for starvation cases were undertaken and most actively pursued.

Leprosy research included the continuation of observations on the results of different kinds of segregation and progress was also reported in work on a specific test for this disease. Advance was made in work directed towards the improvement of anti-plague vaccine. On the pharmacological side, progress was made in investigations to determine the value, if any, of indigenous drugs reported to be of use in certain diseases. A comprehensive and practical programme has been outlined for 1944-45.

INFLUENCE OF VITAMIN C ON BLOOD SUGAR AND BLOOD SUGAR CURVE

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BANERJEE (1944) showed (i) that the glycogen content of the liver is diminished in scorbutic guinea-pigs but is not increased in normal animals receiving injections of large doses of vitamin C, (ii) that the amounts of liver glycogen in scorbutic and partly de-pancreated animals are comparable, (iii) that the ascorbic acid content of the liver is diminished markedly in both sets of animals but is increased in both cases after injection of vitamin C, and (iv) that the injection of vitamin C to partly de-pancreated animals increases the glycogen content of their liver. He further showed that deficiency of vitamin C brings about glycosuria in guinea pigs which exhibit the diabetic type of glucose tolerance curve, and causes reduction of insulin in pancreas and that injection of vitamin C restores the normal metabolism of carbohydrates in scorbutic animals. He also showed that in vitamin C deficiency the islet tissue of the pancreas is greatly increased or hypertrophied. From these evidences he concluded that vitamin C is similar in action to insulin and that glycosuria in scurvy is due to diminution in insulin content of pancreas.

The conclusion that vitamin C is similar in action to insulin is not warranted by these evidences. Insulin has three distinctive functions in the body, viz., it prevents gluco-neo-genesis, promotes glycogenesis in liver, and helps the oxidation of carbohydrates, as is evident from the rise of R. Q. to about 1.* If insulin is injected to normal persons

* The rise of R. Q. may be due either to an increase in oxidation of carbohydrate or to an increase in the conversion of sugar to fat or both. After insulin injection there is not only an increase of R. Q. (i.e. $\frac{\text{CO}_2 \text{ given out}}{\text{O}_2 \text{ consumed}}$),

or animals in high doses, there is a prompt fall of sugar in blood which is of course compensated subsequently to some extent by the liberation of adramalin causing increased glycogenolysis. Banerjee has not been able to show whether vitamin C produces any of these actions in normal animals; on the other hand, he has shown that it does not increase glycogen deposition in normal animals.

In scorbutic animals extravasation is noticed in almost every part of the body. Accordingly one is justified to assume that blood supply to glands would diminish, particularly in such organs as are provided with a rich meshwork of capillaries of which the walls become very fragile in scurvy. The islet tissue of the pancreas is provided with sinus-like capillaries of which the walls are expected to be still more fragile. If these walls give in during scurvy, as they actually do, there would be a deficiency of supply of precursors of insulin and of nutrition to the islet tissue so that its output of insulin would diminish. In consequence, the symptoms noticed by Banerjee in scorbutic animals would necessarily supervene, such as diminished glycogen content of liver, increased sugar content of blood and the diabetic type of blood sugar curve etc. The enlargement of the islet tissue is also expected from the deficiency of supply of precursors of insulin, as a similar enlargement, viz., general hyperplasia, is also noticed in the case of thyroid when animals are deprived of I₂, particularly during embryonic and early post-natal life. It is thus clear that none of the evidences presented by Banerjee can lead to the conclusion that vitamin C

but also an increase in the total amount of CO₂ given out and of O₂ consumed. This shows that there is an increase in the oxidation of carbohydrates.

is associated with carbohydrate metabolism or is similar in action to insulin.

To ascertain whether vitamin C has any role in carbohydrate metabolism it becomes necessary to find out how it affects blood sugar curve of normal persons if it is ingested sometime before, or simultaneously with, the intake of dextrose by subjects under experiment and what relationship exists between this modified blood sugar curve and that obtained after the administration of the second dose of dextrose to experimented subjects immediately after the return of the blood sugar to normal following upon their ingestion of the first dose of dextrose. It is known that the ingestion of a large amount of dextrose stimulates the production of insulin, so that after the intake by a normal person of a large quantity of dextrose which causes rapid and considerable fluctuations in his blood sugar level, he takes in again, within a definite period of time, another dose of dextrose, and the consequent fluctuations in his blood sugar level are much less marked than before. It may be argued that if vitamin C has an insulin-like action, it should prevent fluctuations in blood sugar level provided it be given before the first dose of dextrose, so that it may already attain that concentration in blood which might be necessary for it to cope with the rapid entry of dextrose therein after its ingestion. If, however, the rates of absorption of vitamin C and dextrose from the intestine are the same, the supposed action of vitamin C in preventing fluctuations of blood sugar level would be obtained if they (*i.e.*, vitamin C and dextrose) are given simultaneously.

In view of these considerations the following experiments were performed at the preliminary stage on 3 healthy students, *viz.*, H. R., R. R., and K. S. M. After fasting for 12 hours, their blood was collected for estimation of sugar* and they were given 75g of dextrose. After every ½ an hour up to 2 hours their blood was examined for sugar. At the end of 2 hours they were given a second dose of sugar and their sugar content of blood was again examined after ½ an hour to 40 minutes and after 2 hours. On the day following this experiment each of these students after again a period of fast for 12 hours was examined for his blood sugar (*i.e.*, fasting level of sugar) and then given 300 to 500 mg. of vitamin C. After ½ an hour their blood was collected for sugar estimation and then immediately given a dose of 75g of dextrose. Their blood was henceforth examined for sugar every ½ an hour up to 2 hours or more. The results of these estimations are given in Tables I, II and III.

* The estimation of blood sugar in all these experiments was made by the well-known method of Hagedorn and Jensen.

TABLE I

Showing changes in the percentage of dextrose in mg. in the blood of H. R. after 12 hours' fast due to the intake of 75 g. dextrose in 2 doses, the 2nd dose being given 2 hours after the 1st dose, and also due to the intake of vitamin C (300 mg.) followed after ½ an hour by the intake of 75 g. dextrose.

Changes in dextrose content of blood after 2 doses of dextrose.		Changes in dextrose content of blood after a dose of vitamin C, followed after ½ an hour by 75 g. dextrose	
Time of examination of blood	Percentage of sugar in blood in mg.	Time of examination of blood	Percentage of sugar in blood in mg.
After 12 hours' fast	108	After 12 hours' fast	108
½ an hour after the intake of the 1st dose of 75 g. dextrose	174	½ an hour after the intake of 300 mg. vit. C and just previous to the ingestion of 75 g. dextrose	96
1 hour after " "	148	1 hour after the intake of vit. C (<i>i.e.</i> ½ hr. after the intake of dextrose)	110
1½ " " " "	137	1½ hrs. " " "	121
2 " " " "	128	2 " " " "	103
40 mins. after the intake of the 2nd dose of 75 g. dextrose	155	2½ " " " "	108
2 hours " " "	119	3 " " " "	92

TABLE II

Showing changes in the percentage of dextrose in mg. in the blood of R. R. after 12 hours' fast due to the intake of 75 g. of dextrose in 2 doses as in Table I, and also due to the intake of vit. c. (500 mg.) and 75 gm. of dextrose simultaneously.

Changes in dextrose content of blood after 2 doses of dextrose.		Changes in dextrose content of blood after a dose of vitamin C & 75 gm. of dextrose simultaneously.	
Time of examination of blood	Percentage of sugar in blood in mg.	Time of examination of blood	Percentage of sugar in blood in mg.
After 12 hours' fast	84	After 12 hours' fast	93
½ an hour after the intake of the 1st dose of 75 g. dextrose	125	½ an hour after the intake of 500 mg. of vit. C and 75 g. dextrose simultaneously	141
1 hour " " " "	150	1 hour " " " "	104
1½ " " " "	84	1½ " " " "	98
2 " " " "	76	2 " " " "	108
½ an hour after the intake of the 2nd dose of 75 g. dextrose	79		
1 hour " " " "	95		
1½ " " " "	77		

TABLE III

Showing changes in the percentage of dextrose in mg. in the blood of K. S. M. after 12 hours' fast due to the intake of 75 g. of dextrose in 2 doses as in Table I, and also due to the intake of vitamin C (300 mg.) and after ½ an hour 75 g. dextrose.

Changes in dextrose content of blood after 2 doses of dextrose.		Changes in dextrose content of blood after a dose of vitamin C followed ½ an hour after by 75 g. of dextrose	
Time of examination of blood	Percentage of sugar in blood in mg.	Time of examination of blood	Percentage of sugar in blood in mg.
After 12 hours' fast	107	After 12 hours' fast	140*
½ an hour after the intake of the 1st dose of 75 g. dextrose	177	½ an hour after the intake of 300 mg. vit. C and just previous to the ingestion of 75 g. dextrose.	136
1 hour " " " "	132	1 hour after the intake of vit. C (<i>i.e.</i> ½ an hour after the intake of dextrose)	142
1½ " " " "	138	1½ hrs. " " " "	129
2 " " " "	134	2 " " " "	118
40 mins. after the intake of the 2nd dose of 75 g. dextrose	150	2½ " " " "	115
2 hours " " " "	112		

It will be observed that after the 2nd dose of sugar the rise of blood sugar in all these cases has been distinctly less than after the 1st dose. This was expected. If vitamin C be ingested half-an-hour before sugar (*vide* Tables I and III), thus allowing it to be absorbed before sugar begins to enter blood in large amounts, the rise of percentage of blood

* The subject had a fasting level of 107 mg.% blood sugar on the previous day. This marked increase in the percentage of the fasting level of blood sugar to 140 mg. on the following day raised suspicion regarding his fast for 12 hours previous to the collection of blood in the morning for estimation of sugar, but on enquiry it was learnt that the subject had very great worry and anxiety on the previous night in so much that he practically passed it sleeplessly. That extreme worry and anxiety cause a marked rise in blood sugar due to liberation of adrenaline is well-known and the present observation amply confirms this fact.

sugar is markedly less than after the ingestion of the 1st dose of sugar alone, and may even be less than after the ingestion of the 2nd dose of sugar. If, however, vitamin C be ingested along with sugar and even in greater amounts, the rise of blood sugar is distinctly greater than when vitamin C is ingested even in smaller amounts half-an-hour before sugar, but the level of blood sugar is brought down quickly (*vide* the percentage of blood-sugar occurring one hour after the ingestion of dextrose alone and one hour after the ingestion of sugar and vitamin C in Table II). It is to be noted that while vitamin C prevents the abrupt rise of blood-sugar caused by the ingestion of glucose, particularly if the vitamin be taken sometime before glucose there may be a subsidiary small rise of blood-sugar after it has definitely begun to fall (*vide* Tables I and II). This is probably due to the rapid excretion of vitamin C from blood through urine and sweat. This, of course, requires confirmation by estimating vitamin C in blood simultaneously with sugar, so that the exact relationship between vitamin C content and the sugar content of blood may be ascertained.

Several problems emerge out of these experimental results. First, how does vitamin C prevent the abrupt rise of blood-sugar after its ingestion? If it be solely through the liberation of insulin, then the subsidiary rise cannot be explained. Secondly, if it has any direct action, then the R. Q., liver glycogen and the N₂ excretion through urine require to be studied, for these will show whether its action is similar to that of insulin, *i.e.*, vitamin C may also cause disappearance of sugar of blood by increasing oxidation and glycogenesis and reducing gluconeogenesis in which case N₂ excretion through urine will diminish. Experiments are in progress in the laboratory to record further observations about these interesting results, to find out the mode of action of the vitamin and to assess the vitamin C requirement of humans in view of these observations. These observations have opened up a vista of possibilities with regard to the treatment of diabetes.

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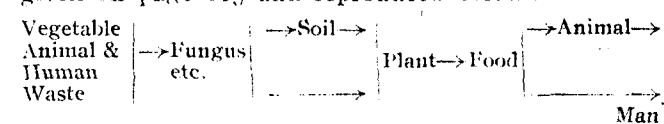
Adequately to review a book of this calibre is a task of no small responsibility. In the first place the volume comprises some 250 pages of closely printed matter, every paragraph packed with carefully reasoned discussion. Its theme has furnished occasion for a full dress debate in the House of Lords. Superficially it is concerned with the relative merits of organic and mineral fertilisers. Fundamentally the discussion involves the future, in the first place of England, and ultimately of world civilization, since life itself depends on the maintenance of soil fertility. The care and competence with which the subject is presented has caused one reviewer to describe the book as among the greatest achievements of women in modern science.

The trouble with regard to discussions on soil fertility, as in so many other regions of debate, has been false simplification, at any rate over-simplification. In the case of agriculture it is necessary to consider the great influence of Liebig who as long ago as 1840 emphasised the essentially chemical nature of crop production. The simplification here was the belief that by returning to the soil the chemical elements found to be present in the ash of growing plants the necessary balance of intake and output was maintained. Even in regard to possible fermentative changes taking place in the organic matter present in the soil, or added to it in manure, Liebig's explanation was still essentially physico-chemical rather than biological. His great influence dominated agricultural research for many years being evident at the great Rothamsted Experimental Station founded by the benefactions of Lawes & Gilbert, themselves supporters of the Liebig school of thought. Later the bacteriologist came into the field particularly in regard to the nitrogen cycle, the biological origin of nitrogen fixation and of the nitrification of ammoniacal products being clearly shown to be due to the activity of specific bacteria. It appeared simple therefore to add the necessary mineral constituents of plant food to the soil, sulphate of ammonia in particular, or nitrate of soda, taking a prominent place. So much was this the case that, as is well known, Sir William Crookes in 1898 gave out the warning of a possible nitrogen famine and stressed the growing need for nitrogen conservation. Largely in response to this, modern methods for nitrogen recovery from the air have been developed and quite recently India's need for a nitrogen recovery industry has been strongly emphasised and

already preparations are being made for its establishment. Nevertheless the error or over-simplification is still present.

As the title of the book under review implies, the soil is not simply a mineral storehouse, but a world of living inhabitants each pursuing its specific vocation, and to a large extent mutually interdependent, and whose proper functioning may easily be upset by uninformed interference on the part of "exploiters" of the soil. "Exploitation" means the avoidance of Nature's necessary "Law of Return" which was at any rate partially recognised by Liebig so far as purely mineral constituents of plant food were concerned.

The contents of the book under review comprise a close discussion of each stage in this far from simple life cycle, which may be summarised in the diagram given on page 103 and reproduced below:



Among these stages special emphasis is laid on the most recently observed link in the chain, viz., the *mycorrhizal association* of fungus and plant root. It is this relation which is largely at the basis of the claims made for the special value of "Compost" as against all forms of mineral or synthetic fertilisers. According to the mycorrhizal theory these types of fungi attach themselves to the finer roots of the plant and the hyphae actually find their way into the vascular stream of the plant in question and are there digested, thus affording protein food to the plant instead of the simplified inorganic compounds hitherto supposed chiefly to contribute its sustenance. Opposite page 68 are shown actual photo micrographs of root sections and various plant cells including those of tea. Both organism and digested hyphae are shown within the cell.

The direct evidence for the mycorrhizal activity is largely based on the researches of Dr Rayner (published in *Forestry*, 1939) who has investigated the action of these fungi on pine roots in Wareham Forest, Dorset.

The wider significance of these researches has been emphasised by Howard. With the assistance of Dr Rayner and others it has been found that a very large number of different types of plant exhibit this mycorrhizal association including such important crop plants as cotton, grapes, hops and sugarcane.

Besides the fungi taking part in this mycorrhizal association it has been shown that other types known

as *predacious fungi* play an active part in destroying pests such as eel worm. Reproductions of drawings are given on Plate XI showing the actual fungal mycelia enveloping the eel worm.

The undoubtedly beneficial effect of organic matter, particularly of *compost*, is believed to be due to the maintenance of fungal activity which it ensures. Against this contention it has been claimed that crops grown purely on mineral nutrients e.g., in water culture, the so-called 'hydroponic' processes, are as prolific and healthy as those grown under normal conditions. It is here that the crux of the discussion is located. The supporters of what may be termed shortly organics vs. minerals say that the question cannot be decided simply on quantitative results, that while e.g., it is possible to increase the normal yield of rice by the application of minerals, it may be found on the other hand that a corresponding increase on the normal amount is required to satisfy the appetite of the consumer.

Moreover the more subtle attribute of *quality* comes into the discussion. Thus a case is mentioned where during a seasonal glut a van load of humus grown cabbages, obviously of special quality, was easily disposed of, while the unsaleable offerings sent on the same day by other growers to the same market were ultimately consigned to the compost heap.

Beyond the comparatively simple question of the satisfaction of appetite and possibly of aesthetic sense is the even more important if debatable factor viz., the effect of the method of culture of food crops on *disease resistance*, both of the crop itself and of the animals or men by whom it is consumed. Evidence is brought forward to show that prolonged sustenance on food raised largely on mineral fertilisers, and at any rate on food which has been "processed" during its journey from the soil to the consumer, results ultimately in decrease of positive health, if not in the production of definite disease.

In addition to all these important matters for discussion is the physical effect on the *soil itself* of any disturbance in the right relations of its living population. Apart from fungal and bacterial activity it is well known that *worms* are very sensitive to change in alkalinity or acidity, and excessive treatment with mineral fertilisers tends to reduce if not to eliminate the worm population. The results of worm activity were long ago shown in Darwin's classical volume in which he describes most graphically the industry of worms not only in loosening up the soil, but in devouring and digesting fallen leaves and cellulosic matter and finally ejecting worm casts held together by excretory protein matter. The effect of worms both in increasing the porosity of the soil, and at the same time producing a satisfactory water

retentivity, can hardly be exaggerated. Remarkable statistical data are given in the book. Thus it is stated that as many as eight million earthworms may be found in a single acre and that their burrows are capable of penetrating the subsoil to a depth of five or six feet.

If the actual nature of the soil is to be impaired or destroyed the results must be *erosion* and lamentable figures are given showing that modern methods—not of agriculture, but of "exploitation" of the soil—have destroyed more soil since 1914 than in many centuries.

It is clear therefore that unless the whole question is ruthlessly taken in hand and impartially investigated many apparently admirable plans for food production and social welfare may go sadly awry. The layer of fertile soil which holds the line between civilization and its final destruction is desperately thin.

The lines of the old water courses of "Nineveh & Tyre" are still visible from the aeroplane speeding over the deserts of Mesopotamia. The cheap food of the "Industrial Revolution" is ultimately paid for by the "dust-bowls" of Western North America.

The whole question is of such importance that as already mentioned it has been discussed at some length by knowledgeable speakers in the House of Lords, and at the present time a long term investigation has been set on foot in what is known as the Haughley Experiment.

In this Experiment to be carried out at the Haughley Research Farm in Suffolk, 200 acres are available of which 94 are devoted to what may be termed *humus farming*, organic fertilisers being used, and 88 acres to the equivalent use of mineral fertilisers. The Research Farm with its attendant buildings and laboratories is under the control of the Haughley Research Trust, with Lady Eve Balfour as farm manager.

Ten years of continuous work are planned watching the food cycle from man and animal through plant and soil back once more to animal and man. As a result it is hoped that the following five propositions, arising from the researches and observations discussed in the book, particularly those of Sir Robert McCarrison and Sir Albert Howard may be definitely answered:—

1. The primary factor in health or the lack of it is nutrition.
2. Fresh unprocessed natural whole foods have the greatest nutritive value.
3. Fresh foods are more health promoting than preserved foods.
4. The nutritive value of food is vitally affected by the way in which it is grown.

5. An essential link in the nutrition cycle is provided by the activities of soil fungi and for this and other reasons the biological aspects of soil fertility are more important than the chemical.

Already satisfactory preliminary work has been carried through, concerned particularly with the bringing into order of the two areas of land, so that the conditions of experiment may be strictly comparative. If as a result of this experiment there should be a general return to humus farming another health problem will soon be on the way to a solution, viz., the economic and healthful disposal of towns' wastes both water-borne sewage and what is generally known as dry or dust bin refuse, or as "katchra" in India.

There is a temptation to enter into greater detail than is possible in a review. It must be sufficient to emphasise that no statement is made in the course of the lengthy discussions occupying with descriptions and illustrations nine chapters and a postscript which is not fully substantiated by carefully documented presumptive evidence, incomplete though some of it may be, and subject to further investigation at Haughley and other centres. There are twelve full or double page plates reproducing photographs of field or pot experiments or of microsections of plant tissue, twelve figures and diagrams illustrating compost making, Haughley Research Farm arrangements, statistical diagrams, etc. Ample and detailed technical references are supplied together with a bibliography and what is very welcome in a scientific discussion intended to be read by laymen or non-specialists, a *Glossary* of the special scientific terms used in the course of the presentation.

The book should be available not only in the library of every agricultural college but in every free library where it can be studied by intelligent and public spirited general readers. For it is more than a specialist discourse, it is a call to the service of humanity.

G. J. F.

'Nutrition'—By Dr W. R. Aykroyd. Published by the Oxford University Press in the series 'Oxford Pamphlets on Indian Affairs', May, 1944.

No subject is more to the fore today than nutrition. 'Through diet a new level of health can be attained, enabling mankind to develop its capacities to the fullest extent.' The correlation between quality of diet and health and physique has been beautifully brought out in the famous experiments of McCarrison at Coonoor. McCarrison's results show that the marked differences in the physique of the people of the different provinces in India were mainly due to the differences in their diets. Faulty diet is the cause of deficiency diseases in people and

of much ill health not sufficiently severe to be classed as disease. Food will occupy a key position in post-war reconstruction. It is essential, therefore, that all the relevant facts should be assembled in good time to put before the public and legislators. A hearty welcome should therefore, be given to Dr Aykroyd's latest book, 'Nutrition', a recent addition to 'Oxford Pamphlets on Indian Affairs'.

After a brief introduction the author gives a short discussion of the dietary requirements of man and only refers to the accepted standards drawn up by authoritative organizations like the Technical Commission on Nutrition of the League of Nations and the National Research Council of America. Dr Aykroyd does not mention the actual amounts of different food constituents recommended for different age groups as also the special dietary needs of different classes. The reviewer would have welcomed a short discussion of this point. Dr Aykroyd summarises the recommendations in the following words, 'In terms of actual foods, this means a high intake of milk and milk products, meat, fish, vegetables and fruit and a relatively low intake of cereals.'

Then follows a survey of the food situation in India. Two well-known and distinct methods are used to estimate the nutrients available per head. On the one hand the amounts of food grown within the country plus the amounts imported enable a calculation of the nutrients theoretically available per head of the nation. The degree of reliability of the results of this method depends on the precision of the knowledge of the amounts of food produced in the country and also of the amounts of food in the country at any time. The second means of gauging continuously the national nutrition is the method of the domestic diet surveys which indicate the food consumed per head of the family. The figures from the diet surveys show broadly the effectiveness of food distribution.

In considering the food production data in India the Gregory Committee in its admirable report had pointed out that the data on the production of food was imperfect and Dr Aykroyd also is fully conscious about it. It has been pointed out in the Gregory report and also by Dr Aykroyd that none of the Indian States, which comprise some 47 per cent of the total land area in India, publish any production figures. While area statistics are fairly reliable, the same cannot be said about the standard normal yield per acre and the condition factor, all of which together determine the figures about annual yield. Ultimately all production statistics in India are based on information supplied by the village chowkidar unlikely to aim at scientific accuracy. Every one will agree with Dr Aykroyd when he says, "Caution is, therefore, necessary in using such statistics for any but the roughest estimates. Accurate statistics

are the life-blood of government; in their absence all planning for the future is handicapped. Improvement in methods of collecting food production data is of essential importance to India." Available figures for the production of various crops like rice, wheat, millets, barley, maize, milk and milk products, nut and oil-seeds, fruits and vegetables, meat, fish, eggs and sugar are given. The total annual yield of cereals, millets, barley and similar grains is estimated to be about 60 million tons of which rice contributes about 28 million tons and wheat about 10 million tons. The total quantity of cereal grains at present produced in India is barley sufficient for the human population. When the requirements for seeds and for cattle and poultry are taken into consideration which Dr Aykroyd does not, the existing production of cereals will not cover requirements. The production of all other items is, as is pointed out by Dr Aykroyd, hopelessly inadequate. 'Imports and exports of food in normal times were small in relation to indigenous food production', says Dr Aykroyd. The only important import of food was Burma rice, supplemented to a small extent by rice from Thailand and Indo-China, amounting to some 4.5 per cent of the total rice supply. "It is quite clear that at present there is no margin of safety for the bulk of the population. 'Agricultural and import statistics', the author points out, 'indicate in a general way the nature of the Indian diet. They show that the main food of the country is cereal grains and that other foods are produced in relatively small amounts. They show that the per capita production of milk is small. Even a rough scrutiny of the food supply justifies the deduction that the national diet is defective in quality and does not conform to standards generally accepted by nutrition workers. Although Dr Aykroyd is not quite certain, the reviewer is definite that quantitatively also the food is insufficient.'

The conclusions about under—and mal-nutrition among the people of India from production and import data are fully corroborated by 100 diet surveys carried out so far in different parts of India. 'In a diet survey a sample of the population is selected and the quantity of all foods consumed by each family over a given period is weighed by trained investigators who make daily house to house visits.' A considerable margin of error is inevitable in analysing the results of dietary surveys. Such surveys however, are the best available means of getting information on the highly important question of the extent to which people of the different classes and in different parts of the country are under-nourished. A brief description is given of diets based either on rice, wheat, millet or tapioca and we shall give Dr Aykroyd's conclusions in his own words. 'Some of the groups included in the surveys were grossly under-fed. * * * Can we venture any tentative esti-

mate of the proportion of the population which is under-fed in normal times? The author's estimate is 30 per cent (the reviewer would put it higher). * * * But, by and large, there is no doubt that a high percentage of the population does not get enough to eat.' Deficiency of fat, calcium and vitamins A, B complex, C and D are the main defects of Indian diets.

Vital statistics and the incidence of deficiency diseases and other manifestations of malnutrition are discussed later in the pamphlet but the reviewer is of opinion that a discussion of this should have followed immediately as this also supplies information on the existence and extent of under- and mal-nutrition. The infant, maternal and general mortality rates in India are high and are the direct effects of faulty and insufficient diet. It is pointed out that a number of well-known vitamin and mineral deficiency diseases are found in India.

In a discussion of the economics of diet Dr Aykroyd points out that in India as in other countries, increase in income leads to an improvement of diet in the right direction. He, therefore, pleads that a rise in the national per capita income will per se tend to improve standards of nutrition. The reviewer would ask, if that is possible without industrialization.

The rapid increase in the population in India and its bearing on the nutrition problem is very ably discussed. The pessimists are of opinion that efforts to improve the diet of the Indian people are futile as the maximum possible increase in the production of food will not keep pace with the growth of population and that public health measures will precipitate the crisis of over-population. On the other hand it is pointed out that utilisation of culturable waste, development of irrigation and land reclamation schemes and steady revolution in agricultural methods leading to increased yields can enable food supply to keep pace with or outstrip population growth. The ability of the country to maintain an optimum population depends upon its agricultural, as well as commercial and industrial wealth. The Malthusian thesis has been completely falsified and England is faced with a rapid fall in population. It is pointed out by Dr Aykroyd that the well-to-do in India are having fewer children and probably the process would spread to lower-income groups.

Having defined the problem Dr Aykroyd proceeds to give his suggestions with regard to its solution. Spread of knowledge of nutrition throughout the whole community is mentioned as the first requisite. The application of scientific planning to the nation's food calls for a better understanding by the public of the elementary principles of nutrition. Administrators, doctors, public health workers,

school-teachers and children—all these and many others must learn about nutrition.

Need for paying special attention to the nutrition of 'vulnerable groups' which include expectant and nursing mothers, infants, pre-school and school-children is then rightly stressed. If the available supply of milk is insufficient for the entire population, they should, the reviewer feels, have priority over others. The organization of school-feeding schemes is recommended.

Dr Aykroyd then insists that agricultural policy must be planned to correct the deficiencies in the diet of the population. The cereal production should, according to him, go up by 15-20%, pulse production by 15-25%, sugar production by 10-20%, milk, vegetable and fish production by 100%. The reviewer feels that our objective should be the provision of an optimum diet for all, irrespective of income, and plans should be laid to reach the objective by forced march, stage by stage, within a specified period of time. One would have welcomed a reference to the need for fertilisers, better seeds, better irrigation, crop-rotation and prevention of soil erosion. The reviewer does not agree that large-scale development of poultry-farming in India scarcely seems a feasible proposition.

One would have welcomed a reference to the need for the production of synthetic vitamins and vitamin concentrates on a large scale. Vitamin defi-

ciency states of various kind and degree are common in India and unquestionably large sections of the population would be benefited in health by taking synthetic vitamins. The administration of vitamins can be combined with that of minerals like calcium and iron.

The processing of perishable foodstuffs during local and seasonal gluts facilitates their storage and distribution and helps to maintain an even flow and price throughout the year. One had expected a paragraph about the need of a well-developed food industry producing a variety of processed foods.

Proper distribution of foodstuffs is as important as production. One, therefore, misses a reference to this, as well as to the importance of communal feeding. A rapid development of communal feeding is going on in Russia and in Great Britain. Catering for people in large groups is not only economical in food, fuel and man-power, but also provides a good opportunity of improving the nutritional status of those fed.

But these are small faults to find with a work that so ably reviews the nutritional situation in India. Dr Aykroyd has succeeded in producing some very readable pages and the pamphlet will be very valuable to all who wish to keep abreast with the problem of nutrition in India.

K. P. B.

LETTERS TO THE EDITOR

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

ALGAE IN THE CRETACEOUS OF THE NARBADA VALLEY

During the microscopic study of the Bagh limestones, with which the present author has been busy for some time past, an interesting suit of well-preserved fossil algae, has been discovered. The family Corallinaceae is represented by *Archaeolithothamnium* (Fig. 1), while, *Dissocladella*, *Indopolia* and *Orioporella* (?) represent the family Dasy-cladaceae.

As in South India¹ and Assam,² association of these families again in the Narbada Valley Cretaceous is to be noted with interest. While the present discovery of these fossil algae thus, makes an important addition to our knowledge of their distribution in space and time, it provides another line of evidence for determining the age of the Bagh Beds, from which the present author³ has already described a rich invertebrate fauna.

A full account of these fossils will shortly be published elsewhere.

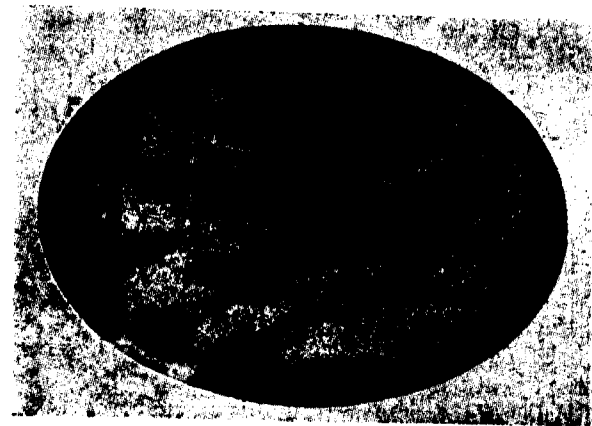


FIG. 1

The author is much thankful to Mr Rama Nagina Singh for his valuable help.

G. W. CHIPLONKAR.

Department of Geology,
Benares Hindu University,
Benares, 10-4-1944.

¹ Rama Rao, L. and J. Pia—*Pal. Ind.* (n.s.), 21, Mem. 4, 1936.

² Sripada Rao, K.—*Proc. Nat. Acad. Sci.* (B), 13, No. 5, 1943.

³ Chiplonkar, G. W.—*Proc. Ind. Acad. Sci.* (B), 6-15, 1937-42.

CHEMICAL INVESTIGATION OF *CYPERUS ROTANDUS* AND *CYPERUS SCARIOSUS*

Cyperus rotandus (N.O. Cyperaceae) grows abundant throughout India and Ceylon in moist soil. It is found in most other hot countries as well. Its vernacular names are Motha (Beng., Hind., Guj., Marathi)—Mustaka—(Sans.). The bulbous roots of the plants are used as a diaphoretic, diuretic, and carminative agent. Along with other drugs it is recommended for dysentery. Rao and Hedji¹ isolated an essential oil from the plant. In our investigation besides the essential oil we have found an alkaloidal body giving positive tastes with Mayer's, Dragendorff's and Wagner's reagents. The base could not be crystallised but the following salts were prepared, hydrochloride m.p. 126°, picrate m.p. 170°, platinum chloride 110-112°. The alkaloid is a very weak base and is very susceptible to decomposition specially in alkaline media.

Cyperus scariosus known as Nagar Motha in Bengali, Hindi and Urdu is also widely used by Ayurvedic and Unani practitioners. We have detect-

Oil from	Yield	Density 300	Ref. Index 300	Optical rotation
I. <i>C. scariosus</i> (distilled at Benares)	0.075%	.9876	1.495	nil*
II. <i>C. scariosus</i> (at Kanauj)	0.080%	.9874	1.4892 to 1.4890	nil*
I. <i>C. rotandus</i> from Rhizome (Rao & others)	.65—.75	.9784 to 1.0009	1.5129 to 1.5132	23.0 to 35.5
II. from roots (Rao & others)	.94	.9827	1.5117	11.2
III. from tubes (Mysore) (Rao & others)	.45 to .61	.9831 to .9843	1.5055 to 1.5060	11.8 to 9.8

* No optical rotation could be detected in a 3% sol. in chloroform.

Cyperus scariosus

	Acid value	Ester value	Acetyl value
I.	14.7	38.28	161.7
II.	12.5	39.48	156.4

Cyperus rotandus

	1.1 to 11.3	4.9 to 20.1	63.3 to 84.0
I.	10.9	6.3	82.4
II.	8.1 to 10.11	4.8 to 8.9	87.4 to 100.8

ed an alkaloidal body giving positive tests with Dragendorff's, Wagner's and Mayer's reagents. We could only prepare a picrate, m.p. 102-103°. It is a very weak base.

However, we have obtained a volatile oil from this plant by steam distillation which differs considerably from that obtained from *Cyperus rotandus* in its physical and chemical constants. The oil has got a pleasant odour not unlike that from *Khas*.

We reproduce above the constants of the oil isolated by us from along with the constants of the oil from *C. rotandus* (Rao & others).

The solution containing the acetylated oil (from Benares) after determination of its saponification value was rendered alkaline with sodium hydroxide and distilled in steam. The distillate was saturated with sodium chloride, extracted with ether and dehydrated over anhydrous magnesium sulphate. The dry oil thus obtained (d_4^{20} .9918; n_D^{20} 1.494) reacts with metallic sodium showing thereby the presence of free alcohol.

Further work is going on in the Department and would be published in due course elsewhere. The authors want to record their thanks to J. N. Kapoor, a third year student of this Department for distilling the oil first in the Department and then in his own works at Kanauj.

N. K. BASU

Department of Pharmaceutics,
Benares Hindu University,
Benares, 5-5-1944.

¹ Rao and Hedji, *J. S. C. I.*, 54, 387-89, 1935.

"VENEZUELA GRASS"

In the *Statesman* of July 21, 1943, there appeared a short note from Shillong to the effect that, the Agricultural Department, Assam, was "conducting experiments with a grass obtained from Venezuela* in S. America which, it is said, drives away mosquitoes, ticks and snakes and at the same time provides pasture for cattle." Neither the Department of Agriculture, Assam, nor the Imperial Council of Agricultural Research has so far given

the botanical name of the grass. From a note published in the *Indian Farming* for December, 1943 (pp. 632-633) it would appear that in the absence of any other name the grass has been named by the Assam Agricultural Department simply as "Venezuela grass".

Through the courtesy of the Assistant Fibre Expert, Bengal, this Department received a small quantity of the seed in August last. The grass raised from this seed flowered freely in our garden and we found it to be *Melinis minutiflora* Beauv.; this determination has since been confirmed by the authorities of the Royal Botanic Garden, Sibpur. The plant is a native of Tropical South America, Africa, and Madagascar and is known as "Molasses grass". It will be interesting to note that in Angola it is believed to be inimical to the dreaded tsetse fly, the bite of which causes sleeping sickness.^{1,2} By virtue of its priority the popular name "Molasses grass" ought to replace the newly coined name "Venezuela grass".

S. K. SEN.

Department of Biology,
Dacca University,
28-7-1944.

* The Secretary, Imperial Council of Agricultural Research, however, states that the seed was obtained from Jamaica.

¹ Bews, *The World's Grasses*, pp. 223-224, 1929.

² Bailey, *The Standard Cyclopaedia of Horticulture*, p. 2026, 1935.

A NOTE ON ELECTROLYTIC INTERRUPTERS

WEHNELT^{1,2,3} was the first to devise an electrolytic interrupter with a lead plate as cathode and the tip of a platinum wire as anode. Later on Caldwell and Simon in their modification replaced the platinum wire by another lead plate. We, under necessity, started with these known types and tried a number of other sets of electrodes of lead (L),* platinum (P), plated tin (T), carbon and copper etc. However, only the following pairs worked. (Table I).

The observations taken in the present case, most of which are visual and qualitative, indicate that the working of the electrolytic interrupter is governed by (i) the diameter of the glass tube enclosing the anode lead rod, (ii) the diameter of the hole, (iii) the length and the diameter of the platinum wire, (iv) the current, (v) the potential difference (P.D.) across the two electrodes, (vi) the temperature of the electrolyte and (vii) the concentration of the electrolyte. In the case of most of these factors it has been observed that there exist limiting lower and higher values below and above which the interrupter stops working altogether. Now practically all the other factors, ex-

TABLE I

S.N.	Cathode	Anode	Remarks
1	L	P	(Wehnelt type). The platinum wire is soon burnt away.
2	L	L	(Caldwell & Simon type).
3	L	L with P	This is the most satisfactorily working type and most of the observations have been taken with this interrupter.
4	L	T	The length of the spark obtained with the T-electrodes is comparatively less but more intense than with the first three types. The working of the interrupter with the T-electrode is however, more satisfactory except for that
5	L	T with P	(i) the T-electrodes are soon burnt away, forming probably stannic oxide, and the black residue falling down chokes the hole which is necessary for the production of the interruptions, (ii) some bad smelling gas, probably SO ₂ , is evolved with great rapidity and (iii) the noise produced is much louder. These defects render the use of the T-electrodes for an appreciable time, practically impossible.
6	T	P	
7	T	T	
8	T	T with P	
9	T	L	
10	T	L with P	

cepting temperature and hence also the P.D. across the electrode (because the P.D. across the electrodes seems to be a function of the temperature of the electrolyte and goes on increasing with increase in the latter), can be given suitable working values at will. The temperature of the electrolyte (and hence the P.D. also), however, goes on increasing with time and finally, exceeding the upper working value, stops the working of the interrupter altogether within 20 to 30 minutes of its start. For a constant use of the interrupter for hours together, therefore, a cooling arrangement, which can maintain the temperature of the electrolyte to a maximum of about 50°C, is necessary.

Different current-values have got different satisfactory working ranges of the temperature and the P.D. The upper limiting values of the temperature and the P.D. are nearly the same for all the values of the current used; only the lower limiting values go on shifting to lower and lower values as the current is increased.

The most important factor is the diameter of the hole used. At a particular temperature a very small change in the value of the diameter of the hole brings about an enormously great change in the value of the P.D. which in its turn affects the working of the interrupter to an equally great extent. At a parti-

cular temperature and current, the P.D. across the electrode is very much higher but less steady with smaller than with bigger holes.

Other two points of importance that need mention are that (i) a hole, though not necessarily at the anode as suggested in the literature, is a necessity (there may be one hole at any one or both of the electrodes) and (ii) the platinum wire of the anode need not protrude through the hole; on the other hand, it is better to keep it centrally above the hole within about 2-5 mm. of it.

The exact mechanism of the working of the interrupter is not clear. It seems, however, that the interruptions are produced by the periodic sheathing and unsheathing of the hole by the gas bubbles produced during the working of the interrupter.

Details will be published elsewhere.

Our thanks are due to Prof. R. K. Asundi.

LALJI LAL

Department of Physics,
Benares Hindu University.
3-8-1944.

* L-electrodes used were cylindrical lead rods.

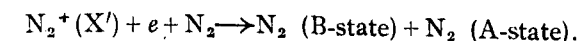
¹ *Dictionary of Applied Physics*, 2, 1078-79, 1922.

² *Electricity and Magnetism* by S. G. Starling, p. 448, 1924.

³ *X-Rays* by G. W. C. Kaye, pp. 66-onwards, 1926.

IONISATION IN ACTIVE NITROGEN

THE author of this note in two recent communications has put forward and substantiated the hypothesis that active nitrogen is simply the positive ions of nitrogen in the N₂⁺(X') state produced by the discharge.^{1,2} The glow of the gas with its characteristic first positive bands was attributed to the excitation of the molecules by a three-body collision process as follows:



According to the hypothesis, therefore, the ionisation and the glow are intimately associated. In the present note results of certain experiments on ionisation in active nitrogen as observed by Rayleigh and by Constantinides will be considered and it will be shown that while these receive easy explanation on the proposed hypothesis, their interpretations by any other theory lead to difficulties and contradictions.

The experimental results are the following:

(1) Ionisation is always associated with the glow; the decrease of the one is accompanied by the decrease of the other.³

(2) The glow and the ionisation persist even after the glowing gas from the discharge tube has been

drawn through a pair of electrodes, with a strong electric field across them, with a view to "trap" any of the ions surviving from the discharge.⁴

(3) Ionisation current flowing between a pair of metallic electrodes immersed in active nitrogen is not the same for all metals; under similar conditions copper electrodes carry about six times as much of ionisation current as electrodes made of other metals.⁵

Experimental result (1) is an obvious consequence of the proposed hypothesis. Since the glow is caused by recombination of ions and electrons the intensity of the glow will diminish with the decrease of the concentration of the ions and electrons.

Experiment (2) is usually interpreted, on the assumption that the "trap" has removed all the ions and electrons coming from the discharge, as showing that the ionisation is produced by the active nitrogen. It is, however, not easy to envisage the mode of ion production. The only ways by which the ionisation can be produced are: (a) by the photo-electric action on the metal electrode by the light of the glow, (b) by photo-ionisation of molecules by same and (c) by energy imparted to N₂ molecules by active nitrogen. Experimental tests on (a) made by Rayleigh definitely exclude the possibility of photo-electric effect.⁶ As regards (b) and (c) we note that the minimum ionisation potential of N₂ is 15.58 e.v. And, spectroscopic evidence show that extreme ultraviolet radiation of wavelength sufficiently small corresponding to this potential is not emitted by the glow. Spectroscopic evidence also show that the maximum energy which the active N₂ molecule can impart to another atom or molecule is only 9.5 e.v.⁷ It is therefore clear that the ionisation cannot be produced by the glow. One is thus forced to the conclusion that the ion trap in experiment (3) is ineffective and that the ionisation in the glow is derived from the discharge. According to the proposed hypothesis this is possible as follows: We recall that according to the hypothesis the long life of active nitrogen is due to the reduction of the 'wall-effect'. This, in other words, means that only a small fraction of the electrons and ions proceeding towards the walls is able to contact the surface and recombine thereon with the glass acting as the catalyst. Now, the electrode surfaces of the ion-trap immersed in active nitrogen also become 'conditioned', at least partially, and, as such, prevent the access of the ions and the electrons on to them. The ions and electrons drawn from the discharge thus pass through the electrode system placed to trap them, and are present in the space beyond. In fact, the ionisation current flowing between such electrodes will only be a small fraction of that which would otherwise flow if the electrode surfaces were normal and unconditioned. It also follows that if the glow-

ing gas be drawn successively through two "traps", the ionisation current flowing between the second electrode system would be hardly affected if a field be applied across the first pair. This is what was observed in the experiment of Constantinides.⁴ Two electrode systems, each consisting of a pair of coaxial cylinders were placed end on and the glowing gas from the discharge tube was drawn through them. It was found that the ionisation current between the second pair was decreased by only 2 per cent when a strong field was applied across the first, though the length of the first pair of electrodes was 1.4 times that of the second pair.

The fact that metal surfaces held in active nitrogen are conditioned is shown by experiments of Rayleigh on the incandescence of metals in it.⁸ The metal piece becomes incandescent if it is not too far from the direct discharge or if it is slightly warmed. The interpretation of the experiment is that the metal is ordinarily unaffected because it is 'conditioned'. Only when the conditioning is destroyed by heating or by the surface being brought close to the discharge that reaction on its surface starts and the metal becomes incandescent by the heat of recombination of the electrons and ions.

Experimental result (3) is easily understood if the very natural assumption is made that different metals are "conditioned" to different degrees in active nitrogen. Indeed, it would have been surprising if it were otherwise. According to the explanation given above, electrodes made of metals which are conditioned to a lesser degree will carry comparatively large ionisation current. Such metals, because they permit electrons and ions to contact the surface, will also have comparatively greater destructive effect on active nitrogen. Experiments show that copper is destructive of active nitrogen to a greater degree than other metals;⁹ electrodes made of copper therefore carry more ionisation current than those made of other metals.

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¹ Mitra, S. K., SCIENCE AND CULTURE, 9, 49, 1943-44; *Nature*, 154, Aug. 12, 1944.

² Rayleigh, *Proc. Roy. Soc., A*, 86, 56, 1911; 180, 123, 1942.

³ Constantinides, P. A., *Phys. Rev.*, 30, 95, 1927.

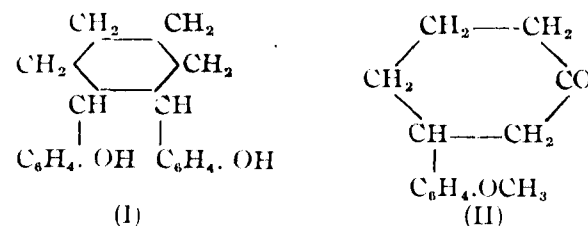
⁴ Rayleigh, *Proc. Roy. Soc., A*, 180, 123, 140, 1942.

⁵ Okubo, J. and Hamada, H., *Phil. Mag.*, Ser. 7, 5, 372, 1928.

⁶ Rayleigh, *Proc. Roy. Soc., A*, 178, 1, 1940; 87, 302, 1912, see also Ref. 3.

SYNTHESIS OF 1, 2-DI-P-HYDROXYPHENYL-CYCLOHEXANE.*

RECENT developments in the field of synthetic oestrogens have stimulated renewed interest in the search for new substances of useful oestrus response having structures closely resembling that of 4, 4'-dihydroxy- α , β -diethylstilbene and its hydrogenation product 4, 4'-dihydroxy- γ , δ -diphenylhexane. With this object in view, we have prepared 1, 2-di p-hydroxyphenyl-cyclo-hexane(I) by a method, which has been described below.



Potassium salt of ethyl p-methoxyphenylcyanoacetate was condensed with ethyl δ -iodovalerate, when diethyl α -cyano- α -p-methoxyphenyl pimelate (b.p. 215-220°/6 mm.) was obtained in good yield. The cyanoester was hydrolysed by prolonged refluxing with concentrated hydrochloric acid and the resulting crude acidic product was esterified by the usual alcohol sulphuric acid method. Diethyl α -p-methoxyphenylpimelate (b.p. 206-208°/6 mm.), thus obtained, was cyclised by means of sodium dust in dry benzene, but as the cyclised product could not be distilled without decomposition, it was hydrolysed, without further purification, by refluxing with an excess of 20 per cent sulphuric acid. 2-p-Methoxyphenyl-cyclohexanone passed over as an oil on purification by distillation in vacuum and solidified on standing. (m.p. 92°, semicarbazone—m.p. 157°). Grignard reagent prepared from p-bromo-anisole and magnesium was reacted with the above ketone and the resulting crude carbinol was dehydrated by heating with fused potassium hydrogen sulphate at 180° to yield 1, 2-di-p-methoxyphenyl Δ^1 -cyclohexene (b.p. 210-212°/5.5 mm.). 1, 2 Di-p-hydroxyphenyl-cyclohexane, which was obtained by catalytic hydrogenation of the above cyclohexene derivative followed by demethoxylation of the latter by refluxing with constant boiling hydrobromic acid in glacial acetic acid solution, melted at a range of 174-178° and seems to be stereochemically impure.

Further, we intended to prepare 1, 3-di-p-hydroxyphenyl cyclohexane by a similar method, using 3-p-methoxyphenylcyclohexanone (II) as the starting material. Previously there had been a claim for the synthesis of the latter by us.¹ But now we have found the compound prepared by us to be retaining an ethylenic linkage adjacent to the carbonyl group in the cyclohexane ring. It was observed during the repetition of these experiments that the

semicarbazone of the final ketone developed colouration on standing. Similar observation was already on record by Simonsen *et al*² in the case of the semicarbazone of synthetic cyperone, where similar groupings are present. Consequently this ketone was subjected to hydrogenation in presence of platinum oxide catalyst and was found to absorb one molecule of hydrogen and the resulting product yielded a semicarbazone (white) melting at 183-184° (shrinks at 180°) as different from that of the unsaturated ketone which melted at 217-219°. It is probable that the lactone of 1-carbethoxy-2-p-methoxyphenyl-2-hydroxypentane-5-carboxylic acid, which was treated with zinc and caustic alkali for furnishing the appropriate pimelic acid, had escaped reduction.

Further confirmation of the recent observation together with the details of works carried out with 3-p-methoxyphenyl-cyclohexanone will be published elsewhere.

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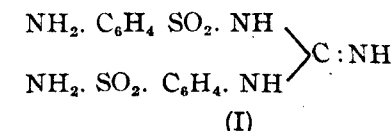
* In view of the recent publications of the attempted synthesis of 1, 2-di-p-hydroxyphenyl cyclohexane by Price and Muller, (*J. Am. Chem. Soc.*, 66, 628, 632, 1944), we have placed on record the work carried out by us on the same.

¹ *J. Ind. Chem. Soc.*, 17, 573, 1940.

² *J. C. S.*, 1576, 1937.

A NEW SULPHAGUANIDINE

RECENTLY considerable interests are being directed towards sulphaguanidine as it is being largely used in the treatment of bacillary dysentery. The drug has, however, certain drawbacks—such as its higher dosage and comparative insolubility that prevents its parenteral use in urgent cases¹



In search of some suitable sulphaguanidine derivative, we have obtained the compound—sulphanilyl-(p-sulphonamido-phenyl)-guanidine (I) by reacting sulphanilyl cyanamide² with p-amino-benzene-sulphonamide itself in molar proportions at a temperature of 180°C. The compound is readily soluble in dilute acid as well as in alkali. It crystallises from boiling water in slender needles, m.p. 215°. The activity of the compound is being studied *in vitro* against

various dysentery organisms in presence of p-amino benzoic acid.

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¹ Hughes, *Brit. Med. Jour.*, 1, 691, 1941.

² Winnek *et al*, *Jour. Amer. Chem. Soc.*, 64, 1682, 1942.

THE EFFECT OF HEAT TREATMENT ON THE K-ABSORPTION EDGE OF ZINC IN ZINC SULPHIDE

It is reported that zinc sulphide, when freshly prepared by the method of precipitation, is not luminescent; but it becomes so after being heated at 900°C for half an hour. Differences of opinion exist as to the exact cause of the luminescence of zinc sulphide. Seit¹ interprets the blue luminescence of this compound in terms of the interstitial zinc atoms, but this interpretation has been criticised by Randall² and others in several respects mainly because the existence of these atoms has not been demonstrated experimentally.

The effect of chemical binding on the X-ray absorption edge has been the subject of many investigations and it is now known that even the K-absorption edge of an element undergoes slight shift in the pure state and in compounds. The presence of interstitial zinc atoms in a sample of zinc sulphide (heated at 900°C) is, therefore, expected to affect the position and width of the K-absorption edges of zinc and sulphur in the zinc sulphide crystal and the effect on the K-absorption edge may throw some light on the question of these interstitial atoms.

In the present investigation, therefore, the K absorption spectra of zinc sulphide freshly prepared and heated at different temperatures have been photographed; positions and widths of the absorption edge have been measured in each case with the purpose of studying the effect of interstitial atoms, if any, on the K-absorption edge.

The electron type of the metal X-ray tube fixed to a spectrograph as devised by Siegbahn has been used in the investigation. The slit through which X-rays enter the spectrograph is covered by an aluminium foil of thickness 0.009 cm. to separate the high vacuum side from the spectrograph. The well-known Bragg method is adopted for focussing with a calcite crystal. The distance between the centre of the crystal and the plate holder in this spectrograph is 17.5 cm., which gives a dispersion of about 16 X.U.

per mm. in the photographic plate in the region studied. The plane calcite crystal is rocked to and fro by an auxilliary motor through an angle of 15° both ways from the proper reflecting angle. An oxide coated 'dull emitter' has been used as the source of electrons.

For the absorption screen the samples were finely powdered and an emulsion of the powder in a gelatinous solution of celluloid in acetone prepared; this emulsion poured on a clean glass surface evaporates into nice absorption screens. The optimum thickness could be obtained by a few trials. For heating the sample, electrical heaters made of nichrome wires were used. The temperature of the heater was measured with the help of a calibrated thermocouple and could be varied by adjusting the current in the circuit. During heating, proper precaution was always taken to prevent oxidation of the sample. The anticathode used was of copper; the Cu $K\beta_1$ (1389.35X.U.) and the platinum $K\alpha_1$ (1310) could be taken as reference lines. Measurements were made on the microphotometer curves; dispersion on the microphotometer record is 2.4X.U. per mm. The measurements are given in the table which is self-explanatory.

TABLE I
WAVE LENGTHS IN X.U.

	beginning of edge	position of edge	End of edge	Width	Shift from Zn metal
Zn. metal	1286.36	1275.75	1289.05	10.6	
ZnS at 30°C.	1289.94	1275.24	1282.54	14.7	2.49
ZnS heated to 500°C.	1289.42	1275.20	1282.31	14.22	2.26
ZnS heated to 590°C.	1289.03	1275.05	1282.18	13.98	2.13
ZnS heated to 1000°C.	1285.71	1275.6	1280.86	11.32	0.81
ZnO	1284.5	1279.1	1381.8	5.4	1.75

In discussing the results insufficiency of data is immediately apparent. The beginning of the absorption edge in metallic zinc is at 1286.36X.U. and

the width is 10.6X.U. For samples of zinc sulphide at room temperature and heated to 500°C and 590°C it is found that the position, width and the beginning of the edge remain unchanged within experimental error. For the sample heated to 1000°C, these are no longer the same but suffer a change, and the change is in every respect towards those of the metallic zinc. These results may be taken at least qualitatively as an indication of the existence of some free zinc atoms in the lattice; of course it must be admitted that further detailed investigations are necessary to settle the question finally.

Our thanks are due to late Prof. B. B. Ray, D.Sc., Khaira Prof. of Physics, Calcutta University for granting facilities of work in his laboratory.

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¹ *Trans. Farad. Soc.*, p. 83, 1939.
² *Ibid.*, p. 85, 1939.

BALANCING OF CHEMICAL EQUATIONS

The above letter by Mr R. Parshad was published (SCIENCE AND CULTURE, 10, 95, 1944) through inadvertence, as such methods of balancing chemical equations are quite well-known and are found in many text books of chemistry. For instance, we may draw the attention of the author in this connection to the Textbook of Physical Chemistry by James Walker (1919 Edition).

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NEED FOR A CENTRAL BUREAU OF STANDARDS

THE subject of standardization, especially the development of the methods of standard specification of industrial and commercial products, has so far received scant attention in this country. At a time when plans for the creation of a number of central laboratories, such as the National Physical Laboratory, the National Chemical Laboratory, the National Metallurgical Laboratory, the Glass and Silicate Research Institute and the Central Fuel Research Station are being discussed and some are already in the process of being executed, it is curious that so little attention is being paid to the all-important question of specifications and maintenance of standards in this country. The establishment of these laboratories, we are given to understand, will provide the necessary scientific background needed for the post-war industrialization of India. But the efficiency of that process, it need hardly be added, requires simultaneous development of organizations for the specifications and maintenance of standard work which is now in a state of hopeless muddle and neglect. Varied and sometimes conflicting standards, not infrequently lacking proper scientific basis, are in use in India and have sometimes become even a retrograde factor in the healthy growth of industries and the smooth operation of commercial transactions. One clearly perceives the paramount need of standardization work in all fields of a country's activities—agricultural, industrial and commercial, and it is high time that the attention of the Government, the industry, scientists and experts concerned were focussed on this question. Elsewhere in this issue we publish an article to indicate more fully the scope of such standardization work and the ways in which such work is being conducted in other countries, notably the U. S. A., and the United Kingdom.

In India we have several purchasing agencies. Apart from the activities of the present Supply

Department, which is purely a war emergency organization, the Indian Stores Department since 1921 been doing all the purchase and inspection of materials on behalf of the various civil departments and railways and has drawn up a number of specifications for various materials (I.S.D. specifications) in collaboration with the Government Test House, Alipore.

The Railways have got their own specifications called the Indian Railway Standard specifications (I. R. S.) to guide them in their purchases. The Railway Board has got a standardizing section called the Central Standard Offices and draws up the I. R. S. specifications through the agency of its committees in close collaboration with the Government Test House, Alipore, and the Indian Stores Department.

The Master General of Supplies has his own specifications (M. G. S. Specifications). The War Department follows the B. S. Specifications and the Air Ministry Material Specifications (D. T. D. specifications) in addition to its own specifications (I. M., T. and R. I. A. S. C. specifications). Other bodies like the Corporations, Municipalities, District and Local Boards, and Indian States adopt any one of the non-military specifications, particularly the I. S. D. specifications, according to their convenience.

The private consumer in many cases is ignorant of all these apparently confusing specifications and is content to be at the mercy of traders and their trade marks.

The present war has introduced further confusion and complications due to the dearth of proper materials, and the springing up of a host of war emergency specifications. Adulteration in foodstuffs is very commonly practised owing to utter lack of any control or standardization in these essential commodities.

As regards weights and measures, nowhere do we find so much confusion as we find in India, and

standardization and verification of local weights and measures constitute an urgent problem.

Some beginning in standardizing work has been made in certain fields. The Agricultural Department, through its Marketing Boards, has been doing useful work in the grading of commodities, such as, eggs, fruits, tobacco, oilseeds etc. agricultural dairy and poultry products bearing the "AGMARK" stamp are considered to be standardized goods. Some textile goods are now coming under standardization as a result of war conditions. There is a standardizing laboratory at the All India Institute of Hygiene for drugs standardization. The I. S. D. and the I. R. S. specifications have done some useful work by laying down standards for certain types of materials for the guidance of manufacturers and consumers. We may, however, add that Metallurgists and Chemists Sub-Committee of the I. R. C. A. has nothing to do with standardization and that the Paints Committee (N. 5 Standing Committee) of the C. G. I. is doing war emergency work of no permanent value.

Various Imperial Conferences have stressed the necessity of co-ordination within the Empire of the nationally agreed specifications, and the desirability of establishing one central national standardizing body in each of the commonwealth units. Most of the Dominions have already established their own standardization organizations. But India, which is the biggest unit in the British Empire has not so far attempted to establish its own central standardizing body capable of co-ordinating the huge mass of heterogeneous work that is going on in this sub-continent.

Some years back, we understand, the Government of India was actually negotiating to have a central standardizing body, similar to those established in the other units of the British Empire, but subsequently it was thought that the creation of a separate body for this specific purpose alone was not financially justified. It was hoped that in the near future a standardizing department could be established at least as an adjunct to an already existing Government Scientific Institution.

It has been the experience of those, engaged in the testing of materials against specifications, that the insistence on rigidly following foreign standard specifications, such as the B. S. Specifications, is not only unnecessary under Indian conditions but is sometimes detrimental to the free development of industries in this country. Numerous instances could be quoted in which the conditions of testing with regard to temperature, humidity, and other atmospheric conditions, and also the limits of chemical composition of the materials in relation to the particular raw materials used, require substantial modi-

fications to suit Indian conditions. Certain raw materials, which otherwise would not have been utilized industrially have now been considered suitable as a result of investigations carried out in some of the existing Government laboratories.

The few engineering and technical institutions existing in India, such as the Institution of Engineers (India) and the Institution of Chemists (India), have not been developed to such an extent as to take up independently the work of standardization and drawing up of specification, as is being done by similar bodies in England and America.

At present there is no central organization in India to deal even with the B. S. Specifications as, and when they are referred to India for suggestions and improvements. Sometimes they are circulated to a few institutions like the Government Test House, Alipore, and a few isolated experts in the country, through their local agency, the Institution of Engineers (India). The Institution of Engineers, as it is at present, is not expected to be very much interested in many of the specifications, referred to them and consequently no organized or substantial co-operation in the framing of these B. S. Specifications is possible. The universities and technical and learned bodies in India do not appear to be interested either on these matters.

The present consciousness that is being roused in industrial research and allied matters in this country will, we hope, bring about a better appreciation of this important subject which is intimately connected with industrial progress.

Industrial research itself is of recent origin in India. The present war has given an incentive to speed up industrial research, due to the cutting off of supplies from foreign countries, and the consequent search for temporary substitutes.

The Council of Scientific and Industrial Research in India is an organization which is trying to organize its activities on the same lines as the Department of Scientific and Industrial Research (D. S. I. R.) of England. Under its auspices various laboratories are carrying out a large amount of industrial research work and it is now proposed to have a number of research institutions (previously mentioned), established in India.

The National Physical Laboratory which is expected to be established soon in one of the important scientific centres of India will, it is expected, be mostly concerned with industrial research in subjects similar to those dealt with by the National Physical Laboratory of England excepting some of the branches like metallurgy etc., which are to be specialized in separate institutions. But unless testing and standardization work is also included in

its principal activities or unless by scientific arrangement with the National Physical Laboratory it is concentrated in an existing institution, such as the Government Test House, Alipore, where testing, standardization, and specification works in limited fields are already being carried out, it will not have the same complexion or the same importance as the National Physical Laboratory of England, so far as industrial standardization work is concerned. Moreover, the proposed National Chemical Laboratory in India may be established at a different place and as such may not be an adjunct of the proposed National Physical Laboratory, as is the case with regard to the National Physical Laboratory and the Chemical Research Laboratory, both situated together at Teddington, and consequently, full standardization work, both physical and chemical, cannot be expected to be carried out efficiently in either one of these proposed individual laboratories; the Government Test House, however, has facilities for both physical and chemical work.

In England, the British Standard Institution is there to collect data and co-ordinate the results obtained at various centres of work, and the National Physical Laboratory is the most important Government institution where standardising work is actually being carried out.

In India, where non-official technical institutions are poorly equipped for this kind of work, a combined institution where both these things could be done without running into heavy expenses is the most desirable at present.

This can be easily achieved if an existing institution like the Government Test House, Alipore, which has got experience in testing, standardizing and framing of specifications in a limited field, is

pressed into service. This can be done either by actually establishing the proposed National Physical Laboratory at Alipore, or by making the standardization work exclusively a responsibility of the Government Test House.

It can expand its activities in the following ways:—

(1) To arrange for test programmes in connection with the drawing up of specifications.

(2) To carry out investigation and research work in order to standardize materials to suit particularly Indian conditions.

(3) To collect data and co-ordinate the work carried out at different places, and also to be in touch with the various technical institutions and learned societies in the country, and draw up specifications.

(4) To prepare chemical standards for use as standards and references in India. To maintain correct standards in weights, measures and instruments for standardizing apparatus used for measurement of heat, electricity, etc.

(5) To standardize methods of testing and analysis in order to ensure uniform results in various testing laboratories, and to develop new methods, whenever possible and necessary; X-ray and spectroscopic analysis, fluorescence method of testing, micro-chemical and semi-micro-methods, spray tests and other new methods for determining the efficiency of metallic coatings, spot tests, and a host of special methods and technique, which are being put to use in other countries, are to be developed here and standardized.

A Central Bureau of Standards of this type, if established in India, would be of immense help not only for the industrial development but also for the progress of industrial research in India.

STANDARDS AND THEIR SPECIFICATIONS

(Contributed)

IN ancient and medieval times, standards of quantities in every day use were in a state of utter confusion. Almost every State, nay every city, had its own standard of length and weight, and it is now one of the tasks of the antiquarian to find out the exact value of many of these ancient standards of length and weight. Thus the English standard yard is supposed to represent the measure of the distance between the tip of the nose and the end of the middle finger of the fully outstretched hand of some ancient English king, possibly Edward I. The first scientific attempt to put weights and measures on a scientific basis was made during the French Revolution, when the metric

system was introduced and the Bureau des Poids et Mesures was established with the object of defining these standards, maintaining them, preparing secondary standards, and working out for the whole country a uniform system of weights and measures. Other countries followed in the wake of the French, some quickly, others more tardily.

Since the rise of the scientific age, hundreds of new measuring devices have been coming into operation, such as thermometers, electrical meters, gas and water meters etc. Hundreds of new commercial products are being put in the market, and they all require 'standard specification'.

WHAT IS 'STANDARDIZATION'?

"Standardization means setting up standards by which extent, quantity, quality, value, performance and service may be gauged".* In all fields of a country's activities—agricultural, industrial and commercial—standardization is of paramount importance. Weights, measures, agricultural products, manufactured goods, building materials, hardware, fuels, paints, textiles, drugs, nay every article that passes through the hands of the producer, the seller and the consumer, need some sort of standardization. This standardization applies particularly to industrial and commercial products.

Tracing the development of standardization in England, we find that the beginning of industrial standards in that country was made by Sir Joseph Whitworth who in 1841 introduced his standards for screwthreads and plane metallic surfaces.

In 1895 one Mr H. T. Skelton, a London engineer and merchant, drew the attention of the public to the numerous variety of steel sections and the consequent loss to manufacturers and merchants through locked up capital in plant and unremunerative stocks.

In 1901 the Council of the Institution of Civil Engineers formed a committee of six to draft standard forms of iron and steel sections. This was the real beginning of the regular standardization work in engineering and industry in England.

Standardization work on industrial products mainly comprises the following:—

- (1) Standardization of nomenclature and symbols.
- (2) Simplification of types and sizes including standards set up to secure interchangeability of parts.
- (3) Standardization of the quality of the materials.
- (4) Setting up of standards for construction and workmanship.
- (5) Standardization of machinery and apparatus for purposes of comparison.
- (6) Standardization of methods of testing and analysis of materials.
- (7) Preparation and maintenance of standards for reference work and comparison.

Products should be standardized so far as is consistent with progressive development of manufacturing and should be standardized to the fewest practical kinds, sizes and grades.

ADVANTAGES OF STANDARDIZATION

The various advantages derived from standardization need hardly be over-estimated. It stabilizes production and employment and reduces cost of production as well as the selling price (the latter is possible through the reduction in advertising ex-

penses). Since the process of standardization is carried on in the light of the latest scientific development, it eliminates faulty practices depending on traditions and accidents, promotes general efficiency and acts as a powerful stimulus to research and development. It promotes fairness in competition and minimizes litigation. It develops healthy foreign trade and facilitates the work of purchasing agencies. The availability of ready standards for reference and comparison promotes industry and trade and makes possible a sympathetic co-operation between the manufacturer and the consumer not only in one's own country, but between country and country, through national and international standardizations adopted by mutual agreement. For a detailed account of the various advantages the reader may be referred to 'Encyclopaedia Britannica.'

WHAT ARE SPECIFICATIONS?

The drawing up of specifications constitutes a very important part of the work of any standardizing organization. Standardization in its ideal form is generally undertaken at the request of industries, or by associations representing such industries in a country. But in places where these are not properly developed, the initiative is to be taken by the State itself. There should be sympathetic co-operation between the producer, the consumer, and the State in arriving at agreed standards. Physical properties, measurements, strength of materials, chemical composition, workmanship, details of inspection, tests etc. are stipulated in the form of a specification—laying down certain limits. Such nationally accepted specifications safeguard purchasers by ensuring a generally suitable quality and performance at a reasonable price. There should not be any coercion on the part of the framers of the specifications, and the initiative for producing better designs should not be curbed, and for this there should be periodical revisions of specifications by mutual agreement. A specification generally lays down the best acceptable performance observed in a particular product, arrived at by committees of persons who represent science, industry, business and also consumers.

Standardization concerns mostly with the fixing up of conditions for the best performance of a group of similar materials. It does not, however, aim at ideals, or the production of the best or the most costly material. The performance of any article and its requirements depend to a considerable extent upon the place, time and circumstances and conditions of its use. For instance, during war time, when articles are expected to give maximum available efficiency during a limited period and have often to be manufactured with unusual raw materials, the quality of

the manufacture may be allowed to vary from those stipulated in ordinary specifications. In such cases we have what are called emergency specifications, adopted for the time being. Similarly, for different climates with different temperature and humidity conditions, particular specifications have to be modified. So also, in cases where different types of raw materials are available for manufacturing a certain product, there ought to be a variation in the specification to suit the raw materials.

Therefore, any specification framed for a particular product or commodity in a particular country may not always be found suitable for another country where conditions are different.

INDUSTRIAL STANDARDIZATION ORGANIZATION

The work of an Industrial Standardization Organization can be broadly divided into the following sections:—

- (1) Actual work on standardizing a product by studying the best performance of a group of similar articles. This involves a considerable amount of research and investigation work.
- (2) Drawing up of specifications in consultation with manufacturers, businessmen and consumers.
- (3) Maintenance of standards, e.g., (i) precision instruments, for measurement of weight and volumes and for measurements of units of heat, electricity, light, magnetism etc. (ii) chemical standards, and standard samples of certain finished products for reference work.
- (4) Standardization of the methods of testing and analysis.
- (5) Co-operation in international standardization, for promotion of healthy international trade.

In all industrially and scientifically advanced countries, we find two sets of organizations working separately but co-operating with each other in standardization work.

The first set comprises the various technical and engineering Associations where membership is open to producers, businessmen, consumers, scientists etc., who are interested in the advancement of industries and industrial research. Their finances are mostly derived from subscriptions from members and industries, and from sale of publications.

These Associations co-operate with one another and form into a national body which is independent of Government, though enjoying its support. This body collects data, appoints committees, and issues specifications for the benefit of the public.

The second type comprises Government Departments where research and investigation work connected with scientific and industrial matters is carried out. Standardization work and certain research programmes connected with the framing of specifica-

tions are mostly carried out in these Government laboratories. The heads of these laboratories and institutions and other members of the staff are closely associated with and represented on the councils of the national organizations and collaborate with them in framing specifications.

The British Standard Institution in England and the American Society for Testing Materials (A.S.T.M.) are examples of the first type.

The National Physical Laboratory and Chemical Research Laboratory, Teddington (England) and the National Bureau of Standards, Washington (U.S.A.) are examples of the second type. Unlike the National Physical Laboratory and the Chemical Research Laboratory, Teddington, the National Bureau of Standards, Washington, frames specifications and commercial standards on behalf of the United States Government.

A brief account of the working of these standardizing institutions in Great Britain and in America will now appear in what follows.

STANDARDIZING INSTITUTIONS

There are about 21 National Standardizing bodies in the British Commonwealth and other foreign countries. The most outstanding organizations in the English-speaking countries are (1) the British Standards Institution, (2) The National Physical Laboratory, Teddington, (3) The Bureau of Standards of the Department of Commerce, U.S.A. and (4) The American Society for Testing Materials.

THE BRITISH STANDARDS INSTITUTION

The British Standards Institution is the National Standardizing Organization of the United Kingdom and it issues the British Standard Specifications (B. S. Specifications). It is an independent body in the closest touch with industrial requirements and modern technical knowledge, and enjoys the fullest Government support but is free from Government control. It co-operates with the Central Standardizing bodies in the various parts of the British Commonwealth of Nations, is in direct touch with the standardizing bodies in foreign countries, and participates directly or indirectly in the work of international standardization in industrial matters. It is a development of the Engineering Standards Committee, which was formed in 1901 by the joint action of the different Institutions of Engineers, and consisted of only eight members.* The British Standard Institution has now more than 700 different com-

* Out of this Committee was born the British Engineering Standards Association (B. E. S. A.) which was subsequently re-named the British Standards Institution. As the specifications issued by the organization cover engineering subjects (both chemical and physical), the change in designation was both appropriate and necessary.

* 'Encyclopaedia Britannica'.

mittees consisting of scientific men, businessmen, industrialists and consumers who give their time and experience freely. Many of the research laboratories and Associations work on certain subjects in close co-operation with this Institution, and in many cases the results of research thus obtained are expressed in the form of British Standard Specifications.

The Institution's funds are mostly derived from contributions from the various industries and sales of publications etc., but the British Government together with the Governments of the Dominions, India, and the Crown Colonies contributes liberally. Also the various Municipal Corporations and Technical Institutions in England subscribe to its funds.

It has four Divisional Councils, namely (1) Building Divisional Council, (2) Chemical Divisional Council, (3) Engineering Divisional Council, and (4) Textile Divisional Council. Each of these councils consist of members representing various interests, official and non-official.

Over these councils, there is a General Council consisting of Chairman, Vice-chairman and members. A certain number of these members are nominated by the following bodies:—

(1) The Board of Trade; (2) The Department of Scientific and Industrial Research; (3) The National Physical Laboratory; (4) The Institutions of Civil, Electrical and Mechanical Engineers; (5) The Federation of British Chamber of Commerce. The others are elected by the four Divisional Councils to represent their various branches. It appoints various sub-committees for different branches of industry and science, and prepares the B. S. Specifications. It undertakes periodical revisions of the specifications if and when necessary. It is also entrusted with the work of preparing what are called the 'British Chemical Standards' for use as standards in all chemical laboratories. From time to time a number of industries and Associations connected with various branches of engineering and industry have approached this Institution for help in their standardizing work, and it has attained a supreme position, as the highest standardizing organization in the whole of the British Empire.

THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON

The National Physical Laboratory at Teddington, near London, is the largest research laboratory in England in physical sciences. Adjacent to it is the Chemical Research Laboratory, supplementing the work done at the National Physical Laboratory in the field of chemical research and investigation of industrial problems. The National Physical Laboratory was founded in 1900, and subsequently incorporated in the Department of Scientific and

Industrial Research in 1918 after the latter body came into existence.

Its functions are controlled by a number of committees e.g.,

- (1) The Committee for Fundamental Research.
- (2) The Electrical units and Standards Research Committee.
- (3) The High Tension Research Committee.
- (4) The Advisory Committee for Metallurgical and Engineering Research on Materials.
- (5) The Advisory Committee for the William Froude Laboratory which is concerned with the investigation of ship design.

One of the purposes for which the National Physical Laboratory was founded was 'to establish and maintain precise standards of measurement'. Even now, out of the funds allotted to general research and the maintenance of standards, more goes to the maintenance of standards than to general research, thus emphasizing its original role as a standardizing institution. A large amount of research is carried out on behalf of the Department of Scientific and Industrial Research, and also for the benefit of the other Government departments and the public. A considerable amount of testing work also is carried out in this Laboratory.

The scientific work of the Laboratory is divided into eight departments, e.g., Physics, Electricity, Radio, Meteorology, Engineering, Metallurgy, Aerodynamics, Ship design Laboratory—each of which is under the charge of a superintendent who enjoys a large amount of freedom in the selection of subjects for research. Most of the departments contain several divisions, each under the charge of a senior officer who in turn also enjoys a certain degree of autonomy in matters of research and investigation.

The National Physical Laboratory, in addition to carrying out research, co-operates very closely with standardizing institutions like the British Standards Institution. This Laboratory, though incorporated now in the D.S.I.R. of England and carrying out researches on its behalf, still maintains its original functions of testing and standardization, and is controlled to a large extent by members nominated by the Royal Society and various other learned and technical societies and institutions in England.

In the Chemical Research Laboratory which was opened in 1925, adjacent to the National Physical Laboratory, varied investigations connected with the chemical industry are carried out. Synthetic resins, paints, low temperature carbonization, high pressure chemical work, corrosion of metals, chemotherapy, water pollution are some of the subjects tackled in its various departments.

THE NATIONAL BUREAU OF STANDARDS, U.S.A.

This was established in Washington, U.S.A. in 1901 by an Act of Congress. Its functions are according to the 'Encyclopaedia Britannica', 'the development, construction, custody and maintenance of reference and working standards, and their inter-comparison, improvement, and application in science, engineering, industry and commerce'. The Bureau is a part of the Department of Commerce, U.S.A. Its services are available without charge to national and State Governments, and under certain conditions, tests and investigations are conducted for the public. It serves as a clearing house for scientific and technical information, and to this end co-operates with similar institutions abroad, and with research laboratories in America. In 1939 its regular staff consisted of 950 employees and 80 Research Associates.

Its work is broadly divided into two sections:—

- (1) Scientific and technical research and testing.
- (2) Establishment of commercial standards including building and housing specifications.

Each is made up of various divisions and sections, each section being the working unit dealing with some specific problems.

Electricity, weights, measures, heat and power, optics, chemistry, mechanics and sound, organic and fibrous materials, metallurgy, and ceramics are some of the important divisions in this organization. The organization and working of this institution is similar to that of the National Physical Laboratory but it appears to cover a greater field in matters of industrial research, testing and standardization than does the National Physical Laboratory.

In addition to this, there is another Standards Department in America called the Standard Weights and Measures Department. Its functions are the custody of the federal standards and verification of local standards, including gas measuring standards and flash point apparatus for petroleum.

The heads of the departments of these Government technical institutions are officially represented on the councils and committees of the various standardizing societies in America.

THE AMERICAN SOCIETY FOR TESTING MATERIALS (A. S. T. M.)

The American Society for Testing Materials was organized in 1898, and finally incorporated in 1902 as a national technical society. Its specific purpose is 'the promotion of knowledge of the materials of engineering and the standardization of specifications and the methods of testing'.

This is being done by (1) presentation of scientific and technical data in the form of papers and discussions, and (2) through the activities of its

technical committees appointed to study the properties of the various materials.

The A. S. T. M. prepares the following:— (1) current standards, (2) tentative standards, (3) emergency standards, (4) methods of chemical analysis of metals and non-metals.

The technical committees are responsible for the development of standard specifications and methods of testing. The members constituting the A. S. T. M. include:— (1) producers of raw materials and semi-finished products, (2) consumers of materials, and (3) general interest groups, comprising engineers, scientists, educationalists, testing experts and research workers.

The funds of this society are mostly derived from subscriptions and proceeds of sales of publications. The most important part of its works is that of standardization as applied to both methods of testing and specifications for materials of engineering. A great amount of authoritative data are brought out by the society either as an adjunct to its standardization work or as the result of independent researches. It has about 60 standing committees which include the most outstanding experts of the country in their technical fields. On its executive committee are to be found the heads of some of the Departments of the National Bureau of Standards, sometimes as President, or Vice-President.

The Committees to develop specifications are made up of producers familiar with the limitations of the manufacturing processes, and consumers fully acquainted with the requirements of the various uses to which materials are put.

Before any standardization is done, some research is carried out to obtain the necessary data, and collaborative tests are done by initiating a test programme to supply the necessary information.

Each A. S. T. M. specification, including methods of testing, is issued in the form of a separate pamphlet on the lines of the B. S. Specifications. But the standards, tentative standards, and emergency standards are published collectively once in three years as the Book of A. S. T. M. Standards, consisting of Metals, (Part I), Non-metallic Materials—Constructional, (Part II) and Non-metallic Materials—General. In addition, the Society publishes A. S. T. M., 'Methods of Chemical Analysis of Metals' and also of non-metallic materials.

The Proceedings of the A. S. T. M. include reports of various committees, and technical papers presented before it along with discussions. Special compilations of standards on the basis of these papers pertaining to specific industries are also published separately. In addition to the above the A. S. T. M. issues many useful technical publications from time to time.

Its specifications have attained as much importance as the B. S. Specifications and are also widely adopted even outside the United States.

ENFORCEMENT OF STANDARDS

It should be added that the institutions above mentioned are not meant to do the policing work. This is done by separate Government departments e.g., the Standard Weights and Measures Department of the Board of Trade in the United Kingdom. Such standards departments act as the custodians of the standards finally accepted by the Government, and their functions include, among other things, 'the periodical comparison of these with their parliamentary copies and verification and re-verification

of local standards and scale beams for local authorities and of any standards submitted by other bodies in this country or by any colonies or foreign countries'. The Department examines and supervises over the work of the inspectors appointed to inspect weights, measures, gas meters etc. It also issues regulations relating to the verification and stamping of instruments, such as weights, to the allowable limits and such other things. It secures that these regulations are strictly carried out and that no infringement of the rules occurs. Similar standard departments are maintained at present in almost all the leading countries and are to be found in Berlin, Paris, Rome, Vienna, Leningrad, Madrid, Washington and elsewhere.

CENTRAL GLASS AND SILICATE RESEARCH INSTITUTE

THE readers of SCIENCE AND CULTURE will recall our editorial and contributed article published some three years ago* when we put forward a strong plea for the establishment of a Central School of Glass Technology. Following the publication of these articles, the Board of Scientific and Industrial Research recommended to the Government of India that a Central Institution for Glass Technology (as envisaged in our editorial) should be established. The Government of India, accepting these recommendations, appointed a Committee to advise the Council of Scientific and Industrial Research in this connection. The report of the Secretary to the Committee (Dr Atma Ram) as accepted by the Committee was considered by the Governing Body of the Council at its recent meeting held at Delhi on 1st August, 1944, and it is hoped that the much needed Central Institute will soon come into being. The Institute is not to confine its activities to glass only; important branches of ceramics, such as pottery and porcelain, enamels and refractories are also included in the subjects for study at the Institute.

The report is valuable for several reasons: It represents a critical analysis of the present status of the industry and reveals that despite strenuous efforts by the industrialists, it has not made the spectacular advances which glass technology has made during the past 25 years. The position of the industry is viewed against the background of the glass and ceramic industry in the advanced countries of the West, particularly the United Kingdom, the United States of America and Germany, and it is shown that in these countries also the industry

during its growth passed through an analogous phase and that Government assistance and technical aid during the past 25 years have led to revolutionary developments which have placed these countries at the vanguard of the world's glass and ceramic producing countries. The report gives a brief account of the varieties of glass and ceramic articles and their numerous applications. The scope for post-war development in India is discussed and it is shown that if the industry is to take its destined place among the major industries, the aid of modern technology which should promote every phase of glass and ceramic manufacture should be enlisted. The most powerful factor in the solution of the numerous impediments to development is *organized scientific research*. One of the important features of the report is the inclusion of several important appendices. The most important of these is the one describing the nature of work done and the part of the technical institutions have played in the development of these industries. The following lines are worthy of note in this connection.

"A review of the progress of glass and silicate industries during the past 25 years, reveals that outstanding developments in the industry are in a large measure due to the labour of physicists and chemists who have solved many problems of great complexity. The engineer has brought about a revolution in the production technique by designing automatic and semi-automatic machinery. A combination of these scientific talents has made at least glass an 'obedient' metal and porcelain a material of far wider utility; the field open for their utilization is now practically unlimited. The notable contribution which these institutions have made to the progress and development of these industries is the establishment of the scientific basis of the manufacturing operations. As a result of systematic studies, they have helped in the production of newer types of articles and in improving the existing technique of production. Above all, they have provided a band of trained workers and have

maintained a consistent supply of trained personnel which is the backbone of modern industries."

The organization of technical institutions concerned with these industries in other countries during the last Great War, has been described in some details. It has been shown that how in the absence of trained men and specialists pure scientists notably Prof. Turner and the late Dr Mellor (both elected Fellows of the Royal Society for their work) developed the Department of Glass Technology at Sheffield and the Mellor Refractories Research Laboratories at Stoke-an-Trent, the leading laboratories in these subjects. We invite the attention of those who always advocate the postponement of the establishment of National Laboratories in India on the plea of war conditions, to those developments that took place during the last war in the country of our rulers. The question of personnel for such institutes is another argument occasionally put forward against their establishment during the war. We reproduce below an extract from our earlier editorial.

"Whenever a proposal is put forward for the organization of such a department, the question regarding the availability of expert technicians is invariably raised. The failure to organize such departments with the help of foreign experts, whether under Government or private bodies, has been amply demonstrated. We feel that India will have to develop such institutions with the help of her own talents. If Turner and Peedle (Dr Peedle was the first research scholar in glass technology under Prof. Turner, and has been largely responsible for the development of optical glass industry in England) in England, Washburn in America, Keppler in Germany, who started their activities in glass and ceramic technology as pure scientists, could develop leading institutions in these subjects, there is every reason to believe that capable Indian scientists and graduates with industrial equipment will succeed in establishing the much needed institution. We should now shake off our inferiority complex and have confidence in the capability of Indian talents. Some people in this country, particularly those in high position are charmed with foreign experts because they think that like magicians of the Arabian Nights Entertainment they should be able to develop an industry overnight with minimum of capital and effort. But the experience of Indian glass manufacturers in this line has not been encouraging."

We should not always look to other countries for supplying us the necessary personnel and should not also expect them to spare their badly needed experts. There is sometimes a tendency to expect spectacular results too early and this may have been the cause of the premature abandonment of many developments. The organization of laboratories takes time and after all the laboratories in other countries were not developed in a day.

PRESENT POSITION

The history of the Indian glass industry has been discussed in several articles appearing in our columns. A remarkable feature of

the industry is that it shows signs of prosperity and progress whenever economic upheavals, such as those prevalent during the present war in Europe and Japan which have prevented these countries from exporting glassware into India. This is a positive proof that the industry has sufficient potentiality to meet the needs of the home market and constitutes a powerful argument for the grant of tariff protection to enable the industry to grow. What public support could do for the industry is clearly and unequivocally demonstrated by the prosperity which the industry enjoyed during the Swadeshi Movement of 1930. These considerations make it clear that there is nothing inherently defective in the industry—but that the industry has never had enjoyed a lay spell of prosperity to enable itself to overcome the difficulties which have blocked progress. The apathy of the Government has contributed in no small measure to this stagnation. The enquiries of the Indian Industrial Commission and the Indian Tariff Board have served to confirm this view. Both these agencies have pointed in unambiguous terms that the industry needs Government aid and that it satisfies the conditions laid down by the Fiscal Commission for the grant of protection. But Government support which would have infused life into the industry and retrieved it from the morass of stagnation has not been forthcoming. In fact, but for the vitality inherent to the industry, a vitality which in no small measure is due to the natural advantage-availability of raw materials, a prodigious home market, cheap and efficient labour and the tenacity of our manufacturers, the industry would have died out in the post-Great War period. What little has been done for the advancement of the glass industry is mostly through non-official agency, such as the Paise Fund. A stage has arrived when further progress will be achieved only through the establishment of one or more research stations for the scientific study of the processes of manufacture, for laying down specifications and for testing the raw materials and finished goods. In fact, the Institute is being established with these functions which are stated to be:—

- (1) As an up-to-date Research Laboratory where knowledge of the fundamental sciences of physics, physical and inorganic chemistry, engineering, etc., will be utilised to solve the problems which face the glass and ceramic manufacturers to-day and are expected to confront them when competition from foreign countries will have to be met,
- (2) As a testing and standardisation laboratory,
- (3) As a clearing house for information and data, and
- (4) Advanced training."

REQUIREMENTS OF THE INDUSTRY

A critical appraisal of the requirements of the industry forms a special feature of the re-

* SCIENCE AND CULTURE, 6, 555-565, 1941.

port. It has been pointed out that information about the raw materials of the industry is meagre. What we do know is that we do not know enough. The question of efficiency of furnaces both for batch making and for annealing has received very little attention. Furnace building is mostly in the hands of mistries who by training and outlook are competent to duplicate existing furnaces and reproduce all the conditions which have made the furnaces wasteful of fuel. Inventions which have contributed to furnace efficiency, which makes all the differences between success and failure, have hardly infiltrated into the Indian industry. The annealing schedules which vary with each type of glass, have not been determined or adopted with the extraordinary result that glassware passes through the annealing kilns but without getting properly annealed. The newer types of articles which have extended the range of application of glass and porcelain in art and industry, are not being produced in the country, even under the stress of war. The optical glass for instance, which enjoys a high priority among strategic materials, has not been produced in India which is a major base of military operations in the Pacific War Zone. There are other problems, e.g., testing and standardization, on which due emphasis has been laid in the report which can be solved only through scientific research.

RESPONSIBILITY OF THE INDUSTRY

It is obvious that the mere inauguration of one or several research institutes will not result in spectacular developments in the industry. The industry should have the will to profit by technological developments and it should have the capacity or ability to absorb and to put into practice new ideas and developments evolved through scientific research. The report reveals that there is a widespread desire among the manufacturers to take advantage of new developments but the capacity to initiate new ideas and

new techniques can be assured only if trained technologists are placed in charge of manufacturing operations. By reason of the size of the country and the magnitude of the industry, the establishment of one central research and training centre through the agency of Government will be totally inadequate. There are day to day problems which the industry itself can solve and the manufacturers should get together and organise co-operative Associations, an institution which has produced such remarkable results in the United Kingdom under the active and vigilant supervision of the Department of Scientific and Industrial Research. If these efforts of the Council of Scientific and Industrial Research are supplemented through tariff protection over a stipulated period so that when the industry is deeply concentrating its attention on consolidation and development, it is not subjected to the paralysing efforts of competition from more advanced foreign countries, the industry will obtain a measure of benign assistance, which will ensure its advancement on sound and fruitful lines and give it the necessary strength to occupy its destined place to major Indian industries of the Post-War period.

From the financial standpoint, the scheme is estimated to involve a non-recurring expenditure of about Rs. 12 lacs and a recurring expenditure of Rs. 1½ lacs in the initial stages, increasing to about Rs. 3 lacs. In view of the total production of these industries being about Rs. 5 crores, the recurring expenditure does even come to *one per cent*. We believe these are very modest estimates and in view of the very important part these industries are to play in the future development and in view of their present unsatisfactory conditions, the Government should provide these funds and the industry should also make its generous contribution. Dr Atma Ram has done a great service both to the industry and the public alike by presenting the case of these important industries in a critical and impartial manner and it is our earnest hope that the proposals embodied in the report will soon be implemented.

IMPROVEMENTS OF RICE YIELDS IN INDIA

S. P. AIYAR

INDIA COMPARED TO FOREIGN COUNTRIES

THE average yield of paddy in India is estimated to be about 800 lb. per acre¹ whereas the yield in Japan, Italy, and Spain is about 3,000 to 6,000 lb. per acre.² One may also quote the phenomenal yield of 10,000 lb. per acre obtained in the valley of the Murrumbidgee River in New South Wales^{3,4}. The

low yield of India has been the subject of much adverse criticism against the Agricultural Departments in India. This criticism may be countered by a reference to the relatively low yield of rice in Java⁵, a country which is a model of perfection in agricultural research. It must also be remembered that in India rice is grown on vast areas of poor land along with good land.

It is a noteworthy fact that the yield of every crop tends to be a maximum towards the coldward limit of its growth. This statement has been verified on a world wide basis by comparison of the yields of wheat, barley, oats, rice, maize, potatoes and several other crops according to latitude.⁵ Many reasons may be suggested for this remarkable advantages possessed by countries in temperate latitudes. These are:

- (a) Industrialization, enabling the liberal use of fertilizers;
- (b) The practical realization of the fruits of advanced scientific research making available superior technical skill and improved varieties of plants;
- (c) Comparative freedom from insect pests and diseases;
- (d) Rotation of crops, made profitable by a highly developed animal industry;
- (e) In many cases, protection of agriculture by the State;
- (f) Favourable temperature and light conditions.

The last factor is, however, by far the most significant.⁶ That the limitation imposed by latitude is a very real one has been verified in Malaya where repeated attempts by the research officers failed to raise the yield of paddy beyond about 3,000 lb. per acre.⁷ This result does not mean that no improvement is possible in India. A great deal remains to be done, however, before the maximum production can be achieved.

GENERAL LINES OF ATTACK

The most valuable contribution may probably be expected to come from the plant breeders in India. There are indications of success but the possibilities have not been fully explored. The handsome yield of 5,000 lb. per acre has been recorded at Coimbatore mainly by the use of the improved strain of paddy GEB '24.⁸ It appears that the limitation imposed by latitude may partly at least be circumvented by breeding methods. An experienced botanist has pointed out that it would be advantageous if in future the plant breeder devoted more attention to the coarser varieties of rice than to the finer rices which now get most of his attention.

The engineer has important contributions to make by providing an adequate water supply to supplement the rainfall. It has been estimated that the minimum annual rainfall required for successful paddy growing without irrigation is about 50 inches.

The control of insect pests and diseases is likely to influence the yield of paddy to an appreciable extent. Unfortunately the crop will have already suffered before the trouble is noticed and control

measures are applied. A great deal remains to be discovered about the factors which predispose the plant to attacks by insects and fungi. There is evidence that the composition of the paddy plant is greatly modified by nutritional deficiencies or excesses.⁹ An increase in sugar content or nitrogen content, for instance, may attract insects and fungi. These are fruitful fields of research and may be left to the specialists concerned.

DISCUSSIONS OF YIELD FACTORS

As is well known, yield is a complex expression of the effect of all the relevant factors. Until all the factors are present in proper proportion maximum yield cannot be obtained. The tendency to oversimplification of the manurial requirements of a crop is responsible for many of the difficulties involved in maximum production.

An increased yield due to the addition of any fertilizer is generally attributed to one of its constituents. This assumption may be correct in a majority of cases but in a fertilizer such as ammonium sulphate the secondary constituent, sulphate, will be effective when there is a sulphate deficiency in the soil. Obviously cheaper substitutes such as gypsum or sulphur will be equally effective in a case of sulphur deficiency. The expensive constituent nitrogen would therefore be wasted in this case and when emphasis is placed on the nitrogen only, the practical man expects results by the use of other nitrogen fertilizers and confusion arises when he fails to obtain an increase in this way.

Again, when a fertilizer produces no effect on yield it is commonly assumed that the added element in the fertilizer is not required by the plant and that the soil is well supplied with this element. Very often, however, the added element is not effective due to the unsuitable form in which it is applied, intensive absorption by the soil or assimilation by microorganisms, or again due to the deficiency of some other factor such as water supply, humidity, minor element, and so on. In fact, a negative result in manuring should not induce complacency but should serve as a stimulus to further research.

One of the chief reasons for the unsatisfactory position in India in respect of information on manuring is the fact that most of the work is done on the trial and error basis by propaganda officers with emphasis on the economic aspects only. Most manurial trials appear to have been restricted to nitrogen and phosphoric acid used in the form of compounds with straightforward composition but often camouflaged under fancy names. Rock phosphate, for instance, is generally quite ineffective, and yet numerous trials are made with it merely because it is marketed under different names. It appears

that agricultural chemists in India are merely called upon to analyse samples of soils, fertilizers and the like, and perhaps asked to tender "advice". The ordinary cultivator rarely asks for advice partly due to lack of education and partly due to lack of faith. One may imagine the position if, say, a thousand ordinary cultivators are asked for departmental advice every year in regard to the manuring of their fields.

The author strongly believes that agricultural chemists should devote more attention to actual plant growing experiments and to a study of the composition and abnormalities of the crop. This work should be done purely from the scientific standpoint as distinct from economic consideration. When a chemist reports that a soil contains a low percentage of, say, phosphoric acid, it is his duty to discover whether the plant growing in that soil suffers from any abnormality and whether the application of phosphoric acid corrects the trouble. Further, if the treatment does not succeed it is also his duty to discover the reasons for the failure and to prescribe additional or alternative treatments. Field demonstrations may then be taken up in collaboration with the District Officers.

The various factors likely to modify the yield may now be considered.

(a) *Effect of Light and Temperature.*—Although experimental control of these two factors may not be practicable in the field it is necessary to take note of them as important factors modifying the yield of paddy. The number of sunshine-hours during the growing season appears to be a varietal constant in paddy. Moreover, paddy is very sensitive to the length of day and, in most cases, flowering is absolutely controlled by the factor. In view of this phenomenon the selection and breeding of varieties must be suited to the light conditions of different localities, particularly the length of day.

High as well as low temperatures may be harmful to paddy. The standing water in a paddy field may easily attain a temperature of 50°–60° during the day, especially in irrigated areas. A low temperature reduces tillering and may prevent flowering but the effects depend on the variety grown.

(b) *Effect of Water Supply.*—The water requirement of the paddy crop is often reported but it does not appear to have been put to any use. A depth of 4-6 inches of water in the field seems to be sufficient for most varieties of paddy. The standing water maintains the soil in proper condition for the crop and also controls the weeds. An important function of water in the paddy field is to maintain a high humidity in the atmosphere which has been stated to be essential for proper pollination in paddy.¹⁰ The question whether a field can produce one crop or two crops of paddy depends ultimately on the available water supply.

(c) *The Soil Factor.*—Apparently paddy is very tolerant of physical conditions in the soil. The main requirement is the ability to retain water. Clay soils are therefore preferred for paddy, though there is the possibility that heavy soils are slow to dry out and may thus delay the ripening of the crop. Sandy soils may be used for paddy growing in regions of high rainfall but such soils should at least have an impervious subsoil under irrigated conditions for economic reasons. Occasionally it is suggested that drainage is essential in paddy soils and that crumb structure is important. These claims seem to be unwarranted in view of the fact that paddy fields are deliberately puddled to render the soil waterproof. The slow surface movement of the water has also no advantage apparently.

Soil reaction of a very wide range is tolerated by paddy. Reports from Japan claim that paddy prefers a fairly acid soil.¹¹ In Sierra Leone paddy thrives at a high acidity.¹² On the other hand, in the Punjab and elsewhere paddy grows well at reactions exceeding pH 8.0. In water culture the optimum pH depends on the composition of the solution, particularly on the relative proportion of ammonium and nitrate-nitrogen. Liming is sometimes recommended for paddy soils of an acid nature but from the limited information available on this problem in India liming is not likely to be useful to the paddy crop even on fairly acid soils. It may be of interest to note that liming of paddy soils was put under Government control in Japan to prevent indiscriminate liming.¹³

The limit for salt content of the soil which can be tolerated by paddy is not known with certainty. The effect of chlorides has received some attention^{14, 15} but the low yields sometimes observed in presence of chlorides may have been due to a deficiency of sulphate. The paddy soils of Sierra Leone contain fair amounts of chlorides whereas workers in Hawaii have reported that chlorides are highly toxic in fairly low concentrations.¹⁶ No injury seems to have resulted in an experiment in which paddy was treated with potassium chloride at 1,024 lb. per acre of soil.¹⁷ Such divergent views may probably be reconciled if the available sulphate content of the soil is also taken into account.

(d) *The Elements of Nutrition.*—The plant depends on the soil for about eleven elements, some major and some minor in regard to the quantities required. In spite of this varied requirements, it appears that the principal demands of the crop are for nitrogen and phosphorus only.

The main facts in regard to the nitrogen manuring of paddy are that this crop prefers ammoniacal nitrogen to the nitrate form, that no nitrification occurs in the paddy field, and that added nitrate may be lost by leaching or denitrification. Of the nitro-

genous fertilizers ammonium sulphate is the most outstanding in its effect while the other chemical ammoniates, such as ammonium chloride, ammonium nitrate, urea, cyanamide, ammonium bicarbonate and others, are poor substitutes for the paddy crop. Apparently the sulphate radical is responsible for the superiority of ammonium sulphate.¹⁸ This observation is supported by the fact that urea mixed with gypsum has given results as good as those given by ammonium sulphate.¹⁹ The organic ammoniates e.g., oil cake, blood meal, green manure and farm yard manure are fairly satisfactory but definitely inferior to ammonium sulphate. Nitrates like sodium nitrate and calcium nitrate are of little use in the field as they are easily lost by leaching, apart from the fact that they do not supply any sulphate.

The nitrogen content of a normal paddy plant tends to be constant at maturity but the actual percentage of nitrogen seems to be of a varietal character. There are thus high nitrogen and low nitrogen paddies. The yield of paddy decreases with increasing nitrogen content of the plant at maturity in any one variety.

A deficiency of phosphoric acid causes the development of certain abnormal features in the paddy plant. Tillering is controlled partly by nitrogen and partly by phosphoric acid.

Phosphate fertilizers are either water soluble like superphosphate or insoluble like bone meal or rock phosphate. There are also many other forms. Superphosphate is universally applicable whereas bone meal is useful only on acid soils with fair amounts of clay. Rock phosphate is quite worthless as a rule.

Potassium does not form any compounds of biological significance within the plant but functions mainly as a catalyst. Apparently limited amounts may suffice as the mobility of potassium within the plant permits repeated re-utilization of the quantity absorbed. Acute potassium deficiency, which may be induced by excess of calcium or undecomposed organic matter, or repeated treatment with fertilizers containing nitrogen and phosphoric acid only may cause abnormalities in paddy but tillering is not much affected.

It is a remarkable fact that potash manures are generally ineffective throughout the tropics even for potash loving crops, whether the potash is applied alone or in combination with nitrogen and phosphoric acid. The inference that tropical soils are well provided with potash cannot, however, be justified from soil analyses. There must be a general reason for the failure of potash to become effective in crop production within the tropics and further research is necessary before this problem can be solved.

In the study of paddy, sulphur has not received the attention it deserves. Like other plants paddy

can utilize only sulphate as a source of sulphur. Under paddy field conditions sulphate is completely reduced to sulphide, or other forms so that deficiency of sulphate must be more widespread than is commonly suspected in the case of the paddy crop. It may be suggested that complete starvation is probably prevented by the existence of secondary reactions. The sulphide may react with ferric iron giving rise to ferrous sulphide which, as is well known, can undergo rapid oxidation to ferrous sulphate from which the paddy plant may obtain both iron and sulphate. The oxygen required for the reaction is probably produced by the action of algae. The vague claim that paddy roots require aeration would thus receive scientific support.

Calcium and magnesium probably play important rôles in the nutrition of paddy but precise information does not exist. Magnesium has been repeatedly mentioned as specially significant for paddy but field evidence is almost non-existent.

Among the minor elements, iron, manganese, boron and copper appear to be essential. Excess of manganese is known to be toxic. Boron and copper are also very toxic except in traces. Root formation is almost completely suppressed by small amounts of copper in water culture. The claim that manuring the crop with copper sulphate gave increased yields must be accepted with reserve. In any case the soil must have protected the crop against injury from copper. Zinc, molybdenum, and cobalt have been found to be useful for certain crops but their significance in regard to paddy remains to be properly investigated.

(e) *Varietal Response.*—Manuring practice must take note of the varietal character. Some varieties respond more than others to manuring. There is at present little information on this subject in India.

(f) *Agricultural Practices.*—There are many practices associated with paddy cultivation. The practice of transplanting is almost universal. Among others one may mention the rab system, silting, burning the stubble, ratooning, encouragement or suppression of algal growth and so on. However, these are of limited significance and are generally restricted to certain localities. There is no uniformity even in such important preliminaries as ploughing and preparation of the land. It has been claimed that early transplanting, double transplanting, and harrowing the crop have given increased yields of paddy.

RECOMMENDATIONS

The above summary is not complete in every respect but it covers a wide field and indicates the lines for further research. At present, however, the main problem is to adopt practical measures. One may recommend the use of high yielding varieties,

the provision of adequate water supply and the intensive use of fertilizers. The difficulty in adopting these suggestions is the inadequate supply of each of the items required.

Even assuming the simplified formula that much improvement in the yield of paddy is possible by the use of ammonium sulphate and superphosphate alone one is faced with the problem of supply. If every sulphuric acid plant in India were to divert its total production of acid to the manufacture of superphosphate from bones for 2 or 3 months a large stock may be accumulated. Ammonium sulphate is a more difficult problem as the existing Indian resources are quite small. Substitutes, such as oil cakes, may be useful but, in the author's view, cannot adequately replace ammonium sulphate.

The quantity of fertilizer to be applied must be adequate for the purpose in view. The minimum rate of application should be between 40 and 80 lb. of nitrogen and phosphoric acid per acre, preferably in the form of ammonium sulphate and superphosphate respectively. It will be useless to apply smaller doses over a wider area if increase in yield is the paramount consideration. It must also be mentioned that manuring the seedbed is of doubtful value for increasing the yield of crop.

While such temporary war time measures are in progress fundamental researches should be initiated to discover the full facts about paddy nutrition and fill up the numerous gaps in our knowledge of this subject. The time is opportune, as war conditions have brought into prominence the insufficient food supply in the country and the weak position of the rice eating areas. It is hoped, therefore, that fundamental researches would receive encouragement and adequate financial support.

CONCLUDING REMARKS

In conclusion, attention may be drawn to the need for improving the methods of carrying out agricultural experiments. At present experiments are laid down on farms and sometimes on cultivators' fields without regard to the soil. A great deal of trouble is taken to satisfy the statistician on the layout, and the significance of any differences produced by treatments is also worked out with care. These are, of course, necessary details in every experiment. The results obtained are, however, of limited application and may not hold good on soils outside the plots actually tested. Field experiments could be made more rational and capable of better generalization by paying attention to the soil. There is now apparently a deep rooted but erroneous idea that one soil is much like another. As typical of this attitude one finds in a recent bulletin on the manuring of paddy published by the I. C. A. R. that the

results of an experiment carried out at Pattambi Farm are assumed to hold good for the whole of Malabar. It will be manifestly absurd to assume that Nagina represents the whole of the U. P., or that Sabour represents the whole of Bihar. To overcome such handicaps a soil map is absolutely essential. This map must be based on the results of a genuine soil survey undertaken to demarcate the boundaries between pedological soil types identified on an objective basis. Unfortunately such a map does not exist at present owing to lack of data and it may be many years before this map takes shape. A limited number of experiments conducted on each soil type can serve to generalize the information for that soil type. The position of a field may be easily identified on the soil map and it is then a simple matter to advise the cultivator on the manuring of his field.

There is another aspect of the soil which must receive attention. Every soil on which field experiments are being planned should be tested to discover the full manurial requirements. This step is carried out partly by analysis of the soil and partly by pot experiments which should include not only the usual N, P, K in all combinations but also other significant elements, such as sulphur, manganese and so on. The treatment rate should be fairly high for major elements, e.g., 80 lb. P_2O_5 per acre. The crop should be analyzed to secure additional information. It must be emphasized that a pot experiment is economical and can give reliable qualitative information on the elements that may have to be added as fertilizers. Again, new fertilizers and fancy fertilizers are best tested in pots for the sake of economy. Pot experiments have been very successfully employed by the author in tracing the causes of certain physiological disorders of paddy.

Much of the antagonism to pot experiments is derived from unsuccessful but unjustifiable attempts in the past to apply these qualitative results to the field without any modification. In fact field experiments are essential to demonstrate and supplement the practical value of the information obtained by laboratory and pot experiments. Having established the manurial requirements for any given soil type, field experiments should be carried out at different centres on that soil type to determine the dosages required to produce maximum yields. The same procedure will have to be followed for every other soil type.

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THE HERBARIUM*

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INTRODUCTION

THE 'Herbarium' means a collection of dried plants or a book containing such pressed plants and also a place where such a collection of plant materials are kept. The word 'Herbarium' used in the modern sense makes its first appearance in print in Pitton de Tournefort's *Elements* of 1694.

The herbalists are considered as the first to recognize the use of dried plants in dealing with herbs for medicinal purposes. This is the utilitarian standpoint of studying plants. The other standpoint from which the plants were studied in ancient times was philosophical as revealed in the writings of Aristotle and Theophrastus. In India records of such a study can be traced from the scriptures and treatises on medical science written by the sages of great antiquity about 2500 years ago.

In Europe the work of the herbalists can be traced to 1470 and evolution of the herbals ended in about 1670 when came the period of renaissance in botanical studies in Europe. The botanical science from this time gradually developed on modern lines and made rapid progress during the last two centuries.

The collections of dried plants hold unique position towards advancing our knowledge of plants, although we owe a deep debt of gratitude to certain branches of arts especially printing and wood engraving of the fifteenth and sixteenth centuries or even earlier. The draughtsman and engraver, indeed, did more than merely disseminate existing knowledge. They lent the botanist their acute and highly trained powers of observations and their work must often have revealed to him much of what he would never have seen without their help. Before the existence of herbarium and the discovery of the art of printing, the herbal tradition in the study of plants passed through a period of 2,000 years from the Hindoo sages and savants to Krateus, the Greek to an old woman "poring over her well-thumbed picture book in an English village."

ORIGIN OF HERBARIUM

The origin of the herbarium can be traced to the Italian botanist Luca Ghini who in 1490 and on-

wards was the sole initiator in the renaissance period of the art of herbarium making. His method of preparation of pressed plants was then disseminated over Europe by his pupils. Luca Ghini was professor of Bologna University and worked at Pisa for some time. He sent dried plants gummed upon paper to Mattioli in 1551. He possessed about three hundred pressed specimens at that period. This collection which must have existed long before 1551 was lost to science, but Luca Ghini's pupil Gherardo Cibo began to collect at least as early as 1532. Among the earlier collectors who possessed herbarium are John Folconer (1553) who travelled in Italy and evidently learned the method of preparing herbarium specimens from Ghini and Turner, Aldrovandi and Casalpino, the three Ghini's pupils, who made good herbarium at this period. Aldrovandi was the first to aim at a collection of dried plants of the whole world. The herbarium of Felix Platter is of great value. Ranwolf established a herbarium in Leyden in 1576. The value of the herbarium specimens as a source of pictures of plants of distant parts of the world was soon realized from this time when the word herbarium meant generally a book of plants or *Flora exsiccata*.

In such an early time Mattioli mentions even the practice of soaking dried plant materials for examination and sketching in order to restore their natural appearance. "Information about the making of herbaria must have transmitted by word of mouth alone for more than seventy years, for it was apparently not until the publication in 1606 of Adrian Spieghel's 'Isagoges', that detailed instructions for forming a collection of dried plants became available in print. Spieghel, a native of Brussels, finally occupied the chair at Padua. In his 'Isagoges'—a general treatise on botany—he explains the method of pressing between sheets of good paper under gradually increasing weights and notes that the plants must be examined and turned over daily. "When they are dry they are to be laid upon inferior paper ("charta ignobilior") and, with brushes of graded sizes,

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painted with a special gum, for which he gives the recipe. The plants are then to be transferred to sheets of white paper; linen is to be laid over them and rubbed steadily until they adhere to the paper. Finally the sheets are to be placed between paper, or in a book, and subjected to pressure until the gum dries."

It is interesting to note that the technique of herbarium making adopted three hundred years ago is more or less followed even in the present time. The science and art of preparing herbarium specimens however has reached a very high standard in these days and various methods and recipe for treating different kinds of plants have been suggested by various workers in different herbaria. The methods of collection and preservation of plants has been dealt with exhaustively by G. N. Johnson with a foreward by Prof. E. D. Merrill, of the Harvard University and Director and Administrator of the New York Botanic Garden and Herbarium in the Arnold Arboretum. This treatise entitled the preparation of botanical specimens for the herbarium was published by the Arnold Arboretum of Harvard University in 1939. It would be too long to discuss the subject here but one point I must impress upon the botanists and amateur collectors that in all cases complete materials should be gathered for identification and study of a plant. By complete material I mean the whole plant with flowers and fruits, where possible, or at least a portion of the plant with flowers, fruits and vegetative parts all in tact. Sterile material is useless for herbarium purposes and proves difficult if not almost impossible, for the purpose of definite determination.

In a modern herbarium is deposited in classified order complete collection of dried plants of a country or different countries of the world. On the sheet of herbarium specimens are noted the specific name of the plant, the name of the locality with elevation from which it has been collected, the habitat of the plant, the name of the collector and the date of collection, the period of flowering and fruiting and other remarks regarding the ecological conditions and economic value of the plant and so on. The value of the herbarium lies in possessing type and co-type sheets, that is, the original specimens of the discoverer of the plant and authentic duplicates of the same. In India such sheets are available only at the herbarium of the Royal Botanic Garden, Calcutta.

THE WORK OF THE CURATOR OF THE HERBARIUM

The officer-in-charge of a recognized herbarium, such as the herbarium of the Royal Botanic Garden, Calcutta, is called the Curator or the Keeper of the herbarium. The curator must be a botanist with special knowledge in systematic botany and taxo-

nomy and should have sufficient training in large herbaria and experience of the work done in the leading herbaria of the world with whom he has to communicate regularly in connection with the scientific aspect of his work. The curator's daily work is to keep constant watch and attention to the preservation and maintenance of the herbarium specimens. This task is really exacting when the herbarium is situated in the tropical atmosphere. Each sheet of specimen requires very careful handling so that a specimen preserved for hundreds of years may not be damaged and thus lost to science. The specimens in a damp climate require also frequent treatment with prescribed chemicals in solution or in powder form to keep off the attack of insects and moulds. The herbarium building must be properly ventilated and should not be too hot and too moist although a little moisture is required for keeping the specimens properly stretched and glued on the mounting paper. Too dry atmospheric condition makes the specimens brittle and susceptible to drop off the sheets. The main scientific work of the herbarium is identification, loan and exchange of materials, supply of various information on the occurrence, distribution, nomenclature and uses of the plant sent for examination and, last but not least, the research work in systematic botany. The work of identification is by no means less arduous than the other items of work. As soon as a plant is received it is recorded in the register and handed over to the expert comparer after ascertaining the family to which it belongs. The herbarium assistants then match the specimen with the one which comes closest to it. The curator then has to examine the descriptions, illustrations of the plant matched and then declare the name of the plant. The name again requires often to be modified in the light of the International Rules of botanical nomenclature. Specimens are exchanged with the various herbaria. Photographs of types and co-type sheets are sent with critical notes and observations on the systematic position of the species of plant to different workers in the various parts of the world. Acquisition of specimens by exploration of unknown and little known areas, writing of floras based on collected materials, ecological study of the vegetation of a country or part of a country, survey and analysis of the flora with a view to silvicultural, arboricultural, horticultural, agricultural and plantation purposes, preparation of regional vegetation maps and so on are some of the important items of work which devolves on the scientific officers-in-charge of a herbarium. On their work depends the advancement of botanical studies in the universities and researches on pure and applied aspects of botany. The latter aspect of investigation is of great importance in commercial and industrial development of a country.

In the different cities of Europe more than twenty herbaria are preserved which were formed or at least begun in the sixteenth century. In India the oldest herbarium was formed by William Roxburgh in the end of the 18th century soon after the foundation of the famous Royal Botanic Garden, Calcutta, in the year 1787 by Col. Robert Kyd. The other important herbaria are the Madras Herbarium at Coimbatore (1874), the Herbarium of Economic Botanists at Poona, Bombay Presidency (1880), the Forest Herbarium of the Imperial Forest Research Institute at Dehra Dun (1890) and the Shillong Herbarium of the Forest Department of Assam which was started systematically by the late Rai Bahadur U. N. Kanjilal of the Forest Service. All these are however daughter herbaria which were fostered in the early days by the Herbarium at Calcutta in various ways and still receive collaboration in their floristic and other work relating to scientific problems. Many leading herbaria in Europe and America also receive help and co-operation in the nature of exchange of specimens, loan of specimens, presentation of specimens and preparation of floras and in connection with their various floristic and taxonomical investigations. There are herbaria attached to the different universities in India and other countries of the world; but most of these are meant for teaching purposes.

In the scientific arrangement of the specimens different systems of classification are followed in the different herbaria of the world. The Government herbaria in the British Empire generally follow the classification of Bentham and Hooker, as laid down in their *Genera Plantarum* (1862-93), but in the Continent many modern herbaria generally adopt the system of classification as outlined by A. Engler and E. Gilg in their *syllabus der Pflanzen Familien* (1924). Most of the universities also follow this highly evolved natural system as it is considered the best with regard to its masterly treatment of the families, genera and species and their affinities under different classes of plant kingdom from the simplest to the most highly advanced forms of plant life.

An ideal herbarium must have an equally good library along with it, and it is essential that it should be associated with a botanical garden for the cultivation of as many species as possible in order to study the range of variations in a plant under living conditions. The Herbarium of the Royal Botanic Garden, Calcutta, and the Herbarium of the Royal Botanic Garden, Kew, fulfil really all the conditions of a perfect herbarium, and they are the source of botanical information in the East and the West. The Herbarium of the Royal Botanic Garden, Calcutta, bears a close similarity to the Kew Garden, the largest botanical garden, but younger than the Calcutta Garden by fifty years. There are in the Royal Botanic Garden, Calcutta about 15,000 plants actually

under cultivation in the open in its respective regional divisions. In addition to this living tropical collection of plants, the Lloyd Botanic Garden, Darjeeling, represents more than thousand temperate plants and possesses more or less a complete local herbarium.

The library contains more than 25,000 volumes, numerous pamphlets and the most valuable set of about 2,500 magnificent large portfolio size coloured illustrations of the Indian plants bound in 35 volumes. These plants are described by Roxburgh in his flora entitled "Flora Indica" on which all subsequent Indian floras are more or less based. This Roxburgh's *Icones*, as it is called, is perhaps the only complete set of its kind in the world. Other equally valuable paintings of Indian plants and documents of famous botanists are carefully preserved in the Sibpur Herbarium building, the sanctuary of botanical science in India.

The present damp-proof and fire-proof building especially designed to house nearly two and a half million authentic sheets of herbarium specimens which form the basis of all botanical and allied investigations was erected in 1883. In this herbarium all these precious sheets consisting of irreplaceable types, co-types, lecto-types, eco-types, etc., are arranged in proper scientific order. The herbarium is thus the depository of a very complete collection of the dried materials of plants of the whole of Indian Empire as also fair collections of those of Asia outside India, of Europe and Australia. Plants of Africa and America are partly represented. For the systematic botanists, forest officers, herbalists, druggists, pharmacologists, industrialists and others interested in plants, this herbarium is the most interesting and valuable spot in Asia. This is the only place for botanical investigation of its kind in India and is recognized as the best herbarium not only in India but also in the East by the international botanical organization of the world. This herbarium is, as the late Sir Arthur Hill, Director, Royal Botanic Garden, Kew, remarked, "the Mecca for the study of Systematic Botany by botanists not only in India but from overseas." It will be interesting to note here what Sir Richard Temple, a Lieutenant Governor of Bengal said on the utility of a herbarium as early as 1870.

"The collection is and will always be most useful in dealing with questions regarding the naturalization of plants, the introduction of new vegetable products into the country, the adaptation of raw produce to the growing requirements of manufacturing industry, the management of the forests and the scientific improvement of Agriculture."

Introduction of quinine, rubber, ipecacuanha, various timber trees, fibre and oil yielding plants and other plants of great economic value is mainly due

to exploration by the scientific officers of the Herbarium of the Royal Botanic Garden, Calcutta.

The Herbarium and the Royal Botanic Garden have thus served the mankind for an unbroken period of more than a century and a half. It is therefore

quite natural that the Indian botanists declared in 1938 at the Silver Jubilee session of Indian Science Congress held in Calcutta that the Herbarium of the Royal Botanic Garden, Calcutta, should be the National Herbarium of India.

THE LATE PROF. K. S. K. IYENGAR

THE sudden and unexpected death from pneumonia of Prof. K. S. K. Iyengar on 23rd June, 1944 at Mysore came as a shock to all those who knew him and his work. The event is all the more tragic as Professor Iyengar was only 45 and at the height of his powers. My purpose in this note is only to pay a *personal tribute* to one of India's most distinguished mathematicians. For further details about Iyengar's life and his research work in pure mathematics, which was after all the main subject of his life, I refer the reader to an obituary in the *Proceedings of the Indian Academy of Sciences* (June, 1944), of which Iyengar was a Fellow.

Kombur Sesha Iyengar Kuppuswamy Iyengar was born on the 29th August, 1899. The foundations of his mathematical education were laid at Central College, Bangalore and later at Presidency College, Madras, where he passed the Honours Examination of the M.Sc. degree with distinction in 1920. Having shown unusual mathematical ability he was sent by his parents to study mathematics at Cambridge, where he passed the Mathematics Tripos as a star wrangler



Prof. K. S. K. Iyengar.

in 1924. In Cambridge he met Prof. Littlewood and came under the influence of the great mathematical tradition of that University. Prof. Littlewood and

the other mathematicians with whom he worked at Cambridge thought very highly of him, and he appears to have won their respect by his "genuine enthusiasm for mathematics" and "high ability."

I first met Iyengar in 1940 when I came to the Indian Institute of Science, Bangalore. He was the head of the Department of Mathematics of the University of Mysore which is housed at the Central College, Bangalore. He was appointed to this post in 1926 on his return to India from Cambridge. That this department today is one of the best centres of mathematical teaching in India is due in no small measure to Iyengar's active enthusiasm and wide knowledge of different branches of mathematics, and to the excellent group of able young mathematicians that he collected around him. He followed closely the latest developments in mathematics and I remember well the enthusiasm with which he spoke about the remarkable school of modern Russian Mathematicians and the new methods they had developed.

It was early in 1941 that I took up again with S. K. Chakrabarty the problem of giving a better treatment of the cascade theory of cosmic ray showers than had been done hitherto. Members of the staff of the Central College, including Prof. Iyengar participated in our colloquia and it was at this time that I put forward to him the problem of finding an exact solution of the fundamental equations of the cascade theory. The problem involves the solution of a rather complicated integro-differential equation. Hitherto only partial solutions of this problem, fairly accurate for high energies, had been given. In all these solutions the collision loss suffered by the cascade electrons, which is vital for the absorption of the shower, had either been neglected altogether, or treated by such defective mathematical approximations as to be worth little. This neglect completely prevented a calculation of the low energy spectrum of cascade electrons. In the processes of radiation loss and pair creation incompleteness of screening was neglected and the asymptotic expansions for extremely high energies used. This approximation is not serious and must be avoided only for relatively low energies especially in heavy substances. It was during this

period that I evolved with Chakrabarty a solution in the form of an infinite series which took account of the collision loss exactly, but still neglected incompleteness of screening. In subsequent work Chakrabarty has given method for taking incompleteness of screening into account approximately. On the other hand, by an extremely ingenious use of the solution of the cascade theory for extremely high energies and neglecting collision loss, which had been given by Landau and Rumer, Iyengar was able to give a remarkable and complete solution of the cascade problem. His solution not only takes account of the collision loss of electrons, but also of incompleteness of screening with mathematical rigour. In my opinion this solution shows Iyengar's profound grasp of mathematical methods and his remarkable ability, especially when one considers that this was an outstanding problem which has been tried by mathematical physicists all over the world. Iyengar was not a physicist and was not interested in obtaining the numerical results required by experimental physi-

cists. Indeed, for this purpose it is simpler to turn to the series solution given by Chakrabarty and myself the first term of which is a powerful approximation from which numerical results can be calculated with a reasonable amount of labour in all except a few special cases. Iyengar's solution however remains the only one which takes account of the incompleteness of screening exactly, and is valid for all energies and all thicknesses. One day when an increase in the accuracy of experimental data requires a more accurate knowledge of the results of theory than can be obtained by other methods, perhaps Iyengar's solution will be used to obtain these exact results with the help of a calculating machine.

K. S. K. Iyengar's premature death is not only a loss to those who knew him but has deprived India of one of her ablest and most promising mathematicians.

H. J. Bhabha.

OBITUARY: DR E. L. G. CLEGG

BY the death of Dr E. L. G. Clegg, Director of the Geological Survey of India in Calcutta at the early age of 50 the Government of India have lost an outstanding administrator and scientist at a critical time when they can ill afford it.

Dr Clegg was born at Manchester in 1894. He was educated in the Central High School and in the Victoria University, Manchester. He served through the 1914-18 war as an officer in the Northumberland Fusiliers and saw much active service in France and Italy.

After the war he took his M.Sc. (Geology) in Manchester and came to India as an Assistant Superintendent, Geological Survey of India on the 1st December, 1920. He was attached to the Central Provinces and Bihar Circle under Sir L. L. Fermor and carried out some valuable mapping in the Chindwara District of the Central Provinces.

The following year he was sent to Burma where he spent 4 years mapping the geology of parts of Minbu and Thayetmyo Districts. The important work then done by him was subsequently published as a *Memoir* of the Geological Survey of India. In 1938 Manchester University conferred on him the degree of Doctor of Science in recognition of this valuable piece of work.

In 1926 he returned to India and remained in Calcutta first as Curator and then as Officer-in-Charge of the Geological Survey Office. During this period he acted as Lecturer in Geology at Presidency College,

Calcutta and in the Bengal Engineering College, Sibpur. In addition he took a keen interest in the work of the Mining & Geological Institute of India and acted as one of the Joint Honorary Secretaries



Dr. E. L. G. Clegg.

from 1927 to 1930, and was Vice-President in 1943. Returning from long leave in 1931 he remained in charge of the Calcutta office for another year and was then transferred again to Rangoon in charge of the Burma Party.

During the next three years of his service he made a detailed map of the Mogoke area in Burma,

and numerous traverses in the defiles of the Irrawaddy, the Jade Mines District, Lai Sai State, and along the Uyu river.

The results of this work were published in 1941 under the title "The Cretaceous and Associated Rocks of Burma". In this Clegg reaches the interesting conclusion that the gem-bearing limestones of Mogok are metamorphosed cretaceous limestones.

As Officer-in-Charge of the Burma Party Clegg had excellent opportunities of visiting the Burmese mineral deposits. He also got an intimate knowledge of the Burma oil fields when acting as Resident Geologist at Yenangyaung in 1935 and 1936. In spite of the heavy administrative work connected with these two posts he was able to make full use of the information he had accumulated at this time in a valuable account of the "Mineral Deposits of Burma" and later, in 1944, in a *bulletin* on "Tin and Wolfram".

Clegg returned to India from Foreign Service in Burma on the 26th June, 1942. On the way he did a valuable traverse through the Hukawng Valley for the military. On his arrival in India he was put in charge of the Central Provinces Party and later for a short time of the Sulphur Operations at Koh-i-Sultan in Baluchistan.

When Sir Cyril Fox retired in July 1943, Clegg became Director of the Geological Survey of India and carried out the functions of that important post with conspicuous success till his death.

As a young man Clegg played Rugby for Manchester University and captained their waterpolo side. While in Calcutta he played for the Services Rugby team and was one of their best forwards. He also won the Calcutta Place Kicking Cup on one or more occasions. Perhaps as a result of his early training in athletics he was always tireless in his field work.

Clegg shone at administration perhaps more than in his scientific work, but his writings prove that he had a clear practical brain, excellent judgment and considerable imagination. These qualities proved particularly valuable to him in advising on the many problems of engineering geology which he was expected to solve. He will be a very great loss to Indian Science and Engineering.

As a man he combined the 'pitho's sense and pride 'o worth' with a very pretty wit. The Geological Survey of India and his many friends both in India and Burma will long miss his cheery face and friendly smile.

H. Crookshank.

Notes and News

DEVELOPMENT OF BENGAL'S POWER RESOURCES

THE need for a thorough survey of Bengal's available power resources, thermal and hydro-electric, has been strongly urged by the Electricity Sub-committee of the Bengal Post-War Reconstruction Committee in its exhaustive report just submitted to the Government of India. The Committee has strongly recommended the creation of an expert committee to undertake this survey work and has stressed on the immediate necessity of approaching the Government of India for making available for this province complete initial equipment for early installation of at least one thermal power station of 10,000 k.w. capacity in the coal-field area of Raniganj.

The Committee has expressed its strong confidence in the availability in this province of power resources, both thermal and hydro-electric, needed for her electrification. In view of the present tendency of existing industries towards the substitution

of electricity for other forms of power, the Committee feels that the provision of cheap electric power, which through electrification of this province can alone make possible, would act as a definite stimulus to the development of industries. In this connection the Committee cited the example of U.S.S.R. which has achieved phenomenal progress in every sphere of economic activity, industrial, agricultural, and transport, through the development of electrical power.

Regarding the distribution of power through the institution of a grid system, the Committee has expressed its view that the question of the grid formation does not arise at the present stage of electrical development in Bengal but will have to be considered in right earnest as soon as a few large-sized regional stations have come into operation. The Committee endorses the policy of ultimate nationalization of electricity undertakings as already accepted by the Government of Bengal, but stresses that such a policy in regard to State-ownership and

State-management should be scrutinized and clarified as soon as possible.

The Committee has further strongly recommended the creation of an Electricity Supply Board to undertake, among other things, a continued and systematic survey of the power resources of the province and the formation of a permanent body of Commissioners after the example of the Electricity Commission of Great Britain.

THE PAPANASAM ELECTRIC PROJECT

The Papanasam Hydro-thermal Electric Project at the Thambraparani Dam was inaugurated by His Excellency Sir Arthur Hope, Governor of Madras, on August 21, 1944, according to *Hindu*. It now forms the third major hydro-electric project under the Madras Grid system. Designed as a hydro-thermal development, the scheme will at present provide hydro-electric power on a scale commensurate with the economics of the site and has under contemplation the building up of a steam station at some future date, probably at Madura, as demand for greater load develops. It is stated that the present works have cost Rs. 163 lakhs out of the estimated total cost of Rs. 179 lakhs.

The development of the Papanasam hydro-electric power has been made possible by regulating and harnessing the waters of the river Thambraparani which drops about 300 feet over the picturesque Papanasam Falls, through the construction of the Thambraparani Dam and Reservoir about six miles above the falls. Initially expected to yield about 5,700 k.w., the Project has already provided or will very shortly provide a load of 11,000 k.w. It is, however, expected to produce 20,600 k.w. in the tenth year. Although the scheme is primarily intended to supply power to Tinnevely, Ramnad and Madura districts and the Travancore State, its association with the Madras Grid which links up Mettur, Pykara and Pallivasal in Travancore will enable the new hydro-electric station to promote economic distribution of electric power throughout the province as a whole.

Apart from the generation of useful electrical power, the dam and the reservoir will act as a flood moderator and thus reduce the disastrous damage that occurs periodically in the ayacut, and will further create extensive irrigation facilities by regulating the flow of water. The rainfall in Tinnevely-Travancore plateau usually varies from 60 to 200 inches a year, and before the construction of the dam this water was simply allowed to run to waste. The construction of the reservoir will now enable the storage of about 5,500 million cubic feet of this water, of which, as the experts estimate, about 1,000 million cubic feet will be available for irrigation purposes. The great benefit which the agri-

cultural population of this region will derive from this development need hardly be over-emphasized.

The Papanasam scheme, as Col. M. G. Platts, Chief Engineer of Electricity, revealed in course of his welcome address, was first investigated in 1926. The execution of the scheme was not, however, undertaken till 1938, because the Governments of earlier decades generally regarded such projects as 'risky ventures', as Col. Platts put it. It is only recently that the Government has come to recognize, and even then reluctantly, the necessity and desirability of power production on a wide scale as an indispensable condition for industrial development and the consequent economic progress. The success of the project in question, as the *Hindu* rightly observes, is largely due to the initiative of the then Congress Ministry which ordered, under pressure of the agriculturists of Tinnevely, the starting of the preliminary operations necessary for the construction of the dam and the power. The Government of Madras, however, deserves to be congratulated for having decided to continue and complete the scheme during the war despite war-time difficulties regarding transport and the supply of plants and equipments from abroad.

MILK SHORTAGE IN INDIA

Milk shortage in India has assumed alarming proportions during recent years. Attention of the public on this all-important question has already been focussed by the daily Press. Meanwhile, the *Indian Farming* (January, 1944) in its leading article, has published some important statistical information regarding the exact nature of this shortage, which will help formulate the real extent of the need for more milk in this country.

India, with her production of 800,000,000 maunds of milk per year, is the second largest producer of milk in the world after the United States. But her *per capita* consumption of milk or its equivalent in milk products is only 7 oz. per day compared to 35 oz. in the U.S.A. The nutritionists have estimated the daily minimum requirement of milk for a growing child at about 32 oz. and at about 16 oz. for an average adult. It is a clear evidence that an average Indian fails to fulfil his minimum requirement under the existing supply of milk, which should be increased to at least three times the present production if any real improvement in the milk-shortage is to be desired.

The shortage of milk has been rightly ascribed to low capacity of Indian cows for milk production and not to any real shortage of cattle population in this country. The Indian cow on an average produces about 625 lb. of milk annually excluding, however, what the calf gets, whereas the average production of milk in Canada, England, the United

States and other countries varies from 5,500 to 4000 lb. per year. In Denmark, the cows are reported to have produced on an average over 8,000 lb. of milk a year before the war.

Therefore, to meet our minimum need for three times of the quantity of milk now produced all over India, i.e., for 2,400,000,000 maunds per year, the Indian cow should be called upon to produce 1,875 lb. per year, which is still a small figure compared to 4,000 for other countries. This obviously implies increased production of cattle feed. An animal with an average body-weight of 600 lb. requires about 8 lb. of dry matter in the feed daily for proper maintenance only. This figure, however, does not take into account the needs for milking and pregnant cows for which more dry matter is needed. The Indian cow at present does not get more than 4.6 lb. of dry matter from all available fodder, grass and farm waste material which the cattle can make use of. The problem is clearly one of increased production of cattle feed and increased efficiency in the conversion of feed into milk on the part of our cattle. These figures make us wonder how Indian cows at all produce any milk. We cannot expect any reasonable supply of milk from our starving cattle, and this is the crux of the present milk shortage in India.

THE UNITED STATES NATIONAL MUSEUM

The annual report of the United States National Museum, submitted by Dr Alexander Wetmore, Director of the U. S. National Museum, records the present condition of the Museum and the work accomplished in its various departments during the fiscal year ended June 30, 1943. The total appropriation of \$892,630, received during the year for the maintenance and operation of the Museum, indicates an increase of \$61,652 over the previous year's appropriation. The Museum received, during the year under review, some 1,355,269 visitors from all parts of the United States, a figure which, although slightly less than the peace-time figure, is sufficiently indicative of the continued interest of the U. S. people in the exhibits of the Museum. In comparison with the last year's collections, however, there was a diminution in the number of accessions and specimens received owing largely to the curtailment in field work. But still the Museum collections were on the whole satisfactory, as new material came in 1,177 separate accessions, with a total of 230,231 specimens. They were distributed among the five departments as follows: anthropology, 2,514; biology, 213,823; geology, 9,725; engineering and industries, 2,266; and history, 1,903.

During the year under review, members of the staff were primarily engaged in work calculated to promote the conduct of the war.

Data were requested for enumeration work on a variety of subjects which included the following: camouflage plants; natural vegetation of specific regions; illustrations of poisonous plants and of emergency food plants and data regarding them; destruction and mosquito-harboring epiphytes; distribution of certain plants of known economic importance; botanical exploration; the palatability of the flesh of land, fresh water and marine animals, their use for food and methods of capture; the serviceability of hides and skins for various purposes; disease transmission; noxious, poisonous or otherwise dangerous animals; intermediate hosts of animal and human parasites; aid in the preparation of survival manuals and other military and naval handbooks; distributional lists of insects and other animals of medical importance; outlines for insect surveys in foreign areas; instruction in mosquito identification; collection and preservation of specimens, especially those of medical importance; supplying duplicate sets of insect material not otherwise readily obtainable for the use of Army and Navy medical schools; biological and oceanographic problems; and marine fouling organisms.

INDIAN CENTRAL COTTON COMMITTEE

At the meeting of the Indian Central Cotton Committee, held on the 28th and 29th July, several important decisions were taken of considerable interest to the cotton growers. On the subjects of the floor and ceiling prices of cotton, the necessity of eradicating the malpractice of mixing different varieties of cotton and the urgency of growing more food crops in the present emergency, the following resolutions were unanimously passed:—

(1) The Indian Central Cotton Committee, while taking full cognizance of the gravity of the food situation in the country and of the urgent necessity of increasing the supply of food grains, is unanimously of the opinion that the lowering of floor and ceiling prices for cotton will not achieve the object in view but will only result in severe hardship to the cotton cultivators and seriously interfere with the economic condition of the rural population as a whole.

The Committee considers that the solution of the food shortage problem lies along the avenue of planned production and not in reducing the income of growers of non-food crops to a bare subsistence. To aim at price levels for cotton which will leave the growers only a bare subsistence is a retrograde step which will greatly add to the difficulties of post-war nation building.

It is the considered view of the Committee that the shortage of foodstuffs can best be met by the enforcement of legislation restricting the area under cotton in accordance with a co-ordinated policy of planned production on an all-India basis, without unnecessarily reducing the purchasing power and the already low standard of living of cotton growers.

The Committee is of the opinion that the floor and ceiling prices for the 1944-45 season, announced by Government in their press note dated the 15th July, 1944, are very low. It, therefore, strongly recommends that the fixed floor prices for Jarila and all other styles should be raised by at least Rs. 50/-. In making this recommendation, the Committee has given due regard to the present increased

cost of producing cotton, arising more especially out of the heavy increased cost of consumers' goods, labour, agricultural implements, plough, cattle, etc.

(2) The Indian Central Cotton Committee is convinced that the malpractice of mixing different varieties of cotton is seriously hampering the work of cotton improvement in the country. It is the considered view of the Committee that until this malpractice is made a penal offence, it will be impossible to provide seed of improved varieties of cotton in quantities adequate to meet requirements. In the interests of Indian cotton as a whole, therefore, the Committee is unanimously of the opinion that, as a first step, the mixing of short staple with medium and long staple cotton and of medium with long staple cotton at the factories should be forthwith prohibited by the Government of India by legislation. The Committee further recommends that steps be taken by the Government of India to ensure that the legislation is put into effect by the Provincial and State Governments as soon as possible and, in any case, well in advance of the cotton season commencing 1st September, 1945. The Committee has no doubt that the adoption of the measure suggested by it will have a beneficial effect on the food position of the country for, if the utilization of short staple cotton for mixing purposes is stopped, the production of such cotton would be automatically reduced to the minimum commensurate with requirements.

(3) In view of the paramount importance and urgency of growing more food during the present emergency and in the interests of improvement of Indian cotton in future so as to make its production remunerative to the grower, the Committee is strongly of the opinion that concerted efforts should be made to develop the agricultural resources of the country to the fullest extent possible. The Committee is convinced that the object in view can be achieved by improved methods of farming, suitable rotation of crops, and, above all, where conditions are favourable, by the introduction of mechanical devices for cultural and harvesting operations. It accordingly requests the Government of India to give immediate facilities for manufacture in the country and import from abroad (to meet immediate requirements) of improved implements and machinery and fertilizers.

THE CYCLOTRON OF THE CARNEGIE INSTITUTION

THE construction of the new giant cyclotron at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington has just been completed, according to *Science*, June 2, 1944. The new cyclotron is reported to be the second largest in the world after the one at Berkeley under the supervision of Professor E. O. Lawrence and generates atom-smashing projectiles of 15 million electron volts energy. The cyclotron weighs more than 225 tons, has an overall height of 12 feet, is 30 feet long and 20 feet wide. The magnet is made up of four

iron castings, of which the largest weighs more than 30 tons. This heavy magnet surrounds the accelerating chamber, i.e., the Dees, having a diameter of about 60 inches. The cyclotron has a supply of 100 k.w. radio frequency and operates at 10 megacycles.

The cyclotron of the Carnegie Institution has been housed 10 feet below the earth's surface so that its radiations may not reach the people outside. In fact, so powerful these radiations have proved to be that mice exposed to much weaker radiations perished within a few hours. The operator of the cyclotron is protected from its rays by specially constructed insulating walls. The introduction of the interlocking system of controlled operation protects the equipment from accidentally being damaged by mistakes in operation, or by failure of any component part of the cyclotron. Another device for avoiding accidents consists in providing master switches in the doors, leading to the powerful high-voltage parts of the laboratory, in such a way that the opening of any of these doors automatically results in the cutting off of all power. Thus, accidental entry into the laboratory while the power is on does not prove fatal.

It required four years to build the new cyclotron. The total cost of erection, including its appurtenances and the special three storey building to house the equipment and workshop, has been estimated at \$500,000.

NEW HORIZONS

We welcome the appearance of the new illustrated monthly *New Horizons* published from Allahabad under the editorship of Mr Satyendra Nath Sanyal. It is a variety journal and contains feature-articles on topical subjects, short stories, light essays, humorous sketches and entertaining discussions on fashion, femininities and such other topics as satisfy popular curiosity and interest. The printing and the quality of the paper, especially the latter, are good, and we hope the journal will appeal to a wide circle of popular readers.

SCIENCE IN INDUSTRY

A NEW SOIL STABILIZER FOR WATERPROOFING OF ROADS

A NEW resin compound derived from pine resin has been developed in U. S. A. for water-proofing the soil and is being used extensively for speedy construction of military roads and airports. It has been named "Stabinol", since by this method the top 6 inches of the surface soil is being stabilized, so that there is no mud formation. The treated soil does not allow rain water to penetrate the soil, water simply being drained off from the top, and the subsoil water also cannot rise because the chemical treatment upsets the natural phenomenon of capillary action. It is a dry powder and is spread over the surface of the soil by hand or by mechanical sprayer and harrowed to the depth required. The amount of Stabinol required varies with the depth of the soil to be treated and with the chemical and physical properties of the particular soil, as well as with the severity of the exposure to be encountered. In fact, its use has varied from 6 lbs. per square yard for a compacted depth of 6 inches for heavy military roads to $1\frac{1}{2}$ lbs. per sq. yard for playgrounds. On the average, it is reported, the Stabinol required is one percent of the soil treated.

N. K. S. G.

INDUSTRIAL APPLICATION OF HIGH VACUUM TECHNIQUE

THE industrial application of high vacuum technique is of very recent date. High vacuum has proved an extremely useful technique in the dehydration of foods and drugs, production of vitamins, refining of certain chemicals and oils and the distillation of a large number of compounds, such as oils, fats and waxes, otherwise liable to decomposition. Important as its application in these various manufacturing processes has been, it is only in the case of magnesium metallurgy and dehydration of penicillin that high vacuum technique has been applied on a really large industrial scale. The manufacturing processes depending for their success on the use of high vacuum technique generally involve the maintenance of a pressure of about 0.001 mm. or 1 micron, which is equivalent to reproducing the vacuum conditions of the ionosphere inside the plant. The instances of the extraction of magnesium and the dehydration of penicillin, which formed the subject of an interesting note by Richard S. More in *The Scientific Monthly*, may be cited to indicate the difficulties and the advantages attending the industrial application of high vacuum technique.

High vacuum is an indispensable factor in the extraction of magnesium. It accelerates the reduction of the ore into the metal and the evaporation of the magnesium molecules and further prevents its oxidation. Bricks of crushed dolomite and ferro-silicon, contained in a chrome-nickel-steel retort, are heated in vacuum to 1100°C when magnesium is vaporized and condensed in the water-cooled end of the retort. The whole process requires about eight hours. The entire system has to be kept air-tight and maintained at a pressure of 1 micron. At such a low pressure a volume of gas at normal atmospheric pressure expands to 160,000 times its volume, and such huge volumes of gas require to be continuously removed. To this has to be added the volume of occluded gases liberated at low pressure. The amount of gases so liberated may be realized from the fact that at atmospheric pressure a piece of metal contains occluded gases of many times its own volume.

Maintenance of high vacuum under these circumstances has been rendered possible by the use of 'new-type industrial diffusion pumps, together with associated vacuum valves, gauges, and similar parts, capable of exhausting tremendous quantities of air and other gases in record time.' The entire vacuum system claims to have a pumping capacity of several thousands of cubic feet per minute in the micron gauge.

The vacuum technique has been applied with great success to the problem of drying penicillin and has removed the disadvantages invariably associated with the freezing methods of dehydration. The formation of heavy ice layers in the compartments designed to collect the vapour is a serious objection to the latter method. Since enormous volumes of water vapour are continuously liberated, the maintenance of high vacuum presents no small difficulty. The technical difficulties are reported to have been solved by handling air and water vapour independently in the vacuum system with different pumping methods.

It is of interest to note that in U. S. A. the credit for perfecting the vacuum technique as applied to magnesium metallurgy and dehydration of penicillin on a large scale uniquely goes to the National Research Corporation in Boston, which built up the first pilot plant for the extraction of magnesium and developed the High Vacuum Diffusion Process for the drying of penicillin.

CHARCOAL BRIQUETTES AS SUBSTITUTE FOR COAL IN LOCOMOTIVES

INDIA'S deficiency in good coking coal needed for her metallurgical industries is well-known to our readers. In fact, her estimated reserve of coking coal, as was shown in a number of articles in the past issues of "SCIENCE AND CULTURE" (Vol. 7, Nos. 3 & 4), can hardly feed her smelting industries for another 60 years. In complete disregard of this serious deficiency, thoughtless use of good quality coal for purposes other than metallurgical, such as steam raising in locomotives, is being continued, specially when inferior coal after some processing can be used with comparable success. Even the use of charcoal briquettes as a probable locomotive fuel is on record, and we may particularly draw the attention of our readers to a recent article in *Nature*, (July 8, 1944) in which Dr H. Greene and T. N. Jewitt, of the Agricultural Research Institute, Anglo-Egyptian Sudan, have described their own experience with charcoal briquettes as locomotive fuel.

Charcoal briquettes to be successfully employed as locomotive fuel must satisfy certain properties. The briquettes must be very strongly bound as they are required to withstand the severe conditions within the locomotive fire box. Weak binding may lead to loss of fuel due to forced draught and shaking and clinker formation at high temperatures. The authors in their experiments used charcoals available in the central Sudan and generally made from three kinds of acacia, namely *A. Arabica* Wild. (ash content 3—5 per cent), *A. Seyal* Del. (ash content 5—11 per cent.), and *A. Mellifera* Benth. (ash content 6—15 per cent.), of which *A. Seyal* Del. appears to be the most promising and satisfactory source. Charcoal of the above description was finely ground and mixed with pitch (Mexphalte D.H. 75/85) which is considered essential for such briquette making. Gum arabic was used as a primary binder. The mixture was stamped into briquettes by three impacts from a 75 lb. weight falling from a height of 6 ft. When such briquettes were hardened on drying they could bear crushing loads up to 2,000 lb. per sq. in. The strength of the briquettes generally depends on several factors, such as gum content, grinding method, number of impacts etc.; and the authors obtained strongest briquettes from a mixture containing 60 parts of water to 100 parts of dry matter.

For successful operation the briquettes must give rise to considerable volume of volatile matter. Charcoal-pitch briquettes prepared in the way described were not as such capable of producing the required amount of volatile matter, but were made to do so by dipping them in furnace fuel-oil. The process, however, means some reduction in the mechanical strength of the briquettes, but it is somewhat compensated for by their increased resistance to rain, which this process makes possible. One set

of charcoal briquettes made in this way and later subjected to a number of full-scale fuel trials had the following percentage composition: charcoal, 75; pitch, 8; oil, 8; gum, 4; water (lost at 105°C .), 4.

Results of trials with briquettes of this type are recorded in the article. The charcoal-pitch briquettes were used in service trains running at moderate speeds in which normal steam pressures of 170-175 lb. per sq. in. were maintained. The results are reported to be satisfactory. It was found that success in all these trials depended markedly on the ability to grind charcoal to a suitable powder. The results steadily deteriorated with the use of coarser material. Charcoal ground in edge-runner mills produced satisfactory results, but charcoal pulverized in heater type mills developed cracks and internal strains and gave poor results. It is interesting to note that such strains were reduced to a minimum when the charcoal was wetted before grinding. In fact, following this method authors produced strong and mechanically sound briquettes from charcoal which was ground by a type of bull-drawn roller specially designed for the purpose, and edge runner mills were not necessary.

In the making of such briquettes pitch is essential, as attempts to prepare them without the use of pitch ended in smoke. Clinker formation is, however, a great disadvantage which at present militates against the free use of charcoal-pitch briquette as a locomotive fuel. The clinker formation is largely due to impurities, such as siliceous matter, which always contaminate dirty charcoal. Its elimination does not seem impossible, and there is a fair chance of coal being largely replaced by charcoal briquettes in locomotives in the days to come, particularly in countries unfavourably placed with regard to the supply of coal.

METHANE FOR PETROL

A REPORT in the *Chemical Age* places on record the increased use of methane in place of petrol as a motor fuel in Sweden. Although methane does not appear to be a very convenient source of fuel to handle, Sweden had to explore all the possibilities for exploiting this waste gas because of her serious scarcity in coal and petrol. The gas is obtained from sewage, and in 1943, the sewage disposal plant of Stockholm produced over 1 million cubic metres of methane gas. During the present year, the plant has undergone further extensions, and the production is expected to increase by about 30 per cent. Buses and other automobiles are already operating in the cities with great success, and its use is being increasingly welcomed. One cubic metre of methane is reported to be almost equivalent to one litre of petrol as motor fuel and is produced at a cost of 25 öre, i.e., 3½d. which is about the same as the pre-war price for 1 litre of petrol in Sweden.

STORAGE AND PRESERVATION OF FOOD GRAINS

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THE important question of the great damage done by insects to stored food stuffs and such other commodities has so far received little thought in this country. It is seldom realized in India that due to want of any good system of storage, a large part of the produce of the land is destroyed by insect pests. These pests attack all kinds of stored products, such as paddy, rice, pulses, wheat, flour, tobacco, dried fruits etc. In this way millions of rupees are lost annually.

DAMAGE CAUSED BY INSECTS

It is said that the damage caused by insects in North America costs annually £200,000,000, that the amount of food-stuffs lost annually as the result of the depredations of insects amounts to £60,000,000, and that the damage caused annually by clothes moths, carpet beetles and other insects which attack silk, wool, furs, feather and other articles of animal origin amounts to £20,000,000. It has been estimated that the loss in maize in the State of Virginia in 1922 due to the Angoumois moth, *Sitotroga cerealella*, amounted to between £100,000 and £500,000. In Germany, the annual loss due to the Mediterranean flour moth, *Ephestia Kuhnella*, is estimated between £25,000 and £50,000. About 15 per cent of the stored grains in New South Wales is lost annually mainly on account of *Sitophilus (Calandra) oryzae*. The annual loss of cigars due to *Lasioderma serricorne* in Manila is said to amount from 3,000 to 65,000 dollars per factory. These figures will suffice to show the great losses which mankind suffer through insects. Indeed the losses are so great that they can not be properly estimated.

INSECTS RESPONSIBLE FOR THE DAMAGE

The insects which are commonly found in association with different kinds of stored produce in this country are:—

Beetles: (1) *Tenebrio molitor*, (2) *Orzaephilus surinamensis*, (3) *Sitophilus oryzae*, (4) *Araecerus fasciculatus*, (5) *Bruchus pisorum*, (6) *Tribolium castaneum*, (7) *Tribolium confusum*, (8) *Lasioderma serricorne*, (9) *Trogoderma granarium*, (10) *Rhizopertha dominica*.

Moths: (1) *Plodia interpunctella*, (2) *Corcyra cephalonica*.

Tenebrio molitor, the meal worm beetle, generally infests meal and flour. It is bred in large numbers as food for cage birds. The eggs are laid singly or in small batches. They are prolific breeders and one female may lay 576 eggs during her life time. The larva is of a bright yellow colour, is omnivorous in its tastes, and generally feeds on anything it comes to find. They breed in large numbers during the rainy season. The larvae of meal worms are very resistant to starvation and may live for from 6 to 9 months without food. *Tenebrio molitor* is widely distributed all over the world and are found in all places where food grains are stored.

Orzaephilus surinamensis is known as saw-toothed grain beetle. It is a small brown beetle, has a flat body which is well adapted to its habits of crawling into cracks and crevices. *O. surinamensis* is found all over the world and is an important granary and storage pest. The female generally lays one to four eggs daily and nearly 300 eggs are laid by her during her life.

Sitophilus oryzae is generally associated with rice and is widely distributed in the warmer parts of the world. The larva feeds on rice, forming a winding tunnel which increases in length as the larva grows. In addition to rice, it also infests the common grains such as millets, oats, peas etc.

Araecerus fasciculatus: is found on coffee, biscuits, nutmegs etc., while *Bruchus pisorum* is found in association with peas and lentils.

Tribolium castaneum, the rust red flour beetle, is not so common as *T. confusum* which is found in stored cereals and the products made from them. It is also found in flour, bran etc. The complete life history takes from 50 to 90 days depending on the temperature and humidity. The larvae do the most damage but the beetles also feed on the preserved food.

Lasioderma serricorne attack cigarettes and cigars etc. The eggs are laid in crevices and wrinkles of a tobacco leaf. The life history from egg to the adult lasts from 70 to 90 days. The adult is found wherever tobacco is grown and manufactured.

Trogoderma granarium is a serious pest of stored wheat and barley and is occasionally found in other stored food stuffs. India is its home, from where it was imported with Indian barley into the British Isles, and it has now established itself in breweries even where Indian barley is not used.

The most advantageous conditions for the life history of this beetle are found in hot, dry weather in the Punjab during the months of May, June and part of July. The beetle is very active during these months and during this time the life history may only last twenty five days. When the beetle meets adverse conditions it becomes dormant and remains so until favourable conditions appear. It can hibernate in the larval stage. The larva has a hairy body and it attacks the grain in a characteristic way. It nibbles at the pericarp and then at the grain. The greatest amount of damage is caused in the top part of the stored grains where the beetle and their larvae are generally found.

Rhizopertha dominica is a cosmopolitan species and is generally regarded as a serious pest of stored grains in India under certain conditions. It lays a large number of eggs, multiplies rapidly under favourable conditions and destroys grains rapidly. It can withstand dry conditions better than can other grain pests. It has been pointed out that it only infests grain in vessels made air tight and never attacks grains in gunny bags and vessels with loose covers. It attacks rice, wheat, barley, beans, lentils etc.

Plodia interpunctella is known as the Indian meal moth. Though it prefers dried fruit, it is commonly found in association with beetles attacking other kinds of stored products. It is cosmopolitan in distribution.

Corcyra cephalonica is also a cosmopolitan species, and is best adapted to live in a warm humid atmosphere. In India, its larvae have been recorded commonly from husked rice and biscuits.

BRITAIN'S EFFORT IN CONSERVING FOOD RESERVES

Since food conservation is of such vital importance especially during war time every effort has been made by Britain to minimize the danger of the destruction of food grains stored in godowns. At the onset of the present war His Majesty's Government in Great Britain visualized the possibilities of the loss of the nation's food reserves by this means and a commission was immediately appointed to harness all scientific knowledge of the life and habits of insect pests in different types of grains and also in different industries with a view to preventing the loss. Their report was published in 1940. Its most important result is the demonstration that infestation occurs throughout all the industries producing, housing, transporting, trading in, or using cereals and cereal products. A nation-wide storage system co-ordinated by a national control body under the Ministry of Food was thereafter inaugurated. This has entirely controlled any great increase of vermin in warehouses and food factories especially now when

they are handling larger stocks of food. This control body has qualified biologists, mycologists and zoologists of wide experience in industrial biology at the head. This body tackles control of rodents, chiefly rats and mice, control of insects, and moulds and bacteria. They make regular inspection and look into methods of checking infestation. This body also studies the usefulness of different vermin poison-baits, fumigants, rat-poisons etc.

When cargoes arrive at a port or warehouse, strict examination is made to see if they harbour any insect pest, and if so, prompt action by the authorities is called for. This has already checked at the ports some that might have become nationally serious. The food supplies are generally scattered and vacant basements of buildings in out-of-the-way towns are used for storing food reserve which are inspected periodically. The survey has proved its value in recognizing and defining the main problems that need to be tackled. Good ventilation, general cleanliness, dry surroundings, segregation of infested consignments and other simple methods of control have yielded results of value. The problem of insecticidal treatment comes to the fore. The cold storage system and equipment have been nationalized so that all resources can be used to the best advantage. The report is very exhaustive and has done good service in stressing risk from insects and rodents and formulating the problems that have to be made when food conservation is of paramount importance. It has been clearly recognized that there is a whole chain of circumstances which require control in stopping the grain destruction of insects during storage.

In the United States, the Bureau of Entomology and Plant Quarantine have published concised information for avoiding trouble from insects in stored foods.

Insect damage to stored food is increased by long storage. Infestations which were small and negligible once may develop into tremendous proportions within a short time. The rate of multiplication varies in different insects, but the most important underlying factors which favour rapid multiplication are optimum temperatures and humidity.

Food cannot be stored anywhere and every where. If possible, the building must be so constructed as to make it air tight. The idea is that the insects are not only prevented from gaining entrance but that, if infestations occur, such buildings should be readily fumigable.

Insects which infest food materials are generally of minute size. These not only hide in cracks and crevices but may also breed there. The floor and walls must, therefore, be insect proof.

BOTH HEAT AND COLD UTILIZED FOR PRESERVING GRAINS

The recourse to adverse temperatures and humidity which have often deleterious effects on the life and multiplication of insects has been widely employed in preserving grains and cereals.

High temperatures of around 140°F do not as a rule affect the quality of most stored products, rice and tobacco being the chief exceptions, nor do they impair the germinating powers of seeds. It is never advisable to go beyond the temperature known to be fatal to the insect pest that is being controlled. The difficulty in high temperature treatment is to decide upon the range of temperature non-injurious to the seed but fatal to the contained larvae and eggs. It is for this reason that the use of heat for controlling insect pests is mainly confined to the treatment of cotton seed against Pink Boll worm, and of flour mills in U. S. A. and Canada against the various pests of flour and grain.

After once the preliminary cleansing has been effected, cold storage at very low temperatures is perhaps the best known method of storing food stuffs under artificial conditions. Although tobacco infested with *Lasioderma* beetles can be easily cured by exposure to 140°F in a steam chamber for half an hour, but it makes the tobacco extremely brittle. For this reason tobacco is disinfested by exposure to a temperature of minus 3 to 4 degrees for several days.

DIFFERENT FUMIGATING AGENTS

The only radical method of ensuring the destruction of insects in the stored products is by fumigation. Hydrocyanic acid gas and carbon bisulphide have long been the favoured fumigants, but within recent years, new materials have come into more or less extensive use, chiefly because these are safer to human life.

Hydrocyanic acid gas, though extensively used as a fumigant, is not so practicable a sterilizing agent owing to a certain lack of penetrative power. This difficulty can be overcome to a great extent if a partial vacuum be created within the container. This method has been adopted by the Federal Horticulture Board of U. S. A. for the sterilization of baled cotton coming from India and Egypt where the Pink Boll worm is present.

The most important factor governing the efficiency of fumigation is adsorption—adsorption of the gas on the walls of the warehouses, on the floors, on the packing cases or sacks, and in the goods themselves. It is highly important, therefore, that one should know how fumigants are adsorbed, what residues are left and how far these can be removed by ventilation or airing in the first instance and by

industrial processes later. Therefore, in the treatment of edible materials, though only a very small amount of the fumigant is adsorbed, this must be without danger before it can be safely used. Cotton seeds exposed to the action of hydrocyanic acid gas under reduced pressure retain a considerable quantity of this gas owing to the solubility of hydrocyanic acid in the oily seed content. This is not wholly expelled by exposure to air. On the other hand this gas has no deleterious effects on flour, grains etc.

Carbon bisulphide is a clear volatile liquid and has a smell resembling chloroform. It is a very heavy liquid and is comparatively non-toxic but it is extremely inflammable and is liable to explode. Its successful application requires a warm atmosphere, not less than 70°F, and an exposure varying from 30 minutes to one or two days.

In order to cure infestation in the house, small quantities of the seed or grain may be treated in a barrel or an iron container by pouring the liquid directly on to the grains. One ounce of carbon bisulphide is necessary to sterilize 100 pounds of seed and within 36 hours the treatment is complete.

Unlike carbon bisulphide, carbon tetrachloride is not inflammable and is often used in fire extinguishers to smother flames. This property makes this gas an extremely safe insecticidal fumigant but its toxicity to insects is relatively low. It is generally combined with ethylene dichloride and the combination has been reported as highly effective. It has also often been used to blanket the carbon bisulphide but in the proportion in which blanketing is effective and fire and explosion risks are negligible, these two vapours or gases generally separate out, and this leads to patchy distribution and patchy kill of the insects.

Fumigation with formaldehyde is laid down as the standard method to be adopted in the Regulations for the Army Medical Services. Formalin is placed in a galvanized iron pail, chloride of lime wrapped in thin paper, which is then pierced, being quickly added. A violent chemical reaction immediately takes place, 80% of the formaldehyde being vaporized by the heat of the primary reaction. Insect eggs are rendered sterile when exposed to this gas for 24 hours.

Napthalene is volatile and is insoluble in water. When placed in a closed chamber, it readily saturates the air. It is not only an insecticide but is also a good insect repellent. Its use is limited to conditions where the food has been stored in an air-tight chamber.

If the moisture content is reduced to less than 7 per cent, it will ensure the destruction of *Calandra* beetles, and according to the report by the Australian Commonwealth Advisory Council of Science and

Industry, such dry storage of sundried wheat will make it possible to store this produce indefinitely without damage from weevils. In case flour has to be stored by this process, the moisture content must be reduced from 10 to 14 per cent to less than 7 per cent by subjecting it to some drying process. In the same way other food products, like maize, can be easily stored for a long time.

Napthalene in proportion of 1 lb to 2,000 lb, when placed in muslin bags and suspended from the top, can be effectively used for storing maize, rice, paddy, wheat, seeds etc. The napthalene should never be mixed with the grain, as airing for even 2 days will not remove the odour.

Chloropicrin (nitrochloroform), this material known during the first world war as tear and vomiting gas, is prepared by adding an aqueous solution of picric acid to an excess of bleaching powder. It has been found to be of considerable application as an insecticidal fumigant. It is extremely toxic to insects and is less toxic to human beings than carbon bisulphide. It is non-inflammable and can penetrate commodities when stored in bulk. It has no action on metals and fabrics and colours are not affected. It has also a pronounced lachrymatory effect, so that its presence can be quickly detected. It has recently been found that it acts better when combined with carbon dioxide than when it is used alone in a pure state. Though it is widely used in U. S. A. and France, it should be remembered that it is liable to impair the germination power of seeds unless they are dry.

Ethylene dichloride is another fumigant. This material although synthesized from ethylene, does not contain an ethylene linkage, the formula being $\text{CH}_2\text{CL}-\text{CH}_2\text{CL}$. This should not be confused with dichloroethane. It is a colourless liquid, non-corrosive to metals and at ordinary temperature is not dangerously inflammable. It possesses an odour similar to that of chloroform. A mixture with carbon tetrachloride in the proportion of 3:1, is an effective fumigant and is relatively safe.

The use of trichloroethylene is known. The pure material decomposes readily when exposed to light, yielding phosgene and hydrochloric acid. It can only be used when mixed with ethylene dichloride. Tetrachloroethane has not been much used as a fumigant for stored products.

Ethylene oxide possesses marked insecticidal properties and can penetrate deeply. Its disadvantages are that in certain concentration this gas, like carbon bisulphide, is combustible and explosive when mixed with air. When mixed with carbon dioxide in a ratio of 1 part of the former to 7.5 parts of the latter by weight, it is non-inflammable and the mixture does not separate or stratify. The

addition of carbon dioxide increases the insecticidal value of ethylene oxide to a marked degree.

The mixture of ethylene oxide and carbon dioxide is now known by the trade name of carb-oxide. It is non-injurious to fabrics, furniture or food products and is little toxic to man. Some insects of stored products are much more quickly affected by this mixture than hydrogen cyanide. It affords an additional advantage as it leaves a residue in fumigated products of no toxicological significance. But it should be remembered that where seeds are concerned ethylene oxide may seriously affect their germination.

Cyclohexene oxide has been patented in U. S. A. for disinfestation of stored products but apparently has not been tested on a large scale.

Methallylchloride is a product manufactured from petroleum hydro-carbons and is a liquid which evaporates easily at normal temperature. This material no doubt possesses good insecticidal qualities but at the same time it is a skin irritant. Too little is yet known of its decomposition products and its reaction with food to justify its extensive use at this stage.

Trichloroaceto-nitrile is lachrymatory; it is probably widely used in Germany and has a number of unpleasant features, the chief being that it is an insidious poison. Its penetrative properties are satisfactory. It is slightly corrosive to iron and steel.

Acrylonitrile is toxic to insects in the gaseous stage. It is miscible in all proportions with carbon tetrachloride; a 1:1 by volume mixture is non-inflammable. This mixture has approximately the same effectiveness on insects as the acrylonitrile alone. Wheat fumigated with this agent should be aerated before milling.

Provided the storage container is air-tight, liquid carbon dioxide may be employed to kill all insect life including eggs within a short time. Even if the carbon dioxide is not introduced from outside, the carbon dioxide, which is produced both by grain and insects acts as a narcotic. Aided by the diminished oxygen pressure brought about by the grain absorbing oxygen, this gas has a toxic effect upon the weevils. If the exposure is prolonged, the power of germination becomes impaired. Otherwise this method can be considered as ideal.

The use of methyl bromide as a fumigant for the control of insect pests has increased markedly within the past few years. It is a highly potent fumigant and is effective in causing death of nearly all types of insects, including their eggs, that infest stored products. It compares favourably with hydrocyanic acid gas, chloropicrin, and ethylene oxide in its toxicity to insects. The amount of methyl bromide (determined as bromide) absorbed during fumigation varies with the nature of articles fumigated, but is

generally decreased after exposure to air. Milled grains have considerable power to adsorb the fumigant and fatty articles absorb more than non-fatty ones. The small amount of methyl bromide residues left on the fumigated stuff is unlikely to be harmful to the consumer, but laboratory experiments have shown definite pathological changes in the internal organs of rabbits receiving high concentration of methyl bromide in olive oil over a prolonged period.

Irrespective of the nature of the agent that is selected, this process to keep grains free from insects by fumigation is expensive and for this reason it can only be practised successfully in places like mills and large Government stores and is totally impracticable of being carried out in the household and in the farmhouse.

CONTACT INSECTICIDES

For commercial stored products the most commonly used insecticide is one that contains pyrethrum. Pyrethrum, whether used in the form of a dust or in the liquid state mixed with some non-odorous mineral oil, is fatal to all types of insects which possess a well-developed tracheal system. Even the eggs are also quickly affected. It also leaves a residual effect which can be made use of to protect the produce in the warehouse from being reinfested during the period when such insects are very active, especially during the rainy season. The dry powder can also be advantageously mixed with the grains as pyrethrum is toxic only to insect-life and not to higher animals.

Pyrethrum-oil sprays are, therefore, used extensively in flour mills, bakeries, wholesale groceries and many other places where foods are made or stored. The dissipation of the odour is usually complete within an hour after spraying.

The use of ordinary hydrated lime has been recommended to protect peas.

Sprays containing aliphatic thiocyanates are reported to make effective warehouse and mill sprays. Lethane 384 is an American discovery which has recently been placed on the market. It is an insecticide concentrate designed specifically as the active agent of a liquid insecticide. It belongs to a class of compounds known as aliphatic thiocyanates, the elements entering into the composition of these compounds are carbon, hydrogen, oxygen, sulphur and nitrogen. No elements which are basically poisonous are involved in its composition. It is non-toxic to human beings in small quantity, but exceedingly toxic to all forms of insect life. A mixture with stainless kerosene in proportion of 1 : 5 forms an effective insecticide for application in warehouses.

In outlining the destruction of stored food grains by insects we have intentionally left out the

part insects play where they interfere with the activities of farmers and agriculturists such as the great ravage done by migratory locusts.

METHOD APPLICABLE TO INDIA

In India, by the Destructive Insects and Pests Act of 1914, there is a general prohibition against the importation of any article liable to infest any crop. By a further Government Order of 1917, no plant is to be imported to British India except fruits, vegetables, and sugarcane unless sterilized with hydrocyanic acid gas at one of the specified ports.

It will be noticed from the above that the fumigating agents which can be used for destroying insect pests in stored food are of a varied nature and, though each presents some particular characters in its favour, for ordinary purposes the choice will lie among hydrogen cyanide, ethylene oxide, carbon disulphide and chloropicrin. The use of chloropicrin in England is not, however, recommended by the Ministry of Health.

For all round use in this country a mixture of ethylene oxide and carbon dioxide is recommended. It has no harmful effect either on the operator or upon the food-stuffs fumigated. It is only when it is present in high concentrations, that it causes irritation to the eyes.

Fumigation cannot be successfully performed in warehouses, factories, mills etc., particularly in India, because of the difficulty in rendering the building gas-tight and also in procuring the necessary equipment. Besides, the high cost involved in its execution will be a great discouraging factor. This difficulty can be readily obviated by using any contact insecticide, such as pyrethrum and derris derivatives and synthetic thiocyanate compounds. Disinfestation by contact insecticides will be particularly suitable especially when the bulk to be treated is not very large and where the container has frequently to be opened as in shops and in households. But when the bulk is large, cold storage will be the ideal method of preserving grains, cereals and dried fruits. A temperature of 40° to 45°F is inimical to most insect life.

PRESENT DAY SCARCITY OF PYRETHRUM

The greatest drawback to the wider use of any vegetable insecticide lies in the fact that derris in the pre-war days came from the Far East and pyrethrum mainly from Japan. A reduced production of pyrethrum flowers in Kenya Colony in East Africa, induced by drought conditions and the increased use of this commodity in the army's aerosol insecticide programme have resulted in a practical stoppage of pyrethrum allocations to normal peacetime consumers. Other than in most exceptional

NEED FOR RESEARCH

To cope with the tremendous damage done by insects, the individual will always look to the State for guidance and advice. Without adequate knowledge of the life and the habits of the attacking insects it is impossible to formulate any rational measure of control. As far as the entomological part of the subject is concerned, the chief requisites are a familiar acquaintance with the common injurious insects and especially a thorough knowledge of their life histories. The latter may be considered as a foundation of the whole structure of economic entomology. In order to attack an enemy we have to know its weakest point and also the conditions favourable for its growth, multiplication and dispersion.

While the knowledge of the habits of insects provided by the entomologists is of considerable interest, it would be of little value without the co-operation of the chemist who provides the lethal weapons necessary for their destruction and produces new and more effective remedies.

cases, no exports have been permitted from U. S. A. in over a year; pyrethrum household fly sprays have received no allocations both in U. S. A. and India under the present emergency, and use in livestock sprays, an important use in milk production, was excluded in U. S. A. last spring. Small quantities have been granted to some pest control operators doing essential public health work, but with scrutiny as to usage and earlier allocation. The American army itself has foregone the use of pyrethrum in military establishments and instead is using synthetic substitutes for all insect control other than malarial mosquito work and this only in field and jungle. It is thought that the scarcity of pyrethrum is to be expected for an indefinite period.

We thus find that we will have no choice left but to use thiocyanate compounds which all come from America and for which we must be prepared to pay high costs.

MEDICINE AND PUBLIC HEALTH

A NEW ANTI-BACTERIAL SUBSTANCE

THE discovery of a new anti-bacterial substance, called chlorellin, resembling penicillin in its action, has been announced in *Science*, April 28, 1944, by a group of twelve scientists working on this problem. The substance is produced from a very common one-celled fresh-water alga known as chlorella, from which the new substance derives its name. The investigating scientists used cultures of two species of this lowly plant, *Chlorella vulgaris* and *Chlorella pyranoidosa*. Masses of the cells were grown in five-gallon tanks and then filtered off. The remaining water was then chemically treated to extract whatever compound might have been left in it. Chlorellin was obtained in the extract, and in the crude condition it appeared as a brown stuff, sometimes tacky and gummy, sometimes hard and brittle.

Trials with chlorellin in solution on test cultures of several kinds of bacteria clearly indicated its bacteriostatic action against such organisms as streptococcus and staphylococcus. In this respect it resembles penicillin closely. It has been further suggested that, unlike penicillin which is only bacteriostatic, chlorellin may actually kill the germs.

The extracts thus far obtained are crude, and large-scale production and the practical use of this

anti-bacterial substance in medicine are yet to be made possible by further researches. The most interesting fact about chlorellin is that it is found in a green plant able to manufacture its own food out of natural raw materials. All previously discovered compounds, including penicillin, are made from moulds, soil bacteria, and other plants which require to be supplied with ready-made foods in the form of glucose solutions and the like.

CAUSE OF CANCER

RECENT studies by Dr Konrad Dobriner and Col. C. P. Rhoads, of the Memorial Hospital, and by Dr S. Lieberman, Dr B. R. Hill and Dr L. F. Fieser, of Harvard University, seem to favour production line trouble in the body's endocrine glands, particularly the adrenals, as a probable cause of both cancer and leukaemia. The results of these studies have been recently reported at the Atlantic City meeting of the American Society for Chemical Investigation, according to *Science News Letter*.

The basis for such a view is the newly observed fact that kidney excretions of cancer patients contain chemical substances which are not found in the excretions of normal persons. Furthermore, there

exists a marked difference in the amounts of certain hormone chemicals excreted by normal persons and by cancer and leukaemia patients. The glands of such patients are supposed to produce cancer-causing chemicals instead of harmless chemicals they should have normally manufactured. The glands involved may be sex glands or the adrenal glands or both.

Faulty function of the cortex of the adrenal glands is particularly suggested. These evidences seem to be in agreement with the recent observation of Dr James B. Murphey, of the Rockefeller Institute, that the development of transplanted leukaemia in rats could be prevented by injections of adrenal cortical hormone.

UNITED NATIONS RELIEF AND REHABILITATION ADMINISTRATION

REPORT OF THE SUB-COMMITTEE ON POLICIES WITH RESPECT TO HEALTH AND MEDICAL CARE

[The first session of the Council was held at Atlantic City, New Jersey, U. S. A., from November 10 to December 1, 1943. Forty-four countries including India, signed the Agreement. Mr Dean Acheson, Assistant Secretary of State of the U. S. A. was the Chairman of the first session. Sir Girija Shankar Bajpai represented India. In all, 47 resolutions were adopted. Four main Committees, with several sub-committees, were formed to discharge the functions of the Council. We shall present the readers today with the Report of the Sub-Committee on Policies with respect to Health and Medical Care. In the next issue we propose to publish the Report of the Sub-Committee on Policies relating to Agricultural Rehabilitation and other means of raising food essential to relief.—Ed. Sc. & Cul.]

SCOPE OF THE HEALTH WORK OF UNRRA

THE health work will necessarily constitute one of the primary and fundamental responsibilities of the UNRRA. The relief and rehabilitation programme must aim toward the maximum of health security within the practicable limits of the resources of the United Nations.

This programme would consist chiefly of the provision of assistance to governments in the rapid re-establishment of their health services, generally preventive and curative. These services include not only disease control and relief from malnutrition, but also the re-establishment of medical services, hospitals, dispensaries, sanatoria, health centres, laboratories, environmental sanitation, maternity and child welfare services, the control of endemic diseases, particularly tuberculosis and venereal diseases, and other essentials for health. For this purpose UNRRA should be prepared to give assistance in connection with equipment and supplies, personnel, expert advice, facilities for technical training, and the collection and dissemination of information bearing on the above problems.

One of the aims of UNRRA should be to equalize

opportunity for the restoration of health in the various countries. This will involve a sharing of responsibilities and equitable distribution of goods and other assistance in proportion to need and in accordance with a co-ordinated plan.

Among the most important functions of the Health Organization of UNRRA will be work in connection with the control of epidemics, particularly those affecting more than one country. Early examination will have to be made of the best method of collecting, analyzing and collating such reports regarding epidemics as may be available from any source including such information as the military may find it possible to furnish, and subsequently distributing this information for the use of member governments as well as UNRRA itself.

Furthermore, the Health Organization will sponsor promptly the conclusion of emergency agreements among the various governments establishing uniformity in the quarantine measures to be observed among them. In addition, the Health Organization will seek to co-ordinate the steps taken by countries mutually concerned in the control of outbreaks of infectious diseases. Moreover, UNRRA may be called upon to provide urgently needed medical supplies for meeting an emergency. In view of the obvious importance of dealing rapidly with epidemics, it is essential that the Health Organization has at its immediate disposal trained personnel and material.

The Health Organization may be called upon to provide for the loan of experts to various countries, particularly in cases where diseases have been introduced for the first time as a result of the war, and with the control of which neither the National Health Authority nor the local practitioners are familiar, or where diseases, already endemic have reached epidemic proportions.

The medical aspects of nutrition will constitute one of the chief preoccupations of the Health Organization which will be urgently concerned with the provision of nutritional standards adequate for the

SUPPLEMENT

Indian Science News Association

PROCEEDINGS OF THE NINTH ANNUAL MEETING

THE Ninth Annual General Meeting of the Indian Science News Association was held on September 9, 1944 at 5-15 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.

Before the business of the meeting was begun all assembled stood in silence as a mark of respect to Acharyadeb and Prof. B. B. Ray.

The proceedings of the last annual 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, 1943 to 30th June, 1944.

ANNUAL REPORT

The Council of the Indian Science News Association have much pleasure in submitting this, the Ninth Annual Report and the Statement of Accounts for the period July 1, 1943 to June 30, 1944.

OBITUARY

Before we proceed I would like to refer to the losses sustained by our Association through the hands of death. During the period under review we lost Sir P. C. Ray, our most revered benefactor, who had been a source of inspiration to us since the inauguration of the Association. He showed his sympathy for our work in the most practical way by making handsome donations to our funds whenever we were in difficulties. The Editorial Board of SCIENCE AND CULTURE has undertaken the publication of an authoritative biography of the late Acharya and this in the least that the Association could have done to show its gratitude. His memory is cherished by our countrymen, but we, in particular who have special reasons to be grateful pay our respectful homage to his hallowed memory on the occasion of this Annual Meeting of ours.

We also lost recently Professor B. B. Ray, one of the founder members of the Association and one of the first Editors of SCIENCE AND CULTURE. The

Association when started in 1935 had no room of its own, and Professor Ray allowed his sitting room to be converted into office for SCIENCE AND CULTURE. He gave his time and energy freely to the service of the magazine which needed fostering care in its early days. Professor Ray's memory will remain fresh in the minds of his colleagues and co-workers, and the Association mournfully records the help and services it received from him.

MEMBERSHIP

During the last year, i.e., 1943-44, 8 new members joined the Indian Science News Association as compared to 14 in the previous year.

The number of life members at the close of the year under review was 110 compared to 103 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, 1944, the last month of the period was 1127 as compared with 1041 in the same month in 1943. The number of subscribers in June, 1944 (including members of the Association) was 954, which represents an increase of 101 since June, 1943. The actual number of new subscribers enrolled was however 104.

We had difficulties owing to scarcity of paper and, in the absence of high quality paper, we were forced to print the journal on inferior paper. Our thanks are due to Mr Raghunath Dutt of Bholanath Dutt & Sons Ltd., who supplied us regularly with paper.

During the year 1943-44 authoritative articles from the pens of specialists were published and the high standard of the journal was maintained. We would take this opportunity of thanking our contributors who by their articles, notes and letters have helped SCIENCE AND CULTURE to step in the Tenth year of its existence.

EXCHANGE JOURNALS

The total number of copies sent out every month in exchange and for review was 62. We received in exchange only 6 English, 14 American, 20 Indian and 1 Australian journal as compared to 4 English, 13 American, 17 Indian and 1 Australian journal in

the previous year. We also received journals of learned societies and publications of 4 Government Scientific Departments. Four Calcutta newspapers, viz., the *Statesman*, the *Hindustan Standard*, the *Amrita Bazar Patrika* and the *Jugantar* supply their daily issues in exchange. The well known Madras daily the *Hindu*, has also been recently added to the list. We send the journal regularly to 18 Societies and Institutions on request.

ADAIR, DUTT RESEARCH FUND

We are glad to announce that the well known firm of Messrs Adair, Dutt & Co. Ltd. has placed at our disposal a further sum of Rs. 2,500/- for award as research scholarships. Last year 4 new scholarships were awarded, and 2 scholarships were renewed. The scholars are:

NEW SCHOLARS

Name	Subject	Under whom research to be carried
1. Mr Govinda Ram Debnath	Androgenic Hormones (Chemistry)	Prof. J. K. Chowdhury, Dacca University.
2. Mr Arobinda Nath Bose	Processing of food-stuffs on vitamin values (Higher Technology)	Prof. B. C. Guha, Calcutta University
3. Mrs Amina Rahman	Methods of estimation of the vitamin of the "B" Group and their assay in Indian foodstuffs (Nutrition)	Prof. B. C. Guha, Calcutta University
4. Mr Amal Chand Ghosh	Cyclotron work (Higher Technology)	Prof. M. N. Saha, Calcutta University

RENEWALS FOR THE SECOND YEAR

1. Mr Satyendra Nath Ghosh	Measures of the intensity of the night sky (Physics)	Prof. S. K. Mitra, Calcutta University
2. Mr Sailendra Nath Ghosh	Feeding in Carps (Zoology)	Prof. H. K. Mookerjee, Calcutta University

We have much pleasure to announce that a further sum of Rs. 3,000/- has been contributed by the above mentioned firm to the fund for carrying on researches in other subjects to be decided by the Committee.

(For statements of account see page 4)

GRANTS

We are grateful to the authorities of the University of Calcutta, the Bengal Chemical & 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.	Rs. 500/-
Indian Association for the Cultivation of Science	Rs. 100/-

During the year the Association was fortunate enough to receive the following donations. We express our sincerest thanks to the donors.

Sir P. C. Ray	Rs. 2,000/-
Messrs. H. Datta & Sons Ltd.	Rs. 1,000/-
Messrs. Soor Enamel & Stamp- ing Works	Rs. 1,000/-
Mr Alamohan Dass	Rs. 750/-
Messrs. Calcutta Chemical	Rs. 500/- with further promise.

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 helped us in securing new subscribers. We would in this connection mention the name of Dr Maneck B. Pithawalla of Karachi who has secured for us nearly half a dozen subscribers and members.

CONCLUSION

As in the past years the Editorial policy of SCIENCE AND CULTURE continued to be to make every attempt to focuss public attention on the importance of the application of science, scientific research and scientific methods to the social and economic problems facing our country. We were glad to find that Prof. A. V. Hill who was in our midst a few months ago whole heartedly supported the stand taken by us. Like us he was strongly of opinion that the solution of many of our problems lay in wider and still wider application of scientific research, of scientific methods and in proper and scientific approach. Prof. Hill demanded from the country and from the Government ruling the country these very things in regard to which SCIENCE AND CULTURE has been pleading all these years. We may perhaps be pardoned if we quote Prof. Hill on this point from one of his speeches. Said Prof. Hill: "Let us aim at giving 1 per cent. of our national budget, 1 per cent. of the value of our industrial and agricultural production, 1 per cent. of the loss due to ill-health, 1 per cent. of the cost of our food, our transport, our houses, our water, our coal, even our broadcasting, to research—and in 10 years we shall find that we are getting back

not 1 per cent. but 10 or 20 or 40 or 200 per cent. in dividends.

"If those who call themselves 'Practical men' object, let us remember Francis Galton's definition of the practical man—"the practical man is the man who practises the errors of his forefathers'."

We may also refer to another aspect of economic development for which SCIENCE AND CULTURE has been preaching since its inauguration and which is now receiving a good deal of public attention. We have recently seen the publication of many "Plans" for the economic regeneration of the country. We have Bombay Plan, People's Plan, Plan for Railway Development, Agricultural Plan and the 300 crores Education Plan. But the fundamental idea lying behind any planning, namely that, planning for forced development to be successful, must be made simultaneously for all the different branches of social and economic life of the country providing correlation between them as necessary, had been stressed in SCIENCE AND CULTURE in many of its articles and editorials. We are also glad to note that the Government of Bengal has officially been recommended to make a thorough survey of the power and economic resources of the province—a survey on the necessity of which also SCIENCE AND CULTURE has been pleading for a long time. Let us hope that the Indian Science News Association, through its organ SCIENCE AND CULTURE, will continue to do the good work it had been doing since its inception in 1935.

(For statement of account see next page)

The following persons were unanimously elected officers and members of the Council for the year 1st July, 1944 to 30th June, 1945:

President.—Sir U. N. Brahmachari.

Vice-Presidents.—Dr S. C. Law, Dr Baini Prashad, Prof. M. N. Saha, Dr B. C. Law, Sir S. S. Bhatnagar and Prof. 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, Prof. D. M. Bose, Mr W. D. West, Dr K. Biswas, Shahibzada M. Yusuf Khan, Col. Sir R. N. Chopra, Dr M. S. Krishnan, Sir J. C.

Ghosh, Dr D. S. Kothari, Mr B. N. Maitra, Dr S. C. Mitra, Prof. H. K. Mookerjee, Prof. J. N. Mukherjee, Dr John Matthai, Mr M. M. Sur, Prof. P. Ray, Dr S. L. Hora and Dr A. C. Ukil.

The Editorial Board of "SCIENCE AND CULTURE" for the next year was constituted with Sir J. C. Ghosh, Prof. M. N. Saha, Dr A. C. Ukil and two Secretaries as ex-officio members.

Prof. P. N. Ghosh then delivered his welcome address and stressed the importance of the scientific journal SCIENCE AND CULTURE, the organ of the Association.

Among the distinguished speakers were Dr D. M. Bose, Prof. M. N. Saha, Dr Nalinaksha Sanyal, Mr S. M. Bose, Mr H. P. Bhaumik and others. Prof. Saha spoke on the need of inaugurating in India an organization like the P. E. P. in Great Britain and referred to the distinguished services this organization consisting largely of eminent scientists, economists and industrialists of England rendered to their country. A similar organization may also be created in this country to its great advantages to tackle effectively with the problem of economic development of this country. The lurking question of fertilizers, for instance, may form the subject of its immediate enquiry and activity when such a body is created here. He invited the active co-operation of distinguished scientists, economists and industrialists in the matter.

Dr N. Sanyal spoke on the need of co-operation between the Government and the scientists of the country. He deplored the utter lack of such co-operation and the callous neglect of the Government with regard to question pertaining to science. Moreover, expert knowledge on the scientific aspects of several questions is not often available before the legislatures when such questions come up for discussion.

Mr H. P. Bhaumik spoke on the need of power development in this province and referred to the significant advances Madras made in this direction. He suggested the introduction of the well-known grid system for the transmission of power when such stations are brought into existence.

Prof. S. P. Agharkar proposed a vote of thanks to the Chair.

INDIAN SCIENCE NEWS ASSOCIATION

(REGISTERED UNDER ACT XXI OF 1860)

Receipts and Payments Account for the year ended 30th June, 1944.

RECEIPTS	RS. AS. P.	RS. AS. P.	PAYMENTS	RS. AS. P.	RS. AS. P.
To Opening Balances on 1-7-43 :-			By Establishment ...		3,170 0 0
(a) At Bengal Central Bank			.. Journal Printing ...		4,646 1 0
Ltd. in Current A/C ...	1,481 13 9		.. Paper ...		3,197 10 6
(b) At Bengal Central Bank			.. Postage & Receipt Stamp ...		657 9 0
Ltd. in Savings A/C ...			.. Conveyance ...		216 10 3
re : Science & Culture			.. Telephone ...		210 13 0
A/C ...	796 13 3		.. Sir P. C. Ray Biography A/c ...		50 0 0
(c) With Treasurer ...	118 3 6		.. Miscellaneous ...		202 11 0
		2,396 14 6	.. Audit Fee (1942-43) ...		40 0 0
.. Grant ...		1,100 0 0	.. Furniture ...		108 0 0
.. Donation ...		4,750 0 0	.. Stationery & Printing ...		154 8 9
.. Life-Membership Fee ...		700 0 0	.. Bank Charges ...		53 12 0
.. Ordinary Membership Fee ...		305 6 0	.. Binding Charges ...		12 8 0
.. Subscription ...		4,588 2 5	.. Closing Balances on 30-6-44 :-		
.. Advertisement ...		5,288 4 0	(a) At Bengal Central Bank		
.. Reprint ...		512 8 0	Ltd. in Current A/C ...	6,353 3 3	
.. Miscellaneous ...		612 2 0	(b) At Bengal Central Bank		
.. Bank Interest ...		31 3 7	Ltd. in Savings A/C ...		
			re : Science & Culture		
			A/C ...	1,143 8 3	
			(c) With Treasurer ...	67 9 6	
					7,564 5 0
					Rs. 20,284 8 6
					Rs. 20,284 8 6

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, 1944, 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 18th August, 1944.

Sd. S. K. MITRA,
Sd. B. C. GUHA,
Honorary Secretaries.

Sd. A. K. GHOSH,
Government Diplomaed Accountant,
Registered Accountant,
Auditor.

Sd. P. C. MITTER,
Treasurer.

ADAIR, DUTT RESEARCH FUND

Receipts and Payments Account for the year ended 30th June, 1944.

RECEIPTS	RS. AS. P.	RS. AS. P.	PAYMENTS	RS. AS. P.	RS. AS. P.
To Opening Balances on 1-7-43 :-			By Stipend ...		2,400 0 0
At Bengal Central Bank			.. Advertisement ...		62 8 0
Ltd. in Savings A/C ...	7,940 2 1		.. Accountancy Charges ...		10 0 0
With Treasurer ...	27 14 6		.. Postage and Receipt Stamp ...		1 0 0
		7,968 0 7	.. Conveyance ...		12 0
.. Bank Interest ...		71 0 0	.. Closing Balances on 30-6-44 :-		
			At Bengal Central Bank		
			Ltd. in Savings A/C ...	5,536 2 1	
			With Treasurer ...	28 10 6	
					5,564 12 7
					Rs. 8,039 0 7
					Rs. 8,039 0 7

AUDITOR'S REPORT TO THE MEMBERS

I have audited the above Receipts and Payments Account of ADAIR, DUTT RESEARCH FUND for the year ended 30th June, 1944, 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 Fund.

10, Old Post Office Street,
Calcutta, the 18th August, 1944.

Sd. S. K. MITRA,
Secretary,

Sd. G. BHATTACHARVA,
Treasurer,

Adair, Dutt Research Fund.

Sd. A. K. GHOSH,
Government Diplomaed Accountant,
Registered Accountant,
Auditor.

October, 1944

MEDICINE AND PUBLIC HEALTH

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maintenance of health in the territories in which it operates.

The Health Organization in collaboration with the member governments concerned will play an extremely important part in the health supervision and control of returning displaced persons. In this connection it will be important to co-ordinate the health measures taken in the country of departure, the countries of transit, and, if the government concerned so desires, in the country of destination.

The special health needs of children and expectant and nursing mothers must be given early recognition by the Health Organization. Prompt and adequate provision for the health and nutrition of these vulnerable groups is essential to the restoration of normal family life and community stability.

The problems of health among orphan children will be acute and must be dealt with in close collaboration with other functional units of UNRRA. Special measures will be required to deal with communicable diseases among all-children, particularly those who are lowered by malnutrition. This may well be intensified by over-crowding, and the lack of clothing and of other essentials for health and normal development.

Although it may be necessary at the outset to deal with the health problems of mothers and children through group arrangements, including maternal and child health clinics, feeding stations and other emergency provisions, yet as soon as possible, such care should be individualized to meet the needs of each. The Health Organization should participate in the development of UNRRA plans for providing food for these special groups in order that food policies may be maintained in consonance with their special physiological needs.

The Health Organization may also be called upon by member governments to assist in dealing with the conditions of anxiety, fear and emotional disturbances which will have arisen in peculiarly great frequency among the children and youth of occupied territories.

A constant objective of the health programme should be to demonstrate the effectiveness and need for international collaboration in public health. In so doing it will facilitate the later development of a permanent world-wide health organization.

POLICIES WITH RESPECT TO GOVERNMENTAL AND NON-GOVERNMENTAL HEALTH ORGANIZATIONS—RELATIONSHIPS WITH NATIONAL HEALTH SERVICE.

It is the duty of national health services to assume full responsibility for public health within their countries and UNRRA should assist in the effective prosecution of these activities directed to this

end whenever this is requested by a member government.

Whenever possible the national and local health services should be the channel through which the health work of relief and rehabilitation operations are carried out, and it should be a constant objective of the Health Organization to assist in strengthening these services.

COLLABORATION BETWEEN MEMBER GOVERNMENTS IN THE CONTROL OF EPIDEMIC DISEASES

Since diseases are not limited by political boundaries, member governments must collaborate fully in the joint adoption of measures designed to control the international spread of disease especially through the exchange of epidemic intelligence so far as military security permits, joint action in connection with the health aspects of repatriation of displaced persons and where necessary direct collaboration between their national health services. Such necessary co-ordination and combined action could best be arranged by the creation of a special section in the Health Organization of UNRRA for epidemiological control.

CO-OPERATION WITH GOVERNMENTAL INTERNATIONAL HEALTH AGENCIES

Co-operation with existing governmental international health agencies should be fostered. The Health Organization of the League of Nations, the industrial health section of the International Labour Office and the Pan-American Sanitary Bureau have much to offer on the basis of their long experience and accomplishments. In view of the importance of nutrition from a health point of view, co-operation should be sought with the Interim Commission established by the United Nations Conference on Food and Agriculture, and with any permanent organization which may succeed it. Co-operation with the International Public Health Office in Paris is, of course, out of the question at the present time.*

CO-OPERATION WITH NON-GOVERNMENTAL HEALTH AGENCIES

The wide experience and goodwill of the non-governmental health agencies should be utilized to the utmost as it is clear that the full participation of all such agencies may well be needed. In accordance with the terms of the Agreement, plans and policies should be developed whereby the resources of such organizations may be used effectively in those health aspects of relief and rehabilitation in which they have special competence.

* Paris was under German occupation at the time when the report was submitted. With the liberation of Paris, the question of co-operation with the International Public Health Office in Paris may be revived.

GENERAL FUNCTIONS OF THE HEALTH ORGANIZATION

The general functions of the Health Organization should include:

- (a) responsibility for the health aspects of all the work of UNRRA;
- (b) assembling of comprehensive data on the health and medical organization of the various countries, including information on hospitals, dispensaries, health centres, laboratories, sanitary installations and scientific institutions; the numbers and kinds of local technical personnel; and the local production and distribution of sanitary and medical supplies;
- (c) collection of information on health conditions in the various territories, including data on epidemic diseases, nutrition, sanitation, maternal and child health, tuberculosis and other diseases, the care of the sick and physically handicapped, the local production and distribution of medical and sanitary supplies and all related matters;
- (d) over-all estimation of the amounts and kinds of medical and sanitary supplies needed, and the arrangement for their procurement, allocation, transportation and distribution;
- (e) recruitment of technical and professional personnel, establishment and conduct of training programme, assignment of personnel to specific fields of operation, and the general direction of health operations in the field;
- (f) preparation, in collaboration with the respective member governments, of plans for health relief and rehabilitation for specific countries;
- (g) where consistent with UNRRA policy and within the general framework of its field operations, temporary general administration of health services in areas where national or local health services are not yet functioning effectively;
- (h) responsibilities in connection with the health of displaced persons;
- (i) preparation of recommendations to the Council or to the governments concerned for any emergency international agreements necessary to control the spread of disease;
- (j) provision of experts or expert teams at the request of a national government;
- (k) assistance in the control of epidemics;
- (l) carrying out of the general health policies of UNRRA in relation to co-operation with the health service of the appropriate inter-Allied military authority; international governmental health agencies; international and national non-governmental health agencies; and other Divisions of UNRRA engaged in activities related to the health field, especially food and agriculture, welfare, and displaced persons.

POLICIES REGARDING THE HEALTH ORGANIZATION OF UNRRA

The re-establishment of health being one of the principal objects of relief work, it is essential that the status of the Health Organization should be commensurate with its importance in the work of the whole administration.

It is a recognized principle of administration that all work of a technical character be carried out under

technical directions. In view of the fact that almost every aspect of the work of UNRRA will necessarily have health implications (programming, supplies, personnel, training, co-operation with governments, field operations, etc.), the Director of Health must be accorded a position in the administration which will enable him under the authority of the Director General, to develop suitable policies and to exercise proper technical direction over all health aspects of the work of UNRRA.

The Health Organization should consist of a Director of Health and a technical and administrative staff, a standing technical Committee on Health of the Council which would be advisory to the Council, to the Central Committee, and to the Medical Director, and the necessary regional organization. Experience has shown that a considerable degree of decentralization is desirable in health administration, so that strong regional organizations will be needed in areas such as Europe and the Far East.

Director of Health of UNRRA.—There should be in the administration a health organization with a Director of Health, who should be accorded a position in the administration, which will enable him, under the authority of the Director General, to develop suitable policies and to exercise proper technical direction over all health aspects of UNRRA.

Acting under the authority of the Director General, the Director of Health would be responsible for the health and medical aspects of all UNRRA activities. He would be directly concerned in all major policy and administrative decisions in which health, medical, or nutrition problems are involved. It follows that the status and success of UNRRA from the health point of view depend on obtaining the services of a Director of Health of the highest possible professional standing, whose previous work is such as to command the respect of those qualified to judge, both from a technical and administrative point of view.

Regional Health Directors.—A Regional Health Director should be appointed to each Regional Organization; his position should be relatively similar to that provided for the Director of Health.

Executive Health and Secretarial Staff.—The greatest care will be required in selecting health personnel for field work in the various countries. Technical competence is fundamental, but almost equally important is the ability to work in a team with others of a different nationality as the staff will necessarily include health personnel from a number of countries. This qualification is of primary importance for members of the staff required to work away from Headquarters, for they must be able to understand the outlook of the people among whom they are called upon to work. In comparison with this quali-

fication, a knowledge of languages, though a valuable asset, is of secondary importance.

During and immediately after the war, it will be by no means easy to find health personnel who possess such divergent capacities. In order to enable UNRRA to obtain promptly the necessary staff, the various member governments should facilitate the secondment or otherwise make available health personnel both from central and local health authorities, including short-term appointments.

Field Missions.—The organization of health missions and the constitution of individual missions should be the responsibility of the Director of Health or the Regional Directors of Health, acting under the authority of the Director General.

With regard to the field organization, however, it is impossible to anticipate what types of individual or special missions may be required. Member governments may well ask for highly technical assistance in almost any branch of medical or sanitary science, particularly in view of the isolation of many of their own experts during the years of war. The Health Organization of UNRRA should, therefore, collect information regarding individual experts and expert teams which might be made available for service in the field should the occasion arise.

Standing Technical Committee on Health.—A standing technical Committee on Health should be appointed as provided for in the Agreement. For efficient work the number of members should be limited to between 9 and 15. Chairmen of the Regional Health Sub-Committees should be included in the membership of the standing Technical Committee on Health. As the Agreement provides that the Council can appoint as members of the Committee on Health alternates of special competence in their respective fields of work, it is urged that members should nominate the Committee alternates technically capable of aiding in the deliberations of the Committee. It is of the greatest importance that such alternates as are nominated be accredited as representatives of their respective Public Health Services.

Regional Health Sub-Committees.—Since experience has proved the desirability of a considerable degree of decentralization on health administration, particular attention should be paid to the setting up of strong Regional Health Organizations including Regional Health Sub-Committees. Undoubtedly the Regional Health Sub-Committees consisting of from 9 to 15 members should be made up of accredited representatives of the national health administrations concerned. The importance of such representation is obvious in the case of epidemics involving more than one country, for these circumstances success in pre-

venting the spread of the epidemic will involve combined action by the several health administrations concerned.

Both the central standing Technical Committee on Health and the Regional Health Sub-Committees should make it a practice to involve the participation of representatives of the health services of any countries in meetings at which important measures directly affecting such countries are discussed.

Expert Commissions.—In view of the highly technical character of the health work of UNRRA it will be essential for the standing Committee on Health and any Regional Health Sub-committee to have authority to appoint expert commissions. The members of those expert commissions should be nominated as individuals and solely on the ground of their special knowledge of the subject concerned. As members of expert commissions speak as individuals only, there is no necessity to make any such commission even approximately representative of a number of countries, except so far as this may be necessary in order to get a balanced representation of several schools of scientific thought. National and administrative views would be represented by the standing Technical Committee on Health and the Regional Health Sub-committees, and it is for this reason, among others, that recommendations of experts or expert commissions should invariably pass through the Committee on Health or the Regional Health Sub-committee, as the case may be, before their final acceptance.

Among others, expert commissions on nutrition will be required which, in view of the wide differences obtaining in the food habits and nutritional status between various parts of the world, might be regional in character. These experts would deal with the scientific and physiological aspects of the nutrition problem and would give advice in connection with any proposed alterations in the constitution of rations, the priorities of special rationing and the classes of the population requiring special consideration, e.g., expectant and nursing mothers, infants, cases of tuberculosis, deprivation diseases, etc.

Consideration should be given to the constitution of an expert commission dealing with the health of mothers and children which might be related to comparable groups of experts dealing with other aspects of maternal and child care.

Conference of Directors of National Public Health Services.—Provision should be made to enable the Director of Health under the authority of the Director General and with the approval of the Council to summon, either centrally or regionally, a conference of Directors of National Public Health Services whenever practicable and desirable.

IMMEDIATE TASKS OF THE HEALTH ORGANIZATION

The tasks calling for immediate action include:

- (a) Selection of a Director of Health, and the recruitment of a competent staff, utilizing the full resources of the United Nations so far as they can be made available at the present time.
- (b) Immediate provision of help upon request of any member government in order to meet emergency health problems which have actually arisen as the result of the war.
- (c) Collection and assembly of all information available on those areas likely to be liberated first and scientific data which may be of value to the Health Organization.
- (d) Conferences with appropriate Health Officials of the member governments concerned with regard to the nature and amount of assistance that may be required of UNRRA.
- (e) Recruitment and training of personnel for field missions.
- (f) Study and collection of previously prepared estimates of health, medical, and sanitation supplies, and arrangement for their scheduling and procurement, with emphasis upon the importance of rapidity in forward procurement particularly in respect of supplies required for the control of epidemics.
- (g) Collaboration with the Allied Military Authorities for the collection of information regarding the existing conditions in liberated areas, the prevalence of epidemics and the arrangements for the orderly transfer of any health responsibility to UNRRA, where this is so requested by the member government or the Military Authorities themselves.

(h) Training of nationals of the various countries in special medical and allied technical work. Whilst facilities have already been made available in connection particularly with training in the making and fitting of artificial limbs, training in the use of mass radiography apparatus, laboratory technical assistants, etc., yet it is felt that this service should be greatly increased so as to cover a much wider scope in order to provide the technicians who will be required for medical relief work immediately a country is liberated; for this purpose it would be desirable for some governments to assign certain of their nationals for training, and for others to offer facilities for such training.

(i) Obtaining of medical literature dealing with the progress of medicine and hygiene during the years of war for the liberated countries. For this purpose the Health Organization of UNRRA should give immediate consideration to the possibility of collecting selected periodicals on the various branches of medical and sanitary science.

Even though it may not be possible for UNRRA to meet all the relief and rehabilitation needs of the populations affected by the war, nevertheless by approaching the tasks through the wise use of the technical resources of the United Nations, mobilized and engaged in the same spirit of co-operation as they are now devoted to the prosecution of the war, it should be possible, in the public health sphere, to attain comparable success in the war against disease and for the restoration of health.

LETTERS TO THE EDITOR

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

MEASUREMENT OF H. F. MAGNETIC SUSCEPTIBILITY OF LIQUIDS AND SOLUTIONS BY HETERODYNE BEAT METHOD

THOUGH heterodyne beat method is extensively used in experimental determinations of the dielectric constant of solutions and liquids at high frequencies, it has been tried and found inconvenient for the measurement of their h.f. magnetic susceptibility. Recently, however, several workers^{1,2} have successfully used this method to measure the h.f. susceptibility or permeability of magnetic substances in form of thin wires. When these wires are introduced into suitably designed inductances of the oscillatory circuits, changes in beat note is observed and original conditions are restored by adjusting the value of the

calibrated variable condenser in the circuit. From the knowledge of the change in capacity required to get the original condition and the dimensions of the wire and inductance h.f. susceptibility of the wires may be easily calculated. In case we want to measure the h.f. susceptibility of liquids or solutions, they must be introduced into the inductance, in tubes of much greater diameter than that of wires, in order to get any appreciable effect. This will, however, produce considerable electrostatic capacity between the inductance and the experimental liquids and the inductance effect may be obliterated. In order to eliminate the capacity effect, Belz³ used inductances wound over glass tube which was thinly coated (thickness of the order of 7×10^{-6} cm.) with

platinum, the latter being connected to the earth. The inductance was thus electrostatically completely shielded from inside. The selection of platinum and extreme thinness of the film were necessitated by the fact that the coated conductor should not reduce the magnetic field of the inductance by any appreciable amount. If H_0 is the intensity of the magnetic field of the inductance at the surface of the conductor and H_t the corresponding value at a depth t inside the mass then $H_0/H_t = e^{-\frac{\sqrt{2\pi\mu p t}}{\sigma}}$, where, μ and σ represent the permeability and specific resistance respectively of the conductor and $p = 2\pi n$, n being the frequency. For platinum $\mu = 1$, $\sigma = 11,000$ c.g.s., e.m.u. and if $n = 4.84 \times 10^5$ per sec. (as used by Belz) within the shield for $t = 7 \times 10^{-6}$ cm., $H_t/H_0 = 0.9997$, that is very nearly equal to unity. It may be seen that if higher frequencies are used the ratio will recede further from unity and the variation of the magnetic field due to appreciable absorption by the shield is bound to introduce errors in the experiment.

The present authors, while carrying out experiments on the measurements of the h.f. magnetic susceptibility of solutions and liquids, have devised an arrangement which appears to be quite effective in shielding the experimental liquids from the electrostatic influence of the inductance and is much more convenient and easily manipulated. The arrangement consists of a double walled glass tube,—the annular space being filled with a non-magnetic solution like KCl or NaCl solution and connected to the earth. The width of the annular space is about 1 mm. The inductance wire is coiled on the outer tube and the inner one contains the experimental liquids. For a solution of NaCl used by us σ was found to be 14.2×10^9 c.g.s. e.m.u. and here $H_t/H_0 = 0.9714$ even for a wave length of 100 meters ($n = 3 \times 10^6$ per sec.) and for a thickness of the liquid (forming the shield) equal to 1 mm. It is unnecessary to discuss here the difference in the procedures and calculations between cases when wires or solutions in thin tubes are used from those in which solutions in wider glass tubes are employed.

B. N. SINGH
LALIT PRASAD

Physics Laboratory,
Science College,
Patna, 3-8-1944.

¹ Wait, G. R., *Phy. Rev.*, 29, 566, 1927.

² Wait, G. R., Brickwedde, F. G. and Hall, E. L., *Phy. Rev.*, 32, 967, 1928.

³ Belz, M. H., *Phil. Mag.*, 44, 479, 1922.

HOW TO MANURE A POND FOR FOOD OF FISHES

IN order to manure a pond for food of fishes one may put bundles of dried straw tied with a string round them in the tank, so that at the time of need these bundles may readily be removed without scattering. Such dry bundles of straw in water make a suitable medium for culturing protozoa¹ like *Paramoecium*, *Vorticella*, *Colpoda* etc. Dried water-hyacinth or pistia may be put in the same way in water of the pond in order to get a culture of minute crustacea like *Daphnia*.² Stable refuse or kitchen refuse has the effect of culturing both algae and protozoa. Sewage water also accelerates the growth of algae more rapidly than anything else. So that by gradually adding some quantities of sewage or stable refuse in a pond, the water could be turned green. This green colour indicates that no more such manures need be added. Putting cowdung or mustard-oil-cakes in the pond renders the growth of algae, protozoa and crustacea. In addition to the above mentioned articles of food of fishes all these manures assist in the excessive growth of aquatic higher plants which also form, not in fresh condition but when they are transformed to a state of semi-rotten condition³ the main bulk of food of adult herbivorous fishes.

Now the question is whether all the above processes of manuring ponds justify, when we know that nearly 95% of our ponds in Bengal are kept for the purpose of procuring drinking water as well as for pisciculture. If that be so, we ought to take every precaution and should not advocate manuring of ponds by stable refuse, kitchen refuse or sewage water which renders the water of the ponds unfit for drinking purposes. This will do more harm than good.

In order to have the desired culture of algae we can take the recourse of having algae culture in *gamlas* with Knop's or Moore's solution. Dried straw or dried water-hyacinth may not pollute water if given in minute proportion, but it is desirable to have the protozoa and crustacea culture in *gamlas* so that after their culture they may be transferred to ponds for further multiplication. So it comes to this, that there are two sets of ponds (1) ponds for the purpose of pisciculture only, (2) ponds for the purpose of both pisciculture and drinking water. For the first set of ponds we can use stable refuse, kitchen refuse or even sewage water and also dried bundles of straw or water-hyacinth directly in the water of the pond, as for the second set of ponds we ought to be very cautious about pollution of water. We should use salts for culture of algae, dried straw or water-hyacinth for protozoa and crustacea either in *hundreds* or *gamlas* to be ultimately transferred to ponds.

Every pisciculturist ought to remember that for the sake of fish we cannot pollute our drinking water.

H. K. MOOKERJEE.

Zoology Department,
Calcutta University,
7-8-1944.

¹ Calcutta Review, 84, No. 3, 1942.

² SCIENCE AND CULTURE, 9, 558, 1944.

³ SCIENCE AND CULTURE, 9, 306, 1944.

SULPHANILAMIDE DERIVATIVES FOR THE TREATMENT OF INTESTINAL INFECTION

SULPHAGUANIDINE, sulphapyridine, succinylsulphathiazole and phthalylsulphathiazole¹ have been found to be useful in the treatment of bacillary dysentery and other intestinal infections. Stovarsol (3-acetylaminio-4-hydroxyphenylarsonic acid), which has been reported to produce favourable effects in the treatment of amoebic dysentery, is not entirely innocuous.

In order to obtain a drug which may prove effective both in amoebic and bacillary dysentery, 3-*p*-acetylaminobenzenesulphonamido-4-hydroxyphenylarsonic acid, m.p. 168-170° (decomp.) (found: N, 6.21; As, 17.60. C₁₄H₁₅O₇N₂SA requires N, 6.51; As, 17.42 per cent) has been obtained by condensing *p*-acetylaminobenzenesulphonyl chloride (1 mol) with 3-amino-4-hydroxyphenylarsonic acid (1 mol) in presence of aqueous solution of sodium carbonate (1 mol.). On hydrolysis of the above compound with 10 per cent hydrochloric acid and subsequent treatment of the hydrochloride with sodium acetate, 3-*p*-aminobenzenesulphonamido-4-hydroxyphenylarsonic acid, m.p. 182-183° (decomp.) (found: after drying *in vacuo* at 110°, N, 6.79. C₁₄H₁₃O₆N₂SA requires N, 7.21 per cent.) has been obtained, the pharmacological examination of which is under investigation.

S. L. LASKER
T. N. GHOSH

Bengal Immunity Research Laboratory,
Calcutta, 7-8-1944.

¹ Poth and Ross, *Proc. Amer. Soc. Pharmacol. Feder. Proc.*, Baltimore, 12, 89, 1943.

THE EFFECT OF QUININE SULPHATE SOLUTION ON HYDRA VULGARIS, PHASE ORIENTALIS

THE effect of different strength of solution of toxic substances like quinine, strychnine, nicotine and venom on some protozoons has been studied by a few workers (Kriz¹; Philpott²; Chopra and Chowhan³ a, b; and Sarkar⁴). But, so far I am aware,

no one has studied the effect of such substances on any Coelenterate material. The object of the present communication is to record my observation on the effect of the different strengths of quinine sulphate solution on *Hydra vulgaris*, phase *orientalis*.

Different grades of quinine sulphate solution were prepared in distilled water for each set of experiments. Three sets of experiments were carried out with three Hydra in each set and their average death time are noted below (Table 1).

TABLE 1

Serial Nos. of experiments	Strength of the solution	Minimum death time	Maximum death time	Mean death time
I	1 in 1,000	9 min.	12 min.	10.5 min.
II	1 in 1,500	12 min.	16 min.	14 min.
III	1 in 2,000	1 hr. 15 min.	1 hr. 30 min.	1 hr. 22.5 min.
IV	1 in 2,500	1 hr. 25 min.	1 hr. 30 min.	1 hr. 35 min.
V	1 in 3,000	1 hr. 30 min.	1 hr. 55 min.	1 hr. 42.5 min.
VI	1 in 5,000	2 hr.	2 hr. 35 min.	2 hr. 37.5 min.
VII	1 in 10,000	6 hr. 30 min.	7 hr.	6 hr. 45 min.
VIII	1 in 25,000	10 hr. 30 min.	12 hr.	11 hr. 15 min.
IX	1 in 50,000	26 hr.	29 hr.	27 hr. 30 min.

From the above table it may be observed that there is a sudden leap of the average death time from 14 minutes to 1 hour 22.5 minutes in the experiment No. II to III.

It may be noted that all the Hydra died within certain definite periods according to the different strengths of solutions used by me. But before their ultimate death the organisms showed some reactions in their movements and behaviours in different strength of the quinine sulphate solution. It is well known that when Hydra comes in contact with any foreign object it at once contracts its body. But soon after it shows the natural relaxation of its body. In the present experiments Hydra contracted at the first instance when they were transferred into the solutions of quinine sulphate from water, but the subsequent relaxation of their bodies disappeared *pari passu* with the gradual increase of the strength of the solution.

In the natural state Hydra is found to attach itself by its base to some foreign object. In the aquarium it is found to attach even to the walls of the vessel. When Hydra were introduced into the watch glass containing the quinine solution upto 1 in 10,000 (Experiments Nos. I to VII) they never

tried to attach their bases to the surfaces of the glass. But after the introduction of the Hydra into the solution of 1 in 25,000 (Experiment No. VIII) they attached their bases to the surface of the watch glass after some time. This shows that Hydra can withstand toxic effect of quinine sulphate solution from 1 in 25,000 onwards.

In all experiments it was observed that just at the time of death the whole body assumed the shape of a bell and floated in the solution upside down. The tentacles were the organs which first manifested signs of paralysis. Later on, the tentacles gradually gave away to maceration, the body remaining intact and showing signs of life. Still later, the anterior part of the body began to macerate and when the body was allowed to stay in the solution for a sufficiently long time a complete dissolution of the whole body took place. This shows that the effect of the solution operates on the tentacles first and then gradually pervades on the body; even then the discharged nematocysts of the tentacles and of the body remain unaffected in the fluid.

The reactions and behaviours of Hydra in different grades of solutions may be summarised as follows:

- (1) Hydra can withstand the toxic effect of the solution from 1 in 25,000 onwards.
- (2) The tentacles are first paralysed, then general maceration of the body follows.
- (3) The discharged nematocysts remain intact in the solution even after complete maceration.

This work was carried out in the Department of Zoology, Cotton College, Gauhati, Assam. My best thanks are due to the College authorities for the facilities given to me for the work.

H. L. SARKAR

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¹ Kriz, R. A., *Amer. Naturalist*, 58, 464-69, 1921.

² Philpott, *Proc. Soc. Exp. Biol. Med.*, 26, 522-23, 1928-29.

³ (a) Chopra, R. N. and Chowhan, J. S., *Ind. Jour. Med. Res.*, 18, 1103-11, 1931.

(b) Chopra, R. N. and Chowhan, J. S., *Ind. Jour. Med. Res.*, 20, 1, 1932.

⁴ Sarkar, S. L., *Archiv Protistenkunde*, 87, Ht. 2, 268-71, 1936.

EFFECT OF SOLAR ECLIPSE ON THE IONOSPHERE

A series of ionospheric measurements were made with the ionosphere apparatus at the University College of Science, Calcutta (lat. 22° 33' N, long. 88° 22' E) during the solar eclipse of July 20, 1944.

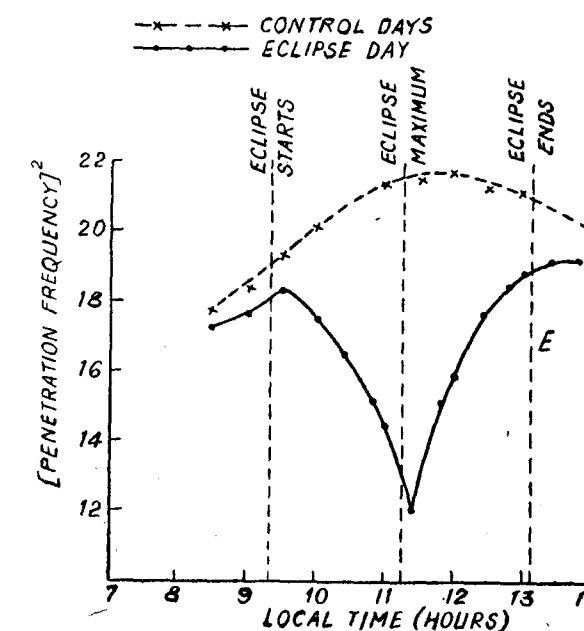


FIG. 1.

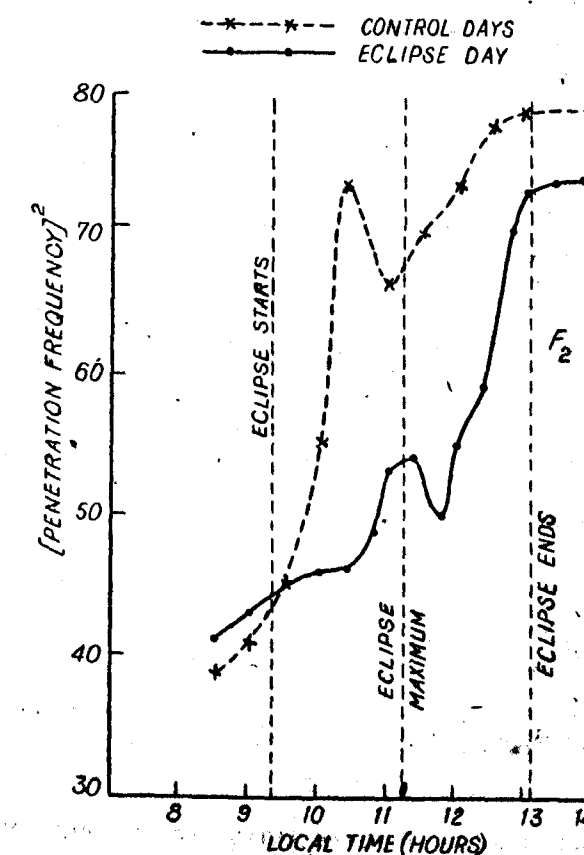


FIG. 2.

Figs. 1 and 2. Depicting the variation of ionisation during the eclipse period. The broken line curve represents the average variation of the square of the critical penetration frequency with time for the six control days—three days before and three days after the date of the eclipse, July 20, 1944. The full line curve represents the ionisation variation on the day of the eclipse.

The eclipse, as observed at Calcutta, was a partial one. At the instant of maximum obscurity 87.5% of the sun's disc was covered. Variations of the penetration frequencies of Regions-E and F₂ were made with the progress of the eclipse. The measurements were started one hour before the commencement of the eclipse and were continued at intervals of about 20 minutes up to one hour after the eclipse was over; the observations were made more frequently about the middle of the eclipse. Observations were also made 3 days before and 3 days after the eclipse during the same local hours to check the average condition of the ionosphere.

The variation of ionisation of both the regions was found to be quite normal on the control days. On the day of the eclipse, during the hours preceding the start of the eclipse the ionisation of Region-E was found to be slightly less and that of Region-F₂ slightly greater than the average ionisation as recorded from the control observations. With the progress of the eclipse, however, the ionisation of both the regions fell below the normal values. For Region-E the ionisation decreased smoothly and the minimum was attained 10 minutes after the eclipse maximum. The minimum of ionisation was about 43% below the normal value. For Region-F₂ the maximum decrease observed was 30% and it occurred 14 minutes after the eclipse had reached its maximum.

Fig. 1 depicts the sharp minimum in the ionisation of Region-E. For the case of Region-F₂ (Fig. 2) however, the minimum is not as marked as in the case of the Region-E, though the ionisation is found to be depressed appreciably below the normal value during the eclipse period.

The observations were undertaken at the suggestion of Prof. S. K. Mitra and the authors take this opportunity of thanking him for providing facilities in the Ionosphere Laboratory to carry out the observations.

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S. N. MITRA

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COEFFICIENT OF RECOMBINATION OF N₂⁺(X') IONS AND ELECTRONS IN THE AFTER-GLOW OF ACTIVE NITROGEN

ACCORDING to the hypothesis of active nitrogen recently proposed by Mitra¹ the positive ions of N₂⁺(X') disappear in the volume of the gas by a

process of three-body collision in course of which the first positive bands, the characteristic spectra of the after-glow are emitted. The coefficient of recombination process can be calculated if the rate of decay of the glow is known (when the wall effect is minimum).

Lord Rayleigh,² in his extensive series of measurements on the variation of brightness of after-glow under different experimental conditions, has made quantitative measurements of the rate of decay of after-glow of active nitrogen when the wall effect is minimum. In the present note these data are used to compute the coefficient of recombination. The data (p. 5, ref. 2) are as follows:

Time (secs.)	0	2.4	4.2	6.4	9.8	22.4
Candle power of glowing gas		1.06	359	203	0.90	0.51
					0.051	0.013

To calculate the coefficient we note that if n be the number of positive ions or electrons per c.c. (assuming the two to be same) and if each recombination of positive ion and electron is assumed to give one quantum, then the number of quanta q emitted per c.c. per unit time will be, $q = \alpha n^2 = \frac{dn}{dt}$.

Here α = coefficient of recombination and is independent of n . From the above it is easy to show that $\frac{d}{dt} (q^{-\frac{1}{2}}) = \sqrt{\alpha}$. This means that if we plot $q^{-\frac{1}{2}}$ against t the curve will be a straight line and its slope will give $\sqrt{\alpha}$.

Let us take, after Rayleigh, the mean wavelength of the after-glow light, in the region of its maximum luminosity to be $\lambda 5560$. Each emitted quantum has therefore the energy $h\nu = 3.57 \times 10^{-12}$ erg. Remembering that 1 candle power = 2.02×10^5 erg per sec. and that the volume of the gas was 19 litres, we can calculate q corresponding to each of the values (candle power) given in the second row of the table. Plotting $q^{-\frac{1}{2}}$ against t we find that the points lie very closely on a straight line. The slope of the line is 2×10^{-7} . Hence $\alpha = 4 \times 10^{-14}$ cm³/sec.

My attention to the problem was drawn by Prof. S. K. Mitra for which I am thankful to him.

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¹ Mitra, S. K., SCIENCE AND CULTURE, 9, 49, 1943-44; 10, 133, 1944; Nature, 154, Aug. 12, 1944.
² Rayleigh, Proc. Roy. Soc., A, 176, 1, 1940.

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PRINCIPLES OF REGIONAL PLANNING

THE unique success of the Tennessee Valley Authority (shortly called TVA), a purely administrative body appointed by the U.S.A. Government to ameliorate the material conditions of a derelict and poverty-stricken region in North America barely ten years ago, has struck the imagination of the world. The example of the TVA will certainly be emulated in many parts of the world, particularly in India, where many regions have gone down in prosperity due to mishandling by men in recent years. A striking parallel is afforded by the Damodar Valley for which a treatment on the Tennessee model has been proposed in the columns of SCIENCE AND CULTURE by Prof. M. N. Saha and Mr K. Ray (Vol. X, No. 1).

But in our opinion, the TVA experiment cannot possibly be repeated with success unless the initiators of such schemes are permeated with the TVA philosophy and TVA spirit. In fact, we wish to issue a note of warning, for almost everyday we read in the papers of pronouncements by highly placed persons of their intention that some project is going to be undertaken in India on the TVA model. But anybody who has read Lilienthal's book will require no arguments to be convinced that the TVA success cannot be achieved by the existing Government machinery* merely by engaging the services of some

engineer who has caught the magic by paying a flying visit to the TVA, or by calling some of the TVA men for a short consultation to the affected spot. It requires a complete revolution in the attitude of the Government towards REGIONAL PLANNING and the setting up of a form of Government machinery almost quite unknown in this country.

Let us explain, in Lilienthal's own words, some of the essential principles of TVA. He says:—

"TVA was initiated frankly as an experiment; it has been administered in the spirit of exploration and innovation. But it is no utopian Brook Farm experiment; not an endeavour to escape into a simpler past (he might have added as in the futile Gandhian experiment with Charka and Khaddar—Ed.), or a more romantic future. TVA and this Valley face the facts of the present with all its complexities and difficulties."

We are not quite sure that the administrative principles which brought the TVA into existence had their roots lying deep in the soil of American tradition, as Lilienthal claims. The question was to anyhow to bring the TVA into existence, and this was the great point:

"It required no change in the constitution of the U.S.A. Congress has maintained full control. Property rights and social institutions have undergone no drastic amendment."

have recently appeared on the subject. The following may be mentioned:

(1) Adventure in Planning by Julian Huxley, Pp. 142 (Architectural Press Ltd., 1943).

(2) The TVA—A Study in Public Administration by Prof. C. H. Pritchett.

(3) TVA—Democracy on the March by David Lilienthal, Chairman of the TVA.

The first primarily deals with technical achievements; the second is a critical examination of the administrative machinery set up for the TVA. The third is by far the most important, as it is from the pen of one who has been in charge of administrative machinery from the very inception of the Authority, and has unquestionably first-hand knowledge and experience of the inner working of the machinery. We have drawn most of our material from the last book.

* The Tennessee Valley Authority was constituted in 1933 by President Roosevelt with an administrative triumvirate of three Directors:—Dr Arthur Morgan, Engineer, Chairman, in charge of construction, H. A. Morgan, Entomologist and Horticulturist specially interested in fertilizer programme, D. B. Lilienthal, a Lawyer with special knowledge of problems of electrical power distribution. Difficulties arose within the Authority and Dr Arthur Morgan had to leave in 1939. Since that time Dr Lilienthal has been Chairman of the Board. A short account of the technical achievements of the the TVA has been given in an article by M. N. Saha and K. Ray in SCIENCE & CULTURE (Vol. IX, Pp. 418 (1944)).

The present article is based on a number of books which

The key to the act which created the TVA is to be found 'in the oneness of men and natural resources, the unity that binds together land, streams, forests, minerals farming, industry, mankind'. Lilienthal designates it as the first law of Nature: we should designate it as the first principle of exploitation of Nature.

President Roosevelt's message to the Congress urging approval of Senator Norris's bill which brought the TVA into existence is indicative of this spirit. The message reads as follows:

"It is clear that the Muscle Shoals development is but a small part of the potential public usefulness of the entire Tennessee River. Such use, if envisioned in its entirety, transcends mere power development: it enters the wide field of flood control, soil erosion, afforestation, elimination from agricultural use of marginal lands, and distribution and diversification of industry. In short, this power development of war days leads logically to national planning for a complete river watershed involving many States and the future lives and welfare of millions. It touches and gives life to all forms of human concerns. (Italics are ours).

"The President then suggested legislation to create a Tennessee Valley Authority—a corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise. It should be charged with the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin and its adjoining territory for the general social and economic welfare of the Nation. This authority should also be clothed with the necessary power to carry these plans into effect." (TVA—Democracy on the March).

Could not this work be done by the ordinary machinery of the Government, or by private agencies?

To this question, Mr Lilienthal says a decided no, and we agree with him. To quote his words in a slightly different setting:

"According to custom and tradition, the instrumentalities of the Government in every country become divided into jurisdictional pigeonholes but the resources of a great river valley like the Tennessee are such that they cannot be dissected into separate bits that would fit into these holes. To integrate the many parts of the problem into a unified whole is clearly the work of one agency. For envisioned in its entirety, this river like many other rivers in the world had manifold potential assets."

These are:—

(1) The river can yield hydro-electric power for the use of industries, for the development of mineral resources lying under the soil, and mountains of the valley, for domestic purposes, and generally for the comfort of the dwellers of the valley. These require construction of dams, hydro-electric stations, and powerlines.

(2) The very same dams, when properly designed, can be made to provide channels for navigation.

(3) The river threatened the welfare of the dwellers of the valley by recurrent floods; this could also be remedied by erection of flood holding dams.

(4) The floods of the Tennessee and its affluents used to carry to the sea every year the top-soil of the hills once lined with valuable timber, and of arable fields. Out of nearly nine million acres of cultivable soil in the valley, nearly 80 per cent became useless and sterile due to soil erosion.

This was remedied by planned afforestation of the valley, which, by the way, also lengthened the life of dams by preventing silting.

And there are many others, namely,—fish culture in the lakes, prevention of pollution of river water by industries etc.—all requiring attention from public authorities.

If the work were entrusted to any one of the Government departments, the 'pigeon holes' as Lilienthal calls them—all other work excepting the work in which that department was interested would have suffered. If the whole work was centralized under one Federal Bureau (Central Department of the Government, as we would call them in India) for the sake of co-ordination, no progress would have been made, as such departments are usually saddled with too much work, and could not possibly concentrate on the Tennessee Valley alone.

If power development were entrusted to private agencies, they would have constructed only power dams and would not have cared for improving navigation, flood prevention, or soil conservation. If the work were entrusted to department of Agriculture, probably only trees would have been planted and irrigation canals excavated, without regard to problems of public health or communication.

But what was needed was 'the total benefit to all that was to be the common goal, and this could be achieved only by the appointment of an Authority' clothed with full powers of execution of the objective, on behalf of the Federal Government.

The jurisdiction of the TVA cut across the existing line of Federal Bureaus departments and of the seven States through which the river runs. It threatened to interfere with private rights, with the privileges enjoyed by the existing business concerns (particularly private power supply companies), and the work has not been smooth. Further it was given a task of integrating the works of specialists and technicians in such diverse subjects as power engineering, navigation, soil conservation, flood prevention, and public health, and anybody who has experience of handling specialists knows this to be no holiday job.

It is now admitted on all hands that the experiment of the TVA, in spite of its perilous nature has been a grand success, much of which was due to the flexibility of the bill appointing the Authority, which was given a task, but was otherwise let free to draw up its own programme, fix upon the method of execution of plans, recruit its own personnel, and

carry out the plans to perfection as it thought best. There had been no predetermined blue prints, but the TVA was itself a planning and executing agency, and the plans evolved like a living organism with time and experience and as a result of free and

protracted discussions amongst specialists and parties concerned.

A great responsibility was thus thrust on the Board of Directors, and we shall see in our next article how they discharged their responsibilities.

ARTIFICIAL RADIOACTIVE BODIES IN PHYSIOLOGY AND MEDICINE*

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WITH the invention of the cyclotron it has been possible to impart radioactive property to every known element. Some of these artificial radioactive elements, such as C, Na, Fe, P, Ca, I etc., have proved to be of the greatest value in the investigation of physiological problems as well as in medicine. It is the purpose of this brief account to explain the method of preparation of these and also to describe some of the many valuable results brought to light with their help.

The cyclotron can properly be named as the machine for producing nuclear transformations. With its help it is possible to transmute one element into another. Some of these man-made elements are unstable, i.e., they emit β or γ -rays just like radium products, in the process of attaining stability. It is this radioactive property which makes these new elements so valuable in therapy and research. In order to understand how this artificial radioactivity may be produced with the help of the cyclotron, it is necessary to have some idea of the nuclear structure of elements.

THE NATURE OF NUCLEUS

According to modern physics, every atom has a heart (or nucleus) which is surrounded by a cloud of electrons. Inside the heart of the atom are present only two types of fundamental particles—neutrons and protons. A neutron and a proton have nearly the same mass, but the proton has unit positive charge while the neutron is neutral. Every nucleus is therefore positively charged, its net positive charge being determined by the number of protons present. The weight of the nucleus is given by the sum of the weights of neutrons and protons inside the nucleus.

The following figures represent diagrammatically the constitution of seven simplest nuclei. A white dot represents a proton, a black one a neutron. The simplest nucleus is that of hydrogen containing a single proton. Both its mass and charge are unity

(${}^1_1\text{H}^1$). Next in simplicity is the nucleus of heavy hydrogen (deuteron) containing one neutron and one proton. Its charge is one but mass is two. This nucleus may be represented by the symbol ${}^2_1\text{H}^2$ where the superscript denotes nuclear mass, subscript the nuclear charge.

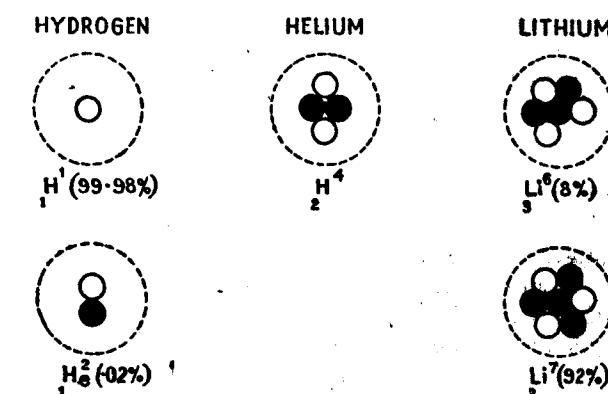


Fig. 1. Nuclei of H, He and Li.

The chemical nature of an element is determined by its nuclear charge i.e., by the number of protons present within the nucleus. As the atom as a whole is neutral, the number of extranuclear electrons is also determined by the charge number or the number of protons within the nucleus. Each succeeding element of the periodic table differs from the one preceding it, by having one more proton within the nucleus and hence one extra electron outside it. Addition or subtraction of neutrons does not alter the nuclear charge. Hence two nuclei with the same number of protons but different number of neutrons will have the same nuclear charge and identical chemical properties. Such nuclei are known as isotopes, e.g., hydrogen (${}^1_1\text{H}^1$) and heavy hydrogen (${}^2_1\text{H}^2$).

The third nucleus in simplicity is that of helium, containing two protons and two neutrons. Then come another pair of isotopes of lithium. ${}^6_3\text{Li}^6$ contains 3 protons and 3 neutrons while ${}^7_3\text{Li}^7$ has 3 protons together with 4 neutrons. As we proceed up the periodic table, nuclei become more and more

* Based on a lecture delivered before the Indian Physiological Society.

massive, but they always retain the same elementary composition at heart, i.e., only neutrons and protons. Compare the cases of berellium, boron and carbon.

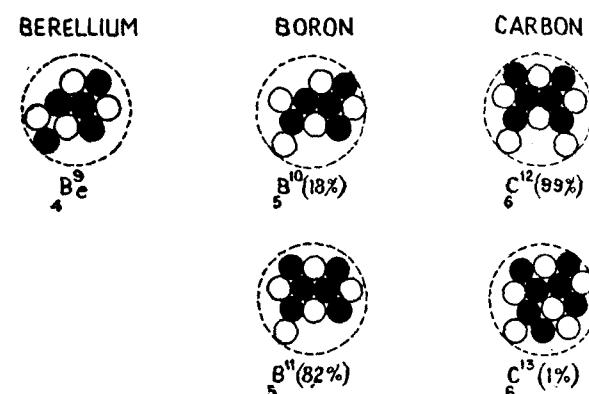


Fig. 2. Nuclei of Be, B and C.

Isotopes occur in nature. Thus normal Li atoms are found to contain 8 p.c. of Li^6 and 92 p.c. of Li^7 nuclei. Similarly natural boron consists of 18 p.c. of B^{10} and 82 p.c. of B^{11} . The percentages of occurrence of natural isotopes are indicated below the figures (1) and (2).

The above picture of the nucleus must be regarded as very elementary. Our knowledge about the nucleus is far from complete. We do not know whether the nuclear particles retain their individuality within the nucleus or if they form a new kind of nuclear substance. But it will be sufficient for the present purpose, if we regard the neutrons and protons inside the nucleus, to be held together by strong forces of the order of million electron volts. If we wish to disrupt the heart of the atom or to bring about changes within it we must hurl at the nuclei projectiles of this energy or more. We must remember that attempts to transform one element into another are being made since the days of early alchemists who tried to change the nature of elements by subjecting them to various chemical reactions. The reason that we have succeeded now where the alchemists failed, is that we now know that so long as the atom remains the same at heart, it will gather round it the same electron cloud and possess the same chemical properties. To transmute one element into another we must produce changes within the nucleus of the atoms. For this purpose such mild persuasions as chemical reactions are entirely ineffective. More drastic methods are required; one of these is to subject the heart of the atom to intense bombardment by other atomic artillery.

CYCLOTRON AND THE GENERATION OF HIGH ENERGY PROJECTILES FOR ATOMIC BOMBARDMENT

Many methods have been developed for generating projectiles with large energies for nuclear bursting. Of these, the cyclotron seems at present to be the

most efficient. Here nuclei of hydrogen, heavy hydrogen or helium are made to move in a circular path inside two semi-circular electrodes (dees), by the application of a strong magnetic field. The 'dees' are like two halves of a pill box cut along the diameter (fig. 3), the two halves are separated from each other by a gap about 2" wide.



Fig. 3. Cyclotron dees and tank.

A rapidly alternating electric field is applied across the two 'dees', the direction of the field changing from one to the other more than a million times a second. Once the particles are inside the dees they are in a field-free space and are unaffected by any voltage changes occurring on the dees. But when they emerge into the gap between the two halves, they are acted upon by the strong electric field and may be either attracted or repelled. The alternating electric field between the two dees is so arranged that whenever the particle is about to jump across the gap, from one dee to the other the field is so directed that the particle is always given a strong pull towards the next dee. The particles take a very small time (about 10^{-7} secs.) to move across a dee from one gap to the next, the voltage also changes within this short interval, so that the particles are always moving in one direction. Step by step their energies are built up in small increments of 50,000 volts, each time they jump across the gap. As the ions gain in energy

it becomes more and more difficult for the magnet to bend them into circular paths. Hence the particles describe spirals of ever-increasing radius until after 100 or more turns, when the energy is of the order of 5 million electron-volts they arrive at the periphery of the dees. By the application of a suitable deflecting field the beam may be pulled out of the chamber and directed towards any target. (fig. 4)

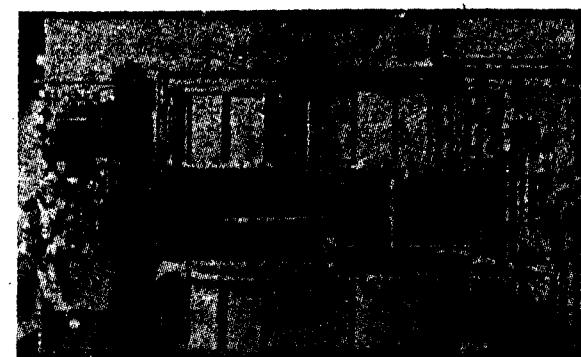


Fig. 4. Deuteron beam emerging from the cyclotron.

From the very brief description given above let no one think that the construction or the successful operation of a cyclotron is a simple affair. The huge tank housing the cyclotron dees must be completely evacuated of air, otherwise the ions going in their spiral paths will bump so many times with air atoms that they will hopelessly wander away from their fixed course and lose all their energy by striking against either the floor or roof of the dees. Every experienced research worker knows how exceedingly troublesome and difficult it may be to hunt out and rectify minute leaks in a chamber of the size of 3 ft. in diameter! Even when all the leaks have been found and carefully sealed the full power cannot be switched on. The metal parts inside the chamber and the oscillator are very apt to pick up gas, when the cyclotron is not in operation even though the high power pumps are constantly on. During work the metal parts heat up and give up the gases they have accumulated during the period of inaction. A sudden puff of gas given out during the operation may mean the burning out of the filament and suspension of work for a couple of days. This accumulated gas must be driven out first or the apparatus degassed by working it at smaller power. Only when all the undesirable gases have been eliminated carefully, can the desirable ones,—hydrogen or heavy hydrogen, introduced and pressure adjusted to the critical value.

The cyclootron filament and the voltages are turned on for the production of ions to circulate, the main power is then switched on and the ions begin their long journey inside the dees. The oscillator must be carefully tuned, otherwise the ions may be

out of step and will not gain much energy. Careful and difficult adjustments in the magnetic field are also necessary in order to keep the ions in focus. Only when all these adjustments have been carried out successfully the beam indicator registers the welcome indication of the ion beam, circulating inside the chamber. Only a fraction of the high energy ion beam circulating inside the chamber, may be brought out of it as shown in fig. 5 by means of a suitable deflecting voltage (about 100 kilovolts).

PRODUCTION OF RADIOACTIVE ISOTOPES OF COMMON ELEMENTS

Let us now try to understand what happens when we expose any substance, say, Na to the beam of such high energy deuterons from the cyclotron. Sodium²³ is a perfectly stable element containing 11 protons, 12 neutrons (written $_{11}\text{Na}^{23}$). If such normal sodium atoms are bombarded with a beam of high energy deuterons (nuclei of heavy hydrogen H^2) some of the deuterons will score direct hits on sodium nuclei. The reaction illustrated in fig. 5 then takes

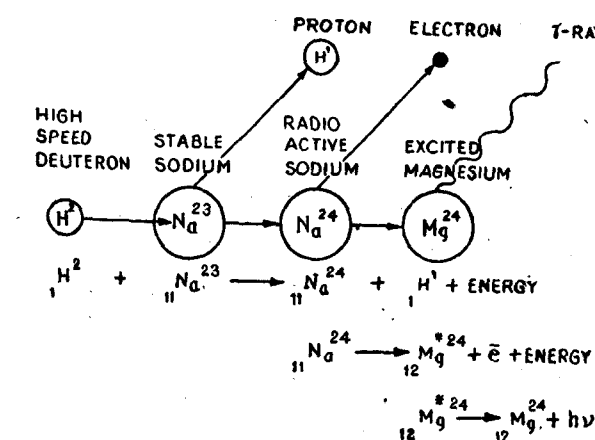


Fig. 5. Production of radio-sodium by deuteron bombardment of normal sodium.

place. The sodium nucleus containing 11 protons and 12 neutrons after capturing the deuteron emits a proton but retains the extra neutron. A new nucleus is formed with 11 protons and 13 neutrons. This is an artificially created isotope of sodium and may be represented as $_{11}\text{Na}^{24}$. It has the same chemical properties as normal sodium.

The newly created isotope of sodium containing an extra neutron is however unstable. Left to itself it emits electrons up to a maximum energy of about 1.4 million electron volts and is thereby transformed into excited Mg which again emits γ-rays of three million volts energy. Thus from radioactive sodium one gets β and γ-rays of the same nature as from radium, and Na^{24} can be used in place of Ra. A similar case is that of radioactive phosphorus P^{32} .

When normal phosphorus P^{31} is bombarded with the deuteron beam, a neutron is captured changing normal phosphorus (P^{31}) to the radioactive phosphorus (P^{32}). This emits β -rays of the maximum energy of 1.7 million electron-volts forming stable sulphur (S^{32}). The reaction is illustrated in fig. 6.

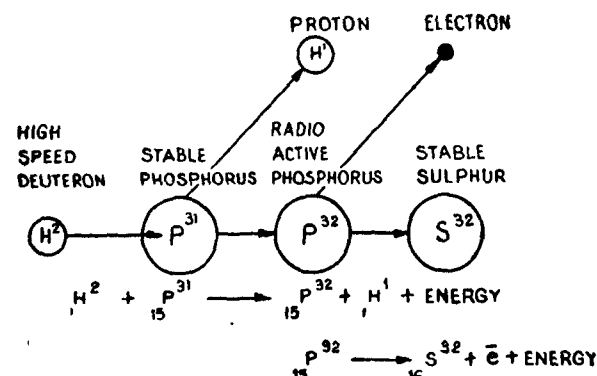


Fig. 6. Production of radio-phosphorus by deuteron bombardment of normal phosphorus.

Radioactive isotopes of almost any element may be produced by bombardment of a suitable stable element either with protons, deuterons or neutrons from the cyclotron. Table I contains a list of those radioactive isotopes which are of biophysical interest. It should be mentioned that the table is not exhaustive. The radioactive isotopes included here are those whose half lives are comparatively long and about whose existence and properties some degree of certainty has been reached. The table gives the atomic number, nuclear mass, nature of radiations emitted, their energy, half lives and the reaction responsible for the production of the isotope. The reactions have been indicated by the usual method, thus the equation $Na-d-p$ against Na^{24} indicates, that Na^{24} is produced by the bombardment of normal sodium by the deuteron beam, when a proton is emitted leaving a residue of Na^{24} . Generally an isotope may be produced by a variety of reactions, of which only one has been indicated.

The yield of artificial radioactive bodies depends on the energy, the number of the projectiles and the nature of the reaction. With the 37-inch cyclotron which is about to be completed the maximum energy of deuterons will be about 8 million electron volts. The 60-inch cyclotron and 200 ton magnet at California produces particles with 16 million electron-volts energy, whose yield of radio-active substance is about 5 times that of the 37-inch one. So great has been the demand for artificial radioactive bodies for medicine and research that a still bigger cyclotron is under construction at California. It will have dees 184 inches in diameter and a magnet weighing 4000 tons. It will produce deuterons of 100 million electron volts energy, its yield of radio-

active substances will be 35 times that of the 60-inch one. This cyclotron will cost about a crore of rupees, of which Rs. 45 lakhs have been subscribed by the Rockefellers.

THE TECHNIQUE OF TRACER STUDIES

The radioactive atoms created by man differ from their normal isotopes in having fewer or greater number of neutrons. They contain the same number of protons and the same chemical properties as their normal isotopes. Chemical or biological systems do not in general distinguish between the two. If a very small quantity of radioactive $NaCl$ be mixed with some common salt and the mixture introduced to any human body either by mouth or by injection, wherever the normal sodium ($_{11}Na^{23}$) goes, it carries with it its radioactive partner ($_{11}Na^{24}$). But the radioactive atoms are *marked* or *tagged atoms*. Wherever they go they give evidence of their presence by emitting β and γ -rays of definite energy-values, which are detected by sensitive electroscopes or Geiger-müller counters. By following the fate of such minute doses of applied radioactive substances one can study the problem of metabolism of any normal element. The radioactive elements thus serve as *tracers*, to trace normal elements through complicated biological processes.

This method has several advantages. In the first place when the radioactive element is detected in any organ, one can be sure that it has come from what has been introduced and not from any other body storage depots. When the radioactive element emits γ -rays, the measurements may be carried out *in situ* without sacrificing the animals. This simplifies the technique and saves a great amount of time. The sensitivity of this method of detection is so great that only a very minute quantity of the substance is sufficient.

Let us give an idea of the sensitivity of radioactive method of detection compared to that of the spectroscope. The latter can detect, the presence of 10^{-7} gms. of sodium. But 10^{-7} gms. of sodium, though it sounds a very minute quantity, is large in terms of numbers of atom. It contains about 10^{15} atoms. But even if we have 10^7 atoms of Na^{24} , about 130 atoms will decay every second, and can be easily detected by the rays they give out. Thus the method is $10^8 \sim 10^9$ times more sensitive. In other words it is 10^8 to 10^9 times, easier to pick out Na^{24} than to detect ordinary sodium.

Two criticisms have been directed against the use of radioactive tracers in physiological experiments: (a) discriminating effect for isotopic elements, (b) change in physiological behaviour due to irradiation. The experiments of Barney, Mullins, Hevesy and others seem to indicate that the radioactive and

TABLE I. RADIOACTIVE ISOTOPES

Radio-element	Radiations emitted		Energy of radiations in million electron-volts		Half-Life	Reaction
	Corpuscular	Electro-magnetic	Particles	γ -rays		
Hydrogen ³	electron	...	0.015	...	31 years	D-d-p
Berellium ⁷	...	γ -rays	...	0.485	43 days	Li-d-n
Carbon ¹¹	positron	...	0.95	...	20.5 min.	B-d-n
Carbon ¹⁴	electron	...	0.145	...	$>10^4$ years	C-d-p
Nitrogen ¹³	positron	γ -rays	0.92, 1.20	0.28	9.93 min.	C-d-n
Oxygen ¹⁵	positron	...	1.7	...	2.1 min.	N-d-n
Flourine ¹⁸	positron	...	0.7	...	112 min.	Ne-d-a
Sodium ²²	positron	γ -rays	0.58	1.3	3.0 years	Mg-d-a
Sodium ²⁴	electron	γ -rays	1.4	1.4, 2.8, 3.6	14.8 hours	Na-d-p
Magnesium ²⁷	electron	γ -rays	1.8	0.64, 0.84, 1.02	10.2 min.	Mg-d-p
Aluminium ²⁹	electron	...	2.5	...	6.7 min.	Mg-d-n
Silicon ³¹	electron	...	1.8	...	170 min.	Si-d-p
Phosphorus ³²	electron	...	1.69	...	14.3 days	P-d-p
Sulphur ³⁵	electron	...	0.107, 0.120	...	87.1 days	Cl-n-p
Chlorine ³⁶	electron	...	0.64 (e)	...	$>10^4$ years	Cl-n-p
Chlorine ³⁸	electron	γ -rays	1.1, 2.8, 5.0	1.65, 2.15	37 min.	Cl-d-p
Potassium ⁴²	electron	...	3.5	...	12.4 hours	K-d-p
Calcium ⁴⁵	electron	γ -rays	0.2, 0.9	0.7	180 days	Ca-n-p
Calcium ⁴⁷	electron	γ -rays	2.3	0.8	2.5 hours	Ca-d-p
Chromium ⁵¹	electron	γ -rays	...	0.5, 1.0	26.5 days	Ti-a-n
Manganese ⁵⁴	...	γ -rays	...	0.85	310 days	Fe-d-a
Iron ⁵⁵	electron	...	...	...	4 years	Fe-d-p
Iron ⁵⁹	electron	γ -rays	0.26, 0.46	1.1, 1.3	47 days	Fe-d-p
Cobalt ⁵⁷	positron	γ -rays	26 (e)	0.12, 0.20	270 days	Fe-d-n
Cobalt ⁵⁸	positron	γ -rays	4	0.6, 0.805	72 days	Fe-d-n
Nickel ⁵⁷	positron	...	0.67	...	36 hours	Fe-a-n
Copper ⁶⁴	electron	...	0.58 (e)	...	12.8 hours	Cu-d-p
	positron	...	0.66 (e)	...		
Zinc ⁶⁵	positron	γ -rays	0.4 (e)	0.45, 1.0, 1.14	250 days	Zn-d-p
Arsenic ⁷⁴	electron	γ -rays	1.3 (e)	0.582	16 days	As-n-2n
	positron	...	0.9 (e)	...		
Arsenic ⁷⁶	electron	γ -rays	1.1, 2.7 (e)	1.5, 2.2, 3.2	26.8 hours	As-d-p
	positron	...	7, 2.6 (e)	...		
Bromine ⁸⁰	positron	γ -rays	...	0.049, 0.037, 0.025	4.4 hours	Br-n-p
Bromine ⁸²	electron	γ -rays	0.46	0.55, 0.79, 1.4	34 hours	Br-n-p
Rubidium ⁸⁶	electron	...	1.56	...	19.5 days	Rb-n-p
Strontium ⁸⁹	electron	...	1.32	...	55 days	Sr-d-p
Silver ¹⁰⁶	electron	γ -rays	1.2	1.06, 0.69	8.2 days	Ag-n-2n
Cadmium ¹¹⁵	electron	γ -rays	1.11	0.64	2.5 days	Cd-d-p
Tin ¹¹³	electron	γ -rays	...	0.85	70-105 days	In-p-n
Antimony ¹²³	electron	γ -rays	81, 1.65	0.96	2.8 days	Sb-d-p
Antimony ¹²⁴	electron	γ -rays	74, 1.53, 2.45	1.82, 1.75	60 days	Sb-d-p
Iodine ¹³¹	electron	γ -rays	1.1	0.5	13 days	Sb-a-n
Iodine ¹³²	electron	γ -rays	0.69, 0.6	0.4	8.0 days	Te-d-n
Barium ¹³⁹	electron	γ -rays	1, 2.3	0.6	86 min.	Ba-d-p
Gold ¹⁹⁸	electron	γ -rays	0.8	0.28, 0.44, 2.5	2.7 days	Au-n-p
Gold ¹⁹⁹	electron	γ -rays	1.01	0.45	3.3 days	Hg-n-p
Mercury ¹⁹⁷	...	γ -rays	...	0.20	23 hours	Hg-n-2n
	...	γ -rays	...	0.09	64 hours	Au-d-2n
Lead ²⁰⁹	electron	...	0.70	...	3.0 hours	Pb-d-p
Bismuth ²⁰⁷	...	γ -rays	...	0.74, 0.93	6.4 days	Pb-d-n
Eka-iodine ²¹¹	α -rays	...	5.94	...	7.5 hours	Bi-a-2n

non-active isotopes have the same physico-chemical properties and as long as the concentration of the radio-element is not so great as to produce changes by the physical effects of radiation, the biological system does not differentiate the stable from the radioactive isotope.*

* Slight biological difference (<5.0) has been reported with isotopes of light elements, e.g., D and H, C^{12} and C^{13} . The greatest difference would arise for the isotopes of those elements which function as single ion or atom. The greater

According to an estimate of Chaikoff, the smallest amount of radioactive phosphorus, the presence of which can be detected with his counter, is about 10^8 atoms (or 5.3×10^{-11} mgms.). This corresponds to an emission of about 60 β -rays per sec.

the weight of the reacting molecule the less will be the effect due to difference of isotopic masses. In the case of P, for example, it is the mass of the phosphate radical that is in question, and the difference in weight between $P^{31}O_4$ and $P^{32}O_4$ is very insignificant.

or an activity of about 1.5×10^{-6} millicuries.* The strength of sources usually employed in tracer work is thus much too small to affect the biological processes by causing radiobiologic changes.

In one experiment varying doses of 1–70 microcuries of radioactive phosphorus were injected to five groups of tumor bearing mice. Although the intensity of radiation varied by a factor of 70 no significant differences could be observed in the percentage uptake of radioactive phosphorus by liver and tumor tissues.

HOW TO INTRODUCE RADIOACTIVE BODIES

The radioactive substances may be introduced in a variety of ways: (a) In the form of an inorganic salt of the isotope used dissolved in water and mixed with other non-radioactive salts; this may be applied either by mouth or injected. (b) In the form of organic compounds where the aim is to study the fate of specific organic compounds; the synthesis may be carried out in the laboratory or even within an organism. Thus Na_2HPO_4 containing radioactive phosphorus is fed to rabbits and hens. Labelled phosphatides formed in the liver are absorbed in the plasma. The plasma containing appreciable amounts of phosphatides may be removed, mixed with non-active corpuscles of another rabbit and then re-introduced. The phosphorus content of the different organs of the second rabbit may then be analysed as usual. (c) In experiments in plant physiology plant roots may be kept immersed in solution containing radioactive salt.

The accumulation of the elements may be measured by means of counter and electrosopes. Autoradiograph technique has also been employed with great advantage.

The maximum quantity of labelling agent that may be administered is determined by the amount of the element normally present in the system. In the case of I, for example, a normal 200 gm. rat contains only .05 mgm. of I. The dose of iodine introduced in such a rat must be small compared to even .05 mgm. On the other hand the normal P content of the body is so high that the introduction

* Half life of P^{32} is 14.3 days, the probability of disintegration per sec. is 5.6×10^{-7} , the number of atoms disintegrating per sec. out of 10^6 is $10^6 \times 5.6 \times 10^{-7} = 56$. This is equivalent to 1.5×10^{-6} millicuries, 1 millicurie signifies 3.7×10^7 disintegrations per sec.

of even 6 mgm. of P does not materially affect the normal P metabolism. The great advantage of the method of tracer analysis is that the amount to be introduced need be so small as not to affect the normal balance of even those substances which occur in minutest proportions.

Not all the artificial radio-elements prepared so far can be used in biophysical researches. Artificial radioactive bodies suitable for biological investigations are limited by three factors. Firstly, the radioactive substance should be capable of production in sufficiently large quantities with the help of the cyclotron. This condition is the most stringent of all, as most of the artificial radioactive substances can be prepared now only in small quantities at a large expenditure of energy. Secondly, the radioactive element for biophysical studies should preferably be one that occurs in the biological system by Nature. Its life should neither be too small for easy manipulation (e.g. O^{15} half life = 2 min.) nor too long to be taken by man and animals without danger.† On account of these limiting factors the number of radio-elements that have actually been used in biophysical investigations are small. There is no doubt that as the technique improves many more of these artificial radioactive bodies will be put in use in research and in therapy.

In the concluding part of this article is given a very short review of the results of experiments that have been made with the help of artificial radioactive bodies to follow the absorption, storage, utilisation and excretion of various elements by the body in health and disease. The preliminary attempts made to control disease by the action of radiation emitted by these elements have also been reported.

(to be continued)

† Radium has a half life of 1600 years. Owing to its extremely long life radium cannot be taken internally. Smallest amount of injected radium proves fatal because it remains in the system and continues its injurious radiation effects practically without any diminution during our lifetime. A few years ago factory girls engaged in the trade of painting luminous dials swallowed by accident very minute amounts of radioactive material. Each time they touched the brush with their lips to put a point on it, they absorbed a little amount of radioactive material. Although the amount absorbed at any time was almost inappreciable, the cumulative effect was fatal due to the long life of radium. With the artificial radioactive bodies, such as sodium or phosphorus, there is no such danger of cumulative effect as radium poisoning. Most of these decay so quickly that they can produce no lasting injury.

EFFECT OF THE FOOD CRISIS OF 1943 ON THE RURAL POPULATION OF NOAKHALI, BENGAL

RAM KRISHNA MUKHERJEE, CALCUTTA

AS a research student of the Department of Anthropology, University of Calcutta, I made a brief survey early in December, 1943 of a few samples of the rural population of the district of Noakhali, affected by the food crisis of 1943. In all I gathered materials from ten villages. The western part of the district was more adversely affected by the food crisis than the eastern one and the Lakshmipur police-station area within the sadar sub-division was the most affected. Unfortunately, I could not collect any data from the Lakshmipur area as necessary facilities for work were not available there.

I did not study the villages as a whole but

collected data from some of the families inhabiting these places. For my study I selected three classes of families:—(i) those which depended on the gruel kitchen, and so may be considered as most affected by the crisis; (ii) those which availed themselves of the dry ration of rice distributed by the Arya Samaj Relief Fund, that is, which were affected enough to accept this charity but had not forsaken their prestige completely to go to the gruel kitchen; and (iii) those who neither went to the gruel kitchen nor received any dry ration. This is a fairly random sample of the rural population investigated.

TABLE I. Showing the particulars of the population studied.

Village	Police-Station	Distance from Chaumohani (in miles)	Family Units	Inhabitants			
				Hindu	Muslim	Total	P. C. of Total
Ganipur Chatkhil	Beganganj Ramgunj	1 17	80 55	18 100	109 125	127 225	
Total			85	118	234	352	87
Percentage				84	66	100	

CLASS II							
Changirgaon	Ramgunj	31	30	108	16	124	
Mashimpur	"	88	81	50	80	130	
Kalupur	"	82	8	25	11	36	
Harishchar	"	32	12		74	74	
Arijpur	"	38	10	21	19	40	
Karoa	"	34	10	72	1	73	
Hajipur	"	84	4		19	19	
Total			105	276	220	496	51
Percentage				44	56	100	

CLASS III							
Fakirpur	Ramgunj	32	28		114	114	12

All classes							
Total			218	394	568	962	100
Percentage				41	59	100	

Table I shows the villages, the total number of inhabitants, family units, and the types of family studied. It will be apparent from it that I have studied nearly a thousand people of whom 37 per cent are most affected, 51 per cent affected perhaps in a lesser degree and 12 per cent who had not asked for charity or accepted it. The percentages of Hindu and Muslim populations studied are 41 and 59 respectively. It is true that my data covers a very small portion of the district population and are restricted to only two police-station areas within the one subdivision. But as the villages where I worked had been moderately effected—less than Lakshmipur which represents one extreme and more than the other areas which were less affected, this report, in a general way can be regarded as indicating the average effect of food crisis on the rural population of the district of Noakhali.

I collected my data from the heads of the families in most cases, but where the heads were not available the statements of the reliable neighbours of such families were recorded, and since I was always accompanied by one or two well informed persons of the area who were aware of my mission and always checked up any wrong statement, the data obtained by me can be regarded as correct. I followed the geneological method in my investigation which was followed up by a set of questionnaires prepared beforehand specially for the data regarding the economic life of these people.

*EFFECT OF THE FOOD CRISIS ON THE ECONOMIC LIFE OF THE PEOPLE

The effect of the food crisis on the economic life of the people is clearly seen, when the loss of property sustained by these people is worked out,

TABLE 2 (A). Showing the assets of the family units in 1939 and December, 1943; and its loss within the period.

Assets of the family	Property owned				Loss during 1939-43				Detail of loss in 1939-48			
	1939		December 1948		Sample		Percentage		Lost in total		Lost in part	
	Family Units	Valuation in Rs.	Family Units	Valuation in Rs.	Family Units	Valuation	Family Units	Valuation	Family Units	Valuation	Family Units	Valuation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Cultivable land	48	36008	29	16499	27	19504	68	54	14	19844	13	5660
Homestead land	70	35409	67	28759	23	6650	38	19	3	941	20	5709
Dwelling	85	4480	84	3475	25	1005	29	22	1	100	24	905
Ornament	60	2965	10	210	55	2755	92	98	50	2640	5	115
Utensil	45	725	9	155	87	570	82	79	86	555	1	15
Live stock	12	655	5	150	12	505	100	77	7	810	5	195
Total		80237		49248		30989		89		18390		12599

CLASS II (Family units—105)												
Cultivable land	50	27968	34	12425	30	15543	60	56	16	5610	14	9928
Homestead land	75	31845	72	30524	11	1821	15	4	3	814	8	1007
Dwelling	100	4767	100	4585	9	182	9	4			9	182
Ornament	29	2235	6	295	25	1940	86	87	23	1910	2	80
Utensil	49	686	25	414	26	272	58	40	24	270	2	2
Live stock	19	765	14	1075	8	810	42	41	5	185	3	125
Total		68266		49818		19568		28		8289		11279

CLASS III (Family units—28)												
Cultivable land	18	18898	17	13881	2	512	7	4	1	896	1	116
Homestead land	26	3498	25	3201	2	297	7	8	1	264	1	88
Dwelling	28	2040	27	1980	1	60	4	8	1	60		
Ornament	6	179	3	65	3	114	11	64	3	114		
Utensil	8	110	7	80	1	80	4	27	1	80		
Live stock	12	1040	7	555	10	485	86	47	5	240	5	245
Total		20760		19262		1498		7		1104		894

since, property is one of the vital indices of economic condition. Table 2 which records the worth of property according to valuation, owned by these people in 1939 and in December, 1943 indicates that from 1939 to 1943, roughly within five years, 39, 28, and 7 per cents of the total property has been lost by the three types of families studied, thus confirming the earlier statement regarding the comparative effect of the crisis on these people. One third or 33 per cent of the families of class I, 32 per cent of those of class II, and 6 per cent of class III have become landless, having lost all their cultivable lands. Further, 4 per cent each of the classes I, II, and III have even lost their homestead land, and two family units belonging to class I and class III have even given up their dwelling!

The table also indicates that of all the assets the ornaments were disposed of earliest, the next in order of disposal being the other belongings like utensils of brass, bell metal, etc. Then came livestock and cultivable land. The homestead land and the dwelling were parted with last of all. It shows that to fight out economic distress the people first gave up the

little reserve which they had as ornaments, used normally as luxury articles; next the belongings like utensils which are needed but may be done without undergoing discomfort. Finally, the live-stock, needed for cultivation, and cultivable land, their sources of living, were given up. As some kind of livelihood might be managed by agricultural labour or such, the homestead land and the dwelling (popularly known in Bengal as *Bastu Vita*) were retained. But when there was nothing else to avert distress even the *Bastu Vita* was given up.

The loss of property due to food crisis cannot be judged properly unless we take into account separately of the loss within 1943 or narrowing down the period still more from March to November 1943, that is, from the time when the crisis was perceptible. This has been done in Table 4 which shows the loss of property during the two periods, (i) 1939 to February 1943 and (ii) March 1943—November 1943.

One point is to be mentioned before discussing the Table 3. In Table 2 the value of property has been determined according to its valuation in December, 1943 and the loss is calculated on this

TABLE 2 (B). Showing the holdings of cultivable and homestead land of the people in 1939 and December, 1943, and its loss within the period.

Assets of the Family Units	Property owned				Loss during 1939-48				Details of loss in 1939-48			
	1939		December 1948		Sample		Percentage		Lost in total		Lost in part	
	Family Units	Acreage	Family Units	Acreage	Family Units	Acreage	Family Units	Acreage	Family Units	Acreage	Family Units	Acreage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Cultivable land	48	21'82	29	10'00	27	11'82	68	54	14	8'39	13	3'48
Homestead land	70	21'46	67	17'43	23	4'08	88	19	3	0'57	20	8'46
Total		48'28		27'48		15'85		87		8'96		6'89

CLASS II (Family units—105)												
Cultivable land	50	16'95	34	7'58	30	9'42	60	56	16	8'40	14	6'02
Homestead land	75	19'80	72	18'50	11	0'80	15	4	3	0'19	8	0'61
Total		36'25		26'08		10'22		28		8'59		6'68

CLASS III (Family units—28)												
Cultivable land	18	8'42	17	8'11	2	0'81	7	4	1	0'24	1	0'07
Homestead land	26	2'12	25	1'94	2	0'18	7	8	1	0'16	1	0'02
Total		10'54		10'05		0'49		5		0'40		0'09

basis.* But the real worth of the property lost by sale or mortgage, cannot be decided according to this valuation. For, the standard of valuation, is the current price while the sale price varies from year to year according to the standard of valuation in particular years and was much less previously. The amount of loan contracted by mortgaging the property is also always much less than its valuation. Thus our enquiry revealed that in all 18'89 acres of land have been sold within four years, the valuation of which is about Rs. 24,166/- whereas the actual price fetched during the sale was Rs. 19,865/- that is, difference of about 18 per cent. This difference will be more marked in case of ornaments since the price of gold and silver has increased immensely. In case of the debts secured by mortgages, it is an established fact that the amount of debt is never equal to the actual worth of the security and is usually its half in amount. Hence, strictly speaking, any comparison of the loss of property according to its sale price and the amount of loan from the mortgage, with its valuation definitely leads to an underestimate.

To find out whether the loss of property through sale and unrepaid or unrepayable loans can really account for the total loss, the total amount obtained from the sales and the loans has, at least, to be doubled to allow a fair comparison with the valuation of property. But it must be borne in mind that

even then the comparison may not be fully accurate. Table 3 shows that after necessary adjustments, roughly speaking, the total loss of property can be accounted for by sale and mortgage.

Now to come back to our point, the extent of loss of property in different periods to denote the effect of food crisis, has, therefore been recorded in the Tables 4 and 5 as per the sale price of the properties sold as well as the amount of loan contracted on its security, which, however, will not affect our conclusion as the standard is the same for both the periods. Table 4 (A) shows that 56, 49, and 65 per cents of the property with respect to the classes I, II, and III have been lost within March—November 1943, the main period of food crisis, while in the previous period of a little more than four years (1939—February, 1944) the rest 44, 51, and 35 per cents have been lost. Besides this the table shows that out of the total number of family units affected by the loss 93, 91, and 75 per cents have been affected during the period of food crisis while in the period before only 26, 27, and 25 per cents respectively have suffered within the period of a little more than four years compared to the formerly noted 93, 91, and 75 per cents within nine months due to food crisis.†

The effect of food crisis is still more sharply brought out in the Table 4 (B) which shows that during the period of food crisis the property has been lost mainly to acquire food, families of class II having

TABLE 3. Comparing the loss of property in Rupees through sale and unredeemed or unredeemable loans after necessary rough adjustment (i.e., doubling the amount) to the worth of it in 1939, as shown in Table 2(A).

Assets	Worth of Property lost through		Total loss (1)+(2)	Total loss of (8) after adjustment	Total loss according to valuation (ref. Table 2)	P. C. of col (4) to col (5)	REMARKS.
	Sale (according to sale price)	Mortgage (according to amount of loan)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cultivable land	15154		20415	40890	47060	87	Ornaments were mostly sold in last 10 months and so fetched high price, which accounts for the p.c. surpassing 100. Some cattle were lost through death and so the p.c. is low.
Homestead land	4711	550					
Dwelling	1158		1158	1158	1200	97	
Ornaments, Belongings like utensils etc.	2340 359	1835	4034	8068	5670	112	
Live-stock	722		722	722	1240	58	
Total	24444	1885	26329	51188		98	

* Thus in December 1943 land was sold at Rs. 1,980 to Rs. 1,320 per acre. Hence the valuation of land is regarded as Rs. 1,650, the average of the two amounts. The valuation of the other forms of property has been estimated in this way. It is noteworthy that in case of dwelling as a form of property what has been lost in most cases is not the entire structure but the iron corrugated sheet used for roofing purposes, the valuation of which has been estimated in terms of current prices. The valuation of the thatched huts has been estimated at Rs. 10/- on the average which is the considered opinion of many reliable persons of the villages.

been most hard hit in this respect for the obvious reason that they being a little better off had some assets which they have now disposed of to avert the crisis, while families of class I having already almost used up their reserves had little more to sell. In the previous period the 'other causes' had some share

† It is noteworthy that many families were simultaneously affected in the two periods, so that, the total numbers of affected families in the two periods are not mutually exclusive.

TABLE 4 (A). Showing the amount of property lost and the number of families affected by the loss in different periods. (According to the sale price of the property sold and the amount of loan on its security).

Class	Affected Families			Percentage of		Amount lost in Rs.			Percentage of	
	1939-Feb'43	March-Nov'43	1939-1943.	col (1) to col (3)	col (2) to col (8)	1939-Feb'43	March-Nov'43	1939-1943	col (6) to col (8)	col (7) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	19	67	72	26	98	6232	7925	14157	44	56
II	17	58	64	27	91	5742	5525	11267	51	49
III	4	12	16	25	75	300	565	865	85	65

TABLE 4 (B). Showing the cause of loss of property in different periods.

Class	Loss in Rs. from 1939-Feb '43			Percentage of		Loss in Rs. from March—Nov. '43			Percentage of	
	On food	on other causes	Total	Col (1) to col (3)	Col (2) to col (8)	On food	On other causes	Total	Col (6) to col (8)	Col (7) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	8994	2288	6282	64	86	5812	2118	7925	73	27
II	1262	4480	5742	22	78	5025	540	5565	92	8
III	185	165	350	45	55	565		565	100	

worth mentioning, specially in case of class II. The 'other causes' are the redemption of old debts, expenses for social rites, like marriage and funeral ceremonies, payment of the rent of land to zeminder due from a long ago, and capital expenditure on erecting new dwellings in place of the worn out old structures.

It has already been mentioned that the property shown as 'lost' comes under two heads: (a) sold and (b) mortgaged to raise loans on its security. Since debts, as declared by the informants, cannot be repaid owing to extreme poverty, the second category of property is also regarded as lost. Table 5 shows the amounts of property lost through sale and such loans. When in dire need the families contracted loans at an exorbitant rate of interest (usually 75 per cent per annum) offering as securities the ornaments and belongings like utensils and rarely the cultivable land. Where land is the security the rate of interest is not so high. Many families took loans mortgaging their lands on terms according to which if the loan be not paid within the settled period of time the land passes on to the money lender.

Table 5 indicates that it is sale which accounts for 92, 93, and 95 per cents of the loss of property. The reason is obvious. Sale fetches a greater amount than mortgaging the property and when there is very little chance of repaying the loans it is best to sell off the property. That sale is of more importance is also proved by the fact that 85, 83, and 88 per cents of the family units have lost their property through sale when the loss through mortgage is only 49, 33 and 13 per cents.

All the tables so far considered prove the fact that the economic condition of these people has deteriorated to an extreme extent and this has mainly taken place in the nine months from March, 1943 to December 1943.

The havoc created by the food crisis in the economic life of the people does not end here. Table 6 which indicates the outstanding debts of these people before and after the main period of the food crisis gives a further glimpse into the picture. Table 6 (A) shows that even before the food crisis the economic life of these people was not a very prosperous one; 15, 8, and 6 per cents of the family

TABLE 5. Showing the loss of property through sale and unredeemed or unredeemable secured loans (according to sale price and amount of loan), and the number of family units affected by such loss within 1939-1943.

Class	Family units affected by loss					Loss of Property in Rupees				
	Sale	Mortgage	Total	P. C. of col (1) to col (3)	P. C. of col (2) to col (3)	Sale	Mortgage	Total	P. C. of col (6) to col (8)	P. C. of col (7) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	61	85	72	85	49	18067	1070	14157	92	49
II	53	21	64	88	33	10542	785	11307	93	8
III	14	2	16	88	13	815	60	865	95	6

units being already indebted at the time. But the food crisis accelerated the deterioration tremendously and in December 1943, just after the height of the food crisis the figure rose to 95, 77, and 93 percents, for the three classes. The different groups contracted 93, 55, and 56 per cent of the loans within the period of March–November, 1943. The table also shows what a huge amount of the total loan has been con-

Now if we reconsider the worth of property held by these people in 1939, as shown in Table 2, we find that the total amount of outstanding debt is practically half the worth of the property already lost. Table 7 which gives a detailed analysis of the debt and also compares the amount of debt with the worth of property held by all the families in 1939 brings it out clearly. In this table in case of the secured loans

TABLE 6 (A). Showing the number of indebted families and the outstanding debts in March, 1943 and December, 1943.

Class	Total Family Units	Indebted Families			Percentage of			Amount of debt in Rs.			Percentage of	
		Dec. 1943	March 1943	March-Dec' 43	col (2) to col (1)	col (3) to col (1)	col (4) to col (1)	December 1943	March 1943	March-Dec' 43	col (9) to col (8)	col (10) to col (8)
		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I	85	81	13	79	95	15	93	7160	849	6311	12	88
II	105	81	8	58	77	8	55	10966	6340	4626	58	42
III	82	26	2	18	93	6	56	1627	210	1417	13	87

TABLE 6 (B). Showing the cause of loan in different periods.

Class	Outstanding debt in March' 43			Percentage of		Debts in March–Dec. 1943			Percentage of	
	On food	On other Causes	Total	col (1) to col (3)	col (2) to col (3)	On food	On other Causes	Total	col (6) to col (8)	col (7) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	644	205	849	76	24	6135	176	6311	97	8
II	3290	8050	6340	52	48	4376	250	4626	95	5
III	150	60	210	71	29	1267	150	1417	89	11

tracted during the period of food crisis alone, it being 88, 42, and 87 per cents of the total for the classes I, II, and III respectively. In class II, it may be noted some families had contracted loans of heavy amounts in the previous period for various purposes mentioned before. Table 6 (B) which records the purposes for which the loans have been contracted indicates that food was the principal purpose of loan even before the food crisis. During the critical months, 97, 95, and 89 per cents are shown to have been contracted to get food in this period as against 3, 5, and 11 per cents in the period before it.

the total amounts have been doubled for necessary adjustments before comparing them with the valuations of property held in 1939, for reasons stated earlier. This is justified as failure to repay will lead to the loss of these securities.

Before discussing the table it may be mentioned here that regarding the secured loans we have already considered the ornaments, belongings like utensils, and land to some extent as security for the secured loans which remain or will remain unpaid. The securities for the loans noted here, which may be repaid some day are mainly land and dwelling in some

TABLE 7. Showing the different forms of loan and the evaluation of its worth to the total valuation of property in 1939, after necessary adjustment for the secured loans (i.e., doubling the amount).

Class	Amount of Debt in Rs.					Percentage to total loans		Total valuation of property in 1939	Percentage to total valuation as in col 8		
	Unsecured			Secured	Total	un-secured	Secured		Un-secured	Secured	Total
	Interest free	with interest	Total								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
I	3798	557	4355	2310	7160	61	89	81900	5	7	12
II	8728	1150	4876	6090	10968	44	56	68650	7	18	25
III	1280	270	1500	127	1627	92	8	20760	7	1	8

cases. Where land is the security most of the loans have been contracted under 'usufructuary mortgage' and the rest under 'Rehani'. The usufructuary mortgage works out in the following way. The debtor allows the money lender to enjoy a part or whole of his cultivable holding, the area of which is determined considering the amount of loan, for a fixed number of years in return to the money he gets, and the loan is thus repaid. It is noteworthy that a considerable portion of the unsecured loan classified as without interest was actually taken on agreement that the interest would be paid when repaying it. But the debtors are now totally unable to repay the principal even, and the money lender also, seeing that there is very little chance of getting back even the principal from these totally impoverished persons who have nothing else to lose, would be very glad if the principal alone is repaid. This is why I have recorded such loans as without interest, otherwise it would seem very strange as to how such a large sum could have been obtained interest free. It should be mentioned here that the rate of interest is extremely variable and varies from 12 to even 75 per cent per annum!

Table 7 also shows that except in case of class II most of the loans are unsecured. The families belonging to the class II could procure loans of comparatively bigger sums by keeping their properties as securities which they had and so in their case the secured loan is of greater amount.

It is interesting to note here that with respect to the loss of property, the class I lost in greater percentage than class II, while with respect to the loans contracted the percentages of the total and the secured loans to the worth of property in 1939 are greater in case of the class II than of class I. It shows that the class I has sunk a step deeper than class II. To the former what is now more important

is to avert death due to the crisis while the latter, although losing a good deal of property still hope to be able to retrieve them on some future day of prosperity.

The table also indicates the percentages of the secured and total loans to the worth of property owned by these people in 1939. The significance of this will be realised if we try to find out the effect of indebtedness on the economic life of the people. So far it has been clear that in the economic life of these people the process runs like this:—With the gradual economic deterioration the people contract loans, unsecured if possible; when no more loans are available they sell or mortgage properties which they will perhaps never be able to regain and thus they have already lost 39, 28, and 7 per cents of the property, the class I being most affected for the reasons mentioned earlier. Now they will have to do something with the standing debts, especially the secured ones, and this they cannot repay from their regular income at the present time; since their present income is already insufficient enough to compel them to abandon their prestige and ask for charity. Hence the only alternative before them is to give up more property which will be 7, 18, and 1 per cent for the secured loans alone and 12, 25, and 8 per cents for the total debt. It means that these people, who have already lost 39, 28, and 7 per cents of the property now face the prospect of losing about 12, 25, and 8 per cents more! That is, the family units belonging to the classes I and II will lose about 50 per cent of whatever assets they had and then what will be left to them is just the roof to live in and perhaps a little of the land and livestock to remind them of their past source of income. The family units belonging to the class III however have not been so adversely affected.

(To be concluded)

A SOURCE OF NITROGEN FOR SOILS

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LOSS of nitrogen from soil occurs mainly by two agencies, namely, (1) by crops and (2) by drainage. The water that percolates through the soil and goes beyond the root range carries down with it large amount of nitrates. In soils where no crop is growing, this loss is tremendous and may be equal to the total amount of nitrogen removed by crops and drainage. It has been estimated both in India and abroad that the total loss in both ways may total up to 100 lbs. of nitrogen per acre per year.

Crop yields in India are quite low in comparison to those of other countries. Indian cultivators usually do not add manure to their fields and the yields, though at a low level, remain surprisingly constant. Thus depletion of soil nitrogen is going on for centuries without apparent deterioration of the general fertility of the soil. To explain this, theories were necessary to be advanced by several Indian workers^{1, 2, 3, 4, 5} where plants like maize, rice etc. were supposed to fix atmospheric nitrogen directly without the help of any associated bacteria. In

some cases, the views appear to be supported by considerable experimental evidence. But plants or crops so studied are very few in number and general possibility of plants fixing their own nitrogen may be ruled out.

Nitrogen content of an average Indian soil may be taken to be in the order of 0.05%. If we consider the soil up to the 3rd feet depth, all nitrogen would have been exhausted in less than 100 years and the soil would have been completely free from nitrogen and hence sterile. As this is not the case, the possibilities of nitrogen addition to the soil may be by (1) rain water, (2) by azotobacter, (3) by blue-green algae and (4) by leguminous crops. It may be assumed that additions of nitrogen by one or other of these agencies account for the constancy of the nitrogen level of the soil despite the huge annual loss of nitrogen.

It has been generally considered possible that the nitrogen status of a soil can be improved by growing leguminous crops. In some cases, if leguminous crops grown are not incorporated to the soil after the grains have been taken out, rather adverse effects are produced. But the acreage under leguminous crops is extremely small as compared to the total cultivated area. An uncertain but moderate estimate of such is about 13% of the total cultivated area. So the rest, that is, about 90%, do not get any benefit from the growth of leguminous crops.⁶

It is known that rain water brings down on an average 4 lbs. of nitrogen in a year per acre.⁷ This is only a small contribution, if not at all insignificant, for the total annual removal.

Fixation of enough nitrogen by azotobacter is rather a doubtful process. Ingham⁸ has calculated the amount of energy materials that would be required for the fixation of enough nitrogen to account for the total annual loss. This comes to be about 5 tons of sugar or 50 tons of green manure per acre. And this has to be repeated every year for the growth of annual single crops. In practice, hardly anything of the kind is added to the soil.

De⁹ obtained evidence that blue-green algae are the main agents of nitrogen fixation in rice soils and the part played by the bacteria is relatively unimportant. Nitrogen fixation by the blue-green algae has also been studied in detail by Singh.¹⁰ Choudhury¹¹ however, has raised doubts about nitrogen fixation by algae. As we leave these uncertain and conflicting views for arriving at a definite conclusion, we turn our attention to yet another possible source of nitrogen, the atmosphere.

That the atmosphere contains traces of ammonia is already well-known.

Some clays¹² and some very common constituents of soil¹³ have got a very high power of absorbing ammonia. Traces of ammonia that occur in the air

may be supposed to be absorbed by the soil, retained, nitrified and made available to the growing crop. It is a common experience in the laboratories to see acid bottles covered with white coatings in time. These are due to ammonium salts of the acids which reacted with the traces of ammonia in the atmosphere of the laboratory. The process in the case of soils is, however, not unnoticed in India. Ammonia is known to condense on the surface layers of cultivated soils.¹⁴ Ingham exposed pulverized soil in trays for 18 months and observed a huge increase in total and ammoniacal nitrogen. No loss of organic carbon was noticed and naturally the fixation was not due to bacteria. Slow nitrification was also observed. The increase in 6 months alone, calculated in lbs. of nitrogen per acre, was enough to support a heavy crop like maize.

Though such heavy fixation is hardly possible under field conditions, it is quite plain that the absorption of ammonia from the atmosphere can alone account for the total annual loss of nitrogen from the soil.

As can be expected, absorption of ammonia is very prominent in acid soils. In a fertilizer experiment by Borden¹⁵ with different ammonium salts and ammonia alone in irrigation water it was seen that in a soil of pH 5.6 anhydrous ammonia gave the highest yields, while a soil with pH 6.5 was indifferent to these different ammoniacal fertilizations.

In a preliminary experiment, it has been found that a soil which has absorbed ammonia retains a certain amount of it tenaciously, and ammonia is not lost even if it is heated to 110 C. A few results are quoted below:

Soil	pH before absorption	pH after absorption and sun drying	pH oven dry	Clay %	NH ₃ retained after drying to 100°C mgs. per 100 gms. soil.
Dacca ..	4.97	8.34	6.26	24.8	86
Ranchi ..	5.98	8.66	8.34	24.1	40
Pusa ..	7.17	7.45	7.59	5.6	18
Sialkot ..	6.86	7.37	7.00	20.1	70
Jorhat ..	5.43	8.38	8.13	10.9	43
Guzranwala ..	7.57	8.05	7.98	18.8	46

Albrecht and McCalla¹⁶ has shown that ammonia retained by the soils easily nitrifies, and nitrates are formed.

Atmosphere is able to supply sufficient ammonia to the plants even in view of the negligible amount of this material in the air. Requirement of carbon for crops is about 100 times more than its requirement for nitrogen. Still it occurs in very small amounts in the air i.e. about 100 parts only per

million. Nitrogen or ammonia is much less required than carbon and the ammonia content of the atmosphere may easily satisfy the requirement. And the air near the dwelling places and crowded cities contains more ammonia than the air above the sea water. A few determinations by Angus Smith¹⁷ showed the following amounts of ammonia per 100 gms of air:

City	Ammonia
London ..	0.05
Glasgow ..	0.06
Manchester ..	0.10

Sea water is alkaline and contains some amount of ammonia which is being constantly released by evaporation. It therefore, appears, that the ammonia content of the atmosphere is maintained at a constant level. As there is absorption by the soil there is also replenishment by the sea water.

India spreads over an area of about 520 million acres, and the ammonia of the air over the country, after Newth,¹⁸ comes to be about 100 million tons. It is reasonable to suppose that this amount of

ammonia may be constantly feeding Indian soils with nitrogen.

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NEW DIRECTOR GENERAL OF OBSERVATORIES

DR S. K. BANERJI, D.Sc., O.B.E., F.N.I.

WE record with great pleasure that Dr S. K. Banerji, D.Sc., O.B.E., F.N.I., has succeeded Dr C. W. B. Normand, C.I.E., as Director General of Observatories on September 10, 1944. Since 1932,

Dr Banerji has been the chief administrative officer in the Meteorological Department and was appointed Superintending Meteorologist (administrative) in October, 1938. He officiated as Director General of Observatories on several occasions for a total period of about 2½ years. He is the first Indian to be appointed in this post.

Dr S. K. Banerji was born on the 27th April, 1893, in Malapdia in the district of Dacca. He had a brilliant career in the schools and colleges and finally passed in first class, in 1914, the M.Sc. Examination in Applied Mathematics from the Presidency College, Calcutta. In 1915, he obtained the Premchand Roychand Scholarship, which is regarded as the blue ribbon of the Calcutta University. In the same year, he was appointed an Assistant Professor in the department of Applied Mathematics of the newly founded University College of Science. In 1918, he obtained the degree of Doctor of Science by a thesis on "Some problems in Diffraction and Wave Motion", and in the same year succeeded Dr Ganesh Prasad in the Chair of Sir Rashbehari Ghosh Professor of Applied Mathematics. He thus became full Professor and Head of the Department of Applied Mathematics at the early age of 25.

Soon after passing his M.Sc., Dr Banerji came under the influence of Mr (now Sir) C. V. Raman



DR S. K. BANERJI

and also Professor Ganesh Prasad. At the suggestion of Professor Raman, Mr Banerji commenced an investigation of the aerial waves generated by impact and the results were published in a number of papers in the *Philosophical Magazine*, the first of which appeared in 1916. In that connection he developed a new instrument, which he called ballistic phonometer. This early work of Dr Banerji has found place in text books on Sound (Text Book of Sound, by A. T. Jones).

His work on the Theory of Foucault's test and the radiation from the edges of diffractive apertures, published in *Philosophical Magazine*, 1918, is a continuation and development of Lord Rayleigh's work on methods for detecting small optical retardations, and on the theory of Foucault's test (*Philosophical Magazine* 1917), and has been acknowledged as such by Lord Rayleigh (*Vide Scientific Papers*, Vol. V).

At the same time, Dr Banerji became deeply interested in boundary value problems, and in Bessel functions, and published several papers on electrical and acoustical wave motions, surface and tidal waves. He published for the first time, the interesting transformation theorems and several others, which are of considerable value in connection with wave equations.

In 1918, Dr Banerji became the Secretary of the Calcutta Mathematical Society, and also the Physical Science Secretary of the Asiatic Society of Bengal, and remained so until 1922 when he joined the India Meteorological Department. During these years, he attracted round him a number of workers. Under his directions, Mr Bholanath Pal published several papers on Zeros of Bessel functions, which have been reproduced in extenso in Hobson's *Spherical Harmonics*; and Mr Abani Bhusan Datta many interesting series in Bessel functions, for which he was awarded the degree of Doctor of Philosophy. Dr Banerji published many papers on harmonic functions, and on acoustical and optical problems in the *Bulletin of the Calcutta Mathematical Society*, *Philosophical Magazine*, *Physical Review*, *Astrophysical Journal*, etc. His paper in *Physical Review* on vibrations of electric shells partly filled with liquid gives a complete theory of "Musical cups." In the Sir Asutosh Mookerjee Silver Jubilee Volume, 1922, he developed a series of ellipsoidal harmonics and solved the problem of vibrations of a gas in an ellipsoidal envelope, the non-stationary state of heat in an ellipsoid, and several other problems by very simple methods. The ideas contained in this paper have been further developed by F. Moglich in a paper on "Bengungs-erscheinungen an Körpern vol ellipsoidischen Gestalt", (*Ann. d. Phys.*, 83, 1927).

Under his vigorous leadership, the Calcutta Mathematical Society showed a considerable development. Monthly meetings were held in which papers

were read and discussed and its bulletins became a quarterly publication.

Dr Banerji took active interest in the Indian Science Congress and contributed papers regularly commencing from its first session in 1914. He was elected President of the Physics and Mathematics Section of the Congress held at Lucknow in January, 1923, and in his presidential address gave a review of the cyclones of the Indian Seas and the theory of their formation, growth and decay.

At the invitation of Sir Gilbert T. Walker, Dr Banerji joined the India Meteorological Service, Class I, in April 1922, and was posted as Director of the Colaba and Alibag Observatories. Here he interested himself in a variety of geophysical problems. His first contribution on the depth of earthquake focus (*Nature*, 1922 and *Phil. Mag.*, 1924) is regarded as a fundamental one and has been widely quoted and referred to in text books on Seismology and Geology. His memoirs of microseisms associated with disturbed weather in the Indian Seas published in the *Philosophical Transactions of the Royal Society*, 1928, opened out a practical method of detecting disturbed weather over the seas, particularly cyclones, and estimating their intensity. He developed the theory of microseisms still further in a paper on "Theory of Microseisms" published in the *Proceedings of the Indian Academy of Sciences*, 1934. He developed a method of recording the electric currents flowing over the surface of the earth ("earth currents") by neutral electrodes, and took continuous records of these currents for a year. The results were published in the *Memoirs of the India Meteorological Department*, Vol. XXVI, 1927, and constitute the only observations available in India of this phenomenon. Dr Banerji set up a series of apparatus for simultaneous recording of electric charges of raindrops, the potential gradient, changes in the gradient produced by lightning flashes, thunder-lightning intervals, and published a number of papers in the *Quarterly Journal of the Royal Meteorological Society* and the *Philosophical Transactions of the Royal Society* on the electricity of overhead thunder-clouds. The distribution of charges in thunder-clouds and other results obtained in these papers have been widely quoted.

Soon Dr Banerji attracted a large number of research students to work with him on various problems, and in recognition of the work done by him the Government of Bombay appointed him as Honorary Professor of Applied Physics in the Royal Institute of Science, Bombay, for a number of years, and conveyed their appreciation of the valuable work done by him. Several students working under him obtained the M.Sc. and Ph.D. degrees of the Bombay University. Investigations carried on covered a large number of subjects, such as discontinuous fluid

motion, evaporation, artificial vibrations of ground, sound characteristics of Indian alphabets, etc. In a recent communication published in *Indian Journal of Physics*, Dr Banerji has discussed in considerable detail the interchange of electricity between solids, liquids and gases produced by mechanical action, and has shown how these results will affect the "Breaking-Drop" theory of the origin of electricity in thunderstorms.

In 1933, he officiated as the Director General of Observatories for eight months. In 1934 he went to Europe on leave and visited all the important meteorological and geophysical centres. He also attended as a member the International Congress of Applied Mechanics held at Cambridge in 1934 and participated in the discussion.

Before being appointed as the Director General of Observatories, Dr Banerji was Superintending Meteorologist in the Upper Air Office, New Delhi for nearly 2 years. During that period he gave considerable attention to radio-sonde; the chronometric type of radio-sonde, which was in the experimental stage was given the final shape, with several new features, and arrangements were made for its mass production and for daily ascents, which is now a regular feature.

In the post-war, the meteorological service has to play a very important part in relation to civil aviation and agriculture, and it is hoped, that under Dr Banerji's leadership, the department will rise to the height of the occasion.

Notes and News

OUR NEW EDITORS

THE readers of SCIENCE AND CULTURE are aware that the Indian scientists who are now visiting the United Kingdom in response to an invitation extended to them by His Majesty's Government and will shortly be in the United States include three editors of SCIENCE AND CULTURE, namely Prof. M. N. Saha, Prof. S. K. Mitra, and Sir J. C. Ghosh. Dr B. C. Guha, Technical Food Advisor to the Government of India and one of our editors and joint honorary secretaries of the Indian Science News Association, it may be recalled, is now also on tour in Great Britain on a special Government mission. The Indian Science News Association has been particularly fortunate to secure the services of Dr D. M. Bose, Director, Bose Research Institute, and Prof. P. Rây, Khaira Professor of Chemistry, University College of Science, Calcutta, who have kindly consented to serve in the editorial board of SCIENCE AND CULTURE during the absence of these editors. Dr D. M. Bose and Prof. P. Rây will further act jointly as the honorary secretaries to the Indian Science News Association till the return of our permanent secretaries. We extend to them our hearty welcome and assure them our best co-operation and service for the successful prosecution of the activities of the Association.

INDIAN SCIENTISTS IN GREAT BRITAIN

THE proposed visit to the United Kingdom of the Indian scientists at the invitation of His Majesty's Government, first announced in April last

and eagerly awaited all these months, has at last taken place. Of the seven scientists constituting the Scientific Mission, Sir S. S. Bhatnagar, Sir J. C. Ghosh, Dr. Nazir Ahmad, Prof. S. K. Mitra and Prof. J. N. Mukherjee left India early in October and are now in Great Britain conferring with eminent British scientists and visiting places of scientific and industrial interest. Prof. M. N. Saha, another member of the Mission, could not accompany the party early in October and later left for England.

The Indian Scientific Mission whose inception may be traced to the influence of Prof. A. V. Hill who recently visited this country has, as its principal object, the establishment of contacts with the scientists of allied nations and to plan arrangements for collaboration and exchange with a view to promoting scientific and industrial status of post-war India. The Mission will also visit the United States of America and, if possible, the Dominion of Canada. The members of the Mission have also expressed their intense desire to visit U. S. S. R., but it is not yet known whether such a visit will be arranged.

The five Indian scientists, immediately after their arrival in London, were accorded a cordial welcome at a historic gathering of scientists at the Royal Society.

At a press conference held in the premises of the Royal Society and presided over by Prof. A. V. Hill, the Indian scientists indicated the need for scientific and industrial development in India. They pointed out that the industries brought into existence as a result of scientific discoveries cannot survive in a competitive world if not continually improved by

fresh ideas and inventions. The war made the authorities in every country conscious of the value of scientific research. Although India has witnessed the creation of a number of scientific organizations, such as Imperial Council of Agricultural Research, the Indian Medical Research Fund Association and the Council of Scientific and Industrial Research, expenditure from public funds on scientific research in India is still insignificant. This war has shown many gaps in India's industrial structure fraught with great danger. Considerable development of war and key industries now awaits materialization in the near future, for which capital goods, machine tools and technical knowledge will be needed in increasing amount and variety. The Mission has been authorized to investigate the possibility of obtaining scientific equipment worth several lakhs of rupees from Britain and U.S.A. In this connection the question was asked as to whether part of India's credit balance with Britain which may amount to a thousand million pounds could be spent partly on research equipment. Prof. Hill said, "India will probably need to spend the credit balance in obtaining capital equipment for industries. Without this she could not start on serious industrial development." The scientists expressed firm conviction that modern scientific and technical methods could banish from India disease and low standards of living if freely applied without any interference from powerful vested interests. They also made it clear that the plan for the industrial progress of India can be best carried out under a National Government.

A CENTRAL PLASTIC RESEARCH INSTITUTE

At its meeting held on September 17 and 18 at the Indian Institute of Science, Bangalore, with Sir J. C. Ghosh in the Chair, the Plastic Research Committee of the Council of Scientific and Industrial Research recommended the creation of a Central Plastic Research Institute at a capital cost of Rs. 20 lakhs and recurring annual expenditure of about Rs. 4 lakhs. The Committee fully realized the growing need for plastic research in this country, which covers a vast field of research and development, and strongly expressed its opinion that every attempt should be made to manufacture in India raw materials essential for the development of the plastic industry. Such raw materials are thenol, urea, pythalic anhydride, polyhydric alcohols, acetone, ethyl-, butyl- and amyl-acetate, cellulose-nitrate, cellulose-acetate and cellulose-ethers, etc. The Committee further considered that in the field of natural resins investigation and technical development should be concentrated on shellac, animal and vegetable proteins, resins, vegetable oils, industrial wastes like horn

waste, bagasse, coffee-beans, seed cakes etc., and lignin. These investigations and developments call for the establishment of a properly constituted Central Plastic Research Institute of the type recommended. The subject is so vast that original investigators in various parts of India should also be encouraged to carry out laboratory experiments in these subjects, as the Committee has rightly suggested. Large scale pilot plant experiments on the basis of results so obtained should, however, be carried out in co-operation with experienced workers of the Central Plastic Research Institute.

MORE BARRAGES FOR SIND

We learn with satisfaction that the Sind Government has completed plans to build two more barrages, one in Lower Sind and the other in Upper Sind, and has already placed order for the machinery needed for the job. The Government intends to start operations as soon as possible, and the first excavation work will in all probability be undertaken in November.

The Lower Sind Barrage will be situated at Hajipur, 16 miles below Kotri, and the Upper Sind Barrage at Gudu Head, 90 miles north of Sukkur. Three big canals, all on the left bank of the Indus, will take off from the head of the Lower Sind Barrage, feeding the Fuleli, Piniari and other small canals. Another big canal on the right bank will carry water to the Calavy and Bagha Canal and to the Osto track. Two big canals will take off water from the right side of the Upper Sind Barrage and feed the Begar's Desert Sindwah and other canals.

The project, when completed, will create fresh facilities for irrigation and will be responsible for bringing under cultivation 49 lakhs of acres of additional lands. Rice will be the main crop to be cultivated in the newly irrigated area, but certain dry crops will also be grown.

The two barrages are estimated to cost Rs. 16 crores, according to pre-war estimate. Sind's first barrage at Sukkur, it may be noted, cost 24 crores of rupees, and the money was realized in course of less than ten years in the shape of increased revenue.

LOCUST CONTROL IN INDIA

In the middle of September, representatives of the Teheran International Locust Control Commission, including British, Soviet and Iranian experts, visited this country to confer with the Indian experts on the question of locust control. The conference took place at New Delhi, and the extent of success of the locust campaign in India during the last summer and the possibilities of the degree of invasion which Iran and Arabia might expect from the Indian

side during the next autumn and winter were discussed. It emerged that owing to unusually good monsoons this year locust breeding had taken place over an extensive area of about one lakh square miles in the deserts of Sind-Rajputana. But the control work had been so efficient that an extremely small percentage of hoppers escaped destruction and had given rise to only two or three swarms. This was responsible not only for the saving of India's own kharif crops from locust depredations, but such effective control prevented swarm invasion of the neighbouring countries, e.g. Afghanistan, Iran and East Arabia. The foreign experts also visited the breeding areas to ascertain the Indian technique of locust control.

INDUSTRY AND ACADEMIC RESEARCH

ACCORDING to a report in *Nature*, the Directors of Imperial Chemical Industries, Ltd. have recently made generous provision for eighty fellowships at nine universities in Great Britain. The fellowships are generally meant to be held by senior workers in various branches of science. Although the universities have been given wide choice in the selection of the subjects for research, emphasis has been laid on such subjects in chemistry, physics and allied sciences, namely physical chemistry, biochemistry, colloid science, chemotherapy, pharmacology, engineering and metallurgy, as have direct bearing on the manufacturing interests of the I. C. I. But these subjects, it is to be noted, themselves cover the entire scientific background of modern industry. Only one notices scant attention being given to biological and social sciences in the scheme of fellowship; but it has also been made clear that the fellowships may be used by the universities to improve the balance of research effort, either in a particular university or between one university and another.

It appears that the main purpose of the fellowship is to strengthen the general provision for scientific teaching and research in British universities. It is realized that future development of industry, particularly the efficiency in industry, depends upon a regular supply of men of requisite ability who can fill high academic and industrial positions. A balanced development of the efficiency in teaching and scientific research in the universities can alone ensure this flow of vital men. In his letter to chancellors of the universities, Lord McGowan most fittingly stated: "Nearly three generations of experience of the administration and conduct of research have convinced us that academic and industrial research are interdependent and complementary, and that it is useless to expect substantial advances in industry without corresponding advances in academic science." Although it is not for the first time that such a remark has been made, Lord McGowan's re-

mark affirming the supreme need for academic research on fundamental problems of science may serve as a warning to those who, in their enthusiasm for industrial research, are prone to underestimate the value of academic research. What is needed is increased co-operation between industry and university, as exemplified in the I.C.I.'s generous provision for fellowships for the promotion of teaching and scientific research in universities. I.C.I.'s instance should inspire similar co-operation in India now that this country is seriously thinking in terms of industrial research and development.

WAR AND OIL

THE old slogan that an army cannot march on empty stomach now stands corrected as that an army cannot march on empty oil tank. Speaking of the Allied victory in the last war, Lord Curzon said that the Allies swam to victory on the wave of oil. The part played by oil in the present global war of three dimensions, in which highly mechanized units are carrying on relentless campaigns on land, at sea, and in air need hardly be overestimated. In his article in a recent issue of *Technology Review*, Roland F. Beers quotes some figures relating to military requirements for oils of various descriptions, which make interesting reading. The U. S. armed forces require approximately 50,000,000 gallons (250 gallons=1 ton) of gasoline, fuel oil, lubricants, and other products of petroleum every day. The U. S. Navy consumed over 1,000,000,000 gallons of oils in 1942 and twice this amount in 1943. Figure for the current year, although not quoted, will doubtless indicate a much greater amount. A mechanized Army division on the move operating with a total horse-power of about 200,000 consumes nearly 18,000 gallons of gasoline per hour.

We have recently heard a good deal about 1000 planes air raids over Germany. A single air raid on such a scale calls for a consumption of more than 1,000,000 gallons of gasoline and 30,000 gallons of lubricating oil. Every Flying Fortress requires not less than 500 gallons of gasoline. It has further been estimated that 3 pounds of gasoline are needed to deliver one pound of bombs filled with petroleum explosives.

The demand for petroleum in the military has become so heavy and exacting of late that even U. S. A., with her vast resources of petroleum, increasingly finds it difficult to cope with it. In 1943, the total consumption of oil in U. S. A. amounted to 1,500,000,000 barrels (42 gallons=1 barrel). At the beginning of the present year she has been producing at the rate of 4,000,000 barrels a day. Her present production rate is estimated at 4,500,000 barrels a day, which is, however, being maintained with great difficulty. Some operators foresee that in

1945 her daily requirement of petroleum may develop into 5,000,000 barrels a day. For the last few years U. S. A. failed to equalize her output rate with consumption rate and had to draw upon her reserve stocks which are being steadily depleted. In January 1941, U. S. A. had in storage above the ground approximately 263,000,000 barrels of crude oil which declined to 249,000,000 barrels by January 1944. During the same period, her heavy fuel oil stocks dwindled from 86,000,000 barrels to 54,000,000 and gasoline stocks from 90,000,000 to 78,000,000 barrels. Only her stocks of light fuel oil indicated a slight increase from 37,000,000 to 39,000,000 barrels. For this growing deficit U.S.A. has at present to depend on foreign sources of oil and on the possible discovery of new oil fields in her own territory. The article describes how intensively the search for new oils is now going on in U. S. A. for which the services of wildcatters as well as competent scientists, including geologists, physicists, chemists, electrical engineers, mathematicians, bacteriologists, biologists, paleontologists, mineralogists, petrographers etc. have been requisitioned on a large scale. Three hundred and fifty of these crews, numbering up to 15 per crew, are now engaged in their search for oil throughout the United States. The total annual outlay for exploration work is now reported to exceed \$350,000,000.

GERMANY'S SYNTHETIC OIL

UNLIKE the United Nations, Germany is quite adversely situated with regard to her supply of natural oils and has to depend largely on synthetic oils for the successful prosecution of the war. Speculation is rife as to the extent of the output of synthetic oil in Germany, and various figures have been quoted from time to time from more than one source. An article in a leading Swiss paper, according to a report in *The Chemical Age*, recently discussed the synthetic oil situation in Germany and estimated her total output of synthetic oil at 10,000,000 tons per annum.

Oil is produced largely from lignite in which Germany abounds. Most of the larger lignite mining companies have established their own plants for the hydrogenation of coal on the right bank of the Rhine under the leadership of the Gelsenkirchner Mining Company. It is stated that about 30,000,000 tons of lignite mined in the neighbouring Geisel valley are being utilized for the production of synthetic oil. On an average, about five tons of lignite yields one ton of motor fuel. At the Saale Water Works near Leuna, about 800,000 cu.m of water are being daily used for the production of hydrogen required for the hydrogenation of coal. Leuna and the Gleiwitz Works in Upper Silesia are reported to

be the most important centres for production of synthetic oil, each having an annual output of over a million tons.

Most of the plants are worked underground for reasons of safety against air raids and are further provided with smoke screen arrangements. The Blechhammer plants are completely underground and are reported to have survived several air attacks. With her growing difficulties of obtaining supplies of natural oil from Rumania, Poland, Hungary and Estonia, Germany will have to depend entirely on her synthetic oils, and her ability to continue the war will be derived from her ability to maintain the tempo of synthetic oil production on an upward curve despite the gloomy prospect of increased Allied air attacks.

INDIAN SUGAR INDUSTRY

THE annual general meeting of the Indian Sugar Mills Association and the 13th convention of the Sugar Technologists Association of India, with Mr Lalchand Hirachand in the Chair, took place at Cawnpore on September 11, 1944. In course of his two presidential addresses, Mr Hirachand reviewed the scientific and the economic aspects of the sugar industry and came forward with a number of significant suggestions. He referred to the low average yield of cane in India, which is only 388 maunds per acre compared to 1446 maunds in Java and 1515 maunds in Hawaii. During recent years a progressive decline in yield per acre has been noticed. Furthermore, the Indian cane is deficient in sucrose content as compared to that of Java and Hawaii, which adversely affects the cost of manufacture. It has been estimated that a difference of 0.3 per cent. in the sucrose content affects the cost of production by six annas per maund. With regard to milling extraction and boiling house practices, the Indian industry suffers from low efficiency. Thus, with a fibre content as high as 15 per cent. to 16 per cent., the Indian manufacturers require large quantities of coal and wood to supplement bagasse, whereas the manufacturers in Java, using cane with a fibre content of 11 per cent., do not require any extra coal or wood.

Hardly any use is now made of the important by-products, such as molasses and bagasse, despite immense possibilities of utilizing them as starting raw materials for useful products. Molasses is a potential raw material for the manufacture of power alcohol which, as motor fuel, very nearly approaches the ideal fuel. The use of power alcohol in mixture with petrol up to a percentage of 50 has been made compulsory by legislation in most of the sugar producing countries. Mr Hirachand estimates that about 19 to 25 million gallons of power alcohol worth about Rs. 75 lakhs to Rs. 95 lakhs can be produced in India

from 3 to 4 lakh tons of molasses which is going to waste at present. Despite repeated attempts, the sugar factories in India have been denied the privilege of undertaking the production of power alcohol in India. The Government of India has thought fit to safeguard the vested foreign oil interests in this country and ignore the demand of Indian industries, which may promote economic well-being. "Here lies the difference," remarked Mr Hirachand, "between the National Government and the Foreign Irresponsible Government."

PALÆOBOTANY IN INDIA

PROF. B. SAHNI, F.R.S., acting as Convener and Dr R. V. Sitholey, D.Sc. as Secretary of a committee of 24 botanists working in Paleobotany have now published the 5th annual report of the progress of current research on fossil plants in India (*Proc. Nat. Acad. Sc.*, 14, 1-2, 1944). Of the 31 papers abstracted, majority are from Lucknow, by Prof. Sahni himself and by his pupils working under his inspiring guidance. Contributions are also noted from Bangalore, Benares, Bikaner, Hyderabad, Madras and Nagpur. The report includes not only abstracts of papers already published elsewhere but also abstracts of work in progress at the respective centres. An additional feature of these abstracts is that they are fully illustrated.

The outstanding contribution included in this report is an abstract of the presidential address delivered by Prof. Sahni to the National Academy of Sciences at a joint meeting with the Indian Academy of Sciences, in December last year, 'On the age of the Punjab salt in the light of recent evidence'. This long debated question of the age of

the saline series has been approached from the micro-paleontological point of view. From the evidences of such microfossils as shreds of Angiosperms, Coniferous wood, wood elements with simple and bordered pits, pollen grains of Angiosperms, cuticles of grasses, fungal hyphae and insect remains *e.g.*, Diptera, it is concluded that the saline series, at least at Khewra in the Salt range, is of Eocene age, as already suggested by Koken and Noetling (1903) and subsequently by Holland, Pascoe, Wadia, Davies and many other geologists. "The saline series of the Punjab salt range, although it underlies the Paleozoic sequence in the eastern part of the range, has come to occupy this inferior position owing to an overthrust of large magnitude which has shoved older beds on the saline series". C. S. Fox and E. R. Gee, however, claim these beds to be as old as Cambrian or Pre-Cambrian.

NOBEL AWARDS FOR 1943 AND 1944

THE report of the Nobel awards in Physiology and Medicine for 1943 and 1944 is just to hand. Professor Kenrik Dam of Copenhagen and Professor Edward Adelbert Doisy of Saint Louis, Missouri, have shared jointly the prize for Physiology and Medicine for 1943. The same award for 1944 has been made jointly to Professor Emeritus Joseph Erlanger of Saint Louis and Professor Herberts Gasser of New York.

Professor Dam discovered vitamin "K" replay and Professor Doisy the chemical nature of the vitamin. Professors Erlanger and Gasser made significant contribution to our knowledge of the manifold and functional differentiations on nerves. It may be noted that the United States alone has annexed three prizes out of four.

SCIENCE IN INDUSTRY

SYNTHESIS OF VITAMIN C FROM BEET PULP

A NEW synthesis of vitamin C based on beet pulp is reported in *The Chemical Age*, July 8, 1944. Developed in America, the method is capable of producing approximately 50 lb. or 23 kg. of vitamin C from one ton of dry beet pulp and bids fair to compare favourably with the process now in commercial use.

The vitamin C, it may be recalled, was first synthesized simultaneously by Reichstein and by Haworth and Hirst. Their method was, however, very laborious and involved the production of galac-

turonic acid from galactose, its subsequent reduction to L-galactonic acid, oxidation to L-lyxose and conversion to L-lyxosone. Vitamin C was finally obtained by adding hydrogen cyanide and then hydrolyzing the product. In this way many analogues of vitamin C were also prepared. But owing to such tedious operations the method could not be applied successfully on a commercial scale.

The abundance of galacturonic acid, the starting material for the synthesis of vitamin C, in plant materials, such as the dry pulp left after the extraction of sugar from sugar beets and the pulp from

citrus fruits and apples, suggested the possibility of synthesizing vitamin C from beet pulp. The dry pulp contains about 30 per cent of the acid in the form of pectic substances, and a simple method for obtaining salts of galacturonic acid in any desired quantity has now been developed. The method consists in treating the pulp in water with 'Pectinol', an enzyme preparation used for the clarification of fruit juices, when galacturonic acid separates from the pulp and remains in solution with water. The acid, however, cannot be crystallized from the solution as such; the calcium, sodium-calcium and sodium-strontium salts are first prepared by neutralizing the hydrolysate with appropriate bases and their crystals obtained by evaporating the solution. The salts of the galacturonic acid, thus prepared, retain about 18 per cent of the original beet pulp.

The salt of galacturonic acid, say sodium calcium galacturonate, is reduced by hydrogen to sodium and calcium *l*-galactonates with the help of a Raney nickel catalyst. The salt is next converted to *l*-galactonate with sodium chlorate in the presence of vanadium pentoxide. The methyl ester is then treated with sodium methylate to give sodium ascorbate which readily yields crystalline vitamin C.

The new method of analysis is much simpler than other methods now practised. 1 mole of galacturonic acid can theoretically produce 1 mole of vitamin C; or 0.7 part of vitamin C may be derived from 1 part of sodium calcium galacturonate. However, the actual yield has not been found to exceed 20 per cent of the theoretical.

CAROTENE FROM SWEET POTATOES

THE United States Government researchers have recently extracted carotene from sweet potatoes, according to a report in *Scientific American*. Sweet potatoes were already recognized as an important potential source of carotene or pro-vitamin A. Acetone was employed for extraction in one of the methods, which gave a product of 90 per cent. purity in a yield of about 39 per cent. The acetone extraction was carried out in four or five stages. The first two stages were concerned with the dehydration of the potato pulp and little carotene was absorbed in these operations. The third and fourth stages in which a greater quantity of acetone was used extracted most of the carotene which was subsequently crystallized.

RUBBER FROM *CRYPTOSTEGIA GRANDIFLORA*

SINCE the Japanese occupation of Malaya and the Dutch East Indies, the United Nations are deprived of about 90% of their supplies of raw rubber, and the possibility of developing other sources of vegetable rubber are being explored.

Mr A. L. Griffith, Silviculturist, Forest Research Institute, Dehra Dun, in the Indian Forest leaflet No. 64 (Silviculture), 1944, describes the practical experience gained during the past year in the raising of *Cryptostegia grandiflora* (Asclepiadaceae), as a war time emergency plantation crop, which calls for maximum production in the minimum time, with cost as a secondary consideration. The information is intended to help those engaged in raising plantations this year so that the best use is made of the experience gained so far.

The plant is indigenous to Madagascar and probably to Africa and many years ago was imported into India as a garden plant for its flowers. It is now found growing in all parts of India in various types of soil, in all climates without regard to temperature, rainfall, humidity, in deserts and in dry areas, in river banks and in places where the sub-soil water table is high. Thus the plant displays an amazing adaptability to wide variations in environment. "A well-drained fertile soil with a gentle slope at about 100 ft. elevation and a rainfall of about 60 inches will suit it best, particularly if facilities exist for irrigation in periods of dry weather."

Care must be taken not to collect the seed until it is fully ripe and also that the seeds are correctly identified, as the pods of *Cryptostegia buchanani* are likely to be mistaken for those of *Cryptostegia grandiflora*. The most successful method is to soak the seed in cold water for 24 hours before sowing. Germination starts in 10 days and is complete in about 24 days.

The leaflet gives full details of nursery practice, plantation technique, rate of growth and other details of cultivation.

The cost of a plantation unit of 5000 acres would be about Rs. 200 per acre and of this about Rs. 100 per acre represent expenditure on equipment etc. The number of plants varies from 7,000 to 10,000 per acre but there is no data of the production of rubber per acre and the per cent of the rubber content of the dry weight of *Cryptostegia*.

Today when this vital war material is discussed interest centres on synthetic substitutes or to other vegetable sources. In America, *Perthenium argenteatum* (Guayule plant), a desert weed which grows wild in Mexico, is now being intensively cultivated in U.S.A. under Government direction. The story of its growth and development, particularly as seen in the Salinas valley of California, is given in the *Geographical Magazine*, XVI, September, 1943.

PROTECTION OF TIMBER FROM BEETLES

MR J. C. M. GARDNER, Forest Entomologist of the Forest Research Institute, Dehra Dun, in another leaflet No. 69 (Entomology), describes preliminary

tests of two methods of temporarily protecting timber from certain borers e.g., Powder-post beetles of the family Bostrychidae.

A mixture of creosote and fuel oil in equal proportions or of 1 creosote to 4 fuel oil applied externally definitely prevents attack for at least 9 months or longer. Tests were made using sapwood of highly susceptible *Dalbergia Sissoo*, kept under shelter.

A coating of lime wash gave complete protection for 3 months using two highly susceptible species e.g., *Mangifera indica*, and *Albizia procera*. The

treatment must be applied within a short period of cutting or sawing and new cuts must be treated at once. Lime wash formula is 5 lbs of lime, 4 chatacks of gum, and 8 seers of water, which is enough to give three coats to 100 sq. ft. *Boswellia serrata* when treated with only ordinary lime in water is immune from both fungus and insects.

Timber of most broad-leaved trees are liable to severe damage by beetles while the wood of Coniferous trees is immune from these borers. The damage is caused by larvae which feed only on sapwood, and losses due to these beetles are very great indeed.

RETTING BY HIPAROL AND ITS COMMERCIAL APPLICATION

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THE process of retting of fibrous plants is well-known. The method practised by the growers is usually one of stacking jute, coconut and other fibrous plant parts in water and letting bacteria decompose the plants and cause separation of the fibre-bundles from cortex and wood. This method has obviously its disadvantages because (1) the time required for retting is unusually long and it varies from 6-10 weeks or more, (2) fibres of low quality due to over-retting or under-retting are usually obtained owing to lack of standard methods determining completion of retting, (3) water is polluted and forms a favourable place for the breeding of mosquitoes. The problems connected with this process have been investigated by various workers using anaerobic and aerobic methods of retting by bacteria (Ruschmann, 1924; Thaysen and Bunker, 1924) or by chemical methods (Chatterjee, Nodder, Sarker, 1944) to improve the quality of the fibre and reduce the time required for retting, but so far, the limits of none of these methods have been fully investigated. Patel and Ghosh (1943) have described in jute the changes due to disintegration of tissues caused by micro-organisms but the rôle micro-organisms play during retting have not been studied. The break-down of plant tissues by bacteria is generally believed to be due to the action of enzymes secreted by the parasites during their growth; pectins in the middle lamella of the softer parenchyma which holds the fibre-bundles together are found to be broken down during retting by the enzymic secretions of bacteria known as pectinases. The delay caused in retting may be due to the slow production of pectinases by bacteria attacking the plants or of insufficient amounts of enzymes produced, because production of pectinases by bacteria is not only influenced by the rate of

growth of bacteria on the plant-tissues but also by the chemical nature of the substrate influencing the formation of enzymes capable of breaking down plant-tissues. It is, however, possible to produce enzymes capable of breaking down plant-tissues actively *in vitro* from fungi or bacteria parasitic on plants and determine the rate of hydrolysis. Since retting involves mainly break-down of pectic materials by enzymes elaborated by bacteria, it is possible that active enzymes produced *in vitro* from fungi may hydrolyze pectins and cause retting of fibrous material. The break-down of plant-tissues is, however, due to a mixture of enzymes and not to one enzyme alone (Baruah, 1942). Hiparol previously reported by us (1944) as being capable of retting fibrous material is a mixture of enzymes and has been extracted from a mould, on a large-scale by methods as followed by Baruah (1942). Investigations described below concern determination of the activity of Hiparol, its use as a retting reagent and its application in commerce.

The terms used to denote the enzymes in Hiparol causing changes in the plant-tissues are as follows. The term lamellase is used to denote maceration of tissues, the macerating enzyme being previously called by various workers, 'cytase', 'pectinase' and 'protopectinase'. The changes in pectin, which, according to Myers and Baker (1934), is a complex of eight molecules of galacturonic acid, seven of the carboxyl groups being methylated with one molecule each of arabinose and galactose and two of acetic acid, are caused by several enzymes, and the term pectinase is used, therefore, in the broad sense, to cover the enzyme complex which breaks down the basic structure of the pectin molecule. The most important enzymes are pectin poly-galacturonase

acting upon the poly-galacturonic acid in the molecule and pectin-methoxylase causing splitting off of the CH_3O groups attached to most COOH groupings of pectins. Protopectinase is used here to denote the activity by which soluble pectin is formed from insoluble protopectin.

ACTIVITY OF HIPAROL

The criteria used for determining the activity of Hiparol were as follows:—(1) rate of maceration of blocks of plant-tissues; (2) the changes in the physical and chemical properties of pectin solutions; (3) rate of break-down of fibrous plant-tissues; methods used for determining the activities were those as followed by Baruah (1942).

Hiparol used was the substrate on which the fungus was grown and enzymes were extracted in water. For the preparation of 2% Hiparol mixture, 2 gms. of the substrate on which the fungus was grown were treated with 100 c.c. of water, and the enzyme extract was used.

Blocks of plant-tissues of 2 cms. $\times$ 1.0 cms. $\times$ 0.5 cms. size were immersed in 2% Hiparol mixture at pH 5.0 and the time required for loss of coherence of plant-tissues was noted. Controls were set by immersing plant-tissues in 2% boiled Hiparol mixture at pH 5.0, enzymes being deactivated by heat. Table 1 shows the time required for maceration of blocks of plant-tissues.

TABLE 1

TIME OF MACERATION OF BLOCKS OF PLANT-TISSUES

Type of plant-tissue	Time required for maceration of blocks of plant-tissues	Control after boiling
Mango	20 minutes	No action
Apple	20 "	"
Pineapple	20 "	"
Grapes	20 "	"
Orange rind	25 "	"
Lemon rind	40 "	"
Tomato	25 "	"
Banana	25 "	"
Guava	35 "	"
Pumpkin	42 "	"
Tender coconut husks	40 "	"
Mature coconut husks	42 "	"
Mature jute stem	8-10 hours.	"

The following facts are evident from Table 1:—

(1) Hiparol macerated mango, apple, pineapple, grapes-tissues in 20 minutes.

(2) Orange rind, banana tissues were macerated in 25 minutes whereas guava, lemon rind and pumpkin-tissues were macerated in 35-42 minutes.

(3) Coconut husks were macerated in 40-42 minutes, fibres being completely loosened from the matrix. Fibres from the outer skin were also separated by the enzyme action.

(4) Jute stem was macerated in 8-10 hours, fibres being completely loosened from the cortex and wood. Slimy material was usually observed on the surface of the skin.

(5) There was no action in the controls, heat deactivating the enzymes.

Hiparol macerates plant-tissues by decomposing the middle-lamella, lamellase being the enzyme responsible for its break-down. (Baruah, 1942). The break-down products of the middle-lamella by lamellase are not yet known. Evidence obtained by studying histological changes in coconut, jute, mango, orange-rind tissues caused by Hiparol shows that loss of coherence of plant-tissues is due to extraction of pectins from the cell-wall and its break-down by the enzymes as well as to the decomposition of the middle-lamella (details to be published in a subsequent paper).

Pectinase breaks down pectin by a sequence of changes, both physical and chemical, affecting the basic structure of the pectic molecule; changes in pectin caused by Hiparol are shown in Table 2 and Fig. 1 and may be described as follows (for experimental purposes, 100 c.c. of 1 per cent pectin and 10 c.c. of 5 per cent Hiparol were used and the changes were noted simultaneously):—

TABLE 2
CHANGES IN PECTIN CAUSED BY HIPAROL

Time in hours	Relative viscosity %	Amount of Un-decomposed pectin	Amount of reducing sugar as dextrose Iodine-reduction	Saponification value as gms. of NaOH per 100 gms. of dry ash-free pectin.
0	100	1.0 gm.	2.5%	9.6 gms.
3	41.3	0.56 "	4.9%	8.9 "
24	7.8	0.42 "	6.2%	6.46 "
48	3.9	0.36 "	31.5%	5.0 "
72	3.4	0.30 "	31.5%	3.52 "
96	2.6	0.21 "	31.5%	2.79 "
120	1.5	0.14 "	32.0%	2.50 "

(1) There was a gradual decomposition of pectin and a rapid decrease in viscosity of pectin solution, relative viscosity of pectin solution being reduced to 7.8 per cent after 24 hours.

(2) The increase in the amount of reducing sugar was rapid within the first 48 hours, after which the rate of production was almost constant.

(3) There was a gradual decrease in the saponification-value of pectins showing the changes in the degree of demethylation during hydrolysis.

It thus appears that the break-down of pectin by Hiparol is accompanied by a decrease in viscosity and in the saponification-value and by a corresponding increase in the reducing power of pectin. The rapid decrease in viscosity may be due to the splitting off

of secondary aggregates of polygalacturonic acid chains in the molecule and may be likened to the liquefaction of starch by enzymes or by acid-hydrolysis (Kertesz, 1939; Hirst and Young, 1939). The chain structure of the pectic molecule and its first break-down products which contain galactose, arabinose and galacturonic acid residues is further broken down and the reduction of pectin and the change in viscosity increased to the maximum (Fig. 1). The sequence of changes in pectin caused by Hiparol is similar to that obtained by *P. digitatum* extract and *B. cinerea* extract (Baruah, 1942).

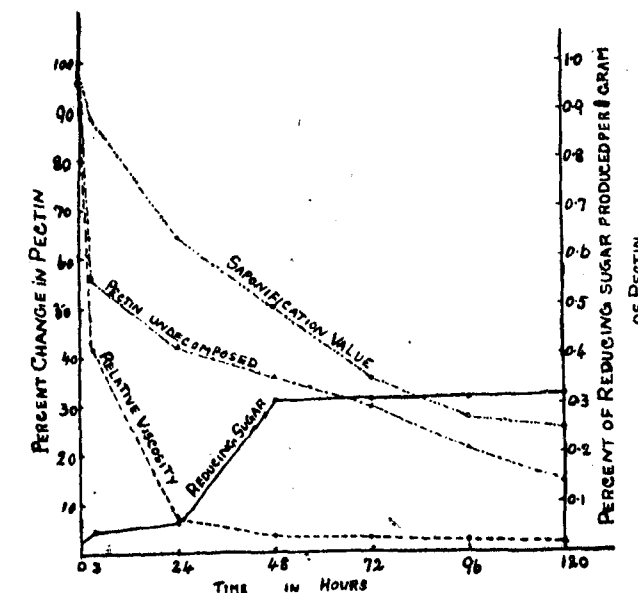


FIG. 1. Extent of changes in Pectin caused by Hiparol (Temp. 25°C.)

The effect of Hiparol on fruit juices was also investigated and it had been found that viscosity of tomato juice, orange juice, apple juice, mango juice, pineapple juice decreases rapidly, the break-down of pectin soluble in juice being accompanied by a rapid decrease in viscosity (Table 3).

TABLE 3
EXTENT OF CHANGES IN VISCOSITY OF FRUIT JUICE BY HIPAROL

Fruit juice	Initial viscosity %	Relative viscosity % after 30 minutes
Orange juice	100	2.8 %
Tomato	100	5.5 "
Mango	100	20.9 "
Pineapple	100	15.8 "
Apple	100	31 "
Grape	100	75.7 "

The maximum change in viscosity was with orange juice and tomato juice, viscosities being reduced to 2.8 per cent and 5.5 per cent respectively. This

property of rapid decrease in viscosity of fruit juices when acted upon by Hiparol, can be made use of in the clarification of fruit juices and the extent of hydrolysis used as a measure of the enzyme action.

Protopectinase, an enzyme that forms soluble pectin from insoluble protopectin, is also present in Hiparol, since the insoluble protopectin present in plant-tissues is rendered soluble and is in turn broken down by pectinase (pectin-polygalacturonase). 1 gm. of lemon protopectin on being treated by 5 per cent Hiparol was broken down, and the amount of protopectin decomposed and the amount of reducing sugar formed during hydrolysis were 0.54 gms. and 0.30 gms. dextrose respectively, soluble pectin formed being decomposed by the enzyme extract to reducing sugar.

Experiments with hemicellulose and cellulose fractions of plant-tissues show that Hiparol has no action on either of the substrates, substrates used being hemicellulose obtained pure from lemon cell-wall material and cellulose being cotton wool, filter paper and tailor's cuttings.

It thus appears that Hiparol attacks chiefly the pectic constituents of the cell wall thereby causing maceration and break-down of the tissues and has no action either on hemicellulose or on cellulose.

USE OF HIPAROL IN RETTING

The fact that break-down of blocks of jute, coconut is due to the removal of pectins from the tissues and the decomposition of the middle-lamella by actively potent pectin-splitting enzymes present in Hiparol has been made use of in the retting of jute, coconut and other fibrous plants on a large scale.

For experimental purposes, 50 gms. of Hiparol powder were suspended in a litre of water and stems 7" in length of jute, coconut husk and *Calotropis* Sp. were immersed in the mixture at pH 5.0; the time required for retting, that is, the time required for maximum ease of separation of the fibres from the cortex and wood was noted, fibres being obtained by washing and stripping (Table 4).

TABLE 4
TIME REQUIRED FOR RETTING BY HIPAROL

Type of plant tissue	Immature	Mature	Dry
Jute	30-48 hrs.	18-24 hrs.	12-18 hrs.
Coconut husk	20 "	16 "	10-12 "
Calotropis*	52 "	30 "	24-30 "

* *Calotropis* stems were kindly supplied by Dr B. C. Kundu.

The time required for retting varies from 12 to 48 hours for jute, from 10 to 20 hours for coconut, and from 24 to 30 hours for *Calotropis*. Coconut husk is easily retted since the fibrous material of the

coconut husk, due to its spongy nature, is readily exposed to the enzymes, but in jute and other fibrous plants having a complete covering of highly cuticularized epidermal tissues, cells of the inner parenchymatous tissues are not freely exposed to the enzyme action. In the normal process of retting by stacking in water, bacteria invade the plant-tissues gaining entrance through wounds, stomata or cut surfaces and multiply inside the plant-tissues causing breakdown of the tissues. In the enzymic process by Hiparol, pectins in the plant-tissues are broken down, resulting in loss of coherence of the tissues. Diffusion of enzymes into tissues taking place through wounds, stomata or cut surfaces of plants causes softening and disintegration of the tissues; continued immersion, however, for one to two days reduces the epidermal resistance, causes swelling of the tissues and makes absorption of enzymes possible on a large scale by the plant tissues, slimy gums being noticed on the stem and young leaves adhering to the stem disorganized.

The time required for retting varies in different regions of the stem. For instance, apical region in jute stem is more susceptible to enzyme action than middle and basal regions of the stem; the time required for retting by the former varies from 12 to 16 hours whereas the middle and basal regions require 24 and 40 hours respectively. The entire breakdown of the apical region and parts of the middle region of the stem in jute by Hiparol shows that the epidermal layer, although resistant to enzyme action, can be broken down by enzymes during hydrolysis, breakdown being probably caused by swelling of the tissues. Patel and Ghosh (1943) also observed difference in the time of retting for different regions of the stem and found that the time varies from 5 to 20 days. This difference in time required for retting may be due to the difference in the degree of hydrolysis of the pectic cell-walls in different regions of the stem, influencing the ease of penetration of enzymes into the plant tissues. Ease of retting appears, therefore, to be influenced by (1) the degree of hydrolysis of the epidermis, and (2) the rate of diffusion of enzymes into plant-tissues. Given, therefore, an exposed surface of pectic cell walls, the action of Hiparol as a retting reagent is most pronounced, as in coconut.

Some of the experiments on a larger scale using different plant tissues are as follows—

(1) 2000 gms. of mature coconut husks were immersed in 20 litres of water containing 200 gms. Hiparol powder at pH 5.0; the time required for retting was found to vary from 16 to 20 hours.

After the retted husks had been removed, another lot of 1000 gms. of husk was immersed in the same mixture; time required for retting was found to vary from 20 to 26 hours. A further addition of 100

gms. of Hiparol powder to the same mixture reduces the time required for retting to about 16 hours. Minute fibres of the outer skin were also extracted easily from the husk. The use of Hiparol in subsequent series of retting after the first retting had been done, may be of economic benefit to the growers, and in case of decrease in activity, the activity can be restored by smaller additions of Hiparol to the original mixture.

(2) Jute plants, both immature and mature, were immersed in troughs of galvanized lead sheets of 9' x 6" x 4" size, containing 400 gms. of Hiparol in 15 litres of water; the time required for retting was found to vary from 2-4 days. The increase in time is probably due to low concentration of Hiparol used, it being only slightly above 2.5 per cent, and also due to nonuniform wetting of the whole plant. Experiments carried out in tanks at higher concentrations of Hiparol may reduce the time required for retting.

The time required for retting of different types of fibrous plants varies with the type of plant, degree of hydrolysis of pectic cell-walls and mechanical hardness of the plant-tissues (Table 5)

It will be seen from Table 5 that the bark of Girardinia heterophylla, commonly growing in Sikkim, yields a fine silk fibre of high tensile strength in 24 hours whereas Calotropis and Pandanus require 2-4 days for retting. The waxy nature of the skin in Calotropis and Pandanus makes retting difficult. Barks of Bauhinia, Maoutia and Plantain sheath were retted in one or two days. Bark of Girardinia, although very hard and tough, was retted more easily than Pandanus, Calotropis and Agave, resistance to enzyme action in the latter being confined to the waxy cuticularized epidermal layer.

TABLE 5
TIME REQUIRED FOR RETTING OF DIFFERENT KINDS OF PLANTS

Type of plant tissue	Time, required for retting	Quality of fibre
*Girardinia heterophylla bark	24 hours	Fine silk fibre
*Bauhinia purpurea bark	24-48 "	Coarse silk fibre
*Maoutia puya bark	2-3 days	Coarse fibre
Calotropis	3-4 "	Cotton-like silk fibre
Pandanus	3-4 "	Coarse fibre
Plantain sheath	1-2 "	Fine silk fibre
Agave	2-4 "	Coarse fibre
Hibiscus	2-3 "	Fine fibre
Linum	2-3 "	Coarse fibre
Pineapple leaf	2-3 "	Coarse fibre

* These were identified by Mr S. N. Bal of the Indian Botanical Survey.

The extent of break-down of jute, coconut, Girardinia and Bauhinia during hydrolysis by Hiparol has been followed by determining the amount

of cell-wall material, prepared from the above mentioned plants by drying, decomposed and the amount of reducing sugars formed. Table 6 shows the amount of undecomposed material and the amount of sugar formed during hydrolysis, after 24 hours (for experimental purposes 1 gm. of cell wall material was treated with 5 per cent Hiparol and the mixture was incubated for 24 hours; method of determination was the same as that used by Baruah, 1942).

TABLE 6
AMOUNT OF CELL-WALL MATERIAL UNDECOMPOSED AND OF REDUCING SUGAR FORMED DURING HYDROLYSIS

Type of cell-wall material	Amount of cell-wall material undecomposed	Amount of reducing sugar as dextrose
Jute	0.50 gms.	0.32 gms.
Coconut	0.82 "	0.16 "
Girardinia	0.70 "	0.18 "
Bauhinia	0.66 "	0.20 "

The extent of breakdown varies with the type of plant used, maximum break-down being with jute and least with coconut. Reducing sugar is formed by the decomposition of the cell-wall material by the enzyme extract, the amount formed being equivalent to that formed when pectin is hydrolyzed by the enzyme extract.

Hiparol is thus capable of retting not only jute but many other fibrous plants, the rates of activity being influenced by the degree of hydrolysis of the pectic cell-walls, uniformity of wetting, diffusion of enzymes and the concentration of the enzyme extract.

QUALITY OF FIBRE AND THE COST OF PRODUCTION OF HIPAROL

Fibres obtained are of uniform quality and retain lustre and high tensile strength and are free from specks of adhering bark. Hiparol appears to be reasonably cheap and is easy to handle (details to be published later).

CONCLUSIONS

The main conclusions reached, concerning the retting of jute and other fibrous plants by Hiparol and its use in commerce, are as follows.

(1) The break-down of plant-tissues is caused by the decomposition of the middle-lamella, by lamellase and the removal of pectin from the cell wall by pectinase complex by a sequence of physical and chemical changes in the pectin molecule.

(2) Retting of jute, coconut and other fibrous plants is more rapid by Hiparol, a mixture of lamel-

lase, pectinase (pectin- polygalacturonase and pectin methoxylase) and protopectinase than by the normal process of stacking in water hitherto used. The extent of breakdown of cell-wall material of jute, coconut, Girardinia and Bauhinia by Hiparol may be used as a measure of hydrolysis of fibrous material during retting, and it is likely that it may parallel the extent of breakdown of jute and coconut by bacteria during retting.

(3) The case of breakdown of plant-tissues is influenced by the degree of hydrolysis of pectic cell-walls, rate of diffusion of enzymes and concentration of the enzymes extract.

There appears to be an immense possibility of Hiparol being used in commerce since the use of this substance may make it possible to ret the fibrous plants in a much quicker time without impairing the quality of the fibre and to clarify fruit juices. The preparation of ropes, mats, coirs and boards from coconut husks may be more readily obtained by using Hiparol than by the methods hitherto used. Extraction of fibres of fine quality and high tensile strength is also possible from many of the fibrous plants. For example, bark of Girardinia and Maoutia yields fine fibres in 24 to 48 hours on being retted by Hiparol.

Some of the results obtained on the nature of break-down products formed during hydrolysis by Hiparol on substances of various compositions and also on fibrous material during retting indicate the complex nature of Hiparol which contains, besides pectin-splitting enzymes, others of the nature of carbohydrases and also anti-bacterial toxins, and they will be published in a subsequent paper.*

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MEDICINE AND PUBLIC HEALTH

THE AMERICAN MEDICAL ASSOCIATION

THE Association's headquarters at Chicago is an impressive building of eight stories. The membership of the Association on the 1st September, 1942 was 122,033 members. It is connected with 2053 Component County and District Societies and 54 Constituent Associations in States and Possessions. The affairs of the Association are managed by the House of Delegates, under whom is a Judicial Council, a Council of Scientific Assembly and a Council on Medical Education and Hospitals, which determines its policies. There is a Board of Trustees which functions as the governing body in the interval between meetings of the House of Delegates and is charged with the duty of administering the affairs of the Association. The Board of Trustees controls the Journal of the American Medical Association, special journals, Hygeia, Library Committee of Scientific Exhibit, Council on Pharmacy and Chemistry, Chemical Laboratory, Bureau of Investigation, Bureau of Health Education, Bureau of Legal Medicine and Legislation, Council on Physical Therapy, Council on Foods and Nutrition, Bureau of Medical Economics, and Council on Industrial Health.

The Annual Sessions of the Association are held in various sections of the United States and are more largely attended than any other medical meeting. The Scientific programmes are presented through the 17 Sections of the Scientific Assembly and the General Scientific Meetings. The Scientific Exhibit is an important and distinctive feature each year, averaging over 200 individual and special exhibits dealing with advances in scientific medicine. The Technical Exhibit is always comprehensive and complete. Many enjoyable social functions are provided for Fellows and their wives.

The Judicial Council deals with all questions of ethics and rights, privileges and obligations of members or fellows. It also advises on controversies between members of different constituent associations.

The Council on Medical Education and Hospitals has helped in improving the standards of medical education to a high level. It also helps in collecting and disseminating information about hospitals.

The Council on Scientific Assembly is charged with the responsibility and duty of arranging the programmes of general meetings of the Scientific Assembly, and considers questions of policy in relation to scientific work.

The Biographical Department maintains a

biographical card index of qualified medical graduates and licensed physicians of the United States and Canada.

The Council on Pharmacy and Chemistry aims at protecting the medical profession and the public against fraud, undesirable secrecy and objectionable advertising in connection with proprietary medicinal articles, and thus acts as a leading advisory body in the field of rational therapeutics.

The Council on Physical Therapy assists in gathering and disseminating such information as will assist the medical profession in determining the therapeutic and diagnostic value of certain devices and methods employed in the practice of medicine.

The Council on Food and Nutrition is concerned with evaluating nutritional claims for food products.

The Council on Industrial Health looks after the improvement of standards in the field of industrial practice. It tries to inform the profession of developments in the industrial field of medical or medico-social nature, fosters research, stimulates provision of training in special fields and employs all necessary means to protect the health of the working people consistent with the ethical and scientific programme of the American Medical Association.

The Chemical Laboratory is concerned with the chemical investigation of the therapeutic agents presented to the medical profession. The Laboratory also serves as a clearing house for information of many new additions to materia medica, particularly the complex synthetics.

The Bureau of Investigation is a clearing house of information on patent and proprietary medicines, all forms of quackery, medical fads and fakes.

The Bureau of Health Education divides its work into (1) service to the public through physicians and medical societies, and (2) direct service to the public. The aim of both is health education of the public. This is done by answering questions, by publishing the well-known journal, *Hygeia* and by doing publicity work in various spheres.

The Bureau of Legal Medicine and Legislation looks after questions of medico-legal significance.

The Bureau of Exhibits promotes graduate medical education for physicians and disseminates health education for the public.

The Bureau of Medical Economics is engaged in the study of all phases of general economics which have a bearing upon the practice of medicine. The Bureau also endeavours to collect, tabulate, study, criticize and to prepare for publication and distribu-

tion, data pertaining to the economics of the practice of medicine; to furnish both critical and constructive information and opinions by correspondence, conferences and addresses on the several phases of medical economics; to encourage the adoption by individual physicians and medical societies of modern, sound, ethical business methods; to urge medical schools to provide medical students with information concerning the economics of medical practice.

DRIED PLASMA SHEETS IN TREATMENT OF BURNS AND WAR WOUNDS

THE urgent need for an ideal coagulum has been stressed many times. It should be durable, noncontractile, pliable, nontoxic, nonirritant, bactericidal, painless, and should contain fibrin. In an article in the *United States Naval Medical Bulletin*, Mr B. Pollocle, Lieut. Commander proposes a new dressing which appears to meet these demands. Plasma sheets were prepared in the following manner: To 20 c.c. of sterile water in a Petri dish 1.5 to 2 gm. of dried

plasma are added and dissolved, and then 0.2 gm. of sulphanilamide powder are added. This preparation is dried in an oven at 140°C. until a firm sheet forms, usually in 15 to 20 minutes. It is then allowed to cool and is applied directly to the burn. The plasma sheet can be made quickly by heating the preparation over a Bunsen burner until the sheet separates itself from the dish. This requires less than 5 minutes. The plasma sheet is applied to the burned area after debridement. Plasma loss is immediately stopped. Within a few minutes the plasma sheet becomes adherent, and in a few hours strands of fibrin can be seen securing the plasma sheet to the burn almost as if the burn were 'fibrin hungry'. No dressing need be applied. The plasma sheets can be preserved for a period of weeks by keeping them moistened with water in a refrigerator. The author states that a dried plasma sheet overcomes most of the objections to ordinary coagulums. Plasma loss is stopped immediately. Dressings may be used but are not essential. His experience in a limited number of cases was gratifying.

UNITED NATIONS RELIEF AND REHABILITATION ADMINISTRATION

Report of the Sub-committee on Policies Relating to
Agricultural Rehabilitation and Other Means of
Raising Food Essential to Relief

GENERAL CONSIDERATIONS

THE world food situation including both supplies and shipping requires that for the first crop year after liberation an absolute priority should be given to the production of foods for direct human consumption.

The rehabilitation of the pattern of agriculture in liberated areas and the modification of that pattern to secure agreed nutritional aims can only be undertaken when danger of actual hunger has been removed. Once this has been accomplished, agricultural production can be adjusted to meet more desirable nutritional and agricultural goals.

At the present time UNRRA should concentrate its attention upon the first crop year after liberation. For that year the following factors are of primary importance:

(a) European agriculture apart from the devastated areas is reduced but is a going concern. It has been producing all the food consumed during the war in Central and Western Europe including the food for the German and other Axis armies. The situation in the Far East, taking the occupied countries as a whole, is not dissimilar.

(b) Agricultural production in these areas has been concentrated on providing food for direct human consumption. Expensive forms of animal husbandry have been drastically reduced (pigs, poultry), and there are serious deficiencies in animal products although efforts have been made in Europe to maintain milk production.

In the first crop year after liberation, the war production pattern should be continued as far as practicable. Intensive efforts should be made to secure a fuller use of the land. When, however, as in certain areas, the war production pattern had been prompted by an acute shortage of foodstuffs resulting in a disproportionate sacrifice in productivity, and provided always that other means can be found for providing essential foods, an early adjustment would be desirable to insure more efficient production.

The first responsibility in most countries from the moment of liberation will be to enable farmers to sow and harvest crops. In European countries assistance may also be required at an early date to prevent the further depletion of dairy herds. The local or national authorities will have the necessary knowledge for this task. These needs can be assessed with considerable accuracy and UNRRA should, in conjunction with the national authorities, start forthwith to make provision to meet these deficiencies.

The maintenance of livestock production and herds which is of such importance to agriculture requires that the control of animal diseases by all feasible methods including the import of veterinary supplies be undertaken at the earliest possible time.

In certain devastated areas the rehabilitation problem will require special additional efforts to re-equip farms with motive power, *i.e.*, draught animals or tractors; to restore fertility to the soil; and to reconstitute essential livestock especially for milk production.

The Sub-committee agrees that the principal responsibility of UNRRA in the field of rehabilitation of agriculture and other forms of food production will be to assist local governments in providing the necessary supplies and equipment to increase production to the extent that such imports will reduce the need for relief after the second harvest. The importation of feedstuffs for milk production should have priority over the importation of feed for other livestock production. The former should receive, in principle, secondary consideration to the requirements for imports of food for direct human consumption. Where the need is urgent, the national governments should present a special case to the Standing Technical Committee on Agriculture for readjustment of these priorities.

Because of the shortage of animal proteins, fats, and vitamins, national governments or recognized authorities should take immediate steps to insure the early expansion of fisheries and of the whaling industry, and UNRRA should assist to the fullest extent possible.

In order to utilize to the greatest advantage the foodstuffs that are home produced or imported, it is recommended that UNRRA should assist the national governments or recognized authorities in restoring necessary processing facilities. It is also recommended that in order to obtain the maximum food value from bread grains the milling ratio should be maintained at high levels, *e.g.*, wheat at 85 per cent.

It is recommended that experimental stations and other agricultural institutions which can contribute to the solution of immediate post-war agricultural and food production problems should be put into a position to resume their work as early as possible after liberation.

Agricultural organizations and services, co-operative and others (including marketing and credit societies), have an important role in the provision of finance and agricultural equipment to farmers and in the collection and processing of farm produce. They should prove of special value in the immediate relief period. Wherever the national authorities desire assistance in the re-establishment of such organizations, UNRRA should give such expert assistance as it can provide.

Shortage of labour is proving a serious handicap to production in a number of countries. The Sub-committee, therefore, recommends that the reinstatement of agricultural workers should be achieved as early as possible.

In the preceding paragraphs the Sub-committee has been dealing with the short-term problems and principally those of the first crop year. The Sub-committee has studied the reports and recommendations of the United Nations Conference on Food and Agriculture and concurs generally in the conclusions reached at Hot Springs. The work of UNRRA will be confined to the short-term problems of relief and the beginnings of rehabilitation. This work will be the basis of more permanent reconstruction, and it is of the utmost importance that the actions taken by UNRRA and by the governments in that period should not hamper the long-term agricultural reconstruction programmes. It should, in so far as possible, assist towards the achievement of the objectives of the United Nations Conference on Food and Agriculture, including the progressive realization in all countries of diets adequate both in quantity and quality.

Responsibility for international action in longer term agricultural reconstruction is likely to rest with the United Nations Organization for Food and Agriculture. The Sub-committee recommends that UNRRA should take every necessary measure to secure the closest association between its own work and the activities of the United Nations Food and Agriculture Organization. The Sub-committee does not consider that it is either desirable or necessary for it to make any detailed proposals as to how this co-operation should be carried out, but considers that UNRRA should seek the closest co-operation, not only between its Council and the Council of the Organization for Food and Agriculture, but also between their respective staffs and standing committees.

PRIORITIES

The Sub-committee recognizes that UNRRA in approaching the problem of supplies for agricultural rehabilitation must relate such demands to the even more immediate need to provide food, medical supplies, clothing and other relief necessities. There is, however, a world shortage of many essential foods and war and relief demands will impose the need for continued economy in the use of shipping.

For these reasons it is of the utmost importance to obtain from the soil of the occupied countries and from sea fisheries including whaling the maximum of food in the shortest possible time.

These considerations clearly indicate the principles that should be adopted by UNRRA in the determination of relative priorities among agricultural and other food production needs.

The agricultural requirements of liberated areas include seeds, veterinary supplies, pesticides, farm machinery and implements, fuel and lubricants, fertilizers, containers and processing equipment, feed-

ing stuffs, and livestock, especially breeding and draught animals; and to this list should be added for certain maritime countries the needs of the fishing industry: boats, repair material, nets, hooks, and other fishing gear. The priorities between these various items will presumably vary from area to area. Generally speaking, the Sub-committee considers that seeds, veterinary supplies, and pesticides should receive priority immediately following that of the minimum programme for food, medical supplies, and other urgent requirements, such as clothing and soap; fuel for existing agricultural machinery and fisheries might have equal priority with fuel for transport and domestic needs. The test should be applied whether the supply of these requirements would bring early and large returns in the form of crops or of fish for direct human consumption; if so, it is recommended that UNRRA should accord the highest priority to such requirements. A further important consideration applying particularly to Europe should be to prevent the further depletion of dairy herds. Where, on the other hand, the requirements are sought for desirable but longer range objectives of agricultural rehabilitation or where the building up of such livestock as pigs and poultry would bring about competition for supplies of direct value to human needs, UNRRA must insist that the fulfilment of these needs must wait until there is no danger of a shortage of essential energy foods. The Sub-committee would not expect that any but a low priority could be granted in the first crop year to supplies for the feeding of pigs and poultry.

The Sub-committee would emphasize that in their recommendations they have attached the utmost importance to the agricultural needs of the first year after liberation. When the supply and import situation is more satisfactory, and especially when feeding stuffs can be made available and meat and fat imported in quantities sufficient to bring consumption to a satisfactory physiological level, a longer term livestock recovery programme should be put into effect.

Having regard to the importance of milling offals as a feed, the Sub-committee considers that the importation of grains should have priority over flour, where the necessary milling capacity and requisites exist in the liberated country.

Similarly, the importation of vegetable oil seeds should have priority over the manufactured products.

The Sub-committee further recommends that particular attention should be devoted to the production of those vegetables and pulses which have a high protein or vitamin content. The production of potatoes and their use for human consumption should also be increased to the maximum in liberated countries. Consequently it is recommended that a high priority should be given to imports of seed

potatoes and to seeds of other vegetables such as cabbages, savoys, swedes, turnips, and carrots.

The application of fertilizers will in certain cases greatly increase food production in the early post-war period. For this reason the Sub-committee considers that everything possible should be done to restore fertilizer plants to working order, and to resume importation of the most urgently needed supplies as soon as possible.

Steps should also be taken to restore oilseed crushing plants in relation to the anticipated supplies of oilseeds. This has particular reference to feed for dairy herds.

The Sub-committee also recommends the re-establishment of factories engaged in the production of pesticides.

The provision of drying plants for meals and fertilizers should also be recognized as important in the immediate relief period.

The problems of countries in the Far East differ in many ways from those of Europe; it is to the latter that the foregoing paragraphs are principally directed, especially as they would seem to be the more urgent in point of time. There is evidence that in the Far East there has been catastrophic depletion of draught animals and this factor may affect the suggested order of priorities for imports. A similar consideration may also apply to the more heavily devastated areas of Europe.

The Sub-committee considers that UNRRA should forthwith consult with the supply authorities in order to insure that no time shall avoidably be lost in securing the most urgently needed supplies. Further, since full use of certain of the requirements for agricultural rehabilitation can only be made at critical seasons of the year, particular attention in the case of these commodities will have to be directed to advance procurement by the appropriate governmental or inter-governmental agencies in order that a full supply of the minimum requirements may be available when the time comes.

OPERATING POLICIES

The Sub-committee recommends that programmes of requirements for agricultural rehabilitation be submitted by national governments in consultation with the regional committees in such detail as the complexity of the problem requires. Arrangements should be made for revising programmes at regular intervals in the light of most recent information.

The Sub-committee recommends that national governments or recognized authorities provide for technical surveys in each area immediately after liberation. UNRRA should hold itself in readiness to provide technical assistance if invited to do so by the national government or recognized authority.

established within the area. The regional organization should collate these surveys in order to insure that so far as possible comparable basis has been used. It will be possible by these means to have early verification or amendment of the estimates which have been prepared in the pre-liberation period.

The Sub-committee recommends that as a result of these national surveys, and as soon as possible after liberation, national production programmes should be developed by the national governments or recognized authorities of the acreages which will be sown with the various crops and of the output expected to be achieved from agricultural and fishery production. National governments or recognized authorities should base their estimates of requirements of agricultural supplies upon these production plans.

It is the national authorities which can best assess the needs of their own countries, and the national representatives, in collaboration with the regional officers of UNRRA, will be able to provide a realistic list of requirements and an appropriate recommendation on priorities.

By these means programmes for agricultural materials which fall within the scope of UNRRA will be related to the detailed needs of each territory in relation to particular crops. They will show whether there are special features of the national production programmes to which it may be desirable to draw attention, particularly if these programmes call for specialized use of fertilizers or other imported materials. Representatives of the countries receiving supplies through UNRRA should agree to develop plans for the control of imported agricultural materials in a manner designed to insure the fullest attainment of the production programme. Such

countries should also develop plans for assembling and distributing agricultural products to insure that food needs of the area are met to the maximum extent.

It is recommended that each national authority should be provided by UNRRA with such information as is available concerning production surpluses in nearby areas in order that the total supply of essential foods may be attained to the maximum extent in relation to factors, such as the availability of imported rehabilitation materials. For instance, it may be possible to use the anticipated surpluses in one area to remedy the deficiencies of an adjacent area. The regional organizations will probably be found to be the most suitable instruments for carrying out this work of co-ordination.

The task which UNRRA will have to undertake will require the appointment of technical officers to serve in its headquarters and regional offices and in the field. So far as technical assistance in the field may be desired by the national authorities, UNRRA should undertake to do this.

The Sub-committee desires to point out that in some countries the national agricultural organization will have an adequate staff of technicians at its disposal and will not so much require assistance for normal agricultural duties as for field officers who are specialists in the critical interpretation of production in relation to requirements.

The Sub-committee notes and concurs in the recommendations made by Sub-committee 1 of Committee 1 to establish a Standing Technical Committee on Agriculture with regional sub-committees. Having regard to the importance of the rehabilitation of agriculture in the immediate post-war period, the Sub-committee recommends that those committees be established and organized as soon as possible.

BOOK REVIEWS

Inorganic Plant Nutrition (Prather Lectures at Harvard University).—By D. R. Hoagland, Ed. 1944. Published by Waltham, Massachusetts, U. S. A., the Chronica Botanica Co.; Macmillan and Co., Ltd., Calcutta, Price \$4, Pp. 1-177 and 28 illustrative plates.

The book under review is volume XIV of "A new series of Plant Science Books," published by the Chronica Botanica Company of Waltham, Mass., U. S. A., and Edited by Frans Verdoorn. It contains seven lectures on the Inorganic Nutrition of Plants given at the Harvard University under the

Prather Lectureship. The broad headings of the seven lectures are:

- (1) A survey of problems of plant nutrition;
- (2) Micronutrient chemical elements and plant growth;
- (3) The absorption and accumulation of salts by plant cells;
- (4) Upward movement and distribution of inorganic solutes in the plant;
- (5) The growth of plants in artificial media in relation to the study of plant nutrition;
- (6) Some biochemical problems associated with salt absorption;
- and (7) Aspects of the potassium nutrition of plants as illustrative problems of the system, soil-plant-atmosphere.

Inorganic nutrition of plant is a subject in which much work has yet to be done. As the author has stated in the preface, the purpose of the small volume is to present a general prospective of several important aspects of the field of plant nutrition. In these series of lectures the author who is a prominent worker on plant nutrition, has naturally emphasised that aspect of plant nutrition with which he has most direct contacts. The relation of inorganic solutes derived from root medium to the growth of the plant has been discussed, including the role of soil colloids. The author has stressed the importance of soil acidity and alkalinity in relation to plant growth. The part played by the so-called micro-nutrient chemical elements like Copper, Zinc, Manganese, Boron, Cobalt, Molybdenum and Selenium, in plant growth, has been discussed. Apart from the diseases which may be caused to plants by the deficiency of micronutrient elements, animals can suffer from deficiency diseases because the vegetations consumed does not supply enough or more of the elements that function in minute quantities. The author has discussed the accumulation of salts by plant cells particularly by barley roots and has pointed out the importance of the study of artificial cells and membranes. The work of the author and Davis on the fresh water alga "Nitella", which produces multinucleate cells is very interesting. The review of the works on the absorption and accumulation of inorganic solutes by excised roots have been followed by a critical review of the upward movement and distribution of inorganic solutes in the plant. The general problem of translocation of inorganic salts in the tissues of plants is very complicated and the theories evolved to explain this type of translocation are various and still highly controversial. The work of Stout and Hoagland (1939) who performed a series of experiments with radioactive tracers of phosphate, bromide and potassium ions on several species of plants showed that the upward movement of solute in the wood was far more rapid than in the bark, but a rapid lateral transfer of solute from wood to bark took place whenever the two tissues were in contact. The author has also surveyed some of the physiological aspects of the inorganic nutrition of plants as they are offered for examination under controlled conditions of artificial culture technique. The author has tried to bring out that artificial culture methods, including climatic control in appropriate cases, as well as control of nutrient media will render important service to plant technique. The author has pointed out that at the heart of the whole question of salt accumulation in its relation to biochemistry is the nature of the energetic coupling of metabolism to the active transport of salt. The author feels, that progress in understanding the mechanism of salt accumulation

will depend largely on advancing knowledge of the biochemistry of respiration, together with a correlation of biochemical transformations with the maintenance of organised structures in the protoplasm.

In the final lecture the author has discussed critically the different aspects of potassium nutrition in plants, and has shown that the potassium supply has indirectly a relation to the respiration of plant tissues. It has been pointed out that the climatic environment influences the requirements of the plant for potassium, or its ability to absorb potassium. The interesting fact is that no indispensable organic combinations of potassium have been discovered and that nearly all potassium exists in inorganic form.

There are twenty-eight valuable illustrative plates in this volume, drawn from the experiments of several groups of Californian workers. Although the book is not a complete survey to the vast number of contributions in the field of plant nutrition, it has presented in a compact form, a number of important problems. It is hoped that the book will be useful to all students and research workers on plant nutrition.

A. T. S.

Agriculture in India.—By NABAGOPAL DAS, Ph.D. (Econ. Lond.), I.C.S. To be had of the Book Exchange, Price Re. 1/-.

Dr Nabagopal Das has already made his mark as a writer of several books on current economic and industrial problems. "Agriculture in India" is a little monograph of 55 pages which the author has done well to write for the general readers at a time when average man in India is beginning to realize the seriousness of her agricultural backwardness. The author has not attempted a thorough discussion of the problem, and this is also not possible within the small compass of a monograph, but he has presented enough facts to convince the lay reader of the magnitude of India's agricultural problem and the need for thorough agricultural development along scientific lines in the immediate future. The book is readable and has general educative value.

S. N. S.

Beyond the Microscope.—By Kenneth M. Smith, F.R.S. Published by Penguin Books.

Viruses and virus diseases have attracted widespread attention during recent years. Although viruses and virus diseases are as old as life itself on this planet, it is only recently that the mystery shrouding these invisible micro-organisms is beginning to be lifted. The nature of, and the diseases

caused by, such micro-organisms which have hitherto baffled all attempt to see them with the help of the most powerful microscope using visible light have formed the theme of the little book, "Beyond the Microscope", under review. *The Penguin Books* has an unerring judgment in its choice of authors for special monographs, which has also been adequately reflected in the present case. Dr Kenneth M. Smith, Director of the Plant Virus Research Station at Cambridge University and author of this monograph and several others on entomology and plant viruses, has worked most of his professional life on plant viruses. His account, although designed for popular readers, has accordingly every stamp of authority and an advantage of first hand information.

Besides, he has told his story—and story-like the book would read—in a fascinating and elegant way that easily appeals to popular imagination.

The book is divided into ten chapters, each devoted to a special topic relating to viruses. The various discussions introduced include such subjects as viruses in every day life, viruses in farm and garden, viruses in the tropics, study of viruses in the laboratory, viruses and tumors, viruses in time of war and peace, combating the viruses etc. The book further contains six illustrative photographs. The book is an invaluable possession for any one intending to know the nature of viruses and virus diseases.

S. N. S.

LETTERS TO THE EDITOR

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

A SIMPLE SUBSTITUTE FOR PERFORATED GLASS DISCS IN SOIL PERCOLATORS

THE perforated glass discs in soil percolators can be replaced by discs made with ordinary wax (m.p. 60°C).

These can be very easily prepared by melting calculated weight of wax in warm water with a known surface to give it the desired thickness and allowing the oily liquid on the top to cool: When cool, the wax solidifies giving a very uniform sheet of wax. Discs can be cut very easily by marking the sheet with a sharp pin and giving slight twists. The holes can be bored easily.

Owing to difficulties of supply of glass discs we are using these discs for soil studies. They are entirely satisfactory. The advantages over glass are the following:

- (1) They are not broken so easily as the glass ones.
- (2) They are not attacked by ordinary chemical reagents *i.e.* acids and alkalis.
- (3) They are cheap.

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PNEUMATIC TIDE-GENERATING MACHINE FOR EXPERIMENTING WITH MODEL TIDAL RIVERS

In a laboratory model of tidal river the tides are artificially generated usually by dipping a drum or 'plunger' in the downstream end reservoir of the model channel. The plunger is dipped or withdrawn with pre-determined speeds controlled by a suitably contoured cam which is figured according to the given tidal curve. For a large model the plunger becomes quite large and the machine unwieldy. In the Severn model designed by Prof. Gibson¹ the plunger has a size of 8½ ft. × 1½ ft. × 2½ ft.—In another method,² water in the downstream reservoir is fed and withdrawn through water valves and floats to give proper rise and fall of the level at the seaward end of the model.

In the present pneumatic tidal machine the downstream tank is partially covered and partitioned out into two compartments with a vertical wall having communication holes at the bottom (fig. 1). Water is first filled in the model up to the required level. Then by introducing air from a compressed air reservoir the level of water in the tidal tank (A) is depressed and water is forced out across the bottom holes (D) into the channel-end (B), giving the swell of a tide. By releasing the air through an exhaust the water in the tidal tank rises again and there is an ebbing in the channel.

It is important that the closed tidal chamber (A) should be air tight above the water level. If the structure is all masonry the internal walls and the cover should be well coated with cement, or better

still with a layer of varnish. For perfect assurance against air leakage, a thin gauged sheet metal tank may be incorporated inside the closed masonry tank, the masonry enclosure will protect the thin metal tank from its tendency of bulging under pressure.

This pneumatic method of generating artificial tide in a model tidal experiment eliminates any mechanically moving heavy part. Quite low pressure is necessary in the tidal tank, the level difference of water in the tank (A) and in the free channel side

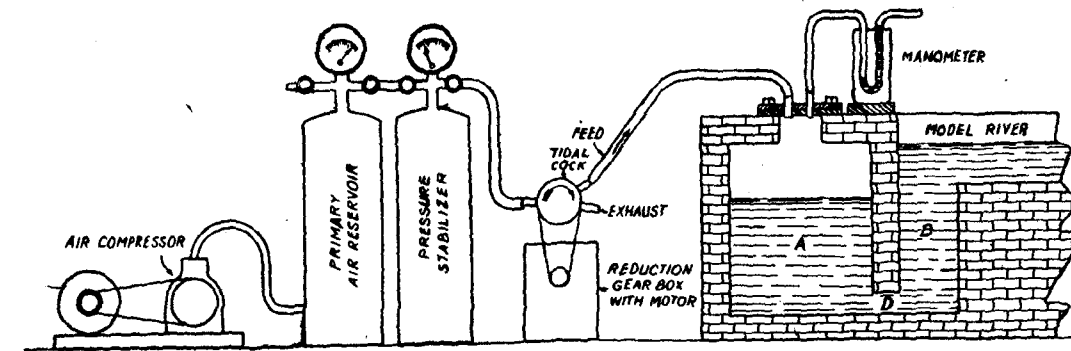


FIG. 1. General arrangements of the tide-generating device.

The intake and exhaust air lines are provided with suitably figured openings in the cock in order that a given tidal action is produced by the controlled rates of feed and exhaust. The cock consists of a cup (stator) and a cone (rotor) as usual. The present rotor is about 2 inch in diameter and 2 inch in height and is made of cast iron. The rotor cone is hollow and is cut with two openings or slots as shown in fig 2. The opening moves on slowly (according to the time-scale of the model experiment) against a slit in the stator cup of the cock. The slit then leads to the nozzle. The figure of the opening in the rotor is derived for a given tidal curve (the present figure represents that for a particular tide at Kultigong). The opening represents the

rate of rise $\frac{dh}{dt}$ of the gauge level h with time t and

the values are derived from the t, h curve of the given tide. The width of the slot at any instant is given

by $y = m \frac{dh}{dt}$, where m is any constant suitable for the

size of the rotor. This approximately represents the feeding (or exhausting) rate of air for the tidal tank, and the opening in the rotor is cut according to this rate. Some corrections, however, are necessary as the channels have not rectangular cross section and that the free surface of water in the channel goes on increasing as the water rises up. The variation, however, is small compared with the total mean surface of water in the tidal section. Some minor, cut-and-try retouching may be necessary on the figure of the opening. Auxiliary cocks and pressure controls are also helpful in obtaining accurate representation of a given tide.

(B) representing the pressure in the tidal tank, which amounts only to some fraction of a pound per sq. in. The volume of air required is, however, large, depending on the size of the model and tidal range. But considering the pressure and volume together, and the time of a complete tidal cycle, the power involved is quite small, so that the compressed air outfit is not large.

The time of tidal cycle is controlled by the rotation of the cock which is driven by a reduction gear and a small electric motor. The nature of the tide is controlled by the figure of the opening in the tidal cock. And the tidal range or amplitude is controlled by the feed pressure of the compressed air across the cock.

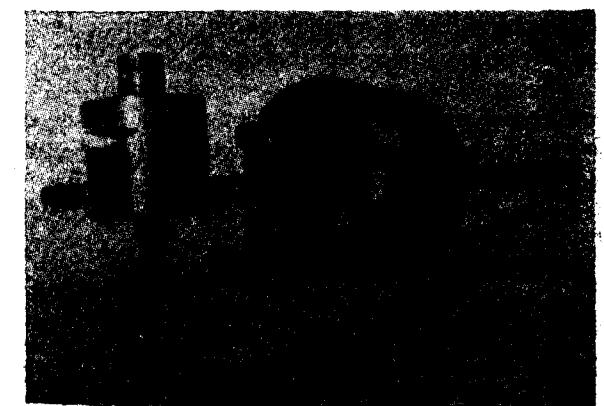


FIG. 2. The tidal cock, dismantled.

Work is in progress and details will be published elsewhere.

My thanks are due to Prof. M. N. Saha, F.R.S., and Dr N. K. Bose, Ph.D., Director of the River

Research Institute, Bengal, for taking keen interest in the work. I am also thankful to the Irrigation Department of Bengal for providing funds to carry out researches in River Physics in this Laboratory.

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¹ A. Gibson, Report of the Severn Model, Manchester University.

² Annual Report (p. 18, 1940-41) of the Central Irrigation and Hydrodynamic Research Station, Poona.

COEFFICIENT OF RADIATIVE RECOMBINATION OF $N_2^+(X')$ AND e

In a recent note by the author the value of the recombination co-efficient of $N_2^+(X')$ ions and electrons in the nitrogen after-glow was computed from the rate of decay of glow as observed by Rayleigh.¹ The value was found of the order of 10^{-14} cm³ per sec. According to Mitra's theory² of active nitrogen this is the co-efficient of recombination of the ion and the electron by the three-body collision process $N_2^+ + e + N_2 \rightarrow N_2(B\text{-state}) + N_2(A\text{-state})$ in course of which the characteristic spectrum of active nitrogen—the first positive bands—are emitted. It is obvious that the value of the co-efficient of radiative recombination $N_2^+(X') + e \rightarrow N_2 + h\nu$ must have to be much smaller than the value 10^{-14} cm³ per sec. as otherwise, the electrons and the ions will disappear rather by this process than by the three-body collision process. That the co-efficient of radiative recombination is small is seen from the following considerations:

The probability of radiative recombination of an electron and a positive ion is proportional to the probability of the opposite process namely ionisation by light absorption ($N_2 + h\nu \rightarrow N_2^+(X') + e$). In fact, according to Milne³ the two are related by the formula

$$Q_e = Q_a \frac{2(h\nu)^2}{m^2 v^2 c^2},$$

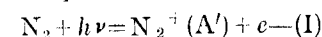
where

Q_a = cross section of light absorption,
 Q_e = cross section of light emission,
 m = mass of electron,
 v = velocity of electron,
 c = velocity of light,
 ν = frequency of emitted radiation.

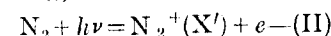
In order to find the cross-section of radiative recombination we require the cross section of light absorption for process $N_2 + h\nu \rightarrow N_2^+(X') + e$ and the

value of ν . Unfortunately, however, the value of Q_a for the above process has not been determined. Nevertheless we can make some idea about its probable magnitude from the following data.

Absorption experiments in the extreme ultra violet show that while light absorption leading to the ionisation process



is quite strong, that leading to the ionisation process



is extremely small. ($N_2^+(A')$ is the excited state of the normal ion $N_2^+(X')$). (See, for instance, energy level diagram of N_2 in Molekülspektren und Molekülstruktur, Herzberg, page 327). In fact, Hopfield⁴ who was the first to study the extreme ultra-violet absorption of N_2 did not observe the absorption in the region $\lambda 794$ which corresponds to reaction (II). In a more recent experiment by Price⁵ 'an absorption continuum was found near the region $\lambda 794$ but the bands going to it could not be identified with the type of bands one would expect to approach the ground state of N_2^+ '. Worley and Jenkins,⁶ however, in 1938, observed that there was a continuum corresponding to reaction (II) with a few tenths of a mm. of N_2 at N.T.P. Worley and Jenkins do not give any quantitative data regarding the value of the absorption co-efficient, but it appears to be very small. Compared to this Takamine⁷ obtained absorption continuum for the reaction (I) strongly with only a few hundredths of mm. of N_2 at N.T.P. From these results one is justified in assuming that the cross-section of light absorption for the ionisation process (II) is much less, more than one order at the least (say one hundredth) than that for process (I). Now an approximate value of the cross-section for reaction (I) has been obtained by Bhar by applying Kramer's formula; the value found is 1.9×10^{-18} cm². The cross-section of absorption for reaction (II) may therefore be taken as 1.9×10^{-20} cm². Assuming electron energy to be 5 e.v., $v = 4.2 \times 10^7$ cm/sec (which is by no means too high a value for electrons derived from powerful discharge) we obtain $Q_e = Q_a \times 0.96 \times 10^{-3}$

$\therefore Q_e [N_2^+(X') + e \rightarrow N_2 + h\nu] = 1.82 \times 10^{-23}$ cm²
And, since the co-efficient of recombination is related to the cross-section for electron-capture by the equation $\alpha = Q_e \times v$ we have for reaction (II), $\alpha = 7.6 \times 10^{-16}$ cm³/sec. This is about two order less than the co-efficient of recombination by the three-body collision as calculated from Rayleigh's experiment.

In view of the uncertainties in the values of the various quantities involved in the calculation, the value of α obtained is to be considered only as a rough approximation. But the fact that the probability of ionisation of N_2 to $N_2^+(X')$ by light absorption is extremely small, is an experimental

one, and it is on this that the result obtained above is mainly based.

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¹ Rayleigh, *Proc. Roy. Soc., A.*, 176, 1, 1940.

² Mitra, S. K., *SCIENCE & CULTURE*, 9, 49, 1943-44 and 10, 133, 1944 *Nature*, 154, Aug. 12, 1944.

³ Milne, E. A., *Phil. Mag.*, 47, 209, 1924.

⁴ Hopfield, J. J., *Phys. Rev.*, 36, 789A, 1930.

⁵ Price, W. C., *Phys. Rev.*, 48, 716, 1935.

⁶ Worley and Jenkins, *Phys. Rev.*, 54, 305, 1938.

⁷ Takamine, Suga and Tanaka, *Sc. Pap., I.P.C.R.*, 34, 854, 1938.

⁸ Bhar, J. N., *Ind. Jour. Phys.*, 12, Part V, 1938.

ON THE ORIGIN OF EXTRA REFLEXIONS IN THE LAUE PHOTOGRAPHS OF PHLOROGLUCINE DIHYDRATE CRYSTALS

BOSE¹ has recently observed that in the Laue photographs taken with X-rays parallel to the c -axis of crystals of phloroglucine dihydrate a few extra spots appear in positions agreeing with those expected for the two-dimensional grating. These spots have further been found to be produced by monochromatic radiations and not by the white radiation. Bose has not offered any explanation regarding the origin of these extra spots, but has called them secondary extra reflections on the assumption that they are similar to some extra reflections observed in the case of diamond and called secondary extra reflections by Jahn and Lonsdale.² He has further stated that since the extra spots due to phloroglucine dihydrate are produced only by those portions of the crystal which are free from internal strain, these facts contradict Lonsdale's theory that the secondary extra reflections from diamond are due to internal strain in the crystal. The object of the present note is to point out that there is a fundamental difference between the nature of the secondary extra-reflections from diamond and that of the extra reflections from phloroglucine dihydrate observed by Bose, and also to offer an explanation regarding the origin of these reflections observed by Bose.

It has been pointed out by Jahn and Lonsdale that the position of the centre of the triangular pattern constituting the secondary extra reflection from (111) planes of diamond shifts as the deviation from the Bragg angle is changed so that the Faxen formula is always approximately satisfied. On the other hand Bose has observed that the positions of the extra spots due to phloroglucine dihydrate do not change appreciably while the Laue spots move

over considerable distances. These facts clearly indicate that the angle $2\theta_m$ between the incident beam and the direction of extra reflection remains constant in the case of phloroglucine dihydrate even when the glancing angle is changed, but this angle changes in the case of diamond with the change of the glancing angle. Hence the assumption made by Bose that the extra reflections observed in the two cases are similar is not correct, and consequently, his inference that the facts observed by him are contradictory to the hypothesis put forward by Lonsdale to explain the origin of secondary extra reflections from diamond is also not correct.

As regards the origin of the extra spots observed by Bose it has to be pointed out that mosaicity of the crystal can produce such extra spots under certain circumstances. When the lines of intersection of planes in successive thin layers of the mosaic block are parallel the Bragg relation may be satisfied by the planes in a particular thin layer although the glancing angle for planes in the other layers is either smaller or larger than θ_B , the Bragg angle. This layer in that case will give rise to an intense Bragg reflection while the intensity of the Laue spots due to the other thin layers will be very small, because the intensity of the corresponding bands in the white radiation is very small in comparison with that of the characteristic radiation. A Laue spot will, however, be produced by the portion of the crystal which is free from mosaicity and the effective thickness of which is much larger than that of any thin layer of the mosaic block. As the spacings of the planes in the different layers of the mosaic block are identical the Bragg reflection will occur in the direction making an angle $2\theta_B$ with the incident beam for all settings of the crystal for which the Bragg relation is satisfied by the planes in anyone of the layers in the mosaic block.

In the case of diamond, internal strain in the crystal may alter slightly the spacings of the planes, and the extra reflections will occur in directions making different angles with the incident beam so that the Bragg relation for the altered spacings is satisfied in those particular directions. Thus imperfections of different types may give rise to extra reflections of different nature and those observed in the case of phloroglucine dihydrate are due to the mosaicity of the peripheral portions of the crystal.

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¹ Bose, C. R., *Proc. Nat. Inst. Sc.*, 10, 201, 1944.

² Jahn and Lonsdale, *Nature*, 147, 88, 1941.

METHODS FOR THE REMOVAL OF THE TOXIC AND INHIBITORY PRINCIPLE OF VARIOUS SOILS

APART from the case of the fertile soils by the side of the river beds and in the delta regions, there are some soils which exhibit total infertility. It has been established that the inability of a soil to promote the plant growth, cannot be entirely attributed to the absence of nitrogenous substances, nutrient salts and soil acidity but that only the micro-organisms are intimately connected with the infertility of the soil.

These micro-biological agents are further recognised to bring about the toxicity during the decomposition of organic Detritus. The methods employed to prevent such inhibitory principles of the soil on the part of the plant-growth are summarised as follows :

- (1) The soil, heated to 40-50 degrees and gradually cooled.
- (2) The soil heated with alcohol.
- (3) Heating with methylated spirit.
- (4) Heating with Acetone.

is studied and discussed here. Thus the common experience of the agriculturist is fully justified in tilling the land and leaving for sometime exposed to the sun before he waters and seeds it. This involves a photo-chemical effect brought in favour of the micro-organism by enabling itself to grow and multiply in a nitrogeneous atmosphere which essentially requires sunlight. In fertile soils the decomposition of the organic bio-humus is absent and the micro-organisms multiply in number by a spontaneous growth. But the fact that some soils cannot promote plant growth means that such a humus-decomposition is associated with the metabolic origin of the particular soil.

Black gram is found suitable for studying the removal of inhibitory principle in a variety of soils and the Table I given below shows the rate of growth dependent on the nature of the soil at the ordinary temperature.

Again the composition of the soil also plays an important role in promoting the plant growth. A preliminary set of analyses of these different soils gave the following results (Table II).

TABLE I

No.	Source and specificity of the soil	Weight taken	Period of exposure to sunlight	Time taken for the first appearance of germination
1.	Sea-side sandy soil	about 10 lbs.	48 hours	about a week
2.	Coarse rocky soil	"	48 "	" 15 days
3.	Lake clay soil	"	60 "	" 3 "
4.	Well clay soil	"	48 "	" 3 "
5.	Pit clay soil	"	48 "	" 2 "
6.	Canal clay soil	"	48 "	" 1½ "

TABLE II

No.	Source and specificity	Amount of mineral matter present as particles of various sizes	Amount of organic matter	Amount of soil made of inorg. salts	Soil atmosphere made up of different germs	Micro-organic population
1.	Sea-side soil	65%	10%	12%	12%	2%
2.	Coarse rocky soil	70%	6%	14%	10%	2%
3.	Lake clay soil	45%	20%	20%	14%	1%
4.	Well clay soil	40%	25%	20%	14%	1%
5.	Pit clay soil	45%	25%	25%	5%	1%
6.	Canal clay soil	30-35%	25%	25%	15%	1-2%

(5) Partial sterilization also can be applied but not so successfully.

(6) A series of papers published in the literature concerning soil chemistry established that solar radiation has got a tremendous effect in promoting the growth by removing the inhibitory principles. The solar radiation effect on the removal of soil toxicity

Further work is in progress.

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Guntur, 5-9-1944.

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No. 6

PLANNING AND POLICY

SINCE his assumption of office in September, Sir Ardeshir Dalal, Member for Development and Planning, had a number of occasions to speak on the question of industrial planning and development. Particular mention may be made of his speeches delivered in connection with his first press conference held early in October and on the occasion of the first meeting of the Policy Committee on Industries, a summary of which appears elsewhere in this issue. More than ordinary interest attaches to the statements and views he has given expression to, which may be safely accepted as a fair and authoritative indication of the Government attitude and policy, if any, with regard to the pressing problem of post-war industrialization of India.

Meanwhile, Sir M. Visvesvaraya has also come forward with his own five-year plan and suggestions for reconstruction which form the subject of a little pamphlet "Reconstruction in Post-War India" issued by the All-India Manufacturers' Organization. Although unofficial in nature, the views and suggestions contained in the pamphlet come from one who has been intimately associated with all the industrial movements of this country for the last quarter of a century and who may be rightly said to have first imported from the West the very idea of planned economy for India as the only solution of her abject poverty and ridiculously low standard of living.

The considered views of the two great industrialists, one speaking under the limitations of his official position and other representing the unofficial point of view, provide new material for discussion, and we offer no apology for reverting to the old but renewed question of planned industrial development of India.

PROGRESS IN GOVERNMENT PLANNING

At his first press conference, the Member for Planning and Development revealed that the Govern-

ment of India had already made considerable headway in certain branches of planning, such as the development of roads, railways, education, agriculture, etc., and that schemes have been prepared and sanctioned. The Sargent Scheme for educational reconstruction, for instance, has been generally accepted as providing the outline of India's future educational development along sound lines. The Government have contemplated a large expenditure of Rs. 400 crores on road development and have projected expansion in railways at a capital expenditure of Rs. 300 crores. Dr Burns' report on the technological possibilities of agricultural development, although not comprehensive, represents, however, an honest effort to assess the agricultural problems of India from a technical point of view and to suggest the most obvious remedies. The Imperial Council of Agricultural Research, we are further told, is also seriously considering the whole subject of agriculture and animal husbandry, and the Government have in the meantime appointed a number of sub-committees to examine, and report on, such questions as the stabilization of price, agricultural indebtedness, land utilization, fish and milk. The Government have also expressed their desire to set up a Central Technical Power Board and a Central Irrigation Board.

These are sufficient indications, as Sir Ardeshir would have us believe, of the Government's earnestness to go ahead with their planning programme. But after the Government have assumed complete responsibility for undertaking planning for this country, it is not enough to be told that Government are taking this planning business earnestly. The points to be made clear are how far the work of the Government proceeds along proper and sound lines, whether the principal issues and the fundamental problems of reconstruction are being given due prominence, whether the lines of development the Government propose to pursue are best calculated

to promote national interest and lastly, whether the plans in individual subjects, drawn up separately, form parts of a co-ordinated planning for all-round economic and social uplift. The object of planning for reconstruction, as we understand it and as it is accepted in other countries which have profited by planned development, is to raise a country's economic efficiency to such a level as guarantees a reasonable standard of living for all, opportunities and employment for all, and some measure of social security to safeguard the subsistence needs of all. It is most important to enquire whether the Government, while proposing a planned development of India, have accepted the above criterion as the cardinal object of planning or have they attached a different meaning to the term. In that case, have they defined that object and explained in clear and unambiguous terms their policy which should guide and determine the entire planning activity? It is on these criteria that Sir Ardeshir's speeches or those of any other spokesman in authority should be judged.

Most of the schemes and proposals referred to above and drawn up so far are unco-ordinated individual schemes and represent mainly unproductive lines of development. The wisdom of showing primary interest in such schemes as the development of roads and railways, some of which are likely to lead to heavy unproductive debts, and sanctioning huge sums of money for their execution may well be called in question. In fact, Sir Visvesvaraya has sharply criticized such practices of sanctioning individual schemes and has raised fundamental objection to such procedure. Nothing is more erroneous than proceeding with schemes framed in isolation before the entire range of development has been envisaged and carefully planned. Moreover, these lines of development though important do not represent the country's prime necessities today whose fulfilment should bring prosperity to the people. And yet the Government have of late been loudly advertising these plans and taking active interest in their execution.

On the other hand, the urgent question of the development of industries, particularly the heavy and basic industries, has received little or no attention and has been ignored. The Government have curiously enough maintained a studied silence and have evaded the issue on constitutional grounds. They have justified their inaction on the plea that industries are Provincial subjects and that the Centre is not expected to meddle in questions relating to them. And this, despite the knowledge that vigorous drive for industrialization is not possible except under a strong and planned central lead. In fact, planned effort means such a central lead. We have ample confirmation of this truth in the fact that the Central Government of India on innumerable occasions, under

the present emergency of war, have acted in their supreme capacity in complete disregard of such Central and Provincial delimitations with great advantage. Industrial development of this country with which the economic well-being of the people is inseparably connected is an emergency of no mean order.* The fact is inescapable that while Governments of other countries have promptly acted to meet similar emergencies arising in their respective countries, the Government of India have not only preferred to remain inactive, but have attempted to shirk responsibility on such artificial pleas. The creation of the Department of Planning and Development and the appointment of one of the signatories of the Bombay Plan as its Member were interpreted in several quarters as signalling a change of Government attitude with regard to their industrial policy. The public naturally expected some clarification of this policy, especially as it applies to the question of setting up of heavy industries. This expectation has hardly been fulfilled.

PLANS FOR THE TRAINING OF TECHNICAL PERSONNEL AND INDUSTRIAL PANELS

The Planning Member has, however, informed us that the Government have proposed to send a large number of men for training in the near future to the United Kingdom and the United States of America. This is undoubtedly a step in the right direction. We share his views when he says that 'the most essential preliminary step was the training of our future scientists, engineers, geologists, doctors, agriculturists, educationists, administrators, etc., in the innumerable different jobs for which they would be required'. Likewise the suggestions for the establishment of a very high grade technological institute on the lines of the Massachusetts Institute of Technology in the U. S. A. and of an All-India Medical Centre will be approved. Sir Visvesvaraya has also pleaded in his booklet for the establishment of an Institute of Higher Technology on the model of the M.I.T. Further, Mr John Sargent, the Educational Advisor

* Sir Visvesvaraya estimates that the average income from industries in normal years is Rs. 15 per head of population in India. In the United Kingdom and the U. S. A., the corresponding figures are Rs. 800 and Rs. 1,000 respectively. Whereas 7.1 per cent. of the population in England and Wales and 22 per cent. in the U. S. A. are engaged in agriculture, India has about 67.2 per cent. of her population dependent on agriculture. In no civilized country has the proportion of agricultural population exceeded 33 per cent. Even in the face of such facts, the ex-Viceroy had no scruples to say that 'India is, and for a long time yet, likely to be, mainly an agricultural country'. For, otherwise how can the chronic poverty of this country, so essential for the prosperity of the country of his birth, be perpetuated?

to the Government, recently visited the U. K. and the U. S. A. to investigate to what extent facilities for the technical training of Indians would be available in those countries. Necessary as these steps are, we are at a loss to understand how one can plan for the training of technical personnel before plans for the development of basic and manufacturing industries requiring such personnel are ready. This is putting the cart before the horse.

So far as the whole question of the development of industries is concerned, the Hon'ble Member has given us nothing more than the bare statement that the Government have further proposed the creation of a number of panels for industries, each composed of a permanent officer of the Planning Department and one or more experts according to requirements, and entrusted with the task of investigating the problems of the development of individual industries or groups of industries. These panels, it is understood, would act in close liaison with the Supply and Industries and Civil Supplies Departments. The final plans will be worked out after due consideration of the findings and recommendations of these panels and the various development committees which the Provinces have been requested to set up in their individual capacities.

We are, however, not in a position at present to judge the merit of the proposed procedure, as detailed information regarding the nature and constitution of such industrial panels is lacking. Perhaps it may be desirable to introduce the panel system; but much depends on the selection of industries and the nature of the Government's industrial policy in the post-war period. In fact, regarding the creation of panels for some heavy industries, such as shipbuilding, air-craft, manufacture of large electrical machinery, plastics, dye-stuffs, etc., Sir Ardeshir's remarks have already proved far from encouraging. The individual industrial concerns, we are told, will be left to themselves to make their own arrangements with regard to such industries. Panels for such industries, even if created, will do no more than suggest in a very general way the feasibility and location of such industries. So even if the development of industries receives any encouragement, the Government are more likely to concentrate on light and less important industries and ignore the claims of heavy and basic ones for which excuses on either technical or economic grounds will not be difficult to advance. That is why industrialists and political leaders of the country have repeatedly pressed the Government for a clear statement of their post-war industrial policy, but without success.

INDUSTRIAL EXPANSION DISCOURAGED

Sir Ardeshir, however, entertains optimistic views regarding the attitude of His Majesty's Government to the question of industrial develop-

ment of India and appears to be confident of their appreciation of India's needs and aspirations. "It is a matter of gratification to observe" says he, "that so far as His Majesty's Government are concerned, there is a clear appreciation of our needs and aspirations." In support of his views he quotes a few lines from Mr Amery's speeches delivered before the Institute of Export and the East India Association. At a meeting of the latter, Mr Amery is reported to have said,

"I can say that the Government of this country (Britain) only wants to see Indian industry developing to the fullest. The last thing the industrialists of this country have in mind is the idea that the British exports industry can best prosper by India being held back in the course of her industrial development."

Sir Ardeshir is to be congratulated on his effort to discover in these words the germ of positive assurances. But we are hardly prepared to accept them as such, knowing full well that they come from the mouth of a die-hard imperialist of the stamp of Mr Leopold Amery.

The Government's attitude in the past was one of uninterrupted obstruction and discouragement. Even during the present war when development of heavy industries was considered essential in the interest of the United Nations by several experts and strategists, His Majesty's Government stubbornly resisted any such development lest it should jeopardize British commercial and trade interests in India when victory comes. Conferences were held and missions were invited at the expense of Indian taxpayers to discuss the question of India's industrial development in so far as it contributes to the war effort, but the decisions were taken secretly and the reports of their deliberations were not published. Sir Visvesvaraya cites, in his booklet, a number of instances of similar missions and conferences which have already elicited bitter criticism in the Indian press. The report of the Roger Mission, as he writes, remains a sealed book to the Indian public to this day. The Mission consisted of a large number of industrialists from England and the Dominions, but none from India. Even the trusted representatives of the Indian people were not taken into confidence when the Mission's proposals were formulated. The report of the Grady Mission was also suppressed. Similarly, while well-known manufacturers from other countries were freely allowed to take part in the Eastern Group Conference, India was represented by a few seasoned Government officials and not by the trusted representatives of Indian manufacturers. In fact, the Government were at pains to explain away the visit of Mr Guy Locock, the representative of the British Board of Trade, to the Eastern Group Supply Conference session held in India in October, 1940. The real purpose which inspired the British Board of Trade to send their re-

presentative to the Conference is briefly referred to in a report of the *Railway Gazette* of London, from which Sir Visvesvaraya quotes the following extract,

"As the Board of Trade representative on the Mission, he (Mr Locock) was entrusted with the task of appraising future efforts on British industry of the war production expansion now being undertaken, always keeping in mind the necessity for giving priority to vital war needs. . . . At the same time Mr Locock holds the view that no steps have been taken to expand production as a result of the Mission's visit which are not essential for war purposes and that on the whole post-war interests in India of British industry are not likely to suffer so greatly as was at one time expected."

These are sufficient instances—and many more can be cited—to indicate clearly the negative attitude of the Government towards industrial expansion of the country. Meanwhile, nothing of importance has happened to foreshadow a substantial change in the Government's industrial policy and to make us interpret Mr Amery's verbal statement as definite assurances on which to work.

Only the other day, a correspondent of the *Hindu* (November 4, 1944), writing from London, drew attention to the possibility of an intensive competition between British and American manufacturers for post-war markets. Preparations for a huge American export trade in the post-war period have already caused grave anxiety in Britain, and recently *The Manchester Guardian* devoted a full editorial article protesting against such uneasy trends in American commercial policy. Complaints that Britain is lagging behind U.S.A. in export plans are now frequently lodged, and from several quarters the demand has been made that the Government should explain at least the broad features of their future commercial policy. An American commentator, on the other hand, would have us believe that 'more than 1,000 British salesmen with passports and special privileges are now roaming through all the friendly nations, offering goods of British manufacture for post-war delivery.' With regard to the menace that American business men who produce better and cheaper articles are least expected to refrain from producing and selling them, *The Manchester Guardian* writes:—

" . . . The United States Commodity Credit Corporation has just announced plans for the resumption of cotton and wheat export subsidies designed to put American surpluses on the world market at artificial prices. Similar 'equalization' or dumping schemes for textile exports are authoritatively reported to be under consideration in Washington. Other facts mentioned in this connection are firstly Admiral Land's statement that the American Merchant Marine would have to be maintained 'by parity payments' to equalize operating costs with those of competing foreign ships; secondly, Mr Harry Hopkins' demand that American loans should be only spendable in the United States; thirdly, 'the propaganda campaign of American exporters in the Indian Press introduced by a series of full-page advertisements signed 'Issued by the Government of the United States.'"

" . . . But how shall we stand, if we ourselves refrain from adopting subsidies, quotas and 'discrimination' of all

kinds, only to find that American exporters are able to override commercial competition by Government aid?"

These developments and the knowledge of huge preparation in Britain and the U.S.A. for export trade in the post-war period, which have caused grave anxiety among Indian manufacturers, do not appear to perturb the Indian Government. It was high time that the Government came forward with an exposition in broad outlines of their policy regarding industrial controls, and the question of protection and tariff. The Government have not thought fit to indicate to the public how industrial controls will operate in future and to what extent they are going to modify their present ill-conceived tariff and protection policy. Sir Ardeshir has stated that it has not yet been possible for Government to arrive at final decisions on the question of protection and tariffs, but that the Government are contemplating a liberalization of the existing protection policy and the elimination of some of the conditions attaching to the grant of protection to industries, as if by way of favour to Indian manufacturers. Further, there is no possibility that the existing controls imposed under the Defence of India Rules and detrimental, by their nature, to the growth of industries will cease to operate in the near future. We agree with the Planning Member that planning by its very nature implies control and regulations and that controls should remain throughout the period of planned development. But these must subserve a national policy. The people of Britain, the United States and the Dominions have submitted to controls first, because these subserve a national policy and secondly, because they have been taken into confidence with regard to their Government's control policy. The Government of this country have not done likewise. It is no wonder, therefore, that the response from leaders of Indian industry was meagre when Sir Ardeshir called upon them to book orders for capital goods in U. K. for which he was prepared to secure facilities.

NEED FOR AN ECONOMIC ORGANIZATION

It is clear from the fore-going discussions that if the Government are really keen on giving a lead which the people can confidently follow, the supreme need of the present time is an announcement from the Government of their policy behind all these plans, particularly of their industrial policy. It is true that the Government have appointed committees, consultants, experts, fact-finders, policy-advisers and others; but in the absence of a unified national policy, their efforts are destined to be 'a case of machinery without functions and of expenditure without result'.

In an all-round planned development for India, planning for economic reconstruction needs must stand out prominently. In economic reconstruction

again industries should occupy the foremost position, and nothing short of a separate Department of Industries can effectively deal with the problem of industrial development of India. In his booklet, Sir Visvesvaraya has pleaded for the creation of an economic organization which should comprise the following:—

(1) A separate Central Department of Industries with a full-time Member of Government in charge;

(2) An Economic Council to secure protection against foreign imports and dumping by adequate tariff regulation and other measures, to represent and protect the economic interests and wants of the people in the counsels of Government and to explore and recommend schemes of economic development generally;

(3) A grant of Rs. 8 crores per annum to be given, for five years to begin with, to carry out all forms of preliminary investigation necessary to stimulate economic advance, to grant subsidies and subventions to small industrialists, mechanics and shopkeepers, and generally to train them and encourage disciplined business life on modern lines in every district or geographical unit area;

(4) Provision of necessary staff and facilities for collecting statistics and other useful information and for pursuing an industrial and production drive in collaboration with the local business and labour population in each area.

The immediate functions of the organizations will be:—

(1) To work out a Five-year Plan for industries and to invest not less than Rs. 1,000 crores in the first five years;

(2) To take immediate steps to help businessmen to establish dozen retarded heavy industries, of which following is the list: automobile, aeroplane, Diesel engine, railway locomotives and power machinery generally, machine tools and machinery, iron and steel, heavy electrical industries, ship-building, special defense machinery (armaments and industrial plant), heavy chemicals such as sulphuric acid, chlorine, caustic soda, soda ash, nitric acid, etc., dyestuffs, rayon and plastics.

(3) To double the production from agriculture and industries in about 7 to 10 years.

(4) To expand the measures already being taken to industrialize rural areas with the help of leading citizens in every district.

(5) To establish an Institute of Higher Technology in some Central Capital City on the model of M. I. T.

ARTIFICIAL RADIOACTIVE BODIES IN PHYSIOLOGY AND MEDICINE

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(Continued from the last issue)

EXPERIMENTS WITH RADIOACTIVE PHOSPHORUS

By far the greatest amount of tracer work has been done with radioactive phosphorus (P^{32}). P^{32} has a very convenient half-life of 14.3 days, occurs very commonly in animal tissues and emits β -rays upto a maximum energy of 1.7 million electron volts. These electrons may be easily detected either with an electroscope or a Geiger Müller counter. P^{32}

Sir Visvesvaraya is strongly of opinion that economic planning for India will hardly be possible without such an organization comprising an Economic Council and a Department of Industries. The creation of the Department of Planning and Development, as can be easily seen, is no substitute for these bodies. Under the present dispensation industrial planning has been rendered difficult by the fact that 'Industries' still continues to be a portfolio of the Department of Industries and Civil Supplies and that the responsibility of developing industries is shared by the Provinces not always prepared to work in conjunctions, thanks to the Provincial Autonomy.

Sir Visvesvaraya's suggestion for the provision of necessary staff and facilities for collecting statistics is an invaluable one. The Government were always unwilling to maintain industrial statistics and discouraged initiation of steps to prepare one for obvious reasons. No planning is possible in the absence of reliable statistics. In fact, the Planning Member has now to depend on the voluntary supply of statistical information by the existing industries. The establishment of a central organization charged with the responsibility of collecting and maintaining up-to-date statistics in every field of human activity is, therefore, a *sine qua non*.

But the main question is: Can India have any workable national planning without a National Government? According to Sir Visvesvaraya, any such idea is as illusory, as it is absurd. So long as India is ruled as a Dependency by a Government responsible not to the people of this country, but to foreign vested interests, no effective and unified national planning is possible, far less its execution. A National Government formed out of the trusted representatives of the 400 million people, and nothing short of that, can alone undertake to plan for India's belated reconstruction.

may be prepared by bombarding ordinary red phosphorus with deuterons. The phosphorus is then converted into a neutral solution of di-sodium phosphate which may be given to the experimental animal either by mouth or by injection. The animals (chicks, rats, mice, etc.) to whom radiophosphorus is given are killed at fixed intervals after the application and all organs and samples of other tissues are removed and

ashed. From a measurement of the radioactivity of the ash, bones, excreta etc., one can follow accurately the absorption, utilisation and excretion of phosphorus by the animal system.

These experiments show that the phosphorus in bones, muscles and fat is continually being added and replaced so that the equilibrium is dynamic and not static. Such dynamic exchange of phosphorus also takes place in the brain. Within an hour of application of labelled phosphorus lecithin containing P^{32} can be isolated from the brain of rats.

The greatest amount of radio-phosphorus is deposited in bones and muscles. When the activities per gm. weight of tissues are compared, bone has the highest activity and blood the least. Spleen, skeletal muscle, fat and liver come next to bone. Comparison of the activities on the 4th and the 6th day of application of labelled phosphorus, indicates that radio-phosphorus shifts mainly from muscles and intestine to bone and bone marrow.

The seat of the greatest production of phospholipides and nucleoproteins is the liver. The liver of normal mice is characterised by a high activity which reaches a maximum within a few hours of application of labelled P. At the height of its maximum activity 3% of administered P is present as phospholipid per gm. weight of liver. The activity of liver decreases rapidly after reaching the maximum, being only 1% at the end of two days.

A comparison of the specific activity of phospholipid phosphorus of plasma with that of the other organs shows that liver is the principal site for phosphorylation of plasma phospholipid. Normally appreciable amounts of radio-phospholipid appear in the plasma within 3 hours of a single injection of P^{32} . But if P^{32} is administered immediately after the removal of liver, no P^{32} appears in blood even 6 hours after application. In normal rats the activity of the plasma reaches a sharp maximum within 36 hours of application of P^{32} , when 0.5-1.0 per cent. of the administered dose may be recovered from plasma phospholipids. Compared with the plasma, the corpuscles take up phosphorus very slowly. The highest activity of the cells (50% of that of the plasma) appears only after 8 days in the case of man.

Compared to liver, kidney and intestines inactive tissues like muscles and brain show very slow but regular uptake of radioactive phosphorus. In the case of brain a progressive increase in the amount of radio-phospholipid can be followed even 9 days after the application of P^{32} . Once P has been deposited in these tissues, its loss is also very slow, 70% of the maximum activity is retained by the brain even after a month.

Egg laying increases the rate of turnover of phosphorus by blood, ovary and oviduct. Hevesy showed that most of the yolk phosphatide is derived

from plasma but formed in liver. The same also applies to milk phosphatides.

Phosphorus metabolism in mice with different tumor transplants has been studied with great care. Four kinds of mouse tumors *viz.*, mamary carcinoma, lymphoma, lymphosarcoma and sarcoma 180, have been investigated. Phosphorus intake per gm. weight of tissues of mouse as a whole, is found to be the same for normal and lymphomatous animals. The activity per gm. of tumor tissues is found to be higher, the excess deposition of radio-phosphorus in the tumor being at the expense of that in bone and liver. The phospholipid turnover in the tumor tissues shows a great resemblance to that of live tissues like liver or kidney. In all such cases the amount of labelled phosphorus deposit rises quickly to a maximum within a few hours of application and then the activity diminishes rapidly. Per gm. weight, the activity of the liver is several times greater than that of any of these tumor tissues examined.

Blood counts of the chicken fed on diet containing P^{32} show a decrease in polymorphonuclear leucocytes without affecting lymphocytes. Since bone marrow produces the polymorphonuclears, a decrease in their number may be explained to be due to the action of selective irradiation from radioactive phosphorus deposited on the bones.

Selective accumulation of radio-phosphorus in nuclei of rapidly growing cells has encouraged its use in leukemia and allied diseases. Radio-phosphorus is applied by weekly intravenous injection and a radioactive level of the whole system is maintained at about 5 millicuries. Most encouraging results have been obtained with polycythemia vera and multiple myeloma. In leukemia, Hodgkin's disease and lymphosarcoma the response seems to be similar to that of X-rays. Experimenting with radioactive phosphorus and leukemic mice Lawrence and Scott have come to the conclusion that in the case of leukemic mice bones do not retain as much phosphorus as in normal ones. In other words, there is something wrong in phosphorus metabolism in leukemia.

Another interesting application of radiophosphorus has been in the study of insect metabolism. Selective accumulation of radioactive substances in different organs of the insect can be studied very conveniently with the auto-radiograph technique.

RADIOACTIVE CALCIUM AND STRONTIUM

Radioactive calcium (Ca^{45} , half-life 180 days) has been prepared by bombarding calcium with the deuteron beam from the cyclotron. The active portion is scraped off from the target, freed from contaminations of radioactive scandium and then finally obtained as carbonate after repeated precipitations as oxalate. Radioactive calcium, however, can only be

obtained in small amounts and emits very feeble beta rays. Pecher has shown that it is much more convenient to use radioactive strontium in the place of radioactive calcium in tracer experiments, as the chemical similarity of the two elements also corresponds with a similarity in their physiological metabolism. Radioactive strontium (Sr^{89}) has a convenient half-life of 55 days, can be prepared in relatively large amounts and emits beta rays of maximum energy 1.5 million electron volts.

Radioactive calcium and strontium lactate are injected intravenously to mice. At different periods after injection, the animals are killed and radioactivity of bones, soft tissues, uterus etc., measured. It is found that the uptake is 3 times as great when calcium is applied intravenously as that after oral administration. No significant differences appear when strontium is given either in chloride, lactate or gluconate form. 58% of the calcium and 33% of strontium are recovered from the bones 24 hours after intravenous injection. Activity of the soft tissues is found to be negligible. The uptake of calcium is greater than that of strontium, but the distribution of activity amongst different organs is almost identical. The following table due to Pecher indicates the percentage uptake of radioactive calcium, strontium and phosphorus by different organs, 24 hours after intravenous injection of radio-calcium lactate, radio-strontium lactate or sodium radio-phosphate.

TABLE II

Radio-element	Percentage of Dose per Gram Wet Weight					
	Bone	Muscle	Skin Hair	Dig. tract	Liver	Other viscera
Ca^{45}	22	.33	.20	.36	.12	.23
Sr^{89}	12	.17	.15	.23	.07	.13
P^{32}	5.2	1.4	.75	1.3	3.0	2.1

Autoradiograph technique has been largely used to study gross distribution of radioactive substances in plant and animal tissues. After the radioactive substances have been applied and absorbed by the tissues, a thin section is cut and placed on the photographic film. The beta-radiation from the radioactive substances affects the photographic plate, the intensity of which is proportional to the amount of radioactive substances concentrated there. The following photographs due to Hamilton, show the difference in distribution of absorbed radio-phosphorus and radio-strontium in rat tissues. It will be seen that while radio-strontium is mostly concentrated in bones, radio-phosphorus is also taken up by the soft tissues.

It has been observed that the activity of the bones increases during the healing of a fractured

bone. The activity of radioactive calcium in the healing tibia of a rat is found to be 1.7% compared with 0.4% in the other.



FIG. 7. Autoradiograph of rat tissues after absorption of radioactive phosphorus and radioactive strontium, showing characteristic differences in the mode of distribution of the two radio-elements.*

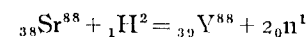
A large fraction of the calcium previously fixed on the bones of the mother, migrates to the foetus during the last days of pregnancy and also to milk during the lactation period. The specific activity of the bones of a new born mice is found to be about twice as great as the activity of the bones of the mother. If radio-strontium is given during the lactation period, a large part of the dose may be recovered from the offspring after two days. Pecher found that almost eight to ten per cent of the injected radio-strontium could be recovered from the milk of cows during the four days following the injection.

The selective fixation of radio-calcium and radio-strontium on growing bones including bone tumors, suggests important therapeutic applications. It remains to be seen whether these substances prove to be of importance in the treatment of osteogenic sarcoma, giant cell tumors, and metastatic bone tumors.

An interesting by-product in the preparation of radio-strontium is radio-yttrium (Y^{88} , half-life 87 days). This is produced in very large intensities

*Photographs by the courtesy of the Journal of Applied Physics.

when stable strontium (Sr^{88} , 82%) is bombarded with deuterons according to the following reaction



13 mgms radium-equivalent of yttrium are prepared per milliamper-hour of the deuteron beam. Radio-yttrium emits a large amount of gamma radiation (maximum energy 2 million electron volts), and may be used in the place of radium as gamma ray source and has also possibilities in radiography.

RADIO-IODINE

Radio-iodine (I^{131} , half-life 8 days) has been used by Hamilton and Soley for studying iodine metabolism in normal subjects as well as in persons suffering from various thyroid disorders. The radio-iodine is prepared by bombarding 1-2 gms. of metallic tellurium with the deuteron beam. The bombarded tellurium is then dissolved in nitric acid and radio-iodine separated by distillation. The iodine may be administered orally as NaI dissolved in water.

The activity of the samples used in such experiments usually varies from 12-50 microcuries. The rate of accumulation of iodine by the thyroid is measured with the help of a Geiger Müller counter placed close against the gland. The accumulated radio-iodine emits gamma rays which are easily detected by the counter. This method has the great advantage over all the chemical methods in that the thyroid need not be removed, the measurements may be carried out *in situ* and the rate of accumulation of iodine followed from day to day. The radioactive method requires fewer subjects, is less time-consuming and can be applied to human patients. The excretion of iodine through urine and faeces can be investigated in the usual way by measuring the activity of these.

These experiments reveal that iodine accumulated by normal thyroid, reaches the maximum equilibrium value within two days of its application. This equilibrium value (4-5% of administered I) is maintained for several weeks afterwards. Non-toxic goitres with normal metabolic rates, show iodine uptake of the same nature but with a higher equilibrium value of 10-12%. In the case of thyrotoxicosis, the rate of iodine accumulation may be very high reaching a peak value of 12-30% of the administered iodine within 4 hours of the application. But the thyroid in such cases is unable to retain the accumulated iodine; the amount of radio-iodine drops to 1/2 to 1/5 of the maximum value within 24 hours. In the case of hypothyroid children without goitre, the uptake of iodine by the thyroid is found to be vanishingly small (0.5 per cent). In some of the cases investigated, the subjects subsequently underwent thyroidectomy and the amount of accumulated iodine

was estimated by direct measurements. The two measurements agreed within 10%.

The experiments indicate that while radioactive iodine may be of value in the treatment of thyrotoxicosis, it is not likely to be of use in the malignant diseases of the thyroid, as cancerous thyroids do not seem to possess the ability to accumulate iodine to a great extent.

A point of great interest in this connection is the discovery of the missing element 85 which is a homologue of iodine and is named eka-iodine. It is found to be radioactive with half-life of 7.5 hours and emit α -rays. The element 85 is selectively absorbed by the thyroid in the same way as it absorbs iodine but to a much lesser extent. However, although the physiological properties of element 85 and iodine are similar, the former emits α -rays of average energy of 4 million electron volts while radio-iodine emits β -rays and γ -rays. The ionizing action of α -rays is confined to regions very close to the source and that of γ and β -rays is spread over comparatively larger volumes. The element eka-iodine is therefore likely to be of great value in diseases of the thyroid.

RADIOACTIVE SODIUM, POTASSIUM, CHLORINE, BROMINE

Radioactive sodium (Na^{24} , half-life 14.8 hours) may be obtained very conveniently by bombarding common salt with deuterons. Both radio-sodium and radio-chlorine are produced, but the radioactivity of chlorine dies out so rapidly (half-life 33 min.) that after about 24 hours we are left with labelled sodium chloride, of which only the sodium atom is radioactive. The radioactive salt may then be injected or applied orally either in an aqueous solution or in a capsule.

In one experiment a person held a Geiger counter by the hand which was protected by Pb on all sides, so that radiations from the radioactive salt present in the body could not affect the Geiger counter. The person drank a solution of the radioactive salt in water. Na^*Cl , K^*Cl , LiCl^* , KBr^* , and NaI^* were used in similar experiments. In every case the counter began to respond within 5 minutes after the solution was drunk, showing that marked atoms are absorbed in the blood stream and reach the fingers within such a short time. The activity of the fingers increases steadily and reaches the maximum equilibrium value within 3 hours. There is not much difference in the rates of absorption of radioactive sodium, chlorine, bromine or iodine, only potassium is found to be absorbed rather slowly.

If radioactive sodium is applied by injection, sodium is found to reach a constant level in blood within 15 to 20 minutes of its application. Subsequent fate of sodium within the human system can

be investigated by measuring the activity of samples of blood, urine, spinal fluids, sweat, etc. with the help of a Geiger counter. A very small quantity of the radioactive sample (about 1/2 millicurie) is sufficient for such experiments. Very little sodium is found to enter the blood corpuscles although there is plenty in the spinal fluid and blood plasma.

Radioactive sodium and potassium ions have been greatly used in experiments on cell permeability. After intravenous injection of Na^{24} and K^{42} to rats it is found that the radioactive isotopes disappear quickly from the plasma. Subsequent analysis of the tissues enables one to determine the relative permeability of the various tissues. Liver, gastrointestinal tract, kidney and heart show a rapid rise and subsequent fall in activity with peaks delayed by different amounts. Skin, muscles, tests, brain etc. show on the other hand a very slow rate of uptake compared to the former tissues.

RADIOACTIVE IRON

Radioactive iron (Fe^{59} , half-life 47 days) may be produced by bombarding normal iron (Fe^{58}) with the deuteron beam. Radio-iron decays with a half life of 47 days emitting β and γ -rays as shown in table I.

Radio-iron has been extensively used to investigate the rate of synthesis of hemoglobin in normal animals as well as in those animals which have been made anemic by repeated bleeding and feeding on a low-iron diet. Iron may be introduced orally in the form of ferric salts. Blood samples are collected at various intervals after the application of radioactive iron and hemoglobin separated. A measurement of its radioactivity indicates the proportion of iron that has been synthesized into hemoglobin during the time of the experiment. The experimental animals may also be sacrificed at various intervals after the application of radio-iron and the activities of the tissues measured with a Geiger counter.

It is found that the site of the greatest absorption of iron is the small intestine and that the rate of absorption is fast in anemia and slow under normal condition when the reserve of iron is ample. When the body tissues have been previously depleted of the iron reserve, by continuing anemia for three or four weeks, the uptake of radio-iron may be as great as fifty times as in normal animals. Plasma is the means of transport of radioactive iron. It is found that the absorbed radio-iron is first present in the plasma and then fixed in the hemoglobin of the red cells. Radioactive iron may appear in the red cells within an hour of feeding iron contained diet; the peak of absorption in anemic dogs occurs within 4-8 hours after feeding and the absorption is practically complete within 18 hours. The muscle tissues appear to be the storage depot for iron, 25 per cent. of the administered iron being accumulated in

the muscle tissues of anemic dogs and 14 per cent. in the blood. The rates of elimination of iron in normal and anemic dogs are however not much different, this seems to indicate that the iron level is controlled not by its elimination as was previously believed but by its absorption.

The amount of iron secreted in the milk of cows fed on an iron-containing diet may also be measured by the same technique. It is found that a cow giving four litres of milk per day secretes on the average about 0.5% of the administered oral dose of 10 gms. of iron. This corresponds to about 12.5 mgms. of iron per litre of milk which is quite sufficient for a growing child consuming a litre of milk per day.

RADIOACTIVE SULPHUR AND ARSENIC

Radioactive Sulphur (S^{35} , half-life 87 days) emits beta rays of very low energies (maximum energy about 1/6 million electron volts). Special types of beta-ray counters are needed for their detection.

Most proteins contain one or more amino acids containing sulphur. Radio-sulphur has been used in the study of protein metabolism. After feeding methionine containing radioactive sulphur to hens, sulphur³⁵ is detected in the egg white on the second day, its concentration reaches the maximum value on the fourth day. Similarly after administration of methionine containing radio-sulphur to rats, it is possible to isolate cystine containing the radioactive isotope from the hair and tissues of experimental animals.

Vitamin B₁, synthesised from radio-sulphur has been injected intramuscularly to human subjects and its storage, excretion and utilisation studied. Presence of radioactive sulphur in inorganic form in the urine, indicates that the injected thiamin is rapidly destroyed in the human system (10% of the injected amount destroyed every 24 hours). When a person is on normal diet 61% of the injected thiamin can be recovered from the urine, 11% from the feces during a period of 3 days following injection.

Radioactive arsenic (As^{74} , half-life 16 days) may be prepared by subjecting stable arsenic (As^{75} , 100%) to neutron bombardment.

Potassium arsenite containing radioactive arsenic As^{74} has been injected in 4 daily doses to albino rats, guinea pigs and rabbits and the arsenic content of liver, kidney, spleen, brain etc. determined. During life, daily blood arsenic determinations are also done. The highest concentration of arsenic in the case of rats seems to be in blood, the measurable amount being confined to red corpuscles. Maximum concentration occurs 24-48 hours after last injection and at this time the total As in blood amounts to 50-60% of the amount injected. Spleen shows the highest and kidney the lowest concentration of arsenic.

Radioactive arsenic has also been injected to

human subjects at the rate of 1.5 mgm. per day for 4 days. It is found that about 50% of the injected daily dose is daily eliminated, 99% of the elimination is *via* kidney. However no arsenic could be demonstrated in the blood either in normal or leukemic subjects.

INVESTIGATIONS IN PLANT PHYSIOLOGY

The earliest experiments with the radioactive bodies as tracers were carried out by Hevesy (1923) on plants using ThB and RaD to trace the fate of lead in plants. Since the discovery of artificial radioactive bodies, radioactive isotopes of many common elements have been used as tracers in place of natural radioactive substances.

In these investigations intact plants are kept rooted in nutrient solutions containing minute doses of radioactive salts (*e.g.*, radioactive phosphorus may be applied as 0.5 per cent. solution of KH_2PO_4). The upward and lateral movement of the salts can then be studied by examining sections of wood, bark etc., either with a Geiger counter or an electroscope. Such experiments indicate that wood is the vehicle of rapid upward movement of both anions and cations assimilated by the roots and that the ions move radially from wood to bark at a comparatively slow speed. It is also observed that there is a downward motion of the assimilated ions.

The autoradiograph technique described above has also been used in these investigations with a great deal of success. The following figure shows the distribution of radio-phosphorus in the leaves of a tomato plant removed 36 hours after the application of radio-phosphate to the nutrient solution.

These radiographs show that the green fruits and particularly the seeds of the green fruits concentrate phosphorus to a marked extent.

The exchange of ions by the living protoplasm has also been investigated with the help of radioactive

tracer ions of K^+ , Na^+ , Rb^+ , Br^- , and HPO_4^{2-} . It is observed that these ions enter the cells by interchange with other similar ions (Na^+ with Na^+ , K^+ with K^+ , hydrogen or organic bases) resulting from metabolic processes. By temporarily associating with the radicals of the protoplasmic protein molecules, the elements travel from one molecule to another until they reach the vacuole. The equilibrium thus becomes a dynamic phenomenon.

A great deal of work on photosynthesis has been carried out with the short-lived radioactive carbon isotope C^{14} . Carbon has a half-life of only 20.5 minutes and emits positrons of about one million electron volts maximum energy. Carbon has also another radioactive isotope of very long life (C^{14} , half-

life 1000 years) which is produced by the bombardment of nitrogen by neutrons.

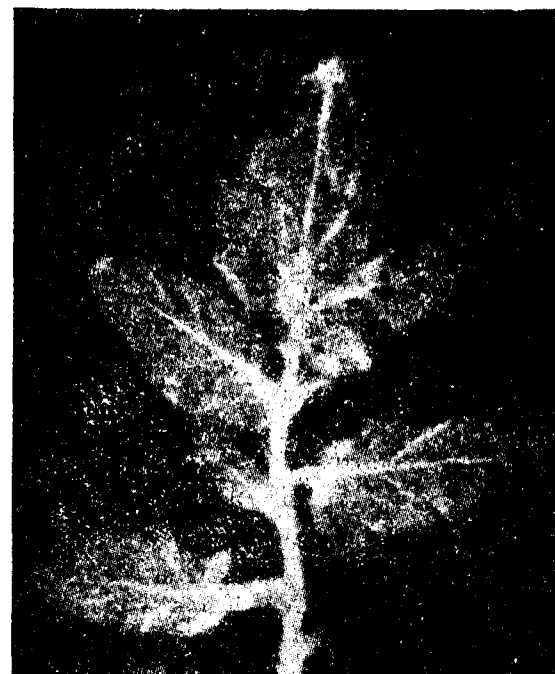
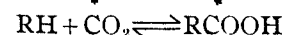


FIG. 8. Autoradiograph of the leaves of a tomato plant grown in a nutrient solution containing radioactive phosphorus.

In the experiments of Ruben and Kamen the gas from the target chamber is passed over heated cupric oxide and carbon dioxide containing radioactive carbon is collected in a U-tube immersed in liquid air. For experiments on photosynthesis unicellular green alga *Chlorella* is exposed to CO_2 , the system is then evacuated and an aliquot of the algal suspension removed and tested for reduced carbon.

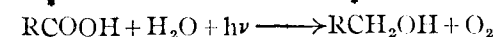
Ruben and his coworkers find that the alga and green plants are definitely able to fix carbon dioxide in the complete absence of light. Diffusion experiments indicate that the first stage in the fixation of CO_2 is its reduction to a carboxyl acid group and that this is a reversible process. The uptake is very rapid at first but at the end of an hour, equilibrium is established. The dark reduction process is believed to be of the following type



Here R is a large molecule. In the absence of light no further reduction probably takes place as all radioactive carbon appear to be in the carboxyl group.

The reduction of CO_2 in the presence of light seems to be non-reversible, the rate of uptake of radioactive carbon being the same throughout the experiment. Only a small fraction of labelled carbon

is found in the carboxyl radical. The light reduction of carbon dioxide is probably a process of the following type



RCH_2OH molecule may then take up further CO_2 . This mechanism of photosynthesis is at variance with the classical ideas. Further these experiments reveal that non-photosynthetic organisms *e.g.*, yeast cell, *B. coli*, rat liver cells etc., also have the capacity to reduce carbon dioxide.

The radioactive nitrogen (N^{15} , half-life 10 min.) has been used to investigate the problem of nitrogen fixation by plants. Charcoal is bombarded by the deuterons in a gas-tight chamber and the gas from the chamber is passed over heated cupric oxide into a desiccator containing barely plants, the roots of which have been previously removed in order to exclude bacteria. For control, other barley plants killed by boiling water are kept side by side with the living. These experiments indicate definitely that nitrogen can also be fixed by the barley plants. The experiments are of great interest as there is a good deal of controversy regarding the fixation of nitrogen by the non-leguminous plants.

In this article only a very brief account is given of the important results obtained with this fascinating

technique of radioactive tracer analysis. This new method of approach to complicated biological problems seems to be the most promising since the discovery of the microscope. The immense possibilities of this new method have been long realised in America, the birth place of the cyclotron. Many philanthropic bodies and research foundations have made special endowments to universities and laboratories for carrying on specially work of this nature. Mention may be made of Rockefeller Foundation, Carnegie Institute, National Research Council, Chemical Foundation, John and Mary Markle Foundation, Jane Coffin Childs Memorial Foundation etc. among many others. All experiments described above have been carried out with financial assistance from one or the other of these research foundations.

In this country we had the good fortune to start this important line of investigations with financial grants from two of the leading industrial houses of India *viz.*, the Tatas and the Birlas. Without their generous help this work could not have been undertaken. We hope that in our work in future we shall continue to receive the same sympathy and assistance from the public as we had in the past.*

* My thanks are due to Prof. M. N. Saha, F.R.S., and Dr B. D. Nag Choudhury for many useful criticisms of this report.

FERTILIZER INDUSTRY IN INDIA

INDIA is a country where 80 per cent of the population are dependent directly or indirectly on agriculture. Yet she is not self-sufficient as regards foodstuff even on a very low standard of diet. Before the war, we used to import about 2 million tons of rice from Burma, Indo-China and also a large quantity of wheat from Australia. Partial failure of rice-crops and stoppage of supply from Burma led to disastrous consequences in Bengal last year. The Government of India and the public are therefore anxious that production of cereals should be so increased in the country as to ensure food to all not only on the existing low standard of diet but on a somewhat higher level considered adequate by experts on nutrition. The Bombay Plan of economic reconstruction aims at increasing agricultural income by 130 per cent. Government's present plan is, however, far less ambitious. As envisaged in the recent report of Dr Burns, a 30 per cent increase in production is urgent, and there is no reason why it should not be achieved even in war time as a result of the grow-more-food campaign.

NEED FOR SYNTHETIC FERTILIZERS IN INDIA

As an illustrative example, we shall take the most important food crop—rice. We grow on an average 28 million tons of rice in an area of 76 million acres, about 750 lbs. per acre. This is the most depressing fact about our agriculture. In U.S.A. the average production is 1500 lbs. and in Japan 2300 lbs. per acre. This is mainly due to lack of water and manure. The agricultural experts are convinced that, given ample water and ample manure, rice yields can be forced very much higher. There are indeed some well-managed farms in Coorg which is so near to us, where a yield of 3000 lbs. per acre is not uncommon. The statistical average of all manurial experiments carried out all over India between 1933-1939 indicates that 80 lbs. of ammonium sulphate applied per acre to land containing sufficient humus increases the production of paddy by 280 lbs. which is equivalent to 210 lbs. of rice, *i.e.* roughly 30 per cent increase in present production. If ammonium sulphate is given along with super phosphate, the

yield is generally higher. At pre-war prices of ammonium sulphate, paddy and straw, the increased net profit per acre was Rs. 7/- (ammonium sulphate to cultivator Rs. 200/-, paddy Rs. 2-4 for 80 lbs., and straw 4 annas for 80 lbs.). If the price of ammonium sulphate to cultivator remains the same, Rs. 200/-, the increased profit per acre at present prices will be far greater—about Rs. 28/-. 76 million acres of rice lands in India will require annually about 2.55 million tons of ammonium sulphate in order that we may reach our target of production which is 36 million tons of rice. Government of India hopes to establish factories under State auspices which will produce 350,000 tons of ammonium sulphate by June 1946. It is also hoped that once this Government enterprise is successful, private enterprise will be soon forthcoming to produce the balance required, *i.e.*, 2.2 million tons of ammonium sulphate.

In 1938-39, India imported 76,000 tons of ammonium sulphate from Great Britain, the cost at port being Rs. 110/- per ton. There is something thoroughly rotten in a distribution system which exacted from the cultivator Rs. 200/- per ton as retail price. With this experience, one cannot be too alert about consumer's interest. There is no reason why the price to the consumer should exceed the factory price or the price at port by more than 10 per cent plus the cost of additional transport.

In 1938-39, the internal production of ammonium sulphate was only 25,000 tons. This was obtained from the coal distillation industry of Behar and Bengal as a by-product. On distillation of coal to form coke, nitrogen of the coal is released in the form of ammonia, which is removed from the coal-gas by scrubbing with sulphuric acid. Those interested in the details of the process developed in India may read the interesting memoir of Wilson Haig, General Manager of the Bararce Coke Oven Co.

FERTILIZER INDUSTRY IN MYSORE

It is to the Government of Mysore that we owe the establishment of the first synthetic ammonium sulphate factory in India. The factory in Mysore at Belagula started producing 5 tons of ammonia per day since 1941. The sulphuric acid plant can produce 27 tons of sulphuric acid per day; the total capacity for production per year is 7000 tons. We shall only outline the broad features of the process:—The manufacture of ammonium sulphate consists, firstly of the manufacture of ammonia by interaction of nitrogen with hydrogen and then the conversion of ammonia into ammonium sulphate. In Mysore (Belagula), the hydrogen is obtained by electrolysis of caustic soda solution using nickel plated anodes. For 1 ton of ammonia we require 2250 cu. metre of

hydrogen gas. We also require 750 cu. metre of nitrogen gas, which in Belagula is obtained by burning 380 cu. metre of hydrogen in 940 cu. metre of air. We thus require 2630 cu. metre of hydrogen and 940 cu. metre of air for the synthesis of 1 ton of ammonia. Taking into consideration losses and impurity of oxygen in hydrogen, we require 2700 cu. m. which will consume 15,200 kWh D.C. power. The mixture of nitrogen and hydrogen is compressed to 300 atmos. perfectly dried and freed from impurities and passed through converters of special steel containing more than 2 per cent chromium, which contained the catalyst. The catalyst is obtained by fusing from oxide and then impregnating it with promoters like Al_2O_3 and K_2O . The cooled mass is broken to requisite grain size, and porous but rugged structure is obtained by reducing in a current of hydrogen at about 500°C. This catalyst at a space velocity of 40,000 cubic feet per hour per cubic feet of catalyst will give about 16 per cent conversion into ammonia. The converter is so designed that under these conditions, the heat of reaction maintains the catalyst at about 480°C. The ammonia is removed by refrigeration which in general commercial practice amounts to 80 per cent of the ammonia present. The uncombined gases containing the residual ammonia is recycled. Auxiliary power necessary for compression and other purposes amounts to 1300 kWh per ton of ammonia. The cost of production of ammonia per ton may be estimated thus:—

16,500 kWh at ¼ anna	...	Rs. 260
Cost of repair and maintenance	„	10
Salaries and wages	...	5
Total		Rs. 275 per ton

If kWh costs 1/10th of an anna, the cost becomes Rs. 18/- per ton.

This is exclusive of depreciation charges which are very heavy and interest on capital invested. If A.C. power in bulk is already available in factory site, as was the case in Mysore (Belagula) the capital cost per ton year of ammonia would be Rs. 500/-. Taking depreciation at 15 per cent and interest at 5 per cent., the running cost of production has to be increased by Rs. 100/- per ton to give the fair selling price of ammonia ex-factory.

In Mysore (Belagula) sulphuric acid is manufactured by burning sulphur vapour with air to SO_2 and passing SO_2 with excess of air over V_2O_5 catalyst in a converter which is maintained by the heat of reaction at about 500°C. There is complete conversion into SO_3 which is dissolved in 98.3 per cent H_2SO_4 to give fuming sulphuric acid. This is continually diluted with requisite water to maintain constant the strength of sulphuric acid. The advantage of the process is that it is practically continuous and automatic and requires only equipment made of iron.

The capital cost of a plant is Rs. 50 per ton year, and the fair selling price of sulphuric acid at factory should not be more than 40 per cent of the cost of pure sulphur and Rs. 20/-. If sulphur is purchased at Rs. 100/-, sulphuric acid should sell at Rs. 60; if bought at Rs. 200/-, the acid should sell at Rs. 100/-.

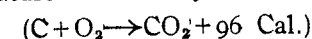
Ammonium sulphate is obtained in the crystalline solid state by combination of ammonia with sulphuric acid in the ratio approximately of 1:3 by weight. The fair selling price of ammonium sulphate per ton should be ¼th that of ammonia + ¾ that of sulphuric acid + Rs. 5 as processing cost. Taking the higher values Rs. 375/- and Rs. 100/-, the selling price of ammonium sulphate should be Rs. 175/- per ton. Taking the lower values 218 and 60, the selling price ex-factory is Rs. 105/- per ton.

MANUFACTURE OF AMMONIUM SULPHATE IN TRAVANCORE

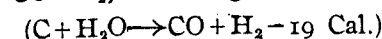
We owe to the Government of Travancore the next advance in our synthetic fertilizer industry. The State is densely populated and only produces 40 per cent of its food requirements. It is the deliberate policy of the State to increase food-production to at least 60 per cent of its requirements. The State possesses several advantages. There are tropical monsoon hard wood forests which can be regenerated in a cycle of 30 years, and it is estimated that 100 tons of charcoal containing 75 per cent fixed carbon could for ages be delivered at a factory site (near the Alwaye Railway Station) at a cost not exceeding Rs. 20/- per ton. There are extensive deposits of gypsum of 85 per cent purity in Trichinopoly which can be carried by rail (to Alwaye) and delivered at factory at a cost not exceeding Rs. 15/- per ton. It is not at all difficult to wash this gypsum off its clayey matter and raise the purity to 95 per cent. Electric power in bulk can be had from the Pallivasan Hydro-electric Station at 1/5th an anna per unit. Alwaye is within 25 miles by rail of the magnificent Cochin harbour and also has waterways which are extensively used by cheap country craft transport.

The method of making hydrogen by the action of carbon on steam is far more complicated than simple electrolytic preparation. The standard method consists of two processes:—

(1) Blowing air over a bed of coke and raising the temperature to 1200°C by the reaction

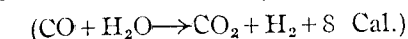


Then passing steam over hot coke and getting water gas, $CO + H_2$, according to reaction



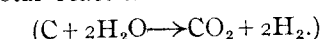
Steam is stopped as soon as the temperature of coke bed falls to 900°C and then air blown in and the cycle repeated.

(2) The second stage consists in converting carbon monoxide of water gas by interaction with steam to carbon dioxide and hydrogen



This is done in presence of catalyst at temperature of 500°C.

The total reaction is therefore

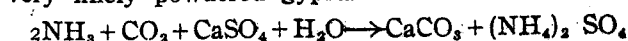


In actual practice, water gas is mixed in suitable proportions 3:2 with producer gas which is obtained by passing moist air over heated coke and has the composition $N_2 = 51$ per cent., $CO = 26$ per cent, $H_2 = 14$ per cent and $CO_2 = 9$ per cent. The mixed gases having the average composition 23 per cent N_2 , 70 per cent $CO + H_2$ and rest CO_2 , hydrocarbons etc. are passed through water gas converter chamber which gives a gas mixture containing H_2 and N_2 in the ratio of 3:1 and considerable quantity of CO_2 . This CO_2 is removed by high pressure scrubbing with water. We shall soon see that this CO_2 recovery is essential in the manufacture of ammonium sulphate with the aid of gypsum.

In the process that will be adopted in Travancore, this separate preparation of water gas and producer gas and then mixing them together in the requisite proportion will be avoided. The only reason why water-gas is made by a discontinuous alternate blow and run process is that ordinary metallic converters cannot stand the extremely corrosive action of steam and CO at 1100°C, and hence furnaces lined with fire bricks had to be used which cannot be economically heated by external firing. The American engineers now claim to have developed suitable alloys which can stand this severe corrosive action; and it is intended to gasify with requisite steam and air 57 tons of charcoal every day in such alloy tubes externally heated with powdered charcoal. Standard methods will be adopted for the purification of N_2 and H_2 mixture before they enter the catalyst chamber at a pressure of 300 atmos. and 475°C.

The ammonia converter at Travancore will differ from that at Belagula in that its capacity will be 8 times larger and that it will not be forged from a single alloy steel cylinder. It will have a laminated structure with several concentric cylindrical forgings pressed one over another to give it the requisite strength. The subsequent stages in the manufacture of ammonia is the same as that at Belagula.

There will be a marked difference, however, in the manufacture of ammonium sulphate. Instead of allowing ammonia to react with sulphuric acid, a mixture of ammonia and carbon dioxide in equivalent proportions will be passed through a suspension of very finely powdered gypsum in water.



In this process, the conversion is complete and a solution containing 35 per cent by weight of ammonium sulphate can be obtained. It is interesting to note that CO_2 obtained in the water gas conversion, if recovered, is sufficient for carrying out this reaction. Hence the gypsum process is always associated with the manufacture of hydrogen from water gas. If, as is anticipated, CaSO_4 of 95 per cent purity is used for this process, the calcium carbonate sludge can be used for the manufacture of cement in an associated cement factory. In the Travancore factory, the sulphate making plant will consist of the following units:—One carbon dioxide recovery unit, one ammonia vaporising unit; one rotary reaction unit, filters, evaporators, crystallizers, gypsum grinding equipment and bagging plant.

The factory will have to be supplied with 5500 KW of electric power at a continuous load.

It has been estimated that the capital cost for this factory which will produce 40 tons of ammonia per day and hence 160 tons of ammonium sulphate will cost 17 crores of rupees, i.e., Rs. 300/- approximately per ton of ammonium sulphate produced in a year. This is rather on the high side, as the pre-war cost was of the order of Rs. 200/- per ton year. It is difficult to forecast the economics of the process. The Imperial Chemical Industries for their 250,000 ton plant at Billingham obtain coke at Rs. 25/- per ton and gypsum at about the same price. On this basis they could land ammonium sulphate at an Indian port at Rs. 110/- per ton. It is probable that the fair selling price of ammonium sulphate ex-factory (at Alwaye) will be about Rs. 90—100 per ton.

TECHNICAL MISSION ON FERTILIZERS

The Government of India have invited a Committee of experts to come from England and advise them on a site or sites suitable for putting up ammonium sulphate plants which will produce in the aggregate 300,000 tons per year and also recommend the most economical process for adoption in British India. The Mission came to Bangalore some-time ago. As far as could be judged, they would recommend practically a duplication of the Billingham plant in the coal fields of Behar and Bengal so far as the production of ammonia is concerned. Whether this ammonia should be converted into ammonium sulphate by sulphuric acid or by gypsum is not yet settled. The extensive gypsum deposits of India are in Rajputana and are at a distance of 1300 miles from the coal fields. It may be cheaper to manufacture sulphuric acid from imported sulphur pyrites and use it for making ammonium sulphate.

Some of the Indian technologists have urged the Mission not to use coke for making hydrogen but to

use cheap non-coking second class coals, in view of the imperative need of conserving our slender resources of coking coal for metallurgical purposes. Pointed attention has been drawn to the remarkably efficient processes that have been developed in Germany for making water gas from lignite which have brought down by 33 per cent the cost of production of hydrogen. It has also been urged that if American engineers could use charcoal containing 30 per cent volatile matter for making water-gas in Travancore, there should be no difficulty worth mentioning, in using cheap non-coking coal of Bengal and Behar for the same purpose. The plant in the coal fields will have one great advantage; coal can be had there at Rs. 4—5 a ton as against Rs. 20/- per ton of charcoal in South India. But this advantage may be counterbalanced by costlier labour and transport charges to consumers' centres.

AMMONIUM NITRATE AS FERTILIZER

Ammonia is a key industry as nitric acid is now manufactured exclusively by the oxidation of ammonia. Nitric acid is the basic chemical for all modern explosives, and its manufacture has increased enormously during the last five years. The possibility of keeping these nitric acid plants active in peace time is engaging the serious attention of chemical technologists in every country. Nitric acid can be made to combine with ammonia to give the solid salt of ammonium nitrate. So far as providing food to plants is concerned, nitrogen-fixed as ammonium nitrate has the same property as that fixed as ammonium sulphate. The use of ammonium nitrate in India will have the additional advantage that the ammonia industry will be absolutely self-contained, independent of any import of gypsum or sulphur to the factory which will in most cases involve long haulage. But there are difficulties in its use as fertilizer; firstly, it is hygroscopic, it absorbs moisture from the air, forms solid lumps which may end in explosion if the cultivator tries to powder it. Secondly, it is said that it is easily leached away from lands subjected to heavy flooding. If these two defects can be removed ammonium nitrate will be the ideal nitrogen fertilizer for India and will be much cheaper for the same fixed nitrogen content than the ammonium sulphate.

PHOSPHATIC FERTILIZERS

The emphasis on nitrogen fertilizer in India has almost made us unremindful of another important fertilizer—the phosphatic fertilizer. In 1939, the world's consumption of phosphatic fertilizer containing about 20% citric acid soluble phosphates was about 18 million tons which is double the production of ammonium sulphate. The consumption in India

was, however, meagre of the order of 12,000 tons. This industry will rapidly expand in India as the cultivator becomes more and more fertilizer conscious. There are phosphate deposits in India—at two centres, the phosphatic nodules in Trichy, and the phosphatic rock in Singhbhum, Behar. The standard practice is to convert the insoluble phosphate by treatment with sulphuric acid to form superphosphate. The large production cost of sulphuric acid in India from imported sulphur has stood in the way of the development of the industry. It has been found, however, that such phosphate rocks can be solubilized by fusion with silica, feldspar, magnesium carbonate, etc. The process is practically the same that takes place in a rotary cement kiln. In the Chemical Department of the Indian Institute of Science, Bangalore a process has been worked out using Trichy phosphate as the starting material. The ore which contains about 52% calcium phosphate is treated first for removal of the incrustation of calcium carbonate, and a material containing 72% calcium phosphate is obtained thereby. This is then

crushed to fine powder mixed with suitable fluxing agents and fed into a rotary kiln fired with an oil burner and maintained at a temperature of 1350°C. The fused mass slowly flows down the rotary conveyor and on sudden cooling gives a feasible material which contains but 16 to 18% citric acid soluble phosphate. It has been estimated that such phosphatic fertilizer can be sold in India at Rs. 50/- per ton which is much cheaper than superphosphate manufactured with the aid of sulphuric acid. Extensive field trials are now being made with this material at the pilot plant of the Indian Institute of Science, Bangalore, and in the Madras Government Agricultural Farm at Coimbatore.

It is hoped that large scale production of this fertilizer will also begin at an early date. The importance of technological studies on problems of synthetic fertilizers industry in India cannot be over emphasized, and in any future plan of economic reconstruction of India, this industry will be considered as a No. 1 key industry.

J. C. G.

EFFECT OF THE FOOD CRISIS OF 1943 ON THE RURAL POPULATION OF NOAKHALI, BENGAL

RAMKRISHNA MUKHERJEA, CALCUTTA

(Continued from the last issue)

The character of the population thus affected by the food crisis is best represented by their source of livelihood which was the most important factor in enabling them to avert or to succumb to the crisis. Table 8 which records the sources of livelihood of the family units in December 1942,

before the food crisis, and in December 1943, after they had borne the main brunt of it, indicates that for all the three classes concerned "agriculture and labour" and "labour" alone were the most important forms before the food crisis. The next group of importance was the combination of "agriculture

TABLE 8. Showing the sources of livelihood of the family units in December, 1942, before the food crisis, and in December, 1943, after the main brunt of it.

Source of livelihood	Class I (N—85)			Class II (N—105)			Class III (N—28)		
	Dec' 42	Dec. 48	Change from (1) to (2)	Dec. '42	Dec. '48	Change from Col (4) to (5)	Dec. '42	Dec. '43	Change from Col (7) to (1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Agriculture	7	3	— 4	5	2	— 3	8	7	— 1
Labour	22	14	— 8	29	25	— 4	5	6	+ 1
Domestic service	5	7	+ 2	...	1	+ 1	...	...	...
Industry	6	3	— 3	6	7	+ 1	...	...	...
Trade	2	2	...	1	2	+ 1	2	2	...
Profession & Liberal arts	2	...	— 2	2	4	+ 2	...	...	...
Agriculture and labour	17	10	— 7	38	10	— 23	8	5	— 3
Agriculture and any (except labour)	13	8	— 10	9	5	— 4	4	5	+ 1
Labour and any (except agriculture)	5	1	— 4	...	1	+ 1	...	...	...
Any other occupation	4	11	+ 7	8	6	+ 8	1	1	...
Unproductive	2	31	+ 29	17	42	+ 25	...	2	+ 2

with any other occupation except labour". The other occupations—agriculture, industry, trade, etc., are of less importance except in class III where agriculture is next in importance to "agriculture and labour". It shows that, as in practically all over rural Bengal, the life of these people is based on agrarian economy.

But only in a few cases these families depend solely on 'agriculture' and usually combine it with other forms, mostly 'labour'. This is because these people have not got sufficient holding (as seen in Table 2(B), 43, 50, and 18 family units, having only 21.82, 16.95, and 8.42 acres of cultivable land between them, that is, about 0.51, 0.34, and 0.47 acres per family on the rough average) to provide their families for the whole year round and so they are bound to depend on earnings by other occupations. In most cases this is done by working on the big holdings of cultivable land of the better off persons who need hired labour.

So we can understand why these people were so much affected by the food crisis. In 1943 the prices

tables 8 and 9. The former table shows that 57, 64, and 15 per cents of the family units who practised 'agriculture' as one of their occupations have given it up, 36 and 14 per cents of the family units belonging to classes I and II who depended on 'labour' as their source of livelihood have given it up, and the number of unproductive families has increased to staggering heights.

Table 9 which gives a detailed analysis of the unproductive families in December, 1943 shows that only a few families are traditionally unproductive, that is, they were unproductive even in December, 1942. About them also, it may be mentioned here, further investigation might show that even these have taken to this as the source of living not long ago and that this is the result of the gradual deterioration of the rural economy of Bengal which has been tremendously accelerated by the food crisis of 1943. The table points out that the rest have been forced to depend on charity as the result of the food crisis. It shows that 37 and 19 per cents of the earners belonging to the unproductive families of class I and

TABLE 9. Showing the number of unproductive families and earners, and the cause of being unproductive in December 1943.

Unproductive causes	Unproductive families			Unproductive earners		
	Class I (N—85)	Class II (N—105)	Class III (N—28)	Class I (N—93)	Class II (N—116)	Class III (N—31)
Earner						
Traditionally unproductive	2	17	...	2	17	...
Dead within Dec., '42--Nov., '43	6	5	...	6	5	...
Invalid from Starvation	1	7	1	1	7	1
" Disease	9	6	1	13	6	1
Emigrant (whereabouts known)	11	3	...	11	4	...
" and Untraced	2	4	...	2	4	...
Total	31	42	2	35	43	2

of food stuffs, specially of rice, began to soar up at a tremendous rate while these people could neither be provided from their small holdings nor could they manage to buy the necessities from their meagre income. The result was that those who had some assets began to sell them and those who had not such things or had lost them already either starved and faced the natural consequence of death or became sick or invalid or took to begging and depending on charity to maintain their physical existence any how. Those who lost their property to avert the natural consequence could not thereby manage to escape it wholly. Many of them sold their holdings and as the result had to give up 'agriculture' (cultivating their own land) and take to other occupations losing even the little production of grains they would get otherwise. This is clearly brought out in the

II respectively were compelled to leave the villages in search of service as the result of the food crisis, leaving behind their family members to depend totally on charity. This means that 13 and 7 per cents of the total number of earners of the classes I and II respectively do not belong to the village economy any more. Due to the crisis 40, 30, and 100 per cent of the unproductive earners, that is 10, 11 and 6 per cents of the total earners are at present invalid through prolonged starvation and disease. That the diseases which have invalidated them are mainly the result of the food crisis is proved by the fact that out of 20 persons invalidated 14 are suffering from fever (malaria in most cases, the after effect of low vitality produced by prolonged starvation), 3 from dropsy, the direct effect of prolonged starvation, and 3 from other cases. Over and above this 17 and 12 per cents

of classes I and II, that is, 6 and 4 per cents of the total earners in these two classes have died and so the only way left to their families for survival is to depend on charity. That this high mortality is mainly due to the food crisis will be shown in a following page. On the whole, the table points out that as a result of the food crisis in the classes I and II, 6 and 4 per cents of the total number of earners have been definitely lost and 23 and 18 per cents of them are either lost or are very probably on the way to it, resulting in the increase of unproductive families from 2 and 16 per cents to 31 and 40 per cents; a big jump of 29 and 24 per cents within the period of a year only!

Table 10 records the total number of earners in all the classes and the comparative importance of the occupations with regard to the earners in December, 1943. The earners have been classified as (i) leading earner, on the income of whom the

gard to their comparative importance. The occupations of the working dependants have always been noted as secondary. The table shows that agriculture is mainly the secondary sources of living for these people which further confirms the earlier statement that though these people live on agrarian economy, 'agriculture' (by which is meant the cultivation of their own land) provides for only a part of their livelihood. The table also shows that 7 leading earners of the class I depend on domestic service which means the occupations like husking paddy etc. by the females. This indicates the severity of distress in the class I where the seven families have to depend on the meagre income from this type of domestic service.

Table 10 has shown that in all there are only 93, 116, and 31 earners in the respective classes I, II, and III of which 85, 111, and 28 are the leading earners and the rest 8, 5 and 3 are the working

TABLE 10. Showing the total number of leading earners and working dependants in each occupation considered as primary or secondary in December 1943.

Source of Livelihood	Class I (N—85)					Class II (N—105)					Class III (N—28)				
	No. of Family units	Primary		Secondary	Total No. of Earners in each occupation	No. of Family units	Primary		Secondary	Total No. of Earners in each occupation	No. of Family units	Primary		Secondary	Total No. of Earners in each occupation
		Leading earner	Working dependant				Leading earner	Working dependant				Leading earner	Working dependant		
(Productive)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Agriculture	16	6	10	...	16	17	4	13	...	17	17	8	9	...	17
Labour	25	25	1	1	27	36	37	...	3	40	11	10	...	...	12
Domestic Service	7	7	...	5	12	1	1	...	1	2	...	...	...	...	...
Industry: Carpentry, Weaving, barber's job, and Washerman's job	3	4	...	1	5	7	9	1	...	10	...	...	...	...	...
Trade: Shop-keeping and Free Trading	2	5	...	...	5	2	5	...	...	5	2	4	...	...	4
Profession & Liberal Arts: Medical, Teaching and Priesthood	...	...	...	...	...	4	7	...	...	7	...	...	...	...	...
Any Other Occupation	11	13	...	1	14	6	6	...	...	6	1	4	...	1	5
Sub-total	54	60	11	8	...	63	69	14	4	...	26	26	9	3	...
Unproductive	31	31	...	...	...	42	42	...	1	...	2	2	...	...	...
Total	85	91	11	8	...	105	111	14	5	...	28	28	9	3	...

particular family mainly depends, and (ii) working dependant whose income is an additional help to the family. Usually the leading earners are not below the age of 25 and the working dependants are within the age-grade of 15—25. The occupations have been classified as (i) primary and (ii) secondary with re-

dependants. That is, very few family units have more than one earner each, the total number of family units of the population studied being 85 in class I, 105 in class II, and 28 in class III. Table 11 which shows the effective population of these units considered together, that is, of the total population,

indicates why there are not many earners in these family units.

Before discussing table 11 which gives us the distribution of the population according to age-grades one thing is to be noted. As has been mentioned in the beginning, the population was studied by the geneological method, with the help of which the population in December, 1943 was recorded. Now as there was no immigration during June—December, 1943 and the number of birth is negligible the population in May, 1943 can be deduced from it with a fair degree of accuracy considering the number of deaths and emigrations within the period of June—December. Following the same principle the population in May, 1942 may be deduced, though with still less accuracy but perhaps sufficient for our purpose of finding out the age-

TABLE 11. Showing the total population of the sample in December 1943, May 1943, and May 1942.

Age-grade	Population in Dec. 1943				Deaths within June-Nov. 1943			Emigration within June-Nov. 1943			Population in May 1943 (Cols. 1+2+3)				Deaths within June '42-May '43			Population in May 1942 (Cols. 4+5)			
	Male	Female	Total	P.C.	Male	Female	Total	Male	Female	Total	Male	Female	Total	P.C.	Male	Female	Total	Male	Female	Total	P.C.
	(1.1)	(1.2)	(1.3)	(1.4)	(2.1)	(2.2)	(2.3)	(3.1)	(3.2)	(3.3)	(4.1)	(4.2)	(4.3)	(4.4)	(5.1)	(5.2)	(5.3)	(6.1)	(6.2)	(6.3)	(6.4)
0-15	263	223	486	51	30	17	47	12	6	18	305	246	551	51	7	12	19	312	258	570	50
15-50	184	229	413	43	17	10	27	27	3	30	228	242	470	43	9	7	16	237	249	486	43
50 & above	38	25	63	6	4	1	5	...	...	...	42	26	68	6	4	4	8	46	30	76	7
Total ...	485	477	962	100	51	28	79	39	9	48	575	514	1089	100	20	23	43	595	537	1132	100

grade ratios, by considering the deaths alone leaving aside emigration which did not play any important part in this period. Thus the table 11 has been prepared in this period. Thus the table 11 has been prepared, 0-15, 15-50 and above 50 of which the age-grade 15-50 may be considered to comprise of the effective population economically. The table shows that the age-grade ratio is practically the same in all the three periods, the percentages of total being 50, 43 and 7 in May 1942 and 51, 43 and 6 in December 1943 for the respective age-grades of 0-15, 15-50 and above 50.

However, as the table shows, the effective population belonging to the age-grade 15-50 covers 43 per cent of the total population. But it is to be noted that only a minor portion of the female population of these villages is directly effective with regard to the sources of income, since their only occupation for direct income in cash or kind is domestic service which accounts for only 5 per cent of the total number of earners when all the types are considered together. It is true that they are effective as housewife or household worker and also as assist-

ants in some occupations, like Agriculture, Weaving, and Washermen's job, but they do not directly bring any money or anything in kind to the family except through domestic service already described. Therefore, to find out the really economically effective population we must consider only 5 per cent of the female population belonging to the age-group 16-50, which again is of greater percentage than the corresponding grade of the males. Hence, the percentages of the really effective population are only 24 and 26 in May, 1942 and December, 1943 respectively. In our sample also the percentage of total number of earners (246) to the total population (962) is 25 per cent. These figures show why there are not many earners in the villages. The result of this is that the earnings of most of the families were not sufficient to fight the food crisis. The earnings have

been further curtailed now as there are 80 unproductive earners (30 per cent of the total) to be considered. The Census of 1941 records that in Bengal only 27 per cent of the total population is economically effective, that is, they earn something to maintain themselves and their family. It is clear therefore that the sample studied is sufficiently close to the norm of economic condition in Bengal.

The effect of the food crisis on the population is best understood when we consider the deaths and emigrations that have taken place between June—November, 1943 when the crisis was raging very high. The deaths within the previous period of one year, from June, 1942—May 1943, is also considered to give a comparative picture. The emigrations in this period have not been taken into account as it was not at all an important phenomenon in this period. It may again be mentioned here that the death rates during June—November 1943, and June 1942—May 1943 have been calculated from the derived population figures of May 1943 and May, 1942 respectively as noted in the previous pages.

According to the table 12 the percentage death rates for the classes I, II and III in the six months from June to November, 1943 were 6, 9, and 3 respectively, that is, 12, 18 and 6 per cents in the year. What a staggering figure when the normal annual

female death rate is slightly higher than that of males, especially in age-groups of 0-15, and 16-50) and the observed value was the higher proportion of male death rate. The test proves that except in the age-group of above 50 to the two values are re-

TABLE 12. Showing the death-rates of the population in percentage during June—November 1943 and June 1942—May 1943

Class	Population in May 1943	Deaths in June—Nov. 1943		Population in May 1942	Deaths in June '42—May '43	
		Sample	Percentage		Sample	Percentage
	(1)	(2.1)	(2.2)	(3)	(3.1)	(3.2)
I	396	24	6	412	16	4
II	566	51	9	585	19	3
III	127	4	3	135	8	5
Total ...	1089	79	7	1132	43	4

death rate is 2.3 per cent on the average* and when we find that during the year before, from June, 1942 to May 1943, the death rates per 100 were 4, 3, and 5 only.

Table 13 which gives a detailed analysis of deaths within June—November, 1943 with respect to age-grade and sex, indicates very high child mortality—17 per cent per year! Death in old age is also no less marked but that is however, less alarming than child mortality. The death rates according to sex

markedly dissimilar and in case of the age-group 'Above 50' also the similarity is very slight. This indicates that there is association between mortality and sex, especially in the age-grades 0-15, 15-50, as well as in the total; that is, more males have died than females.

It is to be mentioned here that the usual large sample test indicates that the sex ratio of the sample studied may be said to represent the district population according to the Census of 1941† when the result

TABLE 13. Showing the male and female death-rates of the total population in percentage in different age-grades during June—November 1943.

Age-grade	Population in May 1943			Deaths during June—November 1943						χ^2 test on male & female death-rates to total population		
				Sample			Percentage of total					
	Male	Female	Total	Male	Female	Total	Male	Female	Total	D. F.	χ^2	P
	(1.1)	(1.2)	(1.3)	(2.1)	(2.2)	(2.3)	(3.1)	(3.2)	(3.3)	(4.1)	(4.2)	(4.3)
0—15 ..	305	246	551	30	17	47	5.4	3.1	8.5	1	0.1414	>0.70
15—50 ..	228	242	470	17	10	27	3.6	2.1	5.7	1	0.3593	>0.50
50 & above ..	42	26	68	4	1	5	5.9	1.5	7.4	1	10.8532	<0.01†
Total ..	575	514	1089	51	28	79	4.7	2.6	7.3	1	0.4248	>0.50

†Significant.

reveal a very significant and at the same time an alarming phenomenon. At a glance it can be seen that more males have died than females, the ratio being roughly 2:1. That the association between death and sex is really significant is borne out by χ^2 test, as shown in the table. In χ^2 test, the expected value was regarded as equal proportions of male and female death rate (although even in normal times, as shown in Census of Bengal 1931, the

of the test, $t=1.25$ and $p(t)=21$ per cent. Hence this phenomenon of differential death rate may be regarded as applicable to the district as a whole.

$$\begin{aligned} \dagger t &= \frac{\pi - p}{\sqrt{p(1-p)}} : \pi = \frac{\text{Total male population of the district}}{\text{Total population of the district}} \\ &= \frac{1,143,174}{2,217,402} = 0.52 \\ &= 1.25 : p = \frac{\text{Total male population of the sample}}{\text{Total population of the sample}} \\ &= \frac{485}{962} = 0.50 \\ &: n = 962. \end{aligned}$$

*Calculated from Public Health Department figures during 1931-40.

As to the reason behind the differential death rate we cannot assert any. It may be due to the fact that the males had to exert much more than the females to avert the crisis, this being very probable regarding the effective male population, who being the leading earners of the family units had to exert their utmost to provide for their dependents, mostly female, and this exertion coupled with ill feeding or starvation, (which, however, was common to both) heavily told upon their health leading to death in large numbers.

Another feature, to be considered here, is that the difference of age of 5 years and not infrequently of 10 or even more is the usual rule with the married couples of these people, so that, the heads of the families who are frequently of middle age have their wives considerably younger to them who could stand this crisis in a better way than their husbands, and the latter being older were already of lower vitality and further had to bear more exertion. The result is that more males of this age-group have died than

TABLE 14. Showing the total number of deaths in different age-grades during June—November 1943.

Age-grade	Deaths	
	Male	Female
	(1)	(2)
0—5	19	11
5—10	7	6
10—15	4	...
15—20	3	1
20—30	...	3
30—40	6	4
40—50	8	2
50—60	2	...
60—70	1	...
70 and above	1	1

females. That this statement is true is further proved by the table 14 which shows the total number of deaths in the age-groups of 5 and 10 years' intervals. The table shows that the difference of male and female deaths is extremely marked in the age-group 40—50 where the total number of male deaths also is only next to that in the age-group 0—5.

Whatever the reason may be the absolute figures supplemented by the χ^2 test indicate it to be a fact that more males have died than females and this is surely going to affect the population very seriously in the long run, especially in case of the Hindus who look down upon widow marriage with contempt and who are now going to face a huge mass of widows in the present generation, (that is, belonging to the age-grade 15—50) and smaller number of women in the coming generation belonging to the age-grade of 0—15. The huge number of deaths within June—

November, 1943 itself shows what has been the effect of food crisis on the population. Table 15 which records the cause of death within June—November, 1943 and June 1942—May 1943 further confirms it.

Table 15 shows that 44 per cent of the total deaths are due to the effects of starvation and of it 89 per cent took place during June—November, 1943. One thing, to be noted here, is that it is true that starvation is the cause of so many deaths as recorded in the table, but the actual deaths might have taken place due to some diseases which, when the entire bodily system is totally deranged by prolonged starvation, could very easily attack and finish off the

TABLE 15. Showing the cause of deaths within June—November 1943 and June 1942—May 1943.

Cause	Deaths		Total deaths within June '42—Nov. 1943	
	June-Nov. 1943	June '42-May 1943	Sample	Percentage
	(1)	(2)	(3)	(4)
Starvation ...	48	16	54	44
Dysentery ...	2	4	6	5
Dropsy ...	7	...	7	6
Fever (mostly Malaria) ...	9	13	22	18
Cholera ...	4	7	11	9
Small Pox ...	5	1	6	5
Other Causes ...	4	12	16	13
Total ...	79	43	122	100

persons. As in most of such cases the informants could not describe the consequent diseases correctly, the deaths have been recorded as due to starvation. Where the disease could be ascertained it has been noted, as seen in the table. Hence, if we consider dysentery, dropsy, fever and cholera to be the diseases which came in consequence of starvation we see that 82 per cent of the deaths are due to food crisis of which again 70 per cent took place during June—November 1943, when the crisis reached its height.

The study of the effect of the food crisis on the population remains incomplete unless something is known about the persons who have emigrated from the villages due to food crisis. We have already noted that a considerable percentage of the earners have left the villages in search of service in some other parts of Bengal and Assam or are untraced. Table 16 shows the total number of the rural population who have emigrated within June—November, 1943 due to the food crisis. As the figures will show, comparing these with those of table 9, most of the emigrants are the earners considered previously, but the females belonging to the age-group 16—50 and all of the age-group 0—15 (except 6 males who are working dependants) are the other family members,

dependants of the earners, who have also accompanied them.

institution among the Hindus, has been effected by the food crisis.

TABLE 16. Showing the emigration of the population during June—November 1943.

Class	Emigration within June—November 1943									Population in May '43	Emigration per 100
	0—15		15—50		50 and above		Total				
	Male	Female	Male	Female	Male	Female	Male	Female	Total		
	(1·1)	(1·2)	(2·1)	(2·2)	(3·1)	(3·2)	(4·1)	(4·2)	(4·3)		
I	5	5	9	2	...	...	14	7	21	396	5
II	4	...	14	...	...	...	18	...	18	566	3
III	3	1	4	1	...	...	7	2	9	127	7

The table shows that 5, 3, and 7 per cents of the population have migrated due to food crisis within June—November, 1943. It also indicates that more males have emigrated than females and that the largest number has emigrated from the economically effective population. The table also indicates that not a single one of the older population has emigrated for the obvious reason that they have no more strength or urge to try their luck elsewhere and so prefer to die if that be the consequence, in the native place. On the whole, the figures on the population problem, so far considered, show that the effect of the food crisis on the rural population of the district of Noakhali is that only within a period of six months from June—November, 1943 6, 9 and 3 per cents of the population have died and 5, 3, and 7 per cents of it have emigrated. Also of the low proportion of economically effective population 6 and 4 per cents of the total number of earners belonging to class I and II have died out, 14 and 7 per cents have emigrated, and 15, 11, and 6 per cents of the classes I, II and III are invalids through starvation and various diseases which are the consequence of starvation. This is how the food crisis has led the rural population towards physical extinction.

EFFECT OF THE FOOD CRISIS ON THE SOCIAL LIFE OF THE PEOPLE

Sufficient data as to how the food crisis is affecting the social life of these people could not be collected within the short period of field work. But in all the villages it was found that Hindus of various castes, like, Kayastha, Napit (Barber), Dhupi (Washerman), Jugi (Weaver), (as shown in table 17 where the class I sample, as mentioned in the beginning, belongs to the gruel kitchens) are taking their food from the same gruel kitchens; the Muhammedans having a separate kitchen. It indicates that even the caste system, the most dominant social

Another feature, to be noted, is that except one family unit under the class II all other found in the villages are simple families composed of the parents and children with rarely a married son. Infrequently there is also a widowed mother or sister or daughter. The system of joint family, so popular in Bengal is practically non-existent. How far this is due to the present food crisis or is the result of the constant deterioration of the economic life of the rural population from a considerable time requires further investigation. However it was found out that the widowed persons who are commonly looked after by the nearest relatives, like, brother or father in rural families have been made to live apart in many cases. At the time of investigation it was found out that in a Muhammedan family belonging to class I an old woman has very recently been put apart by her son and is not provided by him anymore, so that, she has to live with her two grand children by another son, dead long ago, depending solely on begging. In class II two cases were observed—one Hindu and the other Mohammedan—where the families have left the villages and gone to Assam leaving behind their two widowed sisters. In two other families, and in this case also one Hindu and one Muhammedan, the widowed sisters are not provided for any more and they have to live separately even when the two families are there in the villages. These two persons maintain themselves by domestic service and charity. Detailed investigation regarding such disruption in the usual social life could not be carried out, but these few instances indicate how due to the food crisis the social tie has been loosened when nobody cares to look after any other person.

This feature was more sharply brought out in case of three families of class II and of one of class III, the heads of which have sold their eight daughters between 10 to 22 years of age, to some persons hailing from Jessore who came there to procure girls for marriage, at Jessore. It is not definitely

known whether the girls are really married in Jessore or are utilised for immoral purposes, as they themselves could not be sure on this point. The fact remains that the severity of the food crisis has made these people so inhuman that they have sold their daughters even though their future was unknown. Another person, the head of another family unit belonging to class II, told us that he also wants to

The fact and figures prove that this last group is nevertheless affected. This study has revealed that the effect of the food crisis in case of all the types is the same in quality, the variation being only of degree.* Every where, in all cases, the food crisis has economically ruined the people bringing many of them to total destitution. Biologically it has led them to extinction at a tremendous speed and

TABLE 17. Showing the total number of families and persons, according to community and caste, of the population in December 1943

Community, Caste or Sect	Family Units			Population		
	Class			Class		
	I (N-85)	II (N-105)	III (N-28)	I (N-352)	II (N-496)	III (N-114)
	(1)	(2)	(3)	(4)	(5)	(6)
Brahmin	...	2	...	...	14	...
Kayastha	11	27	...	56	158	...
Napit (Barber)	3	1	...	16	1	...
Jugi (Weaver)	1	11	...	4	44	...
Karmakar (Blacksmith)	...	4	...	...	10	...
Sutradhar (Carpenter)	...	2	...	...	11	...
Dhupi (Washerman)	13	7	...	42	26	...
Bairagi (Vaishnava sect)	...	2	...	...	3	...
Natya (Dancer—intermediate between Hindu & Muslim)	...	2	...	...	9	...
Hindu	28	58	...	118	276	...
Muslim	57	47	28	234	220	114

sell his daughter in this way but cannot do it as the girl has no proper clothes to wear!

The report can now be summed up as follows. Through the study of the three classes of families I have tried to find out the effect of the food crisis on the people of the district as a whole. Although I could not collect a large volume of data, yet the three samples studied may be considered to be the cross-sections of the life of the people of the district, where the class I represents the most affected, the class II those affected in a lesser degree, and the class III, the general population of the district of any village who may not have received any relief.

socially it has disrupted their normal family ties and turned them into callous beings bereft of human sympathy and feelings.

This is the effect of food crisis of 1943 on the rural population of the district of Noakhali. It will totally crush these people unless proper steps are taken to rehabilitate them.

* The figures regarding the class III seem to show that this class is not so adversely affected as the other two. It may be that this is the real fact. But we must also bear in mind that our sample is very small with regard to this class (only 28 family units being studied). Hence it may not accurately show the severity of distress of the people belonging to this class.

NEW NOBEL LAUREATES IN CHEMISTRY AND PHYSIOLOGY

PROF. GEORGE V. HEVESY is the recipient of the Nobel Prize in Chemistry for 1943. His main work and notable contributions lie in the field of X-ray Spectrography as applied to the study of chemical problems and in the sphere of radio-activity. His work on the separation of isotopes is also an outstanding one.

In collaboration with Bronsted in 1921, he succeeded in effecting partial separation of the isotopes of mercury and chlorine by fractional distillation under conditions of the so-called ideal distillation, in which the molecules leaving the surface were not allowed to return. Following the same method in 1927, he effected partial separation of the isotopes of potassium and proved that K^{39} is not responsible for the activity of potassium.

In 1922, following the suggestions offered by Bohr's theory of atomic structure, he, in collaboration with Coster, examined numerous zirconium minerals by the X-ray method, which led to the discovery of hafnium, the element No. 72, and proved it to be a homologue of zirconium and not a rare earth element as was believed by Urbain and others. The chemistry of hafnium was developed and elucidated entirely by him. Micro-chemical analysis by means of X-ray spectrography forms also an important feature of his contributions to chemistry.

By far the largest amount of his work lies in the field of radio-activity and specially in connection with the use of radio-elements as indicators. Mention may

be made in this connection of (1) the use of thorium B as indicator for the determination of the solubility of lead chromate in water, (2) exchange between bivalent and quadrivalent lead ions in solution, (3) determination of deposition potential of polonium and bismuth, which verifies Nernst's formula for deposition voltage even in extremely dilute solutions of the order of 10^{-8} N, (4) the use of radio-elements as indicators in colloid chemistry, (5) study of self-diffusion in solid metallic lead and lead salts, as well as the interchange of lead atoms between fused lead and fused lead chloride, and between lead oxide and lead sulphide, (6) absorption and distribution of lead in roots, leaves and fruits of a plant; and the use of radio-active isotope P^{32} in the study of metabolic processes. The nature of radio-activity of the rare earth element samarium was first studied and established by him. He was one of those who investigated the nuclear transmutation of the rare earth elements.

Hevesy was an Ordentlich Professor of Physical Chemistry for several years in the University of Freiburg from where he went to Stockholm before the outbreak of the present war. He is the author of several well-known and standard books like 'Die Seltenen Erden vom Standpunkte des Atombaues' (Rare-earths from the standpoint of Atomic Structure), 'Chemical Analysis by X-rays', and a 'Manual of Radio-Activity' (with Paneth).

P. Ráy.

H. S. GASSER and J. Erlanger were the joint recipients of Nobel Prize for Physiology for 1943, as was announced sometime ago. They achieved their distinction by their brilliant work in the domain of biophysics of nerves in relation to the study of their action potentials by greatly improved technique, viz., by Cathode Ray Oscillograph after suitable amplification, and by their equally brilliant analysis of the results of this study. Although the main part of this work was done by Gasser in collaboration with Erlanger, yet others such as Newcomer, Bishop, Graham, Grundfest, and Blair helped him to a considerable extent in elucidating these problems. Before their work it was known that when a nerve is stimulated, a chain of processes giving electrical, potential signs is set up. The algebraic sum of these potentials is called the "action potential". In an intact nerve the action potential is di-phasic in nature, but if the nerve is damaged at one end, as by the application of a hot wire, the leads

from an uninjured and the injured portions of the nerve show a mono-phasic variation or a mono-phasic wave. Gasser *et al* showed by eliminating diphasicity by potassium method and by applying refined technique that the monophasic action potential wave is not simple but composite, consisting of one larger potential change followed by smaller and slower potential changes which are masked in the di-phasic wave. The larger potential change is the spike potential and the subsequent smaller and slower changes, the after-potentials. These after-potentials consist of a negative after-potential starting while the spike is in progress and finally the positive after-potential which appears after the ending of the negative after-potential. The negative potential is of variable magnitude and duration and the positive potential is very small in frog's nerve fibres, but is sharply defined, constant in form, position and occurrence in those mammalian nerve fibres in which the velocity of transmission of impulse is very fast (i.e., A-fibres).

The duration of spike potential is about 0.4 m. sec.; of this the period of rising potential is $\frac{1}{3}$ and of the falling potential $\frac{2}{3}$ of the time (i.e., of 0.4 m. sec.). The negative after-potential which begins while the spike is in progress reaches zero at about 15 m. sec. from the beginning of the curve. It is then succeeded by the positive after-potential which reaches a maximum at about 30 m. sec. but continues to about 70 m. sec. The potential of the spike at its peak is about 12 mv. Regarding the magnitude of the negative after potential, though no definite value can be given because of its overlapping with the spike, yet there are reasons to believe that it is about 5 to 6 per cent. of the maximum spike potential. The crest of positive after-potential has a value of 20 to 25 μ v., i.e., about 0.2 per cent. of the spike potential.

In freshly mounted (in air or O_2) isolated nerves, in which the fibres are subject to spontaneous discharges, such as the phrenic nerve, the after-potential is rhythmic, i.e., in addition to negative and positive phases, there may be a second cycle of negative and positive waves, and even a third and a fourth one, the discharges increasing during the negative phases and decreasing during the positive phases. Tetanisation and veratrinisation augment both the negative and positive potentials.

Recovery of excitability in a nerve after stimulation was studied in relation to these various phases of action potentials. The absolute refractory period coincides generally with the duration of the spike potential and lasts between 0.41 and 0.44 m. sec. in best preparations, although not infrequently, no sign of a second response can be evoked unless the shock interval is 0.5 m. sec. In nerves functioning under physiological conditions the relative refractory state ends at about 3 m. sec. and the supernormal phase lies between 3 and 15 m. sec. with a maximum of 7 per cent. at 7 m. sec.; subnormality is shown between 15 and 70 m. sec. with a maximum of 3 per cent. at 30 m. sec. In isolated nerves the relative refractory period is shortened by the augmented negative after-potential process and supernormality which coincides generally with the negative after-potential comes on early. In nerves *in situ* the relative refractory period is longer and the supernormal phase is less in degree and shorter in duration. The subnormal phase coincides with the positive after-potential period. Fresh nerves (isolated) show less negativity and less supernormality. In cases, such as after tetanisation where the negative after-potential is sufficiently augmented along with the positive after-potential, the complete cycle through which the excitability of a fibre passes before returning to its steady state is made up of: the refractory period, a first supernormal and then a first subnormal

period, a second supernormal and then a second subnormal period.

In an earlier period of their work, when they first used the lagless instrument, viz., Cathode Ray Oscillograph, for recording action potentials, they noticed that secondary waves occur in the cataplectic limb of the action potential curve. They soon realised that these waves are discrete action potentials originating simultaneously with the main action current but travelling at different rates in fibres possessing different physiological characteristics, for when the action potential of a mixed nerve is recorded by leads placed close to the site of stimulation, it is simple in form; if the leads are placed at a distance of 31 mm., the cataplectic limb shows a hump; if at 82 mm., three or sometimes four separate waves are clearly seen. These waves are called α , β , γ , and δ waves. The three usual waves, viz., α , β and γ , have the same general form but the α -wave has the greatest and the γ -wave the smallest amplitude. These waves may be compared to scratch runners in a race who, though starting together, gradually get separated at longer distances from the start since the faster contestants outstrip the slower. On studying the course of transmission of these waves from the sciatic nerve to its spinal roots, it was noticed that the α -wave is composite, consisting of a sole motor component which passes into anterior roots and α -sensory component which passes into posterior roots. The fibres contributing to these 2 waves have about the same stimulation threshold and rates of conduction. It was further noticed that β , γ and δ waves are entirely sensory and like the α -sensory wave pass into posterior roots only. On stimulation of a motor branch of the femoral nerve α -waves alone are obtained and of a branch of the same nerve going to the skin β and γ waves and not α -waves are obtained. It was, therefore, concluded that α -waves are produced in large efferent (motor) and afferent (muscle sense) fibres of the muscular branch and β and γ waves in afferent fibres subserving skin sensations. All these fibres (α , β and γ) enter somatic nerves via spinal roots. In studying the relation between the activity of a nerve, as revealed by its electrical sign, and its morphology these workers found that a correlation exists between fibre size and the velocity of the action potential wave. Thus three groups of myelinated fibres existing in the peroneal nerve of a frog with diameters of nearly 16, 10 and 5 microns are found to be responsible for the conduction of α , β and γ waves respectively. In the sciatic nerve of dogs and cats the velocities of propagation of α , β and γ waves are 90, 50 and 30 meters per sec., whereas their velocities in the corresponding nerve of bull frog vary between 50 to 10 meters per sec. Thus the greater the diameter of a fibre, the faster

is its conduction rate. The excitability and the length of the refractory period of the fibre also varies with the diameter, the smaller ones possessing a higher threshold and a longer refractory period than the larger.

On applying a stimulus much stronger than that required to elicit α , β , γ (and sometimes δ) waves from a mixed nerve and on greatly increasing the amplification of the instrument these workers found that two other waves (or series of waves) appear if the action potential is recorded from the nerve at a distance of 91 mm. from the seat of stimulation. The first of these appears about 15 μ (i.e., m. sec.) after the crest of the γ -wave and the 2nd wave appears about 110 μ after the termination of the former. Gasser and Erlanger called these B and C waves and included α , β , γ (sometimes δ) waves in A group of waves. The B elevation is sometimes compound like A and the C elevation is usually so. In a mixed nerve A group comprises all those myelinated fibres of which the diameter is 5 μ or upwards, and B and C groups include such myelinated fibres as have a diameter less than 5 μ and unmyelinated fibres.* The conduction rates of B fibres vary between 20 and 10

* The correlation between fibre size and conduction rates that is seen in the case of A group of fibres is not noticed in the case of B and C groups.

meters per sec. in dogs and cats and between 5.5 and 1.3 m. per sec. in bull frogs and of C fibres between 1.6 and 0.3 m. per sec. in the former (i.e., dogs and cats) and between 0.9 and 0.2 m. per sec. in bull frogs. The irritability of A fibres is maximal, that of B intermediate and of C the least. B fibres enter the mixed spinal nerve through grey rami and are accordingly post anglican sympathetic fibres. C fibres are found in (a) anterior roots and white rami (therefore efferent, myelinated pre-ganglionic sympathetic fibres), (b) grey rami, and (c) posterior roots, in which they are non-myelinated. They possibly transmit sensations of pain and are concerned in antidromic dilatation and sherrington contracture.

The work of Gasser and Erlanger once more proves how important is the application of Physics to problems of Physiology. Co-operation or rather combined action between Physicists and Physiologists is essential for the development of Biophysics in this country, for it is rarely that the same individual has a conjoint training in both mathematical physics and higher physiology. It is to be remembered and realised that if a distinction is made between the status of Physicists and Physiologists in the course of such co-operative work, the growth of Biophysics is likely to be hampered.

N. M. Basu

Notes and News

NOBEL AWARDS IN PHYSICS & CHEMISTRY

CLOSE at the heels of the report of the Nobel awards in Physiology and Medicine for 1943 and 1944 comes the announcement of the like awards in Physics and Chemistry for the same years. Prof. O. Stern of the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, has received the Nobel Prize for Physics for 1943. Prof. Stern developed the technique for the study of atomic beams and experimentally demonstrated, in conjunction with W. Gerlach, the directional quantization of atoms, and also determined the magnetic moments. In 1933 he determined the magnetic moment of proton. He was Professor of Experimental Physics in the University of Hamburg till 1933.

The Prize for Physics for 1944 has been awarded to Prof. Rabi of Columbia University, New York.

He began his investigations in Hamburg under Prof. Stern, and with his co-workers has extensively developed the method of atomic beams for the measurement of nuclear magnetic moments of unprecedented accuracy.

Prof. George von Hevesy of Stockholm has been awarded the Nobel Prize for Chemistry for 1943. He developed the use of isotopes as indicators in the study of chemical processes and of biological metabolism. The award in Chemistry for 1944 has been reserved until next year.

PROGRESS OF TELE-COMMUNICATIONS IN INDIA

AN unofficial note relating to the activities and developments of the Indian Posts and Telegraphs Department contains a useful account of the recent progress of tele-communications in India. An exten-

sive scheme for tele-communications development, estimated to cost Rs. 17,00,00,000 and scheduled to be completed in 1944-45, was undertaken in the middle of 1942 in response to the growing needs of the Defence Department. The scheme provides for a five-fold increase in the number of telegraph and telephone channels between the main centres in India for civil and defence purposes and, in addition, seeks to introduce extensive wire communications required by the Defence Services. One hundred and twenty-three thousand miles of wire (with 11,000 miles of new routes) will connect all important cities, enabling a number of messages to be transmitted on a single pair of wires at the same time. Provision has also been made for the expansion of local telephone systems in various places, amounting to 20,000 new connections. Over 100 telephone and nearly 350 telegraph channels are reported to have already been added. Nearly 2,000 miles of post route and over 10,000 miles of wire have been erected so far. Over and above this, 4,000 miles of line and 60,000 miles of wire have been erected for meeting the operational needs of the Defence Services since the outbreak of the war.

It is heartening to learn of such expansion in the tele-communication services in India. But despite all these expansions tele-communication services still cater to an insignificantly small fraction of the Indian population, crowded in a few scattered cities, large and small. These services are mostly unknown to more than 85 per cent. of India's 400 million people, dwelling in about 700,000 villages, and as such are fraught with the possibilities of an immense development in future when more men and women will be released from the plough to the factories.

MICA ENQUIRY COMMITTEE

THE Central Government, according to a press note issued by the Labour Department, New Delhi, have appointed a Mica Enquiry Committee to enquire into the immediate as well as the long term problems of mica mining industry. The Hon'ble Mr Justice E. E. Reuben, I.C.S., of the Patna High Court, has been appointed Chairman, and Rai Bahadur Rai Hardatta Prasad, Secretary to the Committee. The Committee will be assisted in their investigations by assessors from the mica trade and industry and by technical advisers from the Geological Survey of India and the Board of Scientific and Industrial Research.

While the Committee will generally enquire into and report on all problems relating to the mica industry and its present and future developments, it will specifically examine and report on immediate problems relating to the Mica Control Order, 1940, both in regard to war production and long term

policy. The Committee will further review any orders that may have been passed by Government in connection with that Order, such as the present system of marketing both inland and abroad, standardization of quality, the extent to which alternative sources of supply may have jeopardized or are likely to jeopardize the position of India as the principal supplier of muscovite mica, the extent to which other materials that may be used as substitutes for mica may have displaced or are likely to displace mica from its uses in the industry, increased utilization of mica in India for the manufacture of finished goods, methods of development with special reference to research, conservation, mining, processing, marketing and meeting competition, and the desirability of setting up a suitable machinery whether by the appointment of a Central Mica Committee or otherwise to watch the interests of the mica trade and industry. The Committee will have its headquarters at Patna and will tour in mica mining areas to take evidence on the spot.

THE GREAT ENGLISH INDIAN DICTIONARY

THE readers of SCIENCE AND CULTURE will be interested to know that the International Academy of Indian Culture has undertaken to prepare and publish an exhaustive Indian Dictionary of technical, semi-technical and literary words covering the entire range of human thought and life. The work started in 1934 under the inspiring guidance of Dr Raghu Vira, the editor-in-chief and founder of the Academy, with the co-operation of a number of distinguished scientists, linguists, literary men and educationists drawn from all parts of India and constituting the editorial board. The experiments in the formation of suitable terms could take the finished form only in 1943, and the first fascicule was printed in July 1943 in Devanagari. This was soon followed by the second fascicule which was issued in December, 1943 in Devanagari, Bengali, Kanarese and Tamil. Since then progress in the preparation of the Dictionary has been steady, and the first volume on inorganic chemistry has been completed.

The Great English Indian Dictionary, as it has been styled, will contain Indian equivalents for every word of the English language, literary, technical and semi-technical, covering about six hundred special branches of knowledge. The Oxford Dictionary in thirteen volumes and the Webster's Dictionary in two volumes serve as the main sources for English vocabulary. The Indian words are derived from Sanskrit roots and stems and are such as are usable in the diverse literary languages of India and Ceylon, whether Aryan or Dravidian. Every word appears in four scripts, e.g., Devanagari and Bengali for Northern

India, and Canarese and Tamil for Southern India. To indicate the range of information, attention may be drawn to the first volume on inorganic chemistry just completed. It contains the elements, their derivatives and compounds, symbols, prefixes and suffixes, etc. It has further been provided with an introduction dealing with some of the principles underlying the terminology and with two appendices containing the verbs derived from the names of elements and the names of rocks and minerals connected with the element names.

The Dictionary appears in fascicules, and those of the first volume on chemistry are now appearing every month. The publication will cover a period of ten years and will entail a total cost estimated at about ten lacks of rupees.

The importance of such a work need hardly be overestimated. The Dictionary, when completed, is expected to serve as a valuable reference book for translators and authors of technical books in Indian languages, which are destined to play a great part in the future educational development of India.

HIGHER SALARIES FOR TEACHERS

At a meeting of the Teachers' Committee on Higher Education, appointed by the Central Advisory Board of Education, held in Simla on October 2 and attended by distinguished educationists from all parts of India, Sir Jogendra Singh, Member for Education, Health and Lands, said:

"It used to be argued that teachers should practise the virtues of contentment and plain living and take their vocation in a missionary spirit of service to the community and that they ought not to look for worldly reward. Teaching is indeed a form of social service, but in the words of the McNair Committee Report, like other professions 'it is also a bread and butter affair. The missionary spirit cannot be relied upon to maintain the supply and the morale of millions of teachers.'

"There are in British India 16 universities and 13 higher institutions for research of university rank, besides 430 colleges of different types affiliated to universities. It is not unknown to the members of this committee that grave harm has been done to education by recruiting teachers on cheap salaries irrespective of their attainments, and some of the best minds have been lost to the profession owing to this fact. What was said in the earlier committee's report is also true of university teachers. If the teaching service is to secure an adequate supply of the right type of people it must offer practical attractions comparable with those which other branches of public services offer to their members."

It is encouraging to hear such words from the Hon'ble the Member for Education, Health and Lands. But criticisms of this type are not new; it is time for positive action and for the initiation of practical steps to improve the teachers' financial lot. We are interested to know how and how soon the Government propose to give effect to their proposals for ensueing an adequate scale of salary for teachers.

INDUSTRIAL RESEARCH

THE Industrial Research Planning Committee, according to a report of *Hindu*, recently held meetings in Bombay to discuss problems of general strengthening of the scientific departments of universities and scientific institutes of university rank, questions relating to the establishment of administrative machinery for guiding and co-ordinating industrial research, and the setting up of a Bureau of Standards under the central organization for industrial research. Representatives of the University of Bombay discussed with the Committee questions relating to the making of a block grant to the universities for the improvement of equipment in their existing scientific departments and for the organization and development of new scientific departments according to the requirements and resources of different regions. The Committee further met the representatives of the Indian Merchants' Chamber and the All-India Manufacturers' Organization and discussed the question of establishing a suitable administrative machinery with adequate representation of scientific and industrial interests for guiding and co-ordinating industrial research on a comprehensive basis. In connection with this administrative machinery such questions as the exploitation of research processes through a National Board of Trustees and the extent to which available facilities in research institutions were used by industry were also discussed. Finally, the Committee examined the possibility of establishing a Bureau of Standards under the auspices of the Central Organization for industrial research and discussed the nature of the relationship the proposed Bureau should have with the National Physical Laboratory and various other testing laboratories.

Recommendations of the Committee are not yet available. Meanwhile the All-India Manufacturers' Organization has submitted a memorandum, and we understand that several of the recommendations contained in the memorandum have been accepted for inclusion in the Committee's report.

TRAINED PERSONNEL FOR INDIA

At his first press conference after assumption of office, Sir Ardeshir Dalal, Member for Planning and Development, explained the Government policy regarding the problem of the supply of trained personnel in India. He expressed his conviction that the training of scientists, engineers, geologists, doctors, agriculturists, educationists, administrators etc. for innumerable different jobs requiring their services was the most essential preliminary step. "To my mind," said Sir Ardeshir, "the question of personnel is probably the most serious of the difficulties in the way of planning and is likely to impose well-defined limits to the pace of development". The solu-

tion, in his opinion, lies in the expansion and multiplication of educational institutions and in the generous provisions for scholarships and research studentships to enable Indian students to prosecute higher studies both in this country and abroad. Sir Ardeshir revealed that the Government intended to send a large number of men to receive training in the U.K., and the U.S.A. in the near future. In fact, Mr John Sargent, Educational Adviser to the Government of India, has now been visiting these countries with a view to exploring the possibilities of making such arrangements and is expected to submit his detailed scheme when he returns to India. Furthermore, the Government now have had under consideration the establishment of a very high grade technological institute on the lines of the M.I.T. in the U.S.A. and also of an All-India Medical Centre.

PROPOSED PANELS FOR INDUSTRIES

The first meeting of the Policy Committee on Industries, which took place towards the end of October, provided another occasion for Sir Ardeshir Dalal to revert to the Government policy particularly with regard to the development of industries. The Government, it would appear, are inclined to favour the development of industries on a regional basis. The provinces have been requested to form development committees and offices of their own and draw up plans for the establishment of industries suited to their areas. But what is more important the Government have proposed to set up a number of panels for investigating the problems of the development of individual industries or groups of industries. The final plans will be developed after due consideration and co-ordination of the proposals put forward by the provincial committees and panels for industries.

It is proposed to attach to each of these panels one or more experts, according to requirements, as well as a permanent officer of the Planning Department. The panels will be constituted in close consultations with the Supply and Industries and Civil Supplies Departments. It may be necessary to obtain the services of some experts from outside to deal with certain industries. Where there are fully representative and authoritative associations representing any particular industry, such as the Central Board for the cotton textile industry, set up by the Government and fully capable of dealing with all questions pertaining to this industry in India, creation of panels is unnecessary and will not be attempted. But such associations are not many, and panels may be profitably established in several industries and groups of industries. Besides there are industries involving highly complicated technical processes, which would call for the advice of more than one expert to decide the feasibility of establishing them in this country. Shipbuilding, air-craft, manufacture of large electrical

machinery, plastics, dyestuffs etc. are instances of such industries, panels for which will make general recommendations regarding their feasibility and location.

Sir Ardeshir assures us that it is the intention not only to start new industries and to maintain and expand the existing ones with the help of imported machinery, but to make, as far as possible, such machinery in this country.

FRENCH SCIENCE DURING GERMAN OCCUPATION

The American weekly *Time*, October 16th, 1944, gives some news of the work of the French scientists during the German occupation of France. Paul Langevin, the 72 years old veteran physicist has returned to Paris from Switzerland; a reception was given at Sorbonne in his honour. Langevin was arrested in October 1940 while at his post in L'Ecole de Physique. After being imprisoned for two months, he was released as a result of protest riots in which several students were killed. The underground movement helped him to escape from house arrest at Troyes and cross the border. His son-in-law, Jacques Solomon, was amongst the organizers of the clandestine scientific journal *Z'Univusite Libres*. It is reported that all of the organizers were shot by the Nazis. Fedric Joliot, son-in-law of Madame Curie had his troubles. His laboratories at Paris and Ivry were seized in June 1941, and he had a twelve hour ordeal with the Gestapo. He came through well enough to get back his laboratories and the only French owned cyclotron and a precious stock of radium.

It appears that Alexis Carrel, the well-known experimental biologist and author of the books 'The Culture of Organs' and 'Man the Unknown', was the only first rank scientist who collaborated with the Vichy Government; he was provided with plenty of funds for investigations of human problems discussed in his last named book. After the liberation of Paris, Carrel was suspended from his post as director of the research foundation which is being placed under a new management by Joliot.

NEW FELLOWS OF THE NATIONAL INSTITUTE OF SCIENCES OF INDIA

At the meeting of the Council of the National Institute of Sciences of India, held on the 30th October, 1944, the following were duly declared to have been elected Ordinary and Honorary Fellows of the National Institute:

ORDINARY FELLOWS

Prof. Bashir Ahmad, Professor of Organic and Bio-chemistry, Punjab University, Lahore; Prof. N.

ANNOUNCEMENTS

We regret to announce the death of Prof. Sir Ralph Fowler, F.R.S., Plummer Professor of Theoretical Physics, Cambridge University, at the age of fifty-five. He was the son-in-law of Lord Rutherford. We shall publish a biographical sketch of this well-known mathematical physicist in our next issue.

We deeply regret to record the death of Sir Arthur Eddington, Professor of Astronomy in the Cambridge University and Director of the Observatory at Cambridge at the age of 61. He was one of the leading astro-physicists of the present time. The world science has sustained an irreparable loss through his death. A fuller account of Sir Eddington's life and work will be published in a subsequent issue.

News has just been received from London that Mr B. B. Ray, B.Sc. Hons. (Physics) Calcutta, B.Sc. Hons. (Eng.) London, M.Sc. (Eng.) London, A.M.I.E.E. has been admitted to the Fellowship of the Institute of Physics, London. It is understood the honour was bestowed on him on the merits of his work in connection with voltage regulation problem. Mr Ray is at present in charge of Electricity under the Government of Orissa.

HONORARY FELLOWS

Sir Henry Hallett Dale, President, Royal Society of London; Prof. A. V. Hill, Secretary, Royal Society of London.

SCIENCE IN INDUSTRY

COLOUR TELEVISION

SOME time ago, a reporter of the *News Chronicle* related the story of the three dimensional colour television developed and recently demonstrated by Mr J. L. Baird. The new television set is the result of three years of research and for the first time makes possible the reception of television in colour as well as in depth so as to make the images closely resemble objects in three dimensions as well as in natural colours. A short account of the technical features of the television set has appeared in *Nature*, September 23, 1944.

In his new set, Mr Baird has dispensed with the mechanical moving parts such as the revolving disks and lenses and has introduced electronic devices. He has developed a special cathode ray tube, termed a 'Telechrome', which reproduces the received pictures. The tube is provided with a doubled sided transparent screen coated on both sides with fluorescent powders of the appropriate colours. Two cathode ray beams modulated by the incoming signals corresponding to two pictures of a subject, taken in

primary colours, are allowed to impinge obliquely on opposite sides of the screen. The screen develops on its front face an image containing the orange-red colour components and on its back an image with the blue-green components. The two images blend and give rise to an image in natural colour. The pictures in colour have further been used to produce stereoscopic effects.

Mr Baird demonstrated the reception of colour television with the help of such a tube containing a screen, 10 in. in diameter. Pictures were received from a 600-line triple interlaced moving spot transmitter using a cathode ray tube in combination with a revolving disk with orange-red and blue-green filters. The screen developed a very bright picture with good matching of colours, due partly to the absence of colour filters and partly to the use of special fluorescent powders.

Mr Baird is also reported to have perfected another method in which he has used three colours. The back of the screen which is ridged is coated with blue and green powders. The blue and green pictures

are transmitted on the back of the screen, while the third beam containing the red component of the picture impinges on the front of the screen.

RELAXATION METHODS

THE calculation of stresses in highly redundant frames has always presented a complex and laborious problem. Several methods have been devised for their solution, and the one that has been lately propounded is the Relaxation method. It has been worked out by Professor Southwell, F.R.S., the distinguished designer of aircraft structures and investigator of the Theory of Elasticity. In this method he has sought to assess the range and power of a new approach to physical and engineering calculations by what is termed "the systematic relaxation of constraints." By the orthodox methods *viz.*, those based on Castigliano's principle of minimum strain energy, attention is focussed on the quantities whose values are sought, with the result that some difficulty is experienced in trying to formulate and solve the large number of simultaneous equations involved therein. In the Relaxation method the procedure is, as it were, reversed, attention being concentrated on the specified quantities *viz.*, the external loading, and not on the quantities whose values are sought, these quantities in a braced framework representing the stresses or joint displacements in the required configuration. The object of this reversed procedure is to liquidate the external forces, by relaxing each specified constraint which is imposed on a joint, in such a way, that after a few operations the magnitude of the residual forces is very negligible. Thus, though the liquidation is not exact, it is always within some margin, covered by the practical margin of uncertainty. The logicity of this statement is based on the fact that it is only in theoretical or invented problems that the external loading and other data can be specified with certainty: in practice loadings are uncertain to the same or very nearly the same extent as the elastic nature and properties of the structure.

The distinguishing feature of this method, as compared with the other already in use for the determination of stresses in statically indeterminate structures, is that although attention is concentrated on residual forces, the operations required for their liquidation are also recorded, with the result that action in each and every member of the framework can be readily computed, *i.e.*, not only are the values of stresses available, but even the resulting distortion of the framework can be deduced. Besides, redundancy has almost no effect upon the time required for the solution, which, as it were represents the most significant feature in the Relaxation method.

As the basis of the whole Relaxation procedure rests on fundamental principles of Statics, the present

method is found to have applications in far wider fields in engineering. By the use of what is termed Block and Group Relaxations, stresses and strains can be conveniently determined in a framework of several bays, (like a Warren truss) or in a continuous beam having several supports, or in the wing spars and bays of aeroplanes, which present by far the most complicated of all the problems in stress analysis.

In fields where investigation is still continuing, Relaxation methods are applied to the problems of free and forced vibrations, torsion and flexure problems of St. Venant, determination of currents, and potentials in electrical networks and the normalization of simultaneous equations.

Poisson's equation in two dimensions, when solved by Relaxation methods, finds application in the theories of Elasticity and Earth Pressure, in problems of Plastic Torsion, and the stiffened Suspension Bridge, the latter in connection with non-linear systems.

It is hoped that these, and the further investigations which take place will materially benefit the science of engineering in all its branches, and lay in the hands of a designer a powerful and useful tool, for all types of complex structural analysis and research.

S. K. G.

RADIO HEAT DEHYDRATES PENICILLIN

DEHYDRATION of penicillin has presented a great problem to vacuum engineering. Ordinary methods of evaporation by heating are, however, not applicable as these involve the risk of the loss of potency of the drug. Accordingly, the process of bulk reduction by evaporation in a high vacuum at temperatures below the freezing point has been frequently resorted to during recent years. Such methods are technically described as "freeze-drying".

Meanwhile, according to a report in *Science*, Dr George H. Brown, research engineer of the Radio Corporation of America, has developed a method of dehydrating penicillin by radio heat, which is reported to be forty-eight times as fast as the present "freeze drying" method. Experiments on this electronic process were carried out at the new E. R. Squibb penicillin production plant at New Brunswick. The speed of drying may be reflected from the fact that in 24 hours enough penicillin was dehydrated to treat 4,000 patients each requiring 500,000 units of the mold chemical. Besides the saving in time, the new electronic process has several other advantages of which the following may be mentioned: (1) Reduction in operating cost equivalent to the saving of one ton of dry ice a day or about 65 per 24 hours, (2) Reduction in maintenance costs, (3) Smoother flow of productions,

(4) Reduction in floor space requirements by nearly 10 times, (5) Saving in initial investment of several hundred per cent.

VERNALIZATION OF RICE

THIS method of inducing earliness and increased yield of rice is reported by Dr S. M. Sarker of the Botany Department, Calcutta University, in *Nature*, March 25, 1944.

In a winter variety of rice *e.g.*, *Bhasamanik*, 7 days old seedlings were exposed to short days (8 to 10 hours of daylight) for varying periods up to 6 weeks in the seed bed. The seedlings were later transplanted in pots and grown in the field under natural long days. This accelerates ear emergence by about 10 days and increase grain yield by about 16 per cent. With prolonged short days *i.e.*, until the ear emergence, earliness was induced by about 25 days and increased grain yield by 35 per cent. The application of the method in field practices is only possible by the treatment of seedlings in the seed bed. These results are of remarkable agricultural importance for the variety of rice grown after transplantation. In temperate cereals *e.g.*, wheat and winter rye, similar earliness in flowering has also been effected by seedlings treated to exposures of different light periods.

BEEDI LEAF INDUSTRY IN INDIA

DUE to the shrinkage of imports of cheap foreign cigarettes owing to the war, the *beedi* leaf industry

is expanding very rapidly. Revenue from this product has become one of the most important items of forest revenue.

The Indian forest leaflet No. 60 (silviculture) contains all the information that exists with a view to helping increased and better production of the cheap smoke. The subject is of great importance as in the present war conditions the demand for tobacco paper has increased enormously.

The object of this note is to indicate what type of experimental research is necessary for improving the production and quality of leaves for *beedi* wrappers. The leaves of many indigenous plants are used for wrapping tobacco, but *Diospyros melanoxylon* is the species per excellence generally preferred due to the peculiar flavour, flexibility in texture and resistance to early decay, as compared with the leaves of other species. *Diospyros melanoxylon* is one of the characteristic trees of the dry mixed deciduous forests of the Indian peninsula. In Bihar, Bombay, Central Provinces, Madras and Orissa, this is extensively used for *beedis*.

Details of quantity and quality of production of these leaves, of the time of collection, processes of drying, storage, packing and transport, and suggestions for experimental research with regard to pollarding and methods of drying which is subject to variations of weather *e.g.*, heavy rainfall, are detailed in this leaflet.

SOME ASPECTS OF FRUIT CANNING INDUSTRY

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IF photography has brought to us the panoramic sites of various countries, if radio has brought the lilting melodies of different people of the world, canning has done much more. It has brought the delicacies of different nations to our dinner table. No longer need we dwell in the realm of imagination as to the flavour of the Californian string beans or Hawaiian pine apples or English strawberries, we can taste them. The fruit canning industry has made fruits such as peaches, apricots and pine apples familiar to hundreds of thousands of families all over the world who would have known of these only by sight or names. It is the convenience rather than the cheapness that is the main attraction of canned foods and these are available in all their variety at any time of the year and in any climate. Canned food

is ready for serving and therefore there is very little wastage and further expense. Canning has done much more. It has helped armies fighting in out of the way places, navies guarding isolated places of strategic importance and explorers exploring the wilds of Africa or the snowy expanse of the Arctic or Antarctic to enjoy rich nourishing food in their natural flavour.

The old methods of drying, salting and smoking served the purpose to some extent but it was felt in the latter half of the eighteenth century that some better methods of preserving foods should be found, methods which could protect foods from spoilage for a considerable period. Young Nicholas Appert, brought up as a chef, had set up in business as a maker of confections in Paris. In about 1780 he felt

such a necessity and the year 1794 saw the opening of a small factory by Appert for bottling of foods. He filled the food stuffs in a wide mouthed bottle, kept them standing brinful in boiling water for some time and then sealed them with alternate layers of cork and wax.

The introduction of tin canisters for the purpose of filling food by Peter Durand in 1810 in England was a great advance in the canning industry and since then this industry began to develop in England, America and Europe. The tin can has gone through numerous improvements. The cumbersome use of cans with vent holes which were exhausted and then sealed with solder was replaced by the invention of open topped can which is a land mark in the history of canning industry. Today various types of cans are available—plain tin cans, lacquered tin cans and cans with special enamel linings to prevent the bleaching of coloured fruits and the staining of the inside of the can such as occurs with sulphur bearing fruits and vegetables and meat products when packed in plain cans.

FRUIT CANNING OPERATIONS

The fruit canning operations whether done with hand or by machines are essentially the same. The fruits to be canned are first sorted, graded and washed. Then the stalks and calyces are removed and the fruits are peeled, cored and trimmed or cut into slices. Next they are steam blanched and filled into cans and syrupe. The skins of certain fruits like peaches have to be softened by scolding them in hot water or steam or by the use of caustic soda or lye (lye-peeling) for a few seconds, the strength of the solution being about 1 to 3 per cent. The blanching of fruits and vegetables either with steam or hot water has the additional advantage of softening and shrinking them in order to obtain a well filled can or bottle after cooking, as also of driving out from the tissues a great deal of air which might otherwise remain to promote corrosion. The quantity of fruit and sugar used in canning has to be carefully controlled both from the point of view of flavour and economy.

Syruping over, the cans are exhausted by immersing the open cans filled with fruit and syrup as hot as possible, in a large covered tank containing hot water, to within one inch of their top and made to travel through at a regulated rate. The water in the bath is kept at about 180–190°F and the cans usually emerge with their contents at a temperature of about 160°F. The lids are then placed in position, automatically clinched on and rolled tight by the double seaming machine. Then comes the sealing and this is a very important process as the success of the whole canning process depends on obtaining

a perfect seal. This too is a mechanical process. The next operation is that of processing of canned fruits which has for its object the destruction of bacteria and fungi which would otherwise cause spoilage. With fruits this operation is rendered comparatively easy on account of the high acidity of the products and they are readily sterilised at the temperature of boiling water or even at a lower temperature. With vegetables and meat it is more difficult. The latter are subject to spoilage by thermophilic and other heat resisting spore forming bacteria among which is the well known *Bacillus botulinus*. They must therefore be sterilised by heating in retorts at temperatures of 240° or 250°F for a length of time sufficient to destroy such organisms. After sterilisation the cans are cooled, labelled and stored in the proper place so as to avoid getting rusted.

Of late, bottling of fruits has been practised extensively. The advantages of bottling are—the almost complete elimination of the trouble of corrosion except of caps in the case of bottles with metal caps and the visibility of the product from the outside thus enabling the consumer to actually see what he is buying. Against these are the disadvantages of breakages during transport or sterilisation and the decolourisation of some fruits, especially red fruits, due to exposure to light. The process of bottling fruits is essentially the same as the canning of fruits. The trouble of corrosion has been eliminated by the use of caps which have been lacquered inside and with rubber gaskets to fit tightly. Breakages have been reduced by the manufacture of glass which can withstand sudden changes of temperature.

SPOILAGE OF CANNED FRUITS

Spoilage of canned fruits may be due to various causes. It may be due to the growth of micro-organisms such as moulds, yeasts or bacteria, present either through under sterilisation or leaks, due to the corrosion of the tin or iron of which the can is made resulting in discolouration of the contents and in the formation of hydrogen swells and perforations or due to the over filling of the cans or the use of dented or rusty cans.

Hydrogen swells and perforations are caused by the formation of hydrogen in cans by the action of the fruit acids on the tin and iron of which the can is made. When this attack is concentrated at certain spots so as to cause pitting, the can may actually become perforated. Other causes of hydrogen swells are the presence of substances such as sulphides which accelerate corrosion of iron with products of high acidity, storage of canned goods at high temperature, inefficient cooling of the cans after processing, presence of substances which encourage detinning and so on. The remedy for this trouble lies

in proper control in the factory, especially in filling, exhausting and sealing, by storage in cool places, use of sugar free from sulphur compounds and by adjusting the acidity of the syrup.

Discolouration of canned fruits may be either due to injury or over riping or due to the presence of sulphur compounds in the sugar used or due to the use of sulphur sprays or fungicides on the fruits used for canning or due to the presence of sulphur compounds in the fruit itself. Fruits containing anthocyanine like various berries often undergo changes due to contact with metals like iron, aluminium, copper, tin etc. Pipes, pans, utensils etc. should therefore be made of stainless steel or other metals which do not affect the anthocyanins. Many fruits like apples, pears and peaches rapidly turn brown or show other colour changes. Such fruits have been found to contain what is known as the oxidase system which is a system of enzymes which acts upon certain aromatic substances. This system is completely destroyed by heat and it is checked in its action by storage at 32°–40°F or by a weak brine or sugar solution. Each fruit has its own idiosyncrasy and the best canning conditions have to be evolved for each fruit separately. Hirst and Adam¹ have published a useful report dealing with the idiosyncrasies of various fruits and the steps which should be taken to reduce the trouble. The review of Ball² on the different methods for sterilising canned foods and that of Cameron³ on the control of contamination both of the raw products and in the canning plant may also be read with profit by the canners.

CANNED FOODS AND HEALTH

Canned foods may be harmful for three reasons. They may not be as nutritive as fresh foods, poisonous products like tin and lead salts may have been formed and lastly harmful bacilli might be present.

With regard to the nutritive value of canned foods it has been found as a result of extensive work that the nutritive value of canned foods does not change much on canning. Loss of vitamins is not much and is certainly never more than that occurring in ordinary cooking. It has been found that with lacquered cans the tin content after a year's storage rarely exceeds 30 parts per million. Therefore, for practical purposes tin poisoning from canned foods does not occur. With regard to lead poisoning it has been found that except in very rare cases there is no risk of lead poisoning from canned foods.

Another type of poisoning known popularly as 'Ptomaine poisoning' hindered the growth of canning industry for some time, especially in America. Ptomaines are poisonous substances in the product present only when the process of decomposition has advanced so far as to make the food-stuffs too revolt-

ing to be eaten. The assertions that ptomaine poisoning was due to canned foods have been more often than not found to be entirely without foundation though it must be admitted that the toxin type of outbreak is sometimes associated with canned foods for it so happens that in processing though the living bacilli are destroyed the heating is not invariably successful in destroying the preformed toxins. In many cases it has been found that the outbreak of epidemics from eating canned foods have been traced to products of low acidity canned in home under conditions of inadequate heat sterilisation.

A few years back a large scale investigation⁴ was carried out in England in which nearly 1700 rats were used in four successive generations. One group was fed entirely on canned foods, the other on the comparable fresh foods. It was found that the performances of the two groups in respect of breeding, growth and composition of the body as a whole as well as of the bones and teeth separately were in all respects comparable.

The practical experience of the French Mission to Greenland in 1932-33 when 15 men lived for 13 months on canned foods almost entirely without fresh foods and found no poisoning or nutritional defects and the millions of people who eat canned foods day after day without any ill effects are eloquent testimonies to the harmlessness of canned foods.

FRUIT CANNING INDUSTRY IN INDIA

The growth of canning industry in India is of recent origin. Still it is in its infancy. Small scale fruit canning is being done all over India but there are only about half a dozen canneries in India which may be considered to be of some importance. Though our fruit production is very much short of requirements from the point of view of nutrition and self sufficiency, with the extension of fruit plantations it is necessary to develop the fruit preservation industries in order that the produce may not go to waste when transport is not available or due to a glut in the market, but besides these to replace the present imports of preserved fruits by our own and to develop a foreign trade in preserved fruits and thus bring prosperity to the poor horticulturists of this country.

It is necessary to encourage the consumption of fruits by cheapening them owing to the nutritive value of the fruits and canning of fruits ensures this supply to those who can afford them in the off-season. The area under fruits and vegetables is about 1.9 per cent of the net area sown if the figures for the year 1939-40 are taken. There is a considerable amount of uncultivated land classed as "cultivable waste other than fallow" by which is meant land available for cultivation but not taken up or abandoned, and "current fallows" by which is meant land

left uncultivated for a certain period. A part of such land may be brought under fruit cultivation wherever facilities for irrigation exist by encouraging such cultivation by granting concessions to those who are prepared to do so. Hilly regions offer scope for English and Mediterranean fruits and the plains and the peninsular area for tropical and subtropical fruits. The information in respect of each fruit regarding the soils and climate suitable and the other factors necessary for the successful cultivation along with the survey of pests and diseases and their remedies, manurial treatments for different fruit plantations with the time of application and other information of importance to the fruit growers like sorting, grading etc. of fruits should be disseminated through the proper agencies like the government department of agriculture in a language which the cultivators can understand.

Extension of fruit cultivation would be also desirable because "the cultivation of fruits leads to the employment of far more labour than the cultivation of other crops" (Sir John Russell). There is ample market for fresh fruits in this country and if the fruits can be sold at cheaper rates than is now being done, by extensive cultivation, cheaper transport etc. many more people will be able to buy fruits and this will result not only in an improvement in the condition of the fruit growers but will improve the condition of malnutrition so widely prevalent in this country.

REQUIREMENTS OF FRUITS FOR CANNING^{6, 7}

Fruits meant for canning have to fulfil certain requirements and these are to some extent different than those of the fresh fruit market. Canneries accept generally only those varieties which remain firm and lose little of their colour when subjected to the heating and sterilising processes. Appearance is important many a times more than the flavour and the interplay of these two qualities flavour and appearance therefore affect the course of the industry. This necessitates those in charge of canneries to be in direct touch with the market and study its likes and dislikes.

The fruits for canning must be of similar grades so as to maintain a regularity of count in the canned products which is essential not only for the restaurant or catering trade but also for the private consumer to whom it would be irritating if the can cannot be relied upon to give the usual number of pieces. Another factor of vital importance to the canning industry is the regularity of supplies of the raw products at prices that fluctuate little from year to year. If the supplies are not regular the smooth working of the factory is bound to be hampered, labour will have to be kept idle or turned out, thus endangering

harmonious relations between capital and labour, overhead costs are bound to be higher for these will be lowest per tin when the factory works at its maximum.

Sulphur dioxide must not be used for preserving fruits intended for canning. Similarly the use of sulphur sprays or fungicides may also give the canned fruits a disagreeable odour.

Colour, flavour and texture are important considerations in choosing the time for picking and the particular variety of fruit to be canned. It is therefore essential in view of the considerations outlined above that the grower should study the needs of the cannery and plan his production accordingly. In countries like the U.S.A., Canada and South Africa which have advanced considerably in fruit canning industry the cannery agrees to buy the whole crop from a stated acreage at a fixed price per ton, if the production be of a certain standard. The canneries usually employ a field man to advise growers on choice of varieties and other problems of cultivation.

CONTAINERS

In the fruit canning industry the cost of the container is one of the main causes of great disparity in the price of the raw fruit and the canned article and forms more than $\frac{1}{4}$ of the total cost of production even in foreign countries well advanced in canning industry.⁸ In India it is still more and is over $\frac{1}{2}$ the total cost of production as we have to import the containers from outside. The cans used in general are wrought iron tin plates which are lacquered. Such plates are not manufactured in India at present. Even if the tin plates are manufactured in India the question of satisfactory lacquering will remain. Other types of containers like suitable types of bottles and jars are not available in large quantities and the few available are costly. If the cans are manufactured in India the cost of production will decrease as the cans will be available at about 30 to 40 per cent less price. It is therefore necessary that along with the establishment of fruit canning factories either the canning factories themselves or some other parties undertake the manufacture of cans. The price of the containers is a factor of vital importance for the success of the canning industry and self-sufficiency against foreign sources of supplies of containers would be a great step towards the success of our canning industry.

STANDARDS FOR CANNED FRUITS

In all the countries with well advanced canning industry there are certain standards known as the quality standards according to which the products

are classed. Complex regulations have been enforced on the canning industry in various countries to protect the consumer, the grower and the canner alike from each other and amongst themselves in the case of the canners. Standards are provided for syrup strength, colouring matters to be used, forms of records, labelling equipment, factory procedure, stock control and so on. Countries like U. S. A. and Great Britain have even reduced the number of can sizes and specifications for the capacity, height, diameter etc. are given. These standards are fixed up by boards consisting of representatives of industry and government. It is needless to say that in this country also standards must be fixed by the government or by a board consisting of representatives of canning concerns and the government to put a check

on spurious products being sold and also to let the public know what they are buying. The U. S. A. Department of Agriculture is responsible for grade definitions covering production throughout the States. In England the Ministry of Agriculture originated a voluntary scheme in June 1930 known as the National Mark Scheme and set up standards. The "Australian Canned Fruits Control Board" regulates the industry in Australia. "The Central Board of Pineapple Packers, Malaya" regulates the pineapple canning industry in Malaya. The government exercises control over these boards and hence over the industry through their representatives in these boards.

(To be continued)

MEDICINE AND PUBLIC HEALTH

VACCINES WITH ULTRAVIOLET LIGHT

A NEW method of preparing vaccines against a number of diseases, entailing the use of ultraviolet light, has been reported in the *Journal of the American Medical Association* (June 24). The use of ultraviolet light to inactivate germs is, however, not new and was practised in the past with varying degrees of success. But the old technique frequently destroys not only the germs but also their immunizing properties. On the other hand, insufficient irradiation failing to destroy the disease-causing property has on more than one occasion produced fatal results. Accordingly, the older technique hardly guaranteed the production of uniformly safe and potent vaccines.

The new method employing ultraviolet light, it is claimed, completely and almost instantaneously kills germs of both bacteria and virus classes without destroying the potency of the vaccines. A newly developed ultraviolet lamp serves as a powerful source of both total and extreme ultraviolet light, the extreme being below 2,000 Å. Germs in suspensions exposed to such ultraviolet light in continuously flowing thin films are killed in less than one second.

The vaccines thus produced appear to be equal, or superior in antigenic potency, to thermally killed vaccines prepared from the same bacterial suspensions. For instance, rabies vaccine prepared by the new technique induced a higher degree of immunity in mice than vaccines in which germs had been killed by phenol. Six month's storage at a tempera-

ture slightly above the freezing point did not adversely affect the potency of the vaccine. Animal experiments with a vaccine against sleeping sickness, prepared according to the new method, indicated that mice indeed developed a high degree of immunity.

A number of vaccines such as those against typhoid fever, pneumonia type I, and salmonella enteritidis (responsible for food poisoning) have already been prepared by this method.

WORK ON INFLUENZA AND A NEW KIND OF PNEUMONIA

A *Science News Letter* report places on record the results of investigations of a number of U. S. doctors working for the Army regarding the vaccination against influenza. It was known from previous experiments that inhaling sprayed blood serum from persons recovered from influenza would protect against the disease. But results obtained by such inhalation are not always assuring. This led the investigators to try the vaccination method in the case of influenza, and the results appear to indicate that vaccination offers more hope of protection against influenza.

The serum they used for testing the value of third method of giving protection against influenza was not the same as that used in tests at the Naval Laboratory Research Unit at the University of California under the direction of Capt. Albert P. Krueger. In the Navy tests a globulin fraction of influenza immune horse, not human, serum was

found to give protection to laboratory animals. Although this is encouraging, nothing conclusive as to results of human immunization is known yet because tests have not been carried out on a large enough scale. After two years of study of the problem, however, Capt. Krueger's group is coming more to the view that injecting the serum under the skin would be more practical than giving it by inhalation because of the greater certainty that the necessary amount would be assimilated.

The report further refers to a study of a kind of pneumonia which has recently caused great

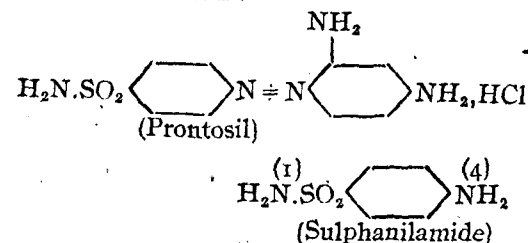
anxiety in some parts of the Tennessee Valley. This is variously known as virus pneumonia and primary atypical pneumonia. It has symptoms different from those of pneumococcal pneumonia and does not respond to treatment with serums or sulphur drugs. Such primary atypical pneumonia has been transmitted for the first time by spraying washings from the noses of persons previously suffering from the disease into the noses of healthy, sound objectors who volunteered for the purpose. Such transmission studies may help to isolate the germ for which work is now in progress.

SOME TRENDS IN BACTERIAL CHEMOTHERAPY

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THE endeavour of man to search out the right chemotherapeutical agents to combat infectious diseases has been crowned with success only in recent times. Most spectacular in degree of success has been that attained in this decade first with the dye, prontosil and then with the derivatives of sulphanilamide. The key to the newer chemotherapy was provided primarily by the discovery of the anti-streptococcal activity of azo-dyes derived from sulphanilamide, an essentially fundamental advance resulting from the perseverance and genius of Domagk.¹ This discovery stimulated interest in ascertaining the most effective members of this class of dyes; the only way to find them out was to make as many of these as possible and try them out. Mietzsch and Klarer, collaborating with Domagk, prepared more than thousand such compounds. Many of these were active in experimental streptococcal infections though, strangely enough, outside the bodies of test animals, i.e., *in vitro*, they were but feeble disinfectants. The most effective of this multitude which has had considerable application in medicine is 'Prontosil'.



¹ Domagk, *Deut. Med. Wochschr.* 61, 250, 929, 1935; Mietzsch and Klarer, *D.R.P.*, 607, 537, 1932.

The next step forward was taken by French workers² at the Pasteur Institute who showed that the activity of prontosil was due to its being cleaved in the animal body to a much simpler substance, sulphanilamide which had been known³ since 1908 under the chemical name of *p*-aminobenzene sulphonamide.

The success of prontosil and later of sulphanilamide attracted to the new field hundreds of workers who hoped to discover substances which would be as good as, or better than, either of these or would be free from their many undesirable by-and after-effects and by means of which the range of therapeutic usefulness could be widened.

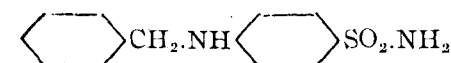
The chemists set to work on the molecular skeleton of sulphanilamide. Research centered chiefly on the synthesis of nuclear, N¹-, and N⁴- substituted derivatives. The compounds with substituents in the benzene ring were usually inactive. By substitutions at the N⁴- position, a series of N⁴-acyl amino, nitro, hydroxylamino, azo, anil and reduced anil derivatives were obtained. Although it has not been proved beyond doubt that the activities of these compounds^{2,4} are entirely the result of cleavage with liberation of sulphanilamide, there is much evidence pointing to such a mechanism. One of these compounds which has found some clinical

² Tréfouël et al., *Compt. rend. soc. biol.*, 120, 756, 1935.

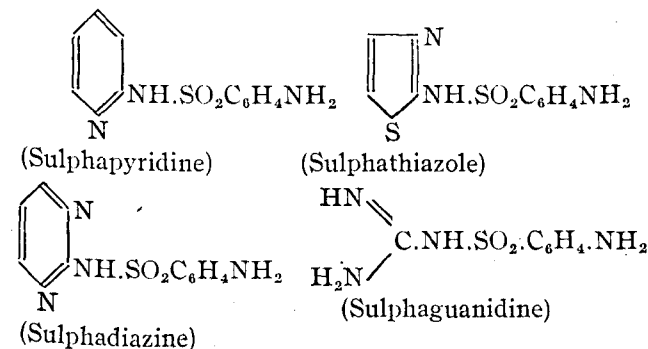
³ Gelmo, *J. Prakt. Chem.*, 77, 369, 1908.

⁴ Fuller, *Lancet*, 1, 194, 1937; Marshall et al., *Proc. Soc. Exp. Biol. Med.*, 42, 849, 1939; Molitor and Robinson, *J. Pharmacol.*, 65, 405, 1939.

application by virtue of its activity and low toxicity is N⁴-benzyl sulphanilamide⁵ or 'proseptasine'.—



Substitution at the N¹- or sulphonamide part of the molecule brought forth a far more interesting group of compounds. From the practical standpoint, the best results were obtained in this group, particularly, those derived from simple heterocycles.



The spectacular success of sulphapyridine⁶ was followed in quick succession by that of sulphathiazole,⁷ a compound superior to sulphanilamide and sulphapyridine in some respects, and by that of sulphaguanidine⁸ and sulphadiazine.⁹ A few others like sulphapyrazine,¹⁰ sulphathiazoline¹¹ etc., which appear promising from preliminary trials, have yet to win their spurs for a definite place in clinical practice.

Research from the purely chemical side has brought forth anywhere between three to four thousand new compounds, but curiously enough out of the hundreds of compounds that have come to light only a few have so far received wide practical application and have been recognized as important

⁵ Goissedet et al., *Compt. rend. soc. biol.*, 121, 1082, 1939; Halpern and Mayer, *Presse Med.*, 29, 201, 1936; May and Baker Co., *Brit. Pat.* 465, 914, 1937; Mayer, *Bull. Acad. Med.*, 127, 727, 1937; Whitby, *Lancet*, 1, 1517, 1937; Buttle et al., *Biochem. J.*, 31, 724, 1937.

⁶ May and Baker Co., *Brit. Pat.*, 1516, 288, 1938; Whitby, *Lancet*, 1, 1210, 1938; New and Non-official Remedies, *J. Amer. Med. Assoc.*, 114, 326, 1940.

⁷ Fosbinder and Walter, *J. Amer. Chem. Soc.*, 61, 2032, 1939; Long, *J. Amer. Med. Assoc.*, 114, 870, 1940.

⁸ Marshall et al., *Bull. Johns Hopkins Hosp.*, 67, 163, 1940; 67, 94, 1941; Lyon, W. Va., *Med. J.*, 37, 54, 1941.

⁹ Roblin et al., *J. Amer. Chem. Soc.*, 62, 2002, 1940; Feinstein et al., *Bull. Johns Hopkins Hosp.*, 67, 427, 1940; Klinefelter, *Proc. Soc. Exp. Biol. Med.*, 46, 591, 1941; Long, *J. Amer. Med. Assoc.*, 116, 2399, 1941; *Bull. Johns Hopkins Hosp.*, 69, 297, 303, 314, 1941.

¹⁰ Ellingson, *J. Amer. Chem. Soc.*, 63, 2524, 1941; Raiziss et al., *Ibid.*, 63, 2739, 1941; Sansville and Spoerri, *Ibid.*, 63, 3153, 1941; Reuggesegger et al., *J. Amer. Med. Sci.*, 202, 432, 1941.

¹¹ Sprague and Kissinger, *J. Amer. Chem. Soc.*, 63, 578, 1941; Raiziss and Clemence, *Ibid.*, 63, 2739, 3124, 1941; Rajagopalan and others, *Ind. Pat.*, 28706.

remedies. The reasons are not far to seek. The pharmacological and bacteriological studies have been unable to keep up the pace set by the chemists. Furthermore, the knowledge accumulated so far regarding their activity and pharmacology should in many instances be taken only as qualitatively indicative due, among other reasons, to a lack of co-ordination among the early workers and the adoption of universal test methods for ascertaining the real value of the sulphonamides and their toxic reactions. A survey of the formulae of the sulphonamides together with their reported activities brings to light many curious generalities. It is beyond comprehension why a particular arrangement of atoms, more than any others, should alone give rise to therapeutically valuable compounds and how the slightest changes in the molecular structure could sometimes completely alter the physiological picture by destroying or accentuating its previous properties or result in compounds with totally new and unpredicted characteristics. A rational approach to the sulphonamides has moreover been delayed by the usual first wave of numerous over-enthusiastic publications embodying preliminary successes and failures, incident to the introduction of new remedies. The latter in their turn have given rise to numerous anomalies, surprises and contradictions in the published literature. In addition, the secrecy surrounding the patent literature and work deliberately maintained by some of the commercial and other vested interests has prevented research workers from profiting by each other's conclusions, always a fertile source of inspiration, has tended to the unnecessary duplication of labours and has been, to a large extent, prejudicial to the progress of chemotherapy. A fruitful line of approach likely to furnish useful information would have been a unified effort to consolidate the positions already gained, namely, concentration on synthetic elaboration of the structural types that have so far been revealed to be of value. Nevertheless, one marvels at the amount of valuable work that has been carried out and yet cannot resist the feeling that much more could have been achieved by a closer co-operation between the chemist, the bacteriologist, the pharmacologist, the clinician and the pathologist as a consequence of hard, unremitting and systematic toil. It is therefore little wonder that the search for new members of this group of compounds remained, since the time of its inception till very recently, of necessity largely a matter of empirical conjecture, and the chemist has had to follow any 'lead' that looked promising or depend on 'lucky strikes'. In the present state of knowledge the conviction grows stronger that, except in a very limited sense, no large scale generalizations or axioms are yet admissible and that the attempt to correlate chemical constitution with antibacterial action even in the sulphonamide

group may not be possible until the many existing gaps in our knowledge are finally bridged.

In the sulphanilamide group of drugs, medical science has acquired a powerful weapon for the conquest of bacteria. Their wide and varied applications have been the subject of reviews and monographs.¹² They are of especial value in many streptococcal, pneumococcal, staphylococcal, meningococcal and gonococcal infections. They are also effective in some strains of the dysentery bacillus, *Hemophilus influenza*, the Welch bacillus and certain members of the Pasteurella group, including the plague bacillus. In addition, they possess remarkable curative effects in certain human urinary tract infections. While recounting the many spectacular successes of chemotherapy, we must not forget its present limitations which are not as widely published. There is still a long list of bacterial diseases uninfluenced by any drugs. Tuberculosis, leprosy, typhoid, paratyphoid, cholera, whooping cough, tetanus and certain kinds of pneumonia are not yet amenable to chemotherapy. In virus infections, the results so far obtained are mostly negative or inconclusive with the exception of lymphogranuloma and trachoma which are susceptible to treatment with the sulphonamides. However, the main body of the virus diseases, small-pox, measles, infantile paralysis, cold, influenza, etc., are not checked by the newer chemotherapeutics. Like most other potent chemotherapeutic agents, the sulphonamides possess a certain amount of concomitant side effects and toxic reactions. Their deleterious effect on hemopoiesis of susceptible individuals is amongst the most dangerous of their toxic effects. Several cases of bone marrow depression, as evidenced by leucopenia with agranulocytosis or thrombocytopenia, have been reported by large or small doses of the drugs and must be considered as their real drawbacks. Cases of agranulocytosis are fortunately rather rare and the drugs would seem to be only as dangerous as any of the general anaesthetics.

While it is indeed difficult to conceive of any other development which has been of greater service to the human race than that which has taken place in the sulphonamide group of drugs, sulphonamides appear only to constitute the first of a series of powerful weapons for the swift and effective conquest of numerous diseases of bacterial origin in a new age of rational antisepsis that is but just dawning.

¹² Mellon, Gross and Cooper, 'Sulphanilamide Therapy of Bacterial Infections', 1938; Findley, 'Recent Advances in Chemotherapy', 1939; Bliss and Long, 'Clinical and Experimental Use of Sulfanilamide, Sulfapyridine and Allied Compounds', 1939; Carey, *J. Amer. Med. Assoc.*, 115, 924, 1940; Kohlmer, *Arch. Internal Med.*, 65, 671, 1940; Lockwood, *J. Amer. Med. Assoc.*, 115, 1190, 1940; Long, *Bull. N. Y. Acad. Med.*, 16, 732, 1940; Marshall, *Science*, 91, 345, 1940; *An. Rev. Physiol.*, 3, 643, 1941; Northey, *Chem. Revs.*, 27, 85, 1940; Reimann, *Arch. Internal Med.*, 66, 478, 1940; 68, 325, 1941.

A rational basis of chemotherapy awaits establishment, firstly, of a chemical relationship between the causative agents of infectious diseases and the changes they bring about to result in a pathological condition, and, secondly, of the mode of action of chemotherapeutic agents. It is therefore gratifying to note that the past three years have witnessed an ever-increasing attention being directed towards the discovery of fundamental laws correlating physico-chemical properties and physiological action. Indeed studies of the ways in which chemotherapeutic activity varies with chemical structures and physical properties have in the past achieved notable practical results, for example, the work done on the relation between narcotic action and lipid solubility and between the action of chaulmoogra analogues on acid-fast organisms and their activity in depressing the surface tension of water. Among others, a recent communication, "Chemistry and Physics of Antiseptics in Relation to Mode of Action" by Albert¹³ will amply bear out the above statement. There is no doubt that such studies would help to remove the empiricism that has hitherto been largely obtaining in the practice of bacterial chemotherapy so that the "rational approach" envisaged by Paul Fildes¹⁴ (1940) might come to be the basis of the future search for new and better chemotherapeutics.

No other group of chemotherapeutic investigations can perhaps claim to be more stimulating and of greater interest than those which have centered round the mode of action of the sulphonamide group of drugs. Sulphonamide chemotherapy may be said to have passed from the empirical to the rational with the discovery by Fildes¹⁴ and Woods¹⁵ of the mode of action of sulphanilamide. Their precise disclosure of its point of attack in chemical terms not only settled an acute controversy but opened the door to further development on more sure and promising lines. Attempts to explain antibacterial action in terms of specific inhibition of some essential metabolic steps have been greatly stimulated by the discovery that *p*-amino benzoic acid (PAB) is an essential metabolite, a fact now established experimentally¹⁷, and that the drug, by virtue of similarity in chemical structure, can compete with it for some enzyme essential to the bacterial cell.^{15, 16} The theory of Fildes and Woods that the action of sulphanilamide on hemolytic streptococci and other bacteria is simply to prevent the utilization of a substance

¹³ Albert, *Lancet*, 2, 633, 1942.

¹⁴ Fildes, *ibid.*, 1, 955, 1940.

¹⁵ Woods, *Brit. J. Exp. Path.*, 21, 74, 1940.

¹⁶ Dorfman et al., *Lancet*, 2, 42, 1942.

¹⁷ Rubbo and Gillespie, *Nature*, 146, 838, 1940; Lampen and Peterson, *J. Amer. Chem. Soc.*, 63, 2283, 1941; Moller and Schwartz, *Ber.*, 74, 1612, 1941; Kuhn and Schwartz, *ibid.*, 74, 1617, 1941; Park and Wood, *Bull. John Hopkins Hosp.*, 70, 19, 1942.

vitaly essential for their growth, namely *p*-amino benzoic acid, has now gained general acceptance. This concept has been extended¹⁸ in recent times to cover the other well-known sulphonamides also; the varying potencies of the latter have been explained by the additional effect of the heterocyclic halves of their molecules on other metabolic processes peculiar to or more important to the particular bacterium under consideration.^{19, 20}

One of the consequences of the postulate of Fildes and Woods is the greater attention paid with some degree of success to interpret chemotherapy through nutritional studies. Thanks largely to the earlier work of Fildes and his collaborators, various substances other than PAB of well-defined chemical constitutions, now referred to as essential growth-factors, are known to be necessary for the growth of many pathogenic bacteria. Nutritional analyses, chiefly by McIlwain, show that bacteria in the presence of anti-bacterial agents require more substance than are usually needed for their growth. The inhibitors (antibacterial agents) therefore increase the nutritional requirements of bacteria. Some substances found necessary for bacterial growth (aneurin, cozymase) take part in the enzyme reactions, and these reactions account for the organism's need of such substances. The additional substances for which need is established by inhibitors are probably required in order to take part in reactions which have been affected by inhibitor.

Enzyme systems can in many cases be considered to correspond to the 'receptors' of Ehrlich. The structural specificity required for drug action is comparable to that required in growth essentials. Some grouping in one drug may be toxophoric by virtue of its similarity to a group in a growth essential; the $-\text{SO}_2\text{NH}_2$ of sulphanilamide simulates the $-\text{CO}_2\text{H}$ of PAB to a degree sufficient to react with and block enzymes which are essential and normally react with PAB. According to this view, chemotherapeutic interference is due to the functional replacement by the interfering agent of substances whose metabolism is affected by the inhibitor. Acridine and some arsenicals interfere, among other processes, with hydrogen transport which interfering agents like methylene blue are capable of performing.

From such considerations, McIlwain and his associates²¹ were able to lay down successfully rules

¹⁸ Landy and Wyeno, *Proc. Soc. Exp. Biol. Med.*, 46, 59, 1941; Straus et al., *J. Clin. Investigation*, 20, 189, 1941.

¹⁹ Green and Bielschowsky, *Brit. J. Exp. Path.*, 23, 13, 1942.

²⁰ Dorfman et al., *J. Bact.*, 43, 69, 1942.

²¹ McIlwain, *Biochem. J.*, 35, 1311, 1941; 36, 417, 1942; *Lancet*, 1, 412, 1942; *Brit. J. Exp. Path.*, 21, 136, 1940; 22, 148, 1941; 23, 95, 1942; McIlwain and Hawking, *Lancet*, 1, 449, 1943.

regarding structural specifications in possible chemotherapeutics required for drug action. They were also responsible for actually demonstrating that slight but definite variations in the architecture of the "essential growth-factors" led to the production of enzyme analogues; the latter were then able to effect a competitive inhibition of the utilization of the normal growth-factors, resulting in metabolic disturbances in the organisms and their ultimate death. Thus a fundamentally new and promising approach to chemotherapy has now been thrown open. A few examples, at this stage, will be illustrative.

The belief that β -trisubstituted propionic acids would be inhibitory to the growth of *M. tuberculosis*, of which phthioic acid—a trisubstituted acetic acid—is a normal constituent, was fully realized by Robinson.²² The fact that *M. tuberculosis* is able to form compounds of a vitamin K nature and that the closely related *M. paratuberculosis* (Johne's bacillus) requires such substances as growth factors²³ suggested²⁴ what appears a highly promising investigation of the chemotherapeutic effect of sulphonamides possessing structural similarities to the anti-haemorrhagic compounds. Inhibition of succinic dehydrogenase by malonate affords a further example,

and more recently ethionine, $\text{C}_2\text{H}_5\text{S}\cdot\text{CH}_2\cdot\text{CH}$ $\begin{matrix} \text{NH}_2 \\ \text{CO}_2\text{H} \end{matrix}$ has been found by Harris and Kohn²⁵ to limit bacterial growth by competition with methionine. Fildes²⁶ showed that indole acrylate inhibited bacterial growth by virtue of its relation to tryptophane. Some aliphatic α -amino sulphonic acids inhibited growth by virtue of the relation to α -amino carboxylic acids, and pyridine, 3-sulphonic acid and its amide by relation to nicotinic acid.²⁷

The latest product of this form of constructive reasoning, one which may prove to be of great therapeutic importance, has now been evolved.^{28, 29} Pantothenic acid is an essential growth factor for many pathogenic bacteria, and an analogue which should be inhibitory is N-(α - γ -dihydroxy, β , β -dimethyl butyryl-) taurine or pantoyl taurine. This substance, as theoretically predicted, inhibits the growth of bacteria requiring pantothenic acid. As in experiments with sulphanilamide and PAB, the presence or absence of growth depends on the

²² Robinson, *J. Chem. Soc.*, 505, 1940; 488, 1942.

²³ Anderson and Newman, *J. Biol. Chem.*, 103, 187, 1933; Almquist et al., *Proc. Soc. Exp. Biol. Med.*, 38, 336, 1938; Woolley and McCarter, *ibid.*, 45, 357, 1940.

²⁴ Sjögren, *Nature*, 150, 431, 1942.

²⁵ Harris and Kohn, *J. Pharmacol.*, 73, 383, 1941.

²⁶ Fildes, *Brit. J. Exp. Path.*, 22, 293, 1941.

²⁷ McIlwain, *Loc. cit.* (*Brit. J. Exp. Path.*, 1940, 1941).

²⁸ Snell et al., *J. Amer. Chem. Soc.*, 62, 1776, 1940; 1940; *J. Biol. Chem.*, 139, 975, 1941; 141, 121, 1942.

²⁹ McIlwain, *Loc. cit.* (*Biochem. J.*, 1942; *Brit. J. Exp. Path.*, 1942).

relative concentrations in the medium of pantoyl taurine and pantothenic acid. Similarly, the capacity of various natural fluids, such as muscle extract, plasma and urine, to antagonize the inhibitory action of pantoyl taurine varies with their content of pantothenate.

It is possible therefore to hope that the future approach to the production of new, *specific* chemotherapeutic agents will consist in modifying the struc-

tures of essential metabolites so as to produce substances which can no longer exhibit any specific action in the cell economy, but will still be able to block the enzymes concerned in the reaction. And this should not be a difficult task since at the present time, more than ever before, knowledge of the 'growth factors' and 'accessory growth factors' of many of the common pathogenic organisms is increasingly being made available.

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Chemistry and Pharmacy of Vegetable Drugs.—

By Noel L. Allport, F.I.C. Published by George Newnes Limited, Tower House, Southampton, Strand W.C. 2, London. Pp. 264.

According to the author the book is 'designed to answer the many questions which must arise in the mind of the student of pharmacy, when making his preliminary acquaintance with numerous vegetable drugs'. For this purpose and also as an aid to the students of materia medica and pharmacology in the medical schools, the book will be eminently suitable and it is hoped, will be enthusiastically received. Years of teaching experience have impressed the reviewer with the need for more and more books which give a 'preliminary acquaintance' to the subject through an interesting mode of presentation and illustration of the subject matter, rather than profusely-documented and scholarly treatises. Both types of text-books are needed perhaps at different stages in the student's career, but it is essential for the maintenance of sustained interest, to start him on with something which he can swallow and swallow with avidity, leaving behind a desire for more. Mr Allport has succeeded in providing such a fare and the reviewer feels little hesitation in bringing the book to the notice of the different schools of pharmacy in India.

The book contains 264 pages divided into 22 chapters and an Index. The author has shown much good sense in not attempting the traditional 'botanical' classification of the vegetable drugs. This would have defeated the very purpose which the author has in view of assisting the student in his study of vegetable drugs. The system of grouping under 'botanical', 'chemical' and 'therapeutic' is most advantageous and the reviewer has adopted more or less the same system in practice at least for the last 6 years with good results. It is best, for example, to discuss

(as has been done in this book) all drugs containing alkaloids or glucosides as their active principles under their respective 'chemical' headings and consider the chemically heterogeneous groups of 'anthelmintics' under a 'therapeutic' classification. It is time that water-tight compartments, often observed in classification by systematists, are removed for a more rational and helpful grouping of the type adopted in this book.

Besides an easy presentation, the book is replete with illustrations and photographs. The practical handling of different apparatus and appliances is also shown wherever possible. Sufficient emphasis has been given to the assaying of the active ingredients both by chemical and by biological methods where considered important. There is every indication that the book has come to stay and will be liked by the students.

B. M.

Decibel Notation—By V. V. L. Rao, Radio Engineer. Published by Addison & Co. Ltd., Madras. Pp. 177, with 52 diagrams, graphs, charts etc. Price Rs. 8/12/-.

"The present work has been undertaken as, that so far as the author is aware, no work on this subject has been published in the English language, having a booklet of 57 pages by Morris," writes the author in the preface, and rightly so. The vast amount of useful information contained in the small book will be welcome to those interested in Radio and Acoustic Engineering. The author has collected the material which may be found scattered in text books on Radio or Acoustic measurements, but when the information is put together in a systematic and judicious manner, the reader finds it handy and convenient for consultation and the usefulness is greatly extended. In the present day of radio and audio broadcasting

the book may be used as a text-book to supplement the teaching of acoustics and radio communication, and as a guide to laboratory practice.

The author starts with the logical basis for decibel notation *viz.*, that perception of sound intensity is proportional to the logarithm of the acoustic power, and explains in the course of the following chapters the measurements of power in amplifiers with reference to the "zero level". Different methods are carefully dealt with and numerical examples are appended in each case—a very useful method in giving a realistic picture of the method that is described. The reader is led through the decibel method in measuring frequency response, hum etc. The subject of "attenuators" and "filters" have been exhaustively treated; except practical details the reader will find everything at hand if he wants to make an attenuator or a filter.

The technical terms in measuring sensitivity of microphones, and the acoustical performances of a loud speaker have been lucidly written; similarly the subject of audio acoustics has also been touched.

In order that the book may be used by students it is desirable that introductory remarks in relation to the apparatus and the formulæ should be included. References to the latter in all cases must be given. For instance, the formula relating to audio transformer have been tacitly assumed and used (page 92), *e.g.*, "the ratio of matching transformer" $\sqrt{500/50} = 3.162$ etc.

may be a difficulty to the student. The formula should be numbered and cross references should be given where necessary. The impression that the book represents a collection of formulæ should be removed, and stress should be laid on the method by a few introductory remarks and references. Much space could be saved if the author uses $10 \log P_2/P_1$ instead of $10 \log \frac{P_2}{P_1}$.

These remarks have been made in order that the author may attend to them in the second edition of the book; the writer congratulates the author on the most useful and readable book that he has written in the most technical subject. The students will profit by the constant use of this book in the laboratory.

R. N. G.

Wulff, E. V. 1943.—An introduction to Historical Plant Geography. Published by Chronica Botanica Co., Waltham, Mass. U.S.A. Pp. 223. Price \$4.75.

This book was originally published in Russian, first in 1932 and then again in a revised form in 1933, and now it has been translated into English after incorporating some further improvements. It was

intended to be followed by a second volume dealing with a history of the floras of the world and a third with the changes in these floras caused by the influence of man. Unfortunately, however, the author died a couple of years ago during the siege of Leningrad, being struck by shrapnel, and although the second volume is said to have been more or less completed, the third may never see the light of the day under Dr Wulff's name.

The author aims at a study of the distribution of the existing species of plants with a view to elucidating the origin and history of development of the floras, which in turn is expected to provide a clue to an understanding of the history of the earth. Of the eleven chapters comprising the book, the first explains the scope of the subject and its relationship with allied subjects; the second deals with the history of the science; the third with areas, their centres and boundaries; the fourth and fifth respectively with the origin and types of areas; the sixth with parallelism in the geographical distribution of plants and animals and a correlation between the distribution of parasites and their plant hosts; the seventh and eighth with the rôle of artificial and natural factors respectively in the geographical distribution of plants; the ninth with a discussion of the migration of species and floras; and the tenth with the historical causes for the present structure of areas and composition of floras. The eleventh and last chapter is concerned with the concept of floral elements and outlines the general principles that ought to be followed in making analyses of floras.

Of special interest, even to non-botanists, will be the information dealing with the rôle of artificial and natural factors in the distribution of plants and a discussion of the historical causes leading to the present composition of the world's floras. The author emphasises that in undertaking a study of this type, one has to consider two main points: (a) does the dispersal of a species takes place by sudden spurts, as a result of its chance penetration or transport into distant localities which are widely isolated from the main area, or, (b) is it mass-like in character, the species as a whole, gradually although perhaps unevenly, covering fresh territory until some barrier either climatic or geographical, puts a limit to its further spread? In the first case its discontinuous distribution is easily understood without any further explanation: in the second alternative this could only result from a dying out of the species in the intervening territories or the isolation of the occupied regions due to geological causes.

The author has dealt with the above points very critically and unemotionally. It is a common textbook statement that several natural agencies, such as wind, water and animals, can successfully transport

plants or parts of plants, such as seeds, to very considerable distances beyond their place of origin. It certainly appears quite comprehensible to the ordinary mind that strong winds may blow certain seeds and fruits, wither due to their lightness or other adaptations, to considerable distances from their place of origin, but the author shows that in actual practice this is very unlikely. We are told, for instance, that there is no proof of seeds having been carried by wind even from England to France or from Ireland to England. Then again, as regards water, this is certainly an important factor in the dispersal of plants along the shores of seas and lakes but it can hardly cause their inland penetration to any appreciable extent. Further, although rivers run long distances over land, they must often transport the seeds to places where they would be unable to establish themselves. Sea-currents also go a long way but they do not usually flow parallel to the equator, and even if the seeds, despite prolonged immersion in sea-water, preserve their germinating power, they are quite likely to be carried into places where the climatic conditions are entirely alien to them. Even if this were not the case, there would still remain the difficulty that unless they can be transported to a new area in *sufficiently large numbers*, they cannot succeed in establishing themselves as a component part of an already existing flora with which they will have to come into competition. Among *animals*, birds have often been credited with a long distance distribution of plants, by the seeds either adhering to their feet and feathers or being carried inside their alimentary canals to be voided later on in new and far off places. But here also, in spite of a careful study of the available information, the author failed to find a single case on record of the transport by birds of any plant that subsequently succeeded in establishing itself and extending its range in a distant habitat.

Man, admittedly, plays a far greater role in the distribution of plants, whether intentionally (as in the case of many cultivated plants) or unintentionally (as in the case of certain weeds). This is due mainly to the present extensive development of the means of communication and the constant movement of people from one part of the world to another, as well as to the expansion of cultivated areas and the introduction of cultivated plants from distant countries. One must however agree with Dr Wulff that even man's significance in the geographical distribution of floras was very much less in the past and that even now there are obvious limitations to it caused by differences of habitat.

Contrary to the general opinion (based more on imagination, however, than on a scientific appraisal of the existing data) the author concludes that plants are dispersed only slowly and gradually, gaining new

territory step by step and not by spurts, and that an explanation of the present discontinuous distribution of our floras has to be sought elsewhere. For this he turns to the geological history of the earth, for there is no escape from the conclusion that lines of communication must have existed in the past between regions now separated by thousands of miles of ocean. The hypotheses of submerged continents, sunken land bridges and continental drift are discussed one after another as the possible clues for an explanation of the present and past distribution of plants. After evaluating all the existing theories of this kind, the author strongly inclines to the Wegener hypothesis which assumes that the continents are comparable to drifting icebergs detached from a once continuous mass. He draws attention to a general resemblance in outline and in geological structure between the eastern edge of S. America and the western border of Africa; the Atlantic is then considered as a great rift which gradually broadened in the course of ages. South America, Africa, India and Australia were once united according to this view into a single vast continent called Gondwanaland which persisted through several geological ages but subsequently disrupted into smaller land-masses which have floated further and further apart into their present positions. The originally continuous distribution of a species would then become discontinuous owing to the sundering oceans which now separate these sub-continent. It must be admitted that the Wegener hypothesis has been subjected to severe criticism and the number of its adherents is perhaps small but from the support that it has received from some quarters during recent years and now from a plant geographer like Dr Wulff, it seems deserving of a more sympathetic consideration than it has hitherto received. The objections that have been raised against it "do not suffice to discard Wegener's theory as incorrect but only indicate that in this theory there is still much that requires further elaboration and modification. In any event its significance for biogeography is beyond doubt. It has thrown light on a number of hitherto entirely incomprehensible moments in the geography of plants."

While it is not possible to say that Dr Wulff has succeeded in establishing his thesis, he has certainly made a very thorough and critical study of a subject that is extremely vast and the information on which is widely scattered over different places. If the results of his analysis are not always clear, this is due to the paucity of any reliable and extended observations in this field rather than to any fault of his own. He may have proved little or nothing but none will deny him the credit of having suggested a great deal and it is here that the value of the book lies. It is the first of its kind in the English language and the

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publishers are to be congratulated on having produced it during these difficult days, with the author in Russia and the general editor of the series, at first in Holland, and then in the United States. The only criticism which the reviewer would like to make is that he found the language and the style a little

difficult in places so that it took him more time to go through the work than its size justified, but this is excusable in consideration of the fact that it is a translation from an alien language.

P. M.

LETTERS TO THE EDITOR

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

ON THE LINEAR SET UP LEADING TO INTRA AND INTER BLOCK INFORMATION

MANY attempts have been made to make a critical study of the hypotheses and the laws of chance involved in the analysis of variance tests for field experiments. An extensive and important contribution is due to Dr Neyman¹ who starting with a suitable linear hypothesis found the limitations of the z-test devised by R. A. Fisher. This was subjected to much criticism by the Fisherian school and many of the statements advanced by them remain unstudied. The actual distribution of Fisher's z on Neyman's hypothesis has been found out in the case of randomized blocks by McCarthy² but it has not much practical utility.

The purpose of this note is to devise a linear set up which is of special importance in the field experiments and consider the problems of estimation and testing of hypothesis in the light of the article "On linear estimation and testing of hypothesis" published by the author elsewhere.³ We shall consider the general varietal trial of which the factorial experiments can be deduced as a special case.

The problem is to test whether one variety is superior to another in a certain specified region. We cannot utilise the whole of the specified region nor is it desirable to choose a certain number of plots at random for one variety and a certain number for the other variety. Evidently two varieties cannot be tried one after the other on identical plots without vitiating the comparisons. So we choose sets of plots adjacent to one another which are called blocks. Let us consider a block of k plots and imagine a uniformity trial on these plots with the yields $Y_1, Y_2, \dots, Y_k$ and define the quantities

$$\beta = \bar{y} \text{ and } \eta_i = y_i - \bar{y} \quad (3.1)$$

with the obvious restriction

$$\sum \eta_i = 0 \quad (3.2)$$

If any variety is tried on the i -th plot then the yield T has the composition

$$T = \tau + \beta + \eta_i + \epsilon \quad (3.3)$$

where ϵ is a technical error due to experimentation and is independent of β or η 's. τ is called the effect of the variety. If $T_1, T_2, \dots, T_k$ are the observed yields of k varieties tried on the k plots with random determination of positions then

$$T_i = \tau_i + \beta + \mu_i + \epsilon_i \quad (3.4)$$

where μ_i can take any of the η 's of (3.1). T_i 's are obviously correlated variables. From this we construct k on other linear functions.

$$B = \frac{\sum T_i}{\sqrt{k}} \text{ and } R_i = \sum l_{ij} T_j$$

$$i = 2, 3, \dots, k$$

such that $\sum l_{ij} = 0$ and $\sum l_{ij} l_{i'j} = 0$ and $\sum l_{ij}^2 = 1$

$$\dots \dots \dots (3.5)$$

with the consequent relations

$$E(B) = \sum \tau / \sqrt{k} + \beta \sqrt{k} \quad (3.6)$$

$$E(R_i) = \sum l_{ij} \tau_j \quad i \geq 2 \quad (3.7)$$

The variance of R_i is called the intra block variance σ_{ia}^2 and is due to the variation of the comparisons from blocks of the same size together with a component due to ϵ . The variance of B in sets of blocks with the same β is however different from σ_{ia}^2 and is caused by ϵ . If we have b , such blocks we get $b(k-1)$ equations of the form (3.7) from which we proceed to the problem of estimation and testing of hypothesis. The variables are all independent and the information supplied by them is called the intra-block information. The estimation of σ_{ia}^2 is supplied by the minimised squares.

We can by a suitable device make use of the equations (3.6) in the estimates of the varietal contrasts. We choose all the blocks or those forming a complete replication close to one another and assign the b sets of treatments at random to these blocks. Any observed yield will then be

$$T = \tau + \mu + v_j + \eta_i + \epsilon \quad (4.1)$$

where $b\mu = \beta$ and v_j is a random variable assuming any one of the values $\beta p - \mu$, $p=1, 2, \dots, b$. The b equations of the form (3'6) will lead to

$$E(B_j) = \frac{\sum \tau}{\sqrt{k}} + \mu \sqrt{k} \dots (4'2)$$

From which we construct b linear equations

$$G_1 = \sum B_j/b \dots (4'3)$$

$$G_i = \sum m_{ij} B_j \quad i \geq 2$$

with the m 's possessing the same properties as the l 's of (3'5),

$$\text{Then } E(G_1) = \frac{\sum r_i \tau_i}{bk} + \mu \dots (4'4)$$

where r_i is the number of times the i -th variety is used and

$$E(G_i) = \sum m_{ij} \tau_j \dots (4'5)$$

where $\sum_j \tau_j$ is the sum of treatment effects from the j -th block. The variance associated with G_i is called the inter block variance and is denoted by σ_{ir}^2 . The estimating equations are $b(k-1)$ of the form (3'7) and $(b-1)$ of the form (4'5) with different variance and all independent of one another. The estimate of σ_{ir}^2 has to be found from (4'5). The information supplied by the relations (4'5) is called the inter block information.

The expressions for variances and covariances of contrasts are to be found as in the papers.^{3, 4} The formulae discussed there hold good. The intra and inter block estimates can be found separately and added together with proper weights. The underlying assumptions and the actual methods of estimation and testing will be dealt with in a detailed paper to be published elsewhere, wherein the results given by Prof. P. C. Mahalanobis⁵ on probable errors of field experiments will also be discussed. Further literature on this subject is found in the lecture notes of Mr R. C. Bose on the application of linear estimation theory to the design of experiments.

C. RADHAKRISHNA RAO

Statistical Laboratory,
Calcutta, 17-8-1944.

¹ Neyman, J. R. S. S. (Supplement), 2, 108-180, 1935.
² McCarthy, Ann. of Math., Stat., 10, 337-360, 1939.
³ C. R. Rao, Current Science (July Number), 1944.
⁴ C. R. Rao, SCIENCE AND CULTURE, 9, 554, 1944.
⁵ P. C. Mahalanobis, I. C. A. R., 96-114, 1925.

SYNTHESIS OF THIAMIN BY GERMINATING SEEDS

VERY little work has been done on the accumulation of thiamin during germination and the stimulating influence of light on the process. In order to find whether thiamin is synthesised during germination and the influence of light, if any, on the process,

experiments were carried out in the spring of this year with soya-bean and *kanch mung* (*Phaseolus Mungo*), germinating in the dark under properly controlled conditions of temperature, moisture etc. and exposing them to sun-light and ultra-violet rays of known wave-lengths for a definite period. Thiamin was determined by thiochrome method of Harris and Wang.¹ It has been observed that thiamin is formed during germination in the dark, and sun-light or ultra-violet light of wave lengths between 3000—400 Å stimulates the process considerably. Some results are given in the table below:

THIAMIN EQUIVALENT IN MG. PER CENT (DRY BASIS) OF GERMINATING SEEDS UNDER VARIOUS CONDITIONS

Seeds	Ungermi- nated seeds	Germinated seeds		
		In dark at 29-30°C.	Exposed for 6 hours at 29-30°C.	
			Sunlight	Ultra-violet between 3000-4000 Å.
Soyabean	0.34	0.81	1.81	1.91
Kanch mung	0.42	0.90	1.91	2.10

Further work is in progress, in order to find in particular whether these observations are confirmed by the biological method of assay.

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¹ Harris and Wang—*Biochem. J.* 35 1051, 1941.

PHARMACOGNOSTIC STUDIES ON LOBELIA NICOTIANAEFOLIA HEYNE

'Tincture Lobelia' of 'British Pharmacopoeia' and 'United States Pharmacopoeia' are prepared from *Lobelia inflata* Linn. (Fam. Campanulaceae), a plant indigenous to Canada and Eastern U. S. A.^{1, 2, 3} The drug is considered to be a good remedy for asthma and chronic bronchitis. The most important constituent of the plant is the alkaloid 'Lobeline', which is considered as a respiratory stimulant and is particularly valued in cases of collapse due to poisoning by noxious gases and narcotics. Five other alkaloids which are less active and whose actions are also somewhat secondary have been further isolated.⁴

Recent pharmacognostic studies on *L. nicotianae-folia* Heyne. which is found in India frequently in the

region from Bombay to Travancore, in Malabar and in Ceylon⁵ have revealed the following important characteristics.

Macroscopic—Stem erect, hollow, somewhat pubescent, leaves nearly obovate lanceolate, subsessile, nearly glabrous above, pubescent beneath; inflorescence, dense terminal raceme; flowers with ½ to 1 in. long peduncles; calyx 5-partite, somewhat hairy; corolla oblique, 2-lipped, upper lip 2-partite, lower 3-lobed; anthers connate; ovary inferior, 2-celled, ovules many, stigma—bifid; fruit-capsule; seeds small, ellipsoid, compressed, coarsely reticulate.

Microscopic—Hairs on stems and leaves are conical and unicellular. Transverse section of the stem shows the presence of well-marked endodermis and pericycle and latex vessels in the phloem. The pith of the stem is characterised by the presence of lignified and pitted parenchyma. The upper epidermis of the leaf is composed of straight-walled cells, and the lower of wavy-walled cells with many stomata. The mesophyll is characterised by the presence of single crystals and oil drops. Laticiferous vessels are present in the phloem of the leaf. The seed coat of the seed is composed of yellowish brown polygonal cells with thick walls.

From the above description it is found that it pharmacognostically resembles *Lobelia inflata* which have the following similar characteristics:—

Cylindrical but slightly angular hairy stem, irregularly denticulate margin of the leaves, acute apex, subsessile leaves 5-partite calyx, connate anthers, 2-celled ovary, capsular fruit small ellipsoid and coarsely reticulate seeds; conical and unicellular hairs on stems and leaves, latex vessels in phloem of stem and leaf; upper epidermis of leaf being composed of straight walled cells and the lower of wavy walled cells with plenty of stomata, lignified pitted parenchyma in the pith of the stem and seed coat of seed being composed of yellowish brown polygonal cells with thick walls.

A chemical assay of the drug revealed that alkaloids of 'Lobeline' group are present in some specimens of this plant in greater strength than that mentioned in British Pharmacopoeia for *L. inflata* Linn. The total alkaloids, calculated as Lobeline was found to be 1.18 per cent in *L. nicotianae-folia* Heyne whereas according to recorded figures it varies from 0.3 to 0.4 per cent in *L. inflata* Linn. The drug consists of the dried aerial parts of the plant and it should not contain more than 60 per cent of stems and not more than 2 per cent of other organic matter.

Adulterant:—An examination of this crude drug obtained from dealers of the local market showed

that it is often adulterated with or substituted by another plant *Verbascum thapsus* Linn. (Fam. Scrophulariaceae). Its presence may be detected in the sample by the following characters.

Stems and leaves densely woolly; leaves oblanceolate, crenate; flowers in spikes; bracts longer than the flowers; stamens 5, fertile, 2 glabrous and 3 with white hairs; fruit capsule; seeds not reticulate; trichomes are branched and multicellular; glandular hairs 2-celled; epidermal cells strongly undulated; stomata broadly elliptical.

The plant *Verbascum thapsus* Linn. is known in Hindi as 'Ban-Tamaku', a name which is also applicable to *L. nicotianae-folia* Heyne. This plant (*V. thapsus* L.) apparently does not contain the 'Lobeline' group of alkaloids in adequate proportions and as such the plant can never be proposed as a substitute for the B. P. drug *L. inflata* Linn. when *L. nicotianae-folia* Heyne will fit in as a suitable substitute.

We are indebted to Messrs. Bengal Immunity Co., Ltd., for providing us the necessary funds for carrying on this work and to Dr B. Mukherjee, D.Sc., M.D., F.N.I., Director, Biochemical Standardisation Laboratory, who kindly carried on the chemical investigation of the plants.

The details of the paper will be published elsewhere.

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Calcutta, 2-9-1944.

¹ The British Pharmacopoeia, 1932.
² A text book of Pharmacognosy by Trease, 1938, London.
³ Pharmacognosy by Gathercoal & Wirth, 1936, U. S. A.
⁴ The Plant Alkaloids by Henry, 1939, London.
⁵ Flora of British India by Hooker.

ASSAY OF 'ENTERO-VIOFORM'

'ENTERO-VIOFORM' containing iodo-chloro-hydroxy-quinoline as the main therapeutic substance is being locally prepared and standardised according to the method described in the New and Non-Official Remedies (1941 Edition) as modified by Pal and Guha.¹ But the recovery of iodine and chlorine from the tablets of various brands of the drug, or, from pure iodo-chloro-hydroxy-quinoline itself, is not being found to be according to the N.N.R. requirements.

Iodo-chloro-hydroxy-quinoline is a pure organic compound separating from glacial acetic acid in fine crystalline greyish-yellow needles, m.p. 177-178°C (uncorrected). As such there is no reason why its

halogen contents could not be rigidly ascertained. A method was, accordingly, been devised in this laboratory by which the percentage of iodine as well as chlorine could be accurately determined. This consists in first finding out the total halides in the form of their silver salts as usual, and subsequently estimating the percentage of iodine separately by the method of Pearl,² slightly modified. The percentage of chlorine can be easily calculated out by subtracting the latter value of iodine from that of the total halides obtained as silver salts. The result of analysis from the average of three samples is being recorded in the table below—

Substance	Iodine %			Chlorine %		
	Found	Theory	N.N.R. value	Found	Theory	N.N.R. value
Powder ..	39.77	41.57	37.5 to 41.5	11.38	11.62	11.5 to 12.2

The details of the work will be published elsewhere.

My best thanks are due to Dr T. N. Ghosh for his interest and Dr U. P. Basu for his suggestions in this work.

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¹ SCIENCE AND CULTURE, 8, 496, 1943.
² Jour. Biol. Chem., 148, 85, 1943.

AMINOMETHYL BENZENE SULPHONAMIDE IN THE CHEMOTHERAPY OF VIBRIO CHOLEREA

RECENTLY¹ *p*-aminomethyl benzene sulphonamide has been recorded to be a very useful drug in the treatment of infected wounds particularly for highly purulent cases of chronic sepsis. Work has also been in progress in this laboratory with the activity of this compound against various bacterial infections. The compound that is being used is its soluble hydrochloride² m.p. 250°. This was prepared from its acetyl derivative which again separates from water in fine prismatic needles, m.p. 175°.

The compound is being found to be definitely bacteriostatic against *vibrio cholerae* (types: Inaba and Ogawa). In a concentration of 1 in 10,000, it prevents the growth of the organisms in a medium made up of a glucose-phosphate-peptone broth. The medium is allowing a free growth of the test organisms. The drug is also somewhat effective against strains of *Bacterium Flexneri* and *Bacterium*

Typhosum. The speciality of *p*-amino methyl benzene sulphonamide is, however, being more noticed in its characteristic power of inhibiting the growth of *V. cholerae* even in presence of *p*-amino benzoic acid at a concentration as high as 20 µg. per c.c. The activity of the other sulpha-drugs like sulphaguanidine, sulphathiazole and sulphapyridine, was being inhibited under similar conditions even when the concentration of *p*-amino benzoic acid was so low as 0.05 µg. per c.c.

It would be of interest to see whether this promising *in vitro* results can also be obtained in cases of cholera infections in man.

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Calcutta, 4-9-1944.

¹ Mitchell, *Lancet*, 1, 627, 1944.
² Miller, et al, *Jour. Amer. Chem. Soc.*, 62, 2099, 1940.

STUDIES ON PARALYTIC ILEUS

PARALYTIC ileus means loss of motor activity of the gastro-intestinal tract. The patients in such condition rapidly develop anhydraemia, hypochloroemia, hypoproteinaemia, azotoemia and disturbances in acid-base equilibrium in blood. The present author has critically studied the changes in pH i.e., disturbances in acid-base equilibrium in blood with a large number of patients suffering from the diseases giving rise to paralytic ileus. It has been found that patients in such cases develop a base deficiency in alkalotic blood and the changes thus produced in blood initiate paralytic ileus and its progress, as well as damage the kidney resulting in azotoemia. Thus, it has been possible to find out the cause of paralytic ileus and also "why in cases of paralytic ileus azotoemia develops", which were hitherto unexplained.

Further work is in progress, the details of which will be published elsewhere.

The author offers his best thanks to Col. F. J. Anderson, Professor of Surgery, Medical College, Calcutta and Dr J. C. Gupta, School of Tropical Medicine, Calcutta for their kind encouragement.

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SPONTANEOUS EMISSION OF NEUTRONS FROM URANIUM

SOMETIME ago an investigation was undertaken in our laboratory for the detection of slow neutrons and slow protons produced in lead by highly energetic cosmic rays, with the help of a large proportional counter lined with boron and filled with CH₄. It was incidentally observed that the back ground count slightly increased when layers of U₃O₈ were kept in the immediate neighbourhood of the counter which was kept within a paraffin enclosure. It was surmised to be due to emission of neutron/proton from uranium because a strong source of γ rays did not affect the back ground count. As the increase in count was slight, not much attention was given to it. In view of our recent experiment on the "spontaneous fission of uranium",¹ it was considered worthwhile to look for neutrons which are usually emitted during such processes.

A small proportional counter was made from a brass tube 5 cms., in diameter and 15 cms. in length. The end pieces were made of ebonite with amber plugs and usual guard rings; a fine tungsten wire was stretched along the axis of the tube. The inside surface was coated with a thin layer (≈0.1 mm.) of amorphous boron powder and the counter was filled with BF₃ to a pressure of 50 cms. The efficiency of such a neutron counter, defined as the fraction of a flux of neutrons which produces counts, is given by

$$E = (N_A \rho / \mu) R_B \sigma_B + N P \sigma_B L \dots (1)$$

the first term of the right-hand side denotes the efficiency of the neutron counter due to boron lining while the second term denotes the efficiency due to BF₃ gas filling,

where N_A = Avogadro's number.

ρ = density of boron.

μ = at. weight of boron.

R_B = the range of α-particles in boron.

N = Loschmidt number.

P = pressure of BF₃ in atmospheres.

σ_B = capture cross-section of ^{10}B for thermal neutrons.

L = average path = diameter of the counter (approx.).

Thus the total efficiency of the counter is ≈10 per cent, each term contributing about 5 per cent to the overall efficiency.

The proportional counter was surrounded with a cylindrical double chamber containing U₃O₈ (equivalent of 800 gms. of uranium). The entire assembly was further surrounded with paraffin bricks of 5 cms.

thickness. The counting rate was 1.8 ± 0.2 per minute above the back ground count of 0.3 ± 0.05 per minute. When the paraffin bricks were removed, the counting rate nearly dropped down to the back ground level. This indicated that neutrons were emitted from the uranium source, which after being slowed down by scattering in the paraffin bricks produced counts in the boron-filled proportional counter tube.

Assuming that the isotope ^{235}U is solely responsible for the spontaneous fission process, and that a single neutron is produced during a nuclear fission, the above emission of neutrons corresponds to a half-life of $\sim 2 \times 10^{15}$ years. A direct detection of fission fragments has yielded a half-life period of $\sim 10^{16}$ years. The discrepancy between the two values is probably due to the following causes:

(1) it is known that during a uranium nuclear fission, more than one neutron is produced; this will increase the half-life period.

(2) the proportional counter does not directly measure the number of fast neutrons crossing the counter volume, which are emitted by the uranium source; it measures the flux of thermal neutrons crossing it, produced by the slowing down and the scattering of fast neutrons in the surrounding paraffin shield. We have not yet been able to determine the ratio between the number of fast neutrons emitted by the uranium source and the flux of thermal neutrons crossing the counter.

More accurate experiment is in progress.

The author is indebted to Prof. D. M. Bose, Director, Bose Research Institute, for his kind interest and helpful suggestions. His thanks are also due to Prof. S. N. Bose for valuable discussions.

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¹ S. D. Chatterjee and P. B. Sarkar, SCIENCE AND CULTURE, 9, 560, 1944.

PHOSPHOLIPID METABOLISM IN EXPERIMENTAL SCURVY

It was reported that fatty livers develop in guinea pigs fed on a scorbutogenic diet and that

daily administration of 20 mg. of cholin had practically no effect in preventing deposition of fat in livers.¹ It was surmised that fatty livers of guinea pigs in experimental scurvy might be due to a failure in the transport of fat from the liver and that this failure is primarily due to decreased synthesis of phospholipids; because it has been demonstrated that (i) phospholipid formation is dependent on tissue respiration and that the cytochrome system is intimately related with phospholipid synthesis²; (ii) activities of succinic dehydrogenase, which is a cytochrome linked enzyme, and cytochrome oxidase of tissues of guinea pigs maintained on scorbutogenic diet is decreased.³

In order to test this hypothesis, studies were undertaken to compare the composition of the different lipid constituents, principally the phospholipids, of various tissues of normal and scorbutic guinea pigs. Analysis of the samples were always made 15-16 hours after the ingestion of last meals.

The experimental results are presented in tables I, II and III; it will be seen that the level of

(c) cephalin of kidney, intestine, adrenal and erythrocytes and (d) sphingomyelins of erythrocytes are

TABLE II

	Total lipid	Total Phospholipid	Neutral fat plus Unsaponifiable matter	Cerebroside
Brain (N)* ..	12.54 g%	6.52 g%	4.52 g%	1.5 g%
" (S)† ..	"	"	"	"
Plasma (N) ..	"	90.4 " mg%	"	13.7 " mg%
" (S) ..	"	81.0 "	"	33.2 "
Intestine (N) ..	2.76 g%	1.27 g%	1.49 g%	"
" (S) ..	2.43 "	0.96 "	1.47 "	"
Adrenal (N) ..	16.2 "	4.2 "	12.0 "	"
" (S) ..	12.8 "	2.94 "	9.82 "	"
Erythrocytes (N) ..	"	100 mg%	"	39.8 mg%
" (S) ..	"	85 "	"	88.6 "

* (N)—Normal.
† (S)—Scorbutic.

TABLE III

	Amount per 100 g of brain, intestine and adrenal. Amount per 100 cc of plasma and erythrocytes.		
	Lecithin	Cephalin	Sphingomyelin
Brain (N) ..	1108.4 mg	3586.0 mg	1825.6 mg
" (S) ..	"	"	"
Intestine (N) ..	610.0 "	470.0 "	190.0 "
" (S) ..	444.0 "	330.0 "	186.0 "
Adrenal (N) ..	1976.0 "	1720.0 "	502.0 "
" (S) ..	1296.0 "	1140.0 "	504.0 "
Plasma (N) ..	41.2 "	30.2 "	19.0 "
" (S) ..	32.0 "	30.0 "	19.0 "
Erythrocytes (N) ..	16.0 "	62.0 "	32.0 "
" (S) ..	12.0 "	47.0 "	26.0 "

below normal; (e) cerebroside of plasma and erythrocytes are above normal.

The details will be published elsewhere. My thanks are due to Dr B. B. Sircar and Mr P. B. Sen for their encouragement and interest.

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¹ Spellberg and Keeton—*Am. J. Med. Sci.* 200, 688, 1941.
² Taurog, Perlman and Chaikoff—*J. Biol. Chem.* 145, 281, 1942; Fries, Schachner and Chaikoff—*J. Biol. Chem.* 144, 39, 1942; Fishler, Taurog, Perlman and Chaikoff—*J. Biol. Chem.*, 141, 809, 1941.
³ Harrer and King—*J. Biol. Chem.*, 138, 111, 1941; Phillips Stare and Elvehjem—*J. Biol. Chem.*, 106, 41, 1934.

(a) neutral fat plus unsaponifiable matter is increased several times in scorbutic livers and to a significant extent in the kidney—that of adrenals is lowered; (b) lecithin of all the organs, excepting brain,

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DRUG SITUATION IN INDIA

POST-WAR reconstruction is now being freely talked of everywhere—in the Press, in the Radio, as well as in public platforms. A special portfolio has been created in the Viceroy's Cabinet on "Post-war Planning and Development", and one of our brilliant industrialists and organizers, Sir Ardeshir Dalal, has taken over charge of this important work. A special Committee on "Health Survey and Development" during the post-war period is carrying on its labours for nearly a year under Sir Joseph Bhore. Of late, several foreign experts have come down to India to advise on the tentative recommendations of this Committee. A scheme for a thorough educational reorganization to remove mass illiteracy and bring India in line with other educated countries in the civilized world has already been mooted by Sir John Sargent, the Educational Adviser to the Government of India, and has been favourably commented upon. A Fertilizers Technical Mission has visited India to advise on the setting up of plants and equipment for the manufacture of nitrogen fertilizers in commercial scale for the development of Indian agriculture. An Indian Scientific Mission has already left India for collecting first-hand information on future scientific, technical and industrial possibilities in this country, and an Industrial Mission consisting of India's leading industrialists are planning to proceed to the United Kingdom and America shortly. 'Grow More Food' campaigns have been started, and attempts are also being made to improve food technology and build up modern processed food industries in the near future in India. After years of inaction and silent waiting, there seems clear indication from all sides that there is a definite and an increasing awareness in India about the need of better and more ample provision for what may be called the very primary requirements of civilized existence—(1) Food (2)

Medicine (3) Education and (4) Clothing. With the World War II coming to its closing phases, India, like many other countries of the world, would have to re-adjust herself to a 'new order' and a new standard of progress, and it is a welcome sign of the times that she is at least attempting to march ahead with this objective in view.

In any scheme of medical relief to the nation, drugs which are the chief weapons in our attack against malnutrition, disease and epidemics, would naturally form an important item for consideration. Next to the supply of food, the provision of medicines of good and dependable quality at a price within the reach of the poor masses of India is an urgent and imperative necessity. The question of drug supply, it need hardly be pointed out, is intimately related with any scheme of post-war public health planning and in every attempt that is made 'to keep the nation fit'. It would be of interest, therefore, to review the drug situation in India, to see where gaps exist in the Indian drug industry and to focus attention on the directions in which the Indian drug industry should try to guide its activities, so that it will be able to discharge its responsibilities to the nation in a more adequate and fuller measure.

THE RECENT DRUG CRISIS

The world knows that Bengal was in the grip of a severe 'food famine', but it is hardly realized that the 'drug famine' in Bengal was even worse. Those who have had something to do with relief organizations, medical aid-parties, Red Cross units, Ramkrishna Mission and other charitable organizations working in the rural areas, where malaria, typhoid, cholera, dysentery and other fevers of unknown origin were devastating the country-side, and who were frantically trying to get supplies of drugs from various sources, know to their cost the extent

and gravity of the 'drug famine' that existed in 1942-43. We have frequently read in the papers of the colossal death rates from food-famine, but no figures are available as to the extent that this mortality is referable to lack of treatment due to shortage of drugs. What is the cause of this shortage? Why could not our Indian manufacturers rise to the occasion and supply the needs?

The reasons are obvious. In the first place, India had depended for years on foreign imports for the supply of many of her essential medicaments, and consequently the drug industry in the country was not prepared to meet the needs in an emergency period. A reference to the sea-borne trade statistics of British India published by the Department of Commercial Intelligence and Statistics would show that as early as 1910 the value of imported drugs (including pharmacopoeial drugs, essential oils, proprietary medicines, medicinal chemicals, toilet products, alcohol used in drugs, spirits for perfumery, etc.) was about Rs. 75 lakhs; in 1937, the figure was about Rs. 285 lakhs, a fourfold increase in 27 years. The import of foreign proprietaries into India amounted to Rs. 33 lakhs during the years 1933-34, and this figure rose to Rs. 73 lakhs within the next four years in 1937-38. Recent figures are not easily available, but there is definite indication that up to the time when shipping facilities were available at pre-war level, India's quota in drug import was not only quite heavy but was definitely on the increase almost every year. Secondly, the demand for drugs has increased tremendously, of late, due to the entry of foreign soldiers to conduct the war, exports by the air-route to China, and also due to the higher incidence, in general, of sickness amongst civilians in war-time. Thirdly, the fall of Java, Singapore, etc., has cut off a flow of certain essential crude drugs, e.g., cinchona, ipecacuanha, etc. and quinine from abroad to India. Fourthly, certain unscrupulous Indian druggists are hoarding what drugs are already in hand for selfish purposes—'profiteering'. The Government of India have taken steps to rectify the emergency situation by freezing essential drugs, by imposing heavy penalties for hoarding of drugs and by devising ways and means to halt inflation by 'price control' etc. In spite of all efforts however, there is clear indication to-day that the civilians are on the point of starvation as far as drug supply is concerned, because many of the essential items are not produced in India. One of the natural questions, that arises in this connection is whether or not the most useful drugs at least can be made in India. If so, the advantages are likely to be numerous, the important ones being self-sufficiency, low cost of production and certainty of delivery and distribution, a factor of no less importance in war time. Besides, any experience gained now will

greatly facilitate post-war reconstruction and pharmaceutical development of India.

INDIA'S DRUG RESOURCES AND THEIR UTILIZATION

To give an opinion as to whether India is in a position to manufacture the most useful drugs, it is necessary to look into India's drug resources and to review the extent to which such resources have been properly harnessed for the benefit of the population. Drugs are usually derived from four sources:—(a) vegetable, (b) mineral, (c) animal, and (d) synthetic sources. Recently another group of substances, (e) anti-biotics, which are the products of the growth of a particular class of fungus, e.g., *Penicillium notatum* and others, have been added to this list.

With regard to *vegetable* drugs, India's position is pre-eminent. Leaving aside for the time being the large number of drugs used in the indigenous systems of medicine, nearly three-fourths of the vegetable drugs mentioned in the British Pharmacopoeia or the United States Pharmacopoeia grow wild and in great abundance in different parts of India. India possesses such wonderful variability of temperature, soil and climatic conditions that every conceivable drug, ranging from those growing in the hottest tropical climate to those growing in temperate and cold climates, may be made to grow in her soil. Moreover, a large number of plants grow in India, which, though not exactly the same as those 'officially' recognized, have properties and actions similar to the imported and often expensive remedies and would form excellent substitutes. Examples of such drugs are numerous but few important ones which have been exploited to a certain extent, e.g., digitalis, ipecac, belladonna, hyoscyamus, nux vomica, ephedra, lobelia, pyrethrum, tephrosia, cinchona, etc. may be mentioned. During the present war, it is encouraging to find that these and other crude drug resources of the country are being largely utilized not only for the preparation of tinctures, extracts, powders, etc., but also for the extraction of active principles, e.g., morphine, codeine, quinine, totaquina, emetine, strychnine, ephedrine, caffeine, santonine, etc. and for the preparation of organic acids, e.g., tannic, citric, etc. Many fixed oils e.g., chaulmoogra, castor, coconut, linseed, etc., and essential oils, e.g., chenopodium, sandalwood, caraway, fennel, rose, cloves, cardamom, cinnamon, etc., of indigenous origin are also being widely used. A dramatic development of very great future promise has been the artificial production of ergot of rye in the Nilgiri Hills for the first time in the history of India.

In the group of drugs derived from *animal sources*, considerable development has been made. It is a fine record of Indian industry that the world shortage of cod liver oil, which was bound to have a serious repercussion on the already low nutritional level of India, has been met here, at least to a certain extent, by the utilization of the Shark liver oil. A satisfactory substitute for Spanish blister beetles (*cantharis vesicatoria*) has been found in Indian beetles of the type of *Mylabris macilenta* and local needs of cantharidin have been met from this source. Glandular products, e.g., thyroid powder, adrenaline powder and posterior pituitary powder, have been successfully made from glands of animals from local slaughter houses. Huge quantities of liver extracts, both for oral and parenteral use, have also been made. Animal bile has been used as raw material for the preparation of sodium taurocholate and glycocholate and its oxidation product, dehydrocholic acid. Attempts have further been made, though as yet unsuccessfully, for the preparation of sex hormones and anterior pituitary-like hormones from natural sources. It is understood that insulin has also been prepared but it is not yet to be seen in the open market. The most outstanding contribution in this field has been the development of the biological products, e.g., sera, vaccines, antigens, antibodies, bacteriophages, etc. for immunotherapy in its various aspects. What was at one time considered impossible to achieve in the hot and humid climatic conditions of Bengal has been successfully done, and to-day drug manufacturers in Bengal are almost in an enviable position with regard to their production capacity of antitetanic, antidiphtheric, anti-dysenteric and anti-streptococcic sera and prophylactic and curative vaccines of every description.

In *mineral wealth*, India's position has been considered very satisfactory by a number of experts. Until recently, sulphuric acid manufacturers in India were importing nearly 25,000 tons of sulphur from Italy, Japan and America. India has deposits of sulphur (native) and also 'pyrites' in Baluchistan, which if worked, would yield at least 36,000 tons of sulphur we need for the manufacture of sulphuric acid for use in pharmaceutical and allied industries. Antimony and arsenic are also available in quantities which ought to suffice for the needs of India in respect of organic arsenical and organic antimonial compounds for the treatment of syphilis and kala-azar respectively. Silver salts and its organo-metallic compounds, e.g., protargol, salts of zinc, copper, aluminium and tin, and permanganates from manganese have also been prepared from India's mineral deposits. Iron salts and its popular scale preparations have been manufactured here. India lacks in adequate supplies of bismuth and mercury, but the quantities needed for pharmaceutical pur-

poses are not of a magnitude which cannot be secured from the borders of Burma or China.

Apart from these drugs of vegetable, animal, and mineral origin, India is very largely dependent for almost all her pure and heavy chemicals used in medicine and pharmacy and in analytical and scientific work on outside sources. In the field of *synthetic and chemotherapeutic products* which stand at the forefront of modern medical progress and which supply more than half of the modern physician's chemical weapons, this dependence is most evident. Practically the whole range of local anaesthetics, e.g., procaine, and the newer general anaesthetics, e.g., divinyl ether, cyclopropane, etc., the whole group of analgesics and anti-pyretics, e.g., anti-pyrine, phenacetin, etc., the recent diuretics, e.g., mersalyl, salyrgan, etc., many hypnotics, e.g., the barbituric acid derivatives, (only veronal has been so far prepared), many stimulants and analeptics, e.g., leptazol, nikethamide etc., vasodilators, e.g., choline chloride, amyl nitrite, benzyl benzoate, etc., almost all germicides, fungicides and parasiticides, e.g., mandelic acid, chloro-cresol, merthiolate, phenyl mercuric nitrate, etc., the constantly growing series of dye-stuffs, e.g., azo dyes, acridine and rosaniline dyes, for surface application and for diagnostic, prognostic, and radiological purposes, many essential oils, vitamins and anti-bacterial agents, e.g., the sulphanilamides, etc.,—to mention only a few—must come from abroad to maintain the health of her countless millions. That it is possible to manufacture most of these in India and that qualified technical personnel are now available to undertake such synthetic and analytical work are shown by the fact that already such drugs as carbarsone, iodochloroxyquinoline, chiniofonum, atophan, sulpharsphenamine, urea stibamine, the sulphanilamides and atebirin have been manufactured on a laboratory and semi-commercial scale in India. Sex hormones of the type of stilboesterol and hexoesterol, thyroxine, and the adrenal cortical hormone, desoxycorticosterone, have also been synthesized in a small scale in certain university laboratories. Attempts are being systematically made for the synthesis of adrenaline from catechol. The greatest gap in Indian synthetic chemistry at the moment is in the direction of the synthesis of the vitamins. Thiamine chloride (vitamin B₁), riboflavin (vitamin B₂), nicotinic acid and nicotinamide (P—P factor), pyridoxine (vitamin B₆), ascorbic acid (vitamin C), and methyl naphthoquinone (vitamin K-like substance), which have already been manufactured by synthetic processes in America and elsewhere, have not been attempted in this country, excepting perhaps nicotinic acid which is reported to have been prepared from tobacco wastes. Vitamin A concentrates and vitamin D are also being made by molecular distillation of fish liver oils in a Hickman Still in

America. This has been attempted in one research institute in India but has not yet been a success. All these things which have been made elsewhere and the processes regarding the manufacture of which are already well-known and are available from recognized sources, can be easily produced in India provided there is proper stimulus and leadership and a collateral development of chemical and technological industries in this country.

PRODUCTION TARGET TO BE AIMED AT

Within the last 30 years, thanks to the enterprising spirit of some prominent chemists and medical men, the drug industry in India has developed fairly well, particularly in the provinces of Bengal and Bombay. It will be admitted on all hands that during this war India's drug production capacity is on a much higher level than during the last war. The total Indian output is, however, very small compared to the size of the country and its large population. The Indian public are becoming more and more conscious of the wonderful achievements of 'modern medicine' (not 'Allopathy' which is almost extinct now), chemotherapy, modern surgery and obstetrics, and are gradually showing preference for this system of treatment over the old indigenous systems of medicine, e.g., Ayurvedic, Unani, Hakimi, etc., which used to claim as their adherents nearly ninety per cent. of India's population until the beginning of this century. A naturally growing demand for modern drugs is, therefore, slowly but surely being created. If, as is expected, as a result of international trends towards socialization of medicine and the recommendations of the 'Health Survey and Development Committee', public health and medical care become a Governmental function immediately after the war is over, India can easily look forward to an enormous drug market within her own borders. For a very much smaller population, Great Britain incurs an expenditure of £80,000 on drugs, medical research, etc. under the National Health Insurance Scheme. If we calculate the cost of medical relief and medical care of the Indian population under a similar Health Insurance Scheme at the modest estimate of 0.1 per cent. of the national income (estimated by Sir J. C. Ghosh at Rs. 65 per head per year), India would require supplies of drugs and other medical requisites valued at 5 crores of rupees. Considering the low nutritional status of the Indian public and their still lower resistance to disease and infections, protective drug therapy with vitamins and preventive inoculations with vaccines against typhoid, cholera, dysentery, etc. may have to be carried on by the Government with much more emphasis than in Great Britain and in America, at least for the next 15 years during

the post-war period. All these steps would naturally require far more energetic drug production than at present. Apart from State needs, there will be private needs for drugs also, whose proportions cannot be ignored. With better industrial development and increase of agricultural resources, India's buying capacity for drugs would undoubtedly increase to at least 10 times more than at present. The scope of expansion and further development of the Indian drug industry can, therefore, be easily imagined. It is not enough to supply a fraction of the requirements of the people, as at present, but the aim should not only be to attain self-sufficiency but also to develop an export trade, at least in vegetable drugs.

During recent years, there are welcome evidences of rapidly growing, though often spasmodic, interest in the building up of newer drug manufacturing industries from the raw materials available in this country. While this is a very hopeful sign, and is a move in the right direction, it cannot be denied that because of lack of proper organization, many such efforts are not meeting with the success they deserve. The development of drug industry, unlike most other industries, is not merely a function of capital and labour and cannot be done by amateurs and novices but should be established on scientific lines under the expert guidance of chemists, chemical engineers, pharmacists and pharmacologists possessing a good knowledge of the technology of the industry. This is not often appreciated by many of the Indian industrialists and capitalists who want a quick turnover and a rapid piling up of their bank balances, not by the slow and often tedious scientific methods but by 'magical' methods. Once this attitude changes, substantial progress will surely be made. The field is so vast in India that there is no fear of 'internal' competition for years to come.

DRUG INDUSTRY'S DIFFICULTIES

The difficulties in the way of arriving at this target are many and varied. Some of the major ones may be briefly mentioned here.

(A) Lack of development of chemical and allied industries:—

(i) *Chemical industry*.—As drugs are primarily chemicals, their manufacture will naturally be conditioned by the development of the chemical industry in general. Most of our leaders cry themselves hoarse complaining against the poor development of pharmaceutical industry in this country and are often in the habit of laying the blame at the doors of our pharmaceutical manufacturers. They fail to realize that pharmaceutical manufacture is only the final stage of an industry whose roots are deeply laid in the chemi-

cal industry. Like tailors working on cloth made in a separate factory, pharmaceutical manufacturers have to carry on their work with chemicals produced by the chemical industry. In no country in the world pharmaceutical industry can be self-sufficient with regard to all its needs, and it has always depended primarily on a well-developed chemical industry. In most instances, pharmaceutical industries are really outgrowths of dye, coal-tar and heavy chemical industries. The great Bayer Corporation of Germany was initially a 'Farbenindustrie' (a dye-making corporation). In India, we have to face the peculiar situation of the cart (pharmaceutical industry) coming before the horse and this is the most important reason for the lack of development of India's pharmaceutical industry.

From the view point of drug production, the chemical industry may be divided under the following heads:—(1) Inorganic—metals, acids, salts, alkalies, etc. (2) Organic—(a) acids, alkaloids, sugars, essential oils of vegetable origin, etc.; (b) fermentation industry; (c) coal-tar distillation products, and (d) synthetic organic chemicals, particularly solvents, and the industries dependent upon them. India has good potentialities in most of these branches, but much remains to be done, though in many cases the fringes of the problem pertaining to some solvents, glycerine, sulphuric acid, magnesium sulphate, coal-tar distillates, certain essential oils, and fermentation products have been touched by progressive manufacturers. To give one example, India imports dye-stuffs of coal-tar origin worth about 3 crores of rupees, but only about 60,000 tons of coal-tar are distilled all over India yielding benzene, toluene, phenol, cresol, naphthalenes, anthracene, pyridine, etc. If sufficient supplies of these were forthcoming dye intermediates, viz., aniline, alkylamines, toluidine, etc., could have been easily prepared. If inorganic heavy chemicals, e.g., caustic soda, nitric acid, etc., and organic solvents were simultaneously available, India could produce at least some chemotherapeutic items of urgent need. The position with regard to organic solvents barring alcohol is also very deplorable. Fortunately, attention has already been drawn in this direction, and before long, alkali and bleaching powder industries are likely to be placed on secure foundation in India.

(ii) *Glass industry*.—The development of glass industry has a very important bearing on drug industry. The 'container' problem is extremely important. Here considerable progress has already been made, and more is likely to come through the efforts of the Board of Scientific and Industrial Research.

(iii) *Toilet and perfumery industry*.—These industries are almost hand-maidens to drug industry

and are mutually inter-dependent. Certain amount of success is already evident, but a bright future depends on collateral developments of essential oil industry, glass industry and a general improvement of the economic status and buying power of the community.

(iv) *Textile industry*.—For surgical dressings and gauges, etc., cotton and textile industry must provide the requirement. This is already developed in India and no difficulty need be anticipated in this direction.

(B) Other Associated Difficulties:—

(i) *Paucity of reliable raw materials*.—One of the chief difficulties which have confronted the manufacturing chemist and pharmacist in India for some time and which is still unsolved is the question of procuring reliable 'raw materials of standard quality'. India possesses vast resources of medicinal plants, but the sources of supply of crude drugs have not been fully explored. There is as yet no reliable organization in India for the collection of drugs in proper manner with adequate arrangements for their drying 'curing' and storing, and later distribution to manufacturing chemists through a regular channel. Except in the case of a few reliable drug dealers, most of the trade in crude drugs is carried through the agency of middlemen who have hardly any botanical or pharmacognostic knowledge of the drugs they deal with. There is no organization such as the 'Bureau of Plant Industry' of Soviet Russia and America, which gives advice and encourages the cultivation of medicinal drugs and takes charge of their distribution to manufacturing centres, through a central agency. The result is that the manufacturers are exposed to all sorts of trickeries and frauds in their drug purchases, and unless they can keep well-equipped laboratories for pharmacognostic testing (with resulting increase in the cost of the finished products, they are forced, often without their knowledge) to use low-strength and deteriorated crude drugs.

(ii) *Transportation problems*.—This is another difficulty in such a vast country as India, where the sources of raw materials and the factories where they are finally processed are often hundreds of miles away. This adds greatly to the cost of manufacture. In spite of vehement advocacy of the Indian Chemical Manufacturers' Association to institute preferential railway rates for crude drugs and other items used for the preparation of medicines, the situation has not so far been remedied. During pre-war days, Strychnos nux vomica seeds growing in the Mayurbhanj State used to be sold in the London drug market at half the price at which these could be purchased at Calcutta. During the present war, the transportation problem has assumed even

more serious proportions. Apart from the question of railway rates, the question of transport 'priority' has arisen. Crude drugs are not considered on the 'first priority' list, and as such, there is quite often considerable delay in the despatch of crude drugs to the producing factories.

(iii) *Excise control*.—Manufacturers and distributors are greatly handicapped due to differences in the Provincial Excise Regulations. While it is not our purpose here to go into the details regarding the intricacies involved in this question, it is important to point out that this is a source of financial loss to many drug manufacturing concerns. The inter-provincial movements of spirituous preparations are beset with difficulties due to excise restrictions which should be removed as soon as possible. Another difficulty is that under the present regulations, all research and analytical works carried out by private manufacturers have to be performed with duty-paid spirits. The same statement holds good in the case of alcohol used for the manufacture of alkaloids and for other extraction purposes. These naturally add to the cost of the finished products issued from the indigenous drug manufacturing houses.

(iv) *Lack of machinery and other technological equipments*.—There is at present no department of chemical engineering in this country which can successfully undertake the designing and running of commercial plants suitable for the manufacture of drugs. Part of the difficulty met by manufacturers in increasing production during this war had been due to the difficulty in obtaining even ordinary drug manufacturing equipments, e.g., mixers, stills, dryers, filters, tanks, vacuum pans, refrigerators, autoclaves, incubators, sterilizers, high-speed motors, vacuum dryers, and a host of others required in every-day work. If all these have to be imported from abroad, progress will naturally be hampered. Even if all these were possible to import, the question as to the installation and proper operation of newly imported machinery by Indian technicians would still remain a major difficulty.

INDIAN DRUG INDUSTRY NEEDS A NEW OUTLOOK

There may be many other difficulties of the drug industry which, as a laboratory worker, the writer is not in a position to anticipate. Some of these can be easily remedied by concerted actions, while others will take probably several years and might require State intervention for their successful solution. These difficulties do not, however, appear as insuperable barriers to the development of a virile drug industry in this country.

What the Indian drug industry is now suffering from, at least in the opinion of the writer, is not

a *physical* difficulty in her production and developmental problems (which should not, as has been shown, necessarily be ignored), but a *mental* difficulty (using both the words in figurative sense) in its *outlook*. A forward outlook which the Indian drug industry should develop, if it wishes to keep itself abreast of modern times, is that it is predominantly a *public health industry*. Unlike many other industries which cater to the comfort and luxury of the public or to the common utilities of modern civilized existence, drug industry caters to the vital health needs of the nation. It has, consequently, a bigger and nobler responsibility to fulfil. It should, therefore, develop the *binocular* outlook—of an ordinary industry interested in money making, as well as of an industry which is an essential cog in the wheel of the public health machinery of the nation. If this outlook is fostered, many troubles in connection with adulteration of drugs and a spurious drug trade will disappear. Indian drugs would be considered more worthy of use by the Indian doctors, and faith and reliance on Indian products will reign supreme where suspicion and confusion now exist. For future success and for withstanding post-war competition, Indian drug industry must actively carry on their educative propaganda to build the 'Home Front'. It must remember only one slogan—*there are no two qualities in drugs*. A drug is either good or bad and cannot be classified in any other third category. The aim should be to produce only the good quality and to see that the same reaches the consumer in the same quality without being tampered in any way in retail trade and by middlemen.

There is another aspect which appears also to have been missed by the drug industry in this country. Being a product of the two World Wars, Indian drug industry has been thinking only of deficiencies and shortage problems—it has been looking to the 'minus' phase and not to the 'plus' phase of its growth. It has always been trying to produce items which are in shortage and in immediate demand, and for this purpose it has done quite a little up-hill work in the mobilization of capital, equipment and expert personnel from all over the country. It has done a good job for the *present*, but, as is to be expected under the circumstances, it is *frankly* lacking in that stability and balance which characterizes a well-planned and well-organized peace-time industry. It is already showing many hiatuses in its pattern of growth and so far has not shown any vision for the *future*. Indian drug industry to-day is really a 'developmental drug industry' where only 'drugs of today' are being produced on a copybook basis, but is not a 'creative drug industry' where new agents and 'drugs of to-morrow' for the alleviation of yet incurable diseases can be manufactured. Modern medicine and therapeutics are progressing

rapidly, and an industry which ultimately aims to supply the needs and requirements of such scientific practices can ill afford to be backward and undergo the risk of being wiped out sooner or later. In India, the capitalists and industrialists are largely ignorant of the rôle of science in industry and are apt to think that any expenditure on scientific and research projects are unjustified and unnecessary. Fortunately, this attitude is fast disappearing, and progressive drug manufacturers are increasingly concentrating on research inside their own manufacturing concerns and also promoting researches in Government institutions and university laboratories.

WANTED A NATIONAL INSTITUTE FOR DRUG RESEARCH

Piecemeal grants of money and haphazard research projects are not, however, going to solve the most difficult problem of finding new curative agents of the type of urea stibamine of Brahmachari every day. What is needed is a comprehensive long-range programme and planning with a vision for the future. The writer is of the opinion that, in addition to research organizations supported by the industries themselves and the Government institutions that are already existing, there is an urgent need for the establishment of a well-equipped and well-endowed National Institute for Drug Research where a quadrangular collaborative scheme between botany, chemistry, pharmacology and clinical medicine can be fostered. This concept has been elaborated by the writer in his Presidential Address for the Section of Physiology entitled; "The Scope and Future of Pharmacology in India". If India is not to remain content by manufacturing only the *substitutes* of what has already been done in foreign countries, and if she has to forge ahead in the elaboration of *new* drugs and medicaments for the relief of human suffering, she must come forward with a well-organized policy for the creation of one or more National Institutes for drug research where every facility will be provided for a collaborative effort between the various groups of scientists that are needed in the evaluation and ultimate clinical use of un-

known drugs obtained either from the natural sources or as a result of synthesis in the laboratory. Expenditure on drug research is not money lost but will pay a large dividend in years to come, as has been shown from the experience of such firms as the Bayer Co. of Germany, Parke, Davies and Co. of America and the Burroughs, Wellcome and Co. of England.

If the drug industry is developed on sound and ethical lines, there is every reason to hope that it will help India's economic progress by utilizing the raw materials produced in the country, will give stimulus to India's chemical and coal-tar industries, will throw open avenues of employment to a very large number of educated Indian youths and will raise the standard of living generally. State help and protection wherever necessary have been accorded to national drug and chemical industries in all progressive countries of the world, as this is predominantly a public health project and is not just an industry for increasing the wealth of the nation. Drug industry need not worry about State aid. In the new world order which is fast coming after the war, there will automatically be a new outlook on things. It will not then be difficult to realize the need for protection of the drug industry by the State in the same way as a protected water supply, preventive vaccination against small pox, typhoid, dysentery, rabies, yellow fever, etc. These functions have already been taken over by the State. It is only the next step for the State to protect the population from food deficiencies by the manufacture of vitamins and to protect public health by eliminating infectious diseases through proper manufacture and distribution of essential life-saving drugs. Drug industry, seen in this outlook, is really helping in one of the major functions of a modern enlightened State and should receive its major attention and guidance. Sir Ardeshir Dalal may well consider in his 'Policy Committee on Industries' the early establishment of a special 'panel' for drug industry. The time is more than ripe for such a step.

B. Mukerji

COST FACTOR IN THE ELECTRICAL DEVELOPMENT OF INDIA

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IN a recent article in *SCIENCE AND CULTURE* (August, 1944), Professor M. N. Saha has rightly stressed the urgent importance of the electrical development of India as the first step towards the industrialization of the country and consequent recovery

from the economic stagnation. The object of the present article is to give some idea of the capital expense of a scheme of electrification as well as the price at which a unit of energy may be sold, with a view to promoting greater interest in the above scheme.

CAPITAL COST

The provision of 100 additional units of energy per head of population annually, as recommended by the National Planning Committee, will be the starting point in the estimation of the capital cost. For reasons stated afterwards, this will first be derived with particular reference to Bengal, from which will be deduced the capital requirement for the electrification of the whole of India.

On the assumption that Bengal has a population of 70 millions, the total number of electrical energy units that has to be supplied is 7000 million per year.

The determination of kw capacity of a plant for the delivery of a given number of energy units per year requires a knowledge of (a) Load Factor, (b) Efficiency of Transmission, and (c) Power Factor of the Load. These can only be estimated from an analogy with similar data available in other countries after due consideration of the local factors that may affect the data.

The load factor* plays by far the most important role in the economics of an electric power plant. A kw plant, for instance, if it delivers its full capacity throughout the year can bring in revenue for 8760 units. On the other hand, if the same plant works at full capacity for 3000 hours during a year or at half its capacity for 6000 hours, on account of the vagaries of load, it can sell only 3000 units. Therefore, to get the maximum benefit out of a given plant, greatest care is to be taken to ensure that the power plant works at near its full capacity for the maximum number of hours.

The following tables give the position of the electrical power industry in general, and of load and

TABLE 1.
ELECTRIC POWER INDUSTRY IN GREAT BRITAIN

Year	Energy generated (million kwh.)	Maxm. demand (million kw)	Plant capacity (million kw.)	Load factor %	Plant factor %
1923	5,250	2.05	3.4	29	17.7
1928	9,324	3.37	5.80	31.6	18.3
1933	13,600	4.8	7.85	32	19.8
1938	24,372		8.26	...	33.5

plant factors in particular, of Great Britain and U.S.A. from 1923 to 1938 at intervals of 5 years.

*Load factor	$= \frac{\text{Total energy generated}}{\text{Maximum demand in KW} \times 8760}$
Plant factor	$= \frac{\text{Total energy generated}}{\text{Plant capacity in KW} \times 8760}$
Reserve capacity of plant	$= 1 - \frac{\text{Load factor}}{\text{Plant factor}} - 1.$

TABLE 2.
ELECTRIC POWER INDUSTRY IN U. S. A.

Year	Energy Generated (million kwh)	Plant Capacity (million kw)	Plant Factor %
1923	55,665	17.46	38.1
1928	87,850	29.63	35.0
1933	85,402	36.04	27.0
1938	111,498	36.52	35.0

The maximum demand on power plants in U.S.A. is not available, but the load factor of that country can be guessed from the ratio of plant factor to load factor of Great Britain.

In Great Britain and other western countries, the two aspects of the domestic load e.g., lighting and heating, go hand in hand with the result that the domestic load imposes a very severe demand on power supply in winter, but assumes quite a small magnitude in summer. Hence the load factor is inherently poor. In India, on the other hand, the increased lighting load due to the longer hours of darkness in winter is more than offset by the increase in the airconditioning load (refrigerators, fans etc.) in summer. This seasonal uniformity of the domestic load will have a beneficial effect on the load factor. With reasonable development of industry, by the time the electrification schemes come into full operation, a load factor of 33% may not be above the ambit of attainment.

With planned development of the electrical power industry whereby not only generation and distribution but also consumption become an integral part of the scheme of electrification, a much better utilization, and hence much higher load and plant factors, may be attained. In Soviet Russia, for instance, where electrical development has taken place on these lines, the plant factor in 1935 was 45.8% and was steadily increasing.

The transmission efficiency is expected to be in the neighbourhood of 80%. For the present rough calculation, the effect of lower power factor on the increase in the capital cost is neglected. Hence the maximum demand on the plant for the supply of 7000 million units is given by:

$$\text{Maximum Demand} = \frac{7000}{0.80} \times \frac{1}{8760 \times 0.33} = 3.0 \text{ million kw.}$$

The cost per kw of installation of a thermal station in Great Britain in 1926 was £15 while that for transmission and distribution was £18 which allowed for final conversion into D.C. current. Hence capital cost of plant, including generation, transmission and distribution, was £33 or about Rs. 440 per kw. Post-war installations which not only in-

corporated normal peace-time progress but also much accelerated technical development during the war period will, it may be expected, cost approximately Rs. 350 per kw of which Rs. 160 may be apportioned to generation and the rest, Rs. 190 to transmission and distribution.

Hence the electrical development of the province of Bengal on the lines suggested by the National Planning Committee will entail a capital expenditure of 105 crores of rupees.

The above estimation is particularly applicable to Bengal where, because of the flatness of the country, super thermal stations and not hydro-electric stations will predominate. The proximity of coal-fields also militates against large scale hydel projects in Bengal. This, however, does not preclude the possibility of development of some of the notorious rivers such as the Damodar and the Tista, but the primary purpose thereof will be flood control, prevention of soil erosion, irrigation, navigation, and control of malaria. Certain amount of electrical energy, of course, may be derived from such schemes.

The fact that thermal stations are more amenable to accurate estimation has induced the author to consider the province of Bengal alone in his calculation of the cost factor. The capital cost of hydro-electric projects which will play a predominant role in other parts of India varies between wide ranges depending on the nature of the scheme. For instance, the hydel scheme for the development of the natural power resources of the Highland of Scotland is estimated to cost £30 million for the output of 450,000 kw (Rs. 900/kw) while a hydel project for the installation of 1,125,000 kw in Canada will cost only £26½ million (Rs. 320/kw). It may, however, be roughly guessed that the execution of the scheme of electrification as recommended by the National Planning Committee e.g., for the supply of 40,000 million units, requires the installation of 20 million kw at a total cost of 1000 crores of rupees.* (This allows a reserve capacity of 17½% on the load factor of 33%. In other words, it allows a plant factor of 29%). Starting practically from void, Soviet Russia attained an output of nearly 40,000 million units in 1937 at the end of the Second Five Year Plan. Cannot India with 2½ times the population of Russia emulate this pioneering enterprise of Russia and reach the same target in the course of the next 10 years?

PRICE OF A UNIT OF ELECTRICAL ENERGY

While capital cost is mainly a concern of a select few, the price at which a unit of energy may be

* This presumes a ratio of 3 kw hydel power to 1 kw of thermal power, generation per kw of the former being assumed to cost Rs. 350.

sold is of paramount importance to every potential consumer. As such, any discussion on the cost factor of the electrical development will be incomplete without a reference to the price at which a unit of energy may be sold.

This thorny problem can only be dealt with from an analogy with data available in the electrically developed countries. The present treatment of the subject is based on the British practice with particular reference to 'Costs and Tariffs in Electricity Supply' by D. J. Botton, Electricity Commissioners' Reports (of Great Britain), and 'Generation, Transmission, and Distribution of Electrical Power' by A. T. Starr.

In the calculation of the capital charge, an interest of 5% has been allowed on the capital outlay and sinking fund. The life of the generating plant (including machinery, land, building) has been fixed at 20 years and that of the transmission and distribution equipment at 30 years. The price of coal is taken to be Rs. 5/- per ton. The following analysis of the cost of unit of electrical energy applies to a super thermal station of 100,000 kw capacity or over with a load factor of 33%.

TABLE 3.

(A) Cost of generation	
Cost of fuel at -5. of coal per unit	054 As.
Salaries and wages Rs. 4.5/kw	025 "
Oil, water, stores, maintenance Rs. 4.5/kw	025 "
Management, rates, rent for generation Rs. 5.0/kw	028 "
Interest on Capital Rs. 8.0/kw	045 "
Depreciation on machinery	026 "
Total cost of generation	0.203 "
(B) Cost of distribution	
Transmission losses	013 As.
Cost of management Rs. 8.0/kw	044 "
Cost of maintenance Rs. 7.0/kw	038 "
Rates and rent for distribution Rs. 8.0/kw	044 "
Interest on capital Rs. 9.5/kw	052 "
Depreciation on equipment Rs. 2.7/kw	015 "
Total cost of distribution	0.206 "
(C) Miscellaneous expenses	001 "
Average cost per unit	0.5 "

The above calculation does not allow for reserve idle capacity of machinery which is essential for continuity of supply, nor does it include profit save 5% interest on capital charge. Accidental damages such as are caused by lightning and fire have also to be provided for. These necessitate the inclusion of 0.091 As. per unit as miscellaneous charge which not only covers the above items but also such sundry items as sales expenses. An average charge of 0.5 As. per unit may be taken as a rough approximation of the price that may prevail in India if the electrical development takes place on the lines suggested by the National Planning Committee.

A domestic consumer, because of the uneconomic nature of his load, may have to pay a charge of one anna per unit or even more. A large industrial concern, on the other hand, with a high load factor and a large consumption of energy may pay only 0.25 As. per unit. The tariff must be fixed so as to encourage high load factor of peak energy consumption and a good power factor. In the following table is given a typical tariff for the different categories of

TABLE 4.

Items	Units sold (million kwh)	% of total units sold	Average price (pence per unit)	% Revenue
Lighting & Domestic	2306	26.1	3.05	55.1
Public Lighting	128	1.6	1.69	1.9
Traction	710	9.1	0.88	5.5
Power	4927	63.2	0.86	37.5

consumers, that was actually in operation in Great Britain in 1928 when the average price of unit was 1.37 d.

The above figures (Table 3) are a sober reminder to many well-intentioned persons who declare that electrical energy may be sold in this country at 0.25 pice or so. Conversion into electric energy requires expensive machinery while efficient distribution in particular demands a highly technical staff. The interest on the enormous capital expenditure, depreciation on

in the price per unit which could be effected would be no greater than could be obtained by increasing the assumed load factor from 33 to 39%.

This clearly shows the extreme seriousness of load factor on the cost of the electricity supply. With hydel stations the importance of load factor becomes even more pronounced. In the following table (Table 5) is given the effect of load factor on the price of unit of energy, the various charges being the same as given in Table 3.

These calculations claim to give nothing more than a mere glimpse of the economics of generation, transmission and distribution as may apply to India. Complete details have been purposely ignored with a view to presenting a comprehensive picture of the cost machinery without sacrificing the essential factors.

CONCLUDING REMARKS

What, it may be asked, is the justification of a scheme of electrification which entails such huge expense? Briefly, electricity is the life-blood of industry which is the mainstay of the economic structure of a country. Electricity is the power behind the economic regeneration of a backward country, it is the light that can relieve the gloom of national poverty. In fact, as Prof. Saha has aptly pointed out, the prosperity of a nation is directly proportional to the "Energy-Index" i.e., the amount of energy consumption per capita. Any capital outlay in the electrification of India is, therefore, a national asset of the first magnitude.

TABLE 5

Load Factor %	10	20	30	40	50	60	70	80	90	100
Price per unit (As.)	1.497	0.782	0.544	0.425	0.353	0.305	0.271	0.246	0.226	0.210

machinery, and salary of staff are the big items which ultimately must be paid by the consumer. It may be seen that fuel accounts for only 15% of the total cost. Indeed it is a striking fact that even if collieries produced coal for nothing and railway companies charged nothing for carrying it, the total reduction

It is highly significant that the Bombay Plan has given first priority to the electrical development of India. Indeed electrification of India cannot but occupy the first place in any programme of economic development of India, which aims at the realization of the national goal of freedom from want.

THE FOOD VALUE OF FISH

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THE problem of ensuring adequate food supply and production is one of supreme importance at the present moment. In the countries involved in the War considerable interest is being shown in the physical fitness of the population as a whole. This has given a fillip to nutritional studies. It seems desirable at this stage to bring together the most important facts relating to the food value of fish in a concise form for the use of workers interested in food problems. The importance of this is the greater since attempts are now being made in India to formulate a food policy for the production and control of foodstuffs, and for improving nutrition in war, which should be permanently recognised as a part of national policy. This survey of the subject is not intended as an exhaustive treatise of all the work done on the subject. It is proposed to include only that work which is of immediate importance at the present moment, with special reference to India.

Next to agriculture and livestock fisheries constitute the most important industry and source of human food. Great Britain, Japan, United States, France, Russia, Spain, Portugal and Norway are the most important countries in which fish constitutes a valuable food. In Japan and Norway, the marine fisheries occupy a place of considerable importance, because of the very limited extent of cultivated land available for growing enough food for the population. In spite of the small landed area, Japan has a coast line of 20,000 miles in extent. The fishing industry has made rapid strides in recent years and has become a highly important source of economic wealth to the Japanese. It is reported that between the years 1906 and 1933, the number of motor fishing boats in Japan increased from 1 to 45,000. It has been estimated that nearly two million men are engaged in fisheries in Japan. It has successfully tackled the problem of supplying the densely populated country in which the population increased by one-fourth during the years 1912-1927, with enough food by increasing fish production three-fold, a sound policy based on scientific knowledge. In addition to Japan, many other countries, such as Norway, Denmark, Scotland, Newfoundland and Canada have developed fishing industry to a considerable extent.

The need to develop fisheries which is the only prime source of food supply to supplement agriculture, as an important food industry, is greater at the present moment because with the increase in population, there is heavy pressure on land for food crops. As a source of food supply our oceans and rivers would constitute an inexhaustible store of food, pro-

vided careful attention is devoted to fish culture. India has a coast line of over 4,000 miles in length surrounding the three sides of the vast peninsula, the Madras coast line alone being 1,750 miles in length. Besides this, there are large rivers such as the Ganges, the Brahmaputra, the Indus, the Krishna, the Godavary and the Cauvery, which contain a large amount of fresh-water fish available for scientific exploitation and for well-planned utilisation.

In India the growth of population is outstripping available food supplies. India's population is increasing at an alarming rate, the present population according to the census of 1941 being 388 millions, an increase of 15 per cent over the last census figure of 338 millions, while the agricultural output of India has remained steady without any significant rise under present conditions. It is reckoned that the total land area of India amounts to about 2.44 acres per head of the population, out of which only about 0.72 acres per head is under food crop, the remaining being under forests and uncultivated and fallow land.* This is indeed quite insufficient to feed the present population. It is, therefore, necessary to explore other sources of food supply in India and fisheries constitute the only important source of food supply to supplement agriculture.

Poor people inhabiting the coastal towns in India consume large quantities of fish in preference to meat because it is a cheaper article of food. Those who cannot afford even the fresh fish consume salted and dried fish which is considerably cheaper than the fresh one. Fish is an important article of foodstuff in Bengal and is taken almost daily by all the classes of the population. They are available throughout the year. Although there are many varieties of fish available for human consumption, a few of them such as Hilsa (*Clupea ilisa*), Ruhee or Rohit (*Labeo rohita*), Katla (*Catla catla*), and Mrigal (*Cirrhina mrigala*) are particularly popular in Bengal, Bihar and Orissa. The important food fish of the Madras and Vizagapatam coasts are Seer (*Scomberomorus*), Sardines (*Clupea*), Horse Mackerel (*Caranx*), Pomfret (*Stromateus*), Jew fish (*Sciaenidae*), Mackerel (*Scomber*), Cat fish (*Arius*), Ribbon fish (*Trichiurus*), Whiting (*Sillago*), Silver Bellies (*Leiognathus* and *Cazza*). The important food fish of the Bombay coastal waters are Halva (*Stromateus niger*), Karli (*Chirocentrus*), Kajura (begti) (*Lates calcarifer*), Ravas (small) (*Poly-nemus tetractylus*), Ravas (big) (*Scioena bleekeri*),

* The annual report of the Public Health Commissioner with the Govt. of India for 1933.

Mushi (*Scoliodon sorrakewah*), Singnada (*Arius dessumieri*), Toki (vekati) (*Trichiurus savala*), Suramai (*Cybbium kuhlii*), Shengti (*Marcones gulio*), Rangoli, Mandeli (*Coilia dessumieri*), Dhumi, Ghol (*Scioena miles*), Wagli (*Dasybatus imbricatus*).

During the last five or six years there has been much investigation in India on the food value of fish. While further investigation is necessary on the food value of fish available in Indian coastal waters, ample data are now available to justify the discussion of their application to practical nutrition work in India.

CHEMICAL COMPOSITION

The importance of fish in human nutrition rests primarily on its content of first class animal protein, its richness in phosphorus and its valuable contribution of vitamins A and D. It is mainly the muscular tissue of fish which is consumed as a foodstuff, and therefore all the investigations are mainly concerned with its chemical composition and food value. The chemical composition of fish varies considerably with season and the species.

Fat: The fat content varies widely with the species of fish. Some species of fish store their reserves of fat in different parts of their body, while in others such as the Cod, the liver is the main fat depot, the other tissues being very low in fat content. In the case of other fish like Herring the fat is deposited beneath the skin and between the muscles. Mackerel, Salmon, Herring, Shad and Butter fish are known as fatty fish, while Ood Pollak, Haddock, Whiting and Cusk are lean fish. The fat content of fish varies with season and spawning. It is found that certain types of fish are much fatter in winter than in spring and summer and that they become very lean after spawning. The fat in fish is as easily digested as those of beef muscle and other animal products.

The proteins of fish: Fish is a valuable protein food. It contains about 15—25 per cent of protein. Fish meal is a highly concentrated protein food which can be used for feeding poultry and live stock. The biological value of the proteins of fish meal is found to vary considerably with the type of fish.

Among the Bengal fish, except in the case of Hilsa, the digestibility and the biological value of the fish proteins are very high. The digestibility varies between 83 and 97 per cent, and the biological value between 70 and 88 per cent. The biological value by growth method showed a growth per gram of protein ingested, varying from 1.48 to 1.83 per day. Thus the biological value of fish proteins compare well with the biological value of milk and beef muscle. In

general the proteins of fish are as easily digested as those of beef and other animal products.

It has to be remembered that in certain parts of India fish is eaten in conjunction with other foods such as rice, wheat etc. and the proteins of these supplement those of fish and make good any defects in the latter. Fish is a valuable addition to a diet the staple of which is rice. It has been shown that the proteins in fish supplement the growth-promoting effect of pulse proteins (Basu and De, 1938). Thus khesari (*Lathyrus sativa*) which does not induce growth in rats when fed at 10 per cent level (Basu, Nath and Mukherjee, 1937) is found to produce appreciable growth when small amount of Ruhee protein is included in the diet. Similarly green gram (*Phaseolus mungo*) and lentil (*Lens esculenta*) which do not promote growth in rats (Basu, Nath and Mukherjee, 1937) induce appreciable growth when mixed with Ruhee fish protein in the proportion 4:1 (Basu and De, 1938a). Thus pulse proteins will be utilised more efficiently when they are supplemented with fish in the diet. This is of great practical importance in human dietetics.

The effect of cooking of fish on the utilisation of proteins has received very little consideration from scientific workers. It has been shown that high temperatures have a detrimental effect upon the quality of fish proteins. According to Basu and De (1938a) the proteins of sun-dried meal are more digestible and show a higher biological value than the proteins of the steam-dried meal. Saha (1940) studied the digestion *in vitro* of raw, fried, boiled and partially boiled fish by pepsin, by trypsin and by pepsin followed by trypsin. He found partially boiled fish to be better digested than the other three forms, and concluded, however, that *in vivo* the break down of fish proteins would be fairly complete.

As regards the chemical composition of fish protein it may be said in general that the amino acid make up of the proteins of fish muscle is of the same as those of other animal muscle such as chicken muscle. The proteins of some Indian fish have been analysed (Basu and De, 1938), (Lahiry and Anantakrishnan, 1942). Rosedale (1929, 1930) has determined the diamino acid content of various types of fish which constitute a very important source of food in Singapore.

The mineral content of fish: The mineral content of various species of fish available in Indian coastal waters have been determined by various workers (Bengal fish: Saha and Guha, 1939, 1940, 1941; fish from Bombay coastal waters, Niogi *et al*, 1941, Appanna and Devadatta, 1942; fish consumed in Bihar, Mitra and Mitra, 1941; fish from Waltair coastal waters, Khorana *et al*, 1943; Mangalore fish, Health Bulletin No. 23).

VITAMINS

With the development of our knowledge of vitamins and of methods for their determination much work has been carried out on the food value of fish with respect to its vitamin content.

Vitamins A and D: Fish oils constitute important source of vitamins A and D. They form two main classes—(a) fish liver oils and (b) fish body oils. The importance of Cod liver oil as a source of vitamin A and D in medical practice is too well known to need special mention. It is not only rich in these vitamins, but also contains in addition certain unsaturated fatty acids which are of great therapeutic value. Its fat is valuable and is easily absorbed. In general the oil content of fish liver (Haddock, Cod, Whiting, Halibut, Tunny, Dog fish, Ling) varies from 50-75 per cent depending on seasonal variations. Good Cod liver contains about 75 per cent of oil. Livers of fish with fatty muscle (e.g., Herring and Salmon) contain small quantities of oil (about 10 per cent).

The vitamin A content is influenced by age, sex, spawning, fishing season, type and location of fishing grounds etc. It is found that if the other factors are nearly equal the vitamin A content of the oil increases with decrease in the oil content of the liver (Higasi, 1940). Thus the liver oils of Herring and Salmon whose livers contain very little oil, yield liver oils of high potency. It is stated that variation in the oil content of the liver is related to spawning. The Cod, for example, ceases to feed during spawning and a large proportion of the oil is transferred to the gonads, the vitamin content being unaffected. The liver oil, therefore, contains higher concentration of vitamin A than when the fish is feeding normally. It is stated that the reverse process takes place during intensive feeding on a diet deficient in vitamin A (Shortland, 1937, 1938).

Small species of fish such as Haddock, Whiting, Plaice etc. contain relatively low proportions of vitamin A than those large species of fish e.g., Tunny, Halibut, Sword fish, Sturgeon and certain sharks, which contain high concentration of vitamin A. Young ones of any particular species are found to be considerably poorer in vitamin A than older ones. In general, however, the different species of fish investigated may be classified roughly as follows according to the potency of the oils:

Haddock, Whiting etc. ..	worthless oils
Cod etc. ..	medium oils
Turbot etc. ..	good oils
Halibut ..	very good oils

Many fish such as Cod and Halibut store large amounts of vitamin A in their liver although they consume food deficient in this vitamin, and the older fish, therefore, contain higher concentrations of vitamin A (Drummond and Hilditch, 1930; Lovern

et al, 1933; Macpherson, 1933). The potency of Halibut liver oil is found to be related to the oil content of the liver (Bills, Imboden and Wallenmeyer, 1934). It is said that a very large Halibut may contain 90 grams of vitamin A (Lovern, 1942). The cause of such accumulation of large reserves of vitamin A in certain species of fish which eat the same diet as other species of fish whose vitamin A content is considerably less, is quite obscure. It would, however, appear that such species of fish may synthesise vitamin A in the body.

Although liver is considered to be the main storage depot for vitamin A, it is found that in some species of fish, of which Halibut is one, the alimentary tract may contain as much, or even more vitamin A than the liver (Edisbury *et al*, 1938). The viscera (excluding the livers) of Halibut has been found to yield abnormally rich oils. The stomach is practically devoid of vitamin A, while the pyloric caeca and intestines contain very large amounts of the vitamin A. This discovery has led to the commercial production of fish intestinal oils in Canada. The spleen is reported to contain large amount of the vitamin. Herring also contains large quantities of vitamin A in the alimentary tract, particularly in the pyloric caeca (Edisbury *et al* 1938). The body oils of fish contain little or no vitamin A. There are, however, certain body oils of fish such as Sardine, which are equal in potency to cod-liver oil. In general, fish flesh is not a good source of vitamin A. Fatty fish such as Mackerel, Salmon, Herring etc. are found to be richer in vitamin A than are lean fish such as Cod, Haddock etc.

Fish liver oils are, as a class, the most potent of all known natural sources of vitamin D. They are able to store large quantities of vitamin D in their livers. Some of them contain an extraordinarily high content of the vitamin. Although Cod liver oil is a good source of vitamin A, it is not potent enough in vitamin D. Even Halibut liver oil which contains a large proportion of vitamin A is not proportionately rich in vitamin D. Tunny-fish liver contains a large amount of vitamin D, and it provides a new and valuable supply of the vitamin.

As regards the vitamin D content of fish flesh, lean fish (Cod, Haddock etc.) are shown to be devoid of this vitamin, while fatty fish (Herring, Mackerel, Salmon etc.) contain appreciable amounts (300—1700 I.U./100 gr.) of it. Thus lean fish flesh is a very poor source of both vitamin A and D, while fatty fish flesh is a fairly good source of these two vitamins.

Indian fish oils.—In the present war supplies of vitamin A and D for medicinal use have been affected considerably and in order to meet the growing demand for Cod liver oil, search began in India for other species of fish giving liver oils comparable with

Cod liver oil in vitamin potency. The results obtained from some species of fish, particularly sharks, which so far on Indian fish oils are presented in Table I. infest the Indian ocean are rich natural sources of The investigations have shown that the liver oils vitamin A (Madras Fisheries Department, De *et al*,

TABLE I
VITAMIN A AND D CONTENT OF INDIAN FISH LIVER AND BODY OILS

Common Name	Zoological Name	Source	Vitamin A I. U. per gr.	Vitamin D I. U. per gr.
A. Liver Oils :				
Air	<i>Arius arius</i>	Bengal	200, 650	—
Dhain	<i>Silonia silundia</i>	"	563	6.67
Hilsa	<i>Clupea ilisa</i>	"	120	—
Katla	<i>Catla Catla</i>	"	207	—
Mrigel	<i>Cirrhinia mrigala</i>	"	583	—
Naindal	—	"	377	—
Ruhee	<i>Labeo rohita</i>	"	405	—
	"	"	622	—
	"	"	461	—
	"	"	475	—
Sankhachur	—	"	387	5.0
Sarputi	<i>Barburs sarana</i>	"	Nil	—
Vetki	<i>Lates calcarifer</i>	"	909	—
	"	"	457	2.8
Ghol	<i>Scioenia miles</i>	Bombay	28—32	575
Mushi	<i>Scioliodon sorokowah</i>	"	7.0—7.4	97
Eagle Ray	<i>Aetobatis guttata</i>	Madras	1140	—
Gunna Sorrah	—	"	2200r	—
Kanan Kalaru	<i>Arius thalassinus</i>	"	250r	—
Pothikelaru	<i>Arius jello</i>	"	trace	—
Komban Sura	<i>Spyrna blonchii</i>	"	50 times as potent as commercial Cod-liver oil	—
	—	"	351	—
Karakutti	—	"	114	—
Cat Fish	—	"	494	—
Manthal	—	"	806	—
Nethal	—	"	2925	—
Saw Fish	<i>Pristis perrotleti</i>	"	—	180-200
	"	"	8000—12000	—
Shark (hammer-headed)	<i>Zygæna blochii</i>	"	19,760	—
" (man-eating species)	—	"	10,750	—
Shark	—	"	4,331	—
"	—	"	450—50,100	—
"	—	"	(av. 13,600)	—
"	—	"	190,000	—
Mackerel	—	"	—	210-260
	—	"	220	—
	—	"	160	—
Plough Fish	<i>Rhyncobatus dieddedsis</i>	"	—	250
Sardine	—	"	246	200
Cod	—	Calicut	2600	—
B. Body Oils :				
Chital	<i>Notopterus Chitala</i>	Bengal	26	—
Dhain	—	"	8—10	—
Hilsa	<i>Clupea ilisa</i>	"	0	—
Katla	<i>Catla catla</i>	"	49	—
Koi	<i>Anabus testudineus</i>	"	0	—
Magur	—	"	Nil	—
Mrigel	<i>Cirrhinia mrigel</i>	"	90	—
Ruhee	<i>Labeo rohita</i>	"	98—100	—
"	—	"	109	—
Kurimeen	<i>Pomadasys moculatum</i>	Madras	less than 2.6	—
Narimeen	<i>Lates calcarifer</i>	"	2.6	—
Neimeen,	—	"	—	—
Palameen,	—	"	—	—
Orace oil	—	"	2.6	—
Ribbon Fish	—	"	—	—
Sardine	—	"	2.6—5.2	—
Turtle	—	"	13	—
	<i>Barbus dubius</i>	"	494	—

1938 ; Rajagopal, 1942) and these oils are now being manufactured and have become commercially important. The production of shark liver oil on a commercial scale has proved so successful that nearly 30,000 gallons of oil have been manufactured in the year 1942. The oil is now widely used in Government civil and military hospitals.

The liver oils of some of the species of Bengal fish *e.g.*, Ruhee, Naindal, Katal, Air, Mrigel, and Hilsa are found to contain appreciable amount of vitamin A (Basu *et al*, 1940). The Ruhee, Naindal, Mrigel and Katal liver oils are very good sources of vitamin A, having higher potency of the vitamin than the imported Cod liver oil. The vitamin A potency of some samples of Indian Cod liver oil is found to be about three times more potent than that of the average sample of Norwegian Cod liver oil (De *et al*, 1938). The liver oils of some of the species of Bombay fish, namely Ravas, Ghol, Shengti, Mushi and Halva are found to be several times richer in vitamin A than ordinary Cod liver oil (Niogi *et al*, 1941). Among Indian fish body oils, the oil obtained from *Barbus dubius* is a good source of the vitamin, containing 490 I.U. per gram of the oil.

Although the vitamin A content of some varieties of Indian fish oils is known, very little information is available regarding their vitamin D values. Recently, however, it is reported that the liver oil of Ruhee (*Labeo Rohita*), a variety of fish in Bengal is the most potent source of the vitamin among the others examined. The values on the whole are very small compared to the antirachitic potency of Cod liver oil (Basu and Sen Gupta, 1940) ; Bragaca A. *et al*, 1942) ; Ranganathan (1941) investigated the vitamin D content of fish oils and found that shark liver oils had an average vitamin D content of 210 I.U. per gram, a value about twice that of B.P. Cod liver oil. Among the Bombay fish examined Ghol liver oil is a good source of the vitamin containing 575 I.U. per gram of the oil (Niogi *et al*, 1943). There is a need for further investigation on the vitamin D content of Indian fish liver oils.

Manufacture of fish oils.—The method generally employed for the manufacture of fish liver oils is by blowing low pressure steam into the fresh livers. This process causes the cells to burst with the result the oil is freed from the cells. Various modifications in the process are introduced depending on the grade of the oil required. Cod liver oil which is not intended for medicinal use is prepared by the above crude method. For the preparation of medicinal oils special precautions are taken, such as the selection of good and fresh livers, the use of vacuum boilers so as to render the oil at lower temperature to improve the colour and odour of the oil.

The crude oil thus obtained is refined by removing the stearine which separates after keeping the oil in cold for long period. The oil is then washed with caustic soda, which converts the free acids present in the oil into soaps. These soaps are then removed by washing with water. In order to remove the traces of alkali it is then washed with dilute sulphuric acid solution. The oil thus obtained is bleached by filtering through fuller's earth. The bleaching is also effected by exposing the oil to sunlight.

The vitamin A potency of fish liver oil is influenced by the process of manufacture. It is stated that considerable loss of vitamin A occurs when the oil is heated or cooked in open vessels in contact with air (Robinson, 1938 ; Seshan, 1940). For the preparation of oils with high vitamin potency, it is necessary to minimise the extent of exposure to air, thereby preventing the oxidation taking place.

Hydrogenation and bleaching by treatment with hydrogen or other reducing and oxidising agents are known to cause destruction of the vitamin content of the oil. It is, therefore, necessary to avoid the use of oxidising and reducing agents for bleaching purposes. Bleaching is generally done by treatment with fuller's earth. It is reported that this method of bleaching yields an oil with undesirable keeping quality as a result of the removal of the natural antioxidants of the oil by the fuller's earth.

Properties of the oil.—The medicinal oil is generally light yellow in colour and it should have very slight fishy odour. The acid value and the proportion of volatile fatty acids should be low. The Reichert value should be less than 0.5. The iodine value should not be less than 167. The amount of unsaponifiable matter should be less than 1.5 per cent and higher value is an index of adulteration with mineral oils which are rich in unsaponifiable matter.

With the discovery that Indian Shark liver oil possesses very high vitamin A potency, the Madras Fisheries Department at the instance of the Government considered the question of organising and developing the manufacture of Shark liver oil as a cottage industry in the Presidency in 1937. A scheme for initiating a medicinal oil industry has since been sanctioned by the Government. Medicinal liver oil from the Shark and Saw-fish is now being manufactured in Calicut. The Government of Bombay and the State of Travancore are also manufacturing the oil.

The medicinal value of Shark and Saw-fish liver oil was recognised in India long before vitamins were known and it is stated that fish liver oil industry existed in the Madras Presidency eighty years ago. According to the report on the sea fish and fisheries of India and Burma by Surgeon-Major Francis Day, Inspector General of Fisheries, published in 1873,

in the sixties of the last century there was considerable production of fish oil in the West Coast. It is stated that during the period 1864-71, 3,194,672 lbs. of oil (mainly Sardine oil), valued at Rs. 2,03,829 were exported from Madras alone. Medicinal oil from Shark and Saw-fish was being manufactured and the Shark liver oil was being used both medically and in the leather manufacture. The manufacture of the oil was initiated in 1854 in Calicut and the production amounted to over 5000 lbs. per annum, the price ranging from nine annas to Rs. 1-4-0 per lb. In the year 1870 the cost of imported Cod liver oil fell below that of Indian fish liver oils and consequently the industry suffered a great deal as it could not compete with the imported product. The initiation of the industry in Calicut is only a revival of the flourishing fish liver oil industry in Madras Presidency eighty years ago. Very recently investigations on their therapeutic properties have been carried out. In order to stabilise the industry in India extensive investigations on the extraction, storage, purification and the keeping quality of these oils are necessary because of their high market value.

Stability of vitamin A in fish liver oils.—Fish oils are, in general, highly unsaturated and are therefore very susceptible to oxidative deterioration resulting in the destruction of vitamin A contained in the oils. It is found that the samples of medicinal Cod liver oil show wide variations in their potency ranging from 390 to 1500 International units per gram of the oil. It is, therefore, suggested that from the public health point of view and in the interest of the lay public who are ignorant of the quality of the preparations at the time of buying, the manufacturers should state the potency and the extent to which such preparations can be stored without much loss of the vitamin, particularly in tropical countries like India. There is an urgent need for investigation on the factors such as method of preparation, storage, rancidity etc. influencing stability of vitamin A in Indian fish liver oils.

The development of off-odours and flavours, which decrease the quality of the oils is attributed to the formation of aldehydes, ketones and acids. The percentage of vitamin A oxidised is found to be related to the peroxide value of the oil and the higher the peroxide value the more vitamin A oxidised. With the more unsaturated oils, e.g., Cod, Pollard, the percentage of vitamin A oxidised is found to be smaller at various peroxide values than in the less unsaturated oils e.g., Halibut, Dog fish, at similar peroxide values (Simons *et al*, 1940). It is, therefore, necessary to incorporate substances with fishery products, which have the property of arresting such oxidative changes in the oil.

Antioxidants.—Although a number of substances has been described in the literature possessing the

property of retarding oxidative changes in fats and oils, very few of them have been found to be suitable for use in preventing the rancidity in fish oils. In recent years a number of investigations have been carried out with a view to stabilising vitamin A contained in fish liver oils. Hydroquinone which is known to function as antioxidant for fats and oils has been used to protect the vitamin A in fish liver oils (Holmes *et al*, 1936). Lecithin is found to exert protective action against the oxidative destruction of the vitamin. The combination of the two affords remarkable protection against the oxidative destruction of vitamin A in Halibut liver and Cod liver oils, which is much greater than would be expected from additive effects (Homes *et al* 1936). Lowen *et al* (1937) have tested the antioxidant value of oat flour on Halibut liver and Salmon oils. Oat flour was found to retard the initial peroxide formation, and its effectiveness in retarding rancidity increased as less accelerated conditions of exposure to air were used. Maleic acid has been recommended by the Biological Board of Canada (*Bulletin No. XLVI of the Biological Board of Canada*) as antioxidant for preventing the loss of vitamin A occurring on storage of fish liver oils.

THE RELATION BETWEEN CHEMICAL CHARACTERISTICS, PHYSICAL PROPERTIES AND VITAMIN CONTENT OF FISH LIVER OILS

Holmes *et al* (1941) determined the chemical and physical characteristics and vitamin potency of thirty five fish liver and body oils. It was found that the vitamin potency of the Sword fish and Mackerel liver oils increased with increase in the amount of unsaponifiable material. The relation, however, was not entirely consistent. In the case of other oils no consistent relation between any of the chemical or physical properties and their vitamin potency was observed. From the results the authors conclude that it is difficult if not impossible to know the vitamin potency of the oils by determining the chemical and physical properties.

THE B VITAMIN IN FISH

Vitamin B₁.—Relatively little work has been done to determine the vitamin B₁ (thiamine) content of fish muscle. From the results of the few investigations carried out, it may be stated that fish muscle is not a rich source of vitamin B₁ containing only about 0.20-0.40 International units per gram. The liver is somewhat richer in vitamin B₁ the content ranging from 0.4 to 1.8 I.U. per gram. (Fixen and Roscoe, 1937-38, 1940). Fish roe contains more vitamin B₁ than the liver. Some of the Bengal fish (Bhetki, Hilsa, Kholsa, Mrigel, Rohit) contain 10-33 I.U. per 100 grams.

Vitamin B₂ (Riboflavin).—Vitamin B₂ content of fish muscle (Cod, Halibut, Haddock) ranges from 0.05-0.180 mg. per 100 grams (Fixsen and Roscoe, 1940). Recently Billings *et al* (1941) have determined the riboflavin in several Pacific fishes, particularly livers and viscera of Salmon, Tuna, Pilchard and Herring. Fish liver meal is found to be one of the richest natural source of riboflavin, most of the values being between 50-100 γ per gram of moisture and fat free substance. Commercial Pilchard, Salmon and Herring meals were found to contain from 9 to 22 γ per gr. of natural meal. There is need for systematic investigations on the vitamin B₁ and B₂ contents of fish available in Indian coastal waters.

Nicotinic acid (Antipellagra factor).—Among the fish investigated Salmon appears to be a good source of nicotinic acid containing 7 to 8 milligrams of nicotinic acid per 100 grammes of the muscles. Other fish investigated contain on an average 2-5 milligrams per 100 grammes of the muscle. Fish muscle is as good a source of nicotinic acid as beef and the muscle tissue of other animals. (Kodicek, E., 1940; Khorana *et al*, 1943).

Vitamin C.—The vitamin C content of fish varies considerably with species containing about 5-200 mg. of the vitamin per 100 gr. Fish liver and roe are found to be rich in this vitamin having the potency of orange juice. Among the Indian fish examined (Rudra, 1936 and Saha, 1939) Koi (*Anabas testudineus*) has the highest ascorbic acid content in the muscle (30 mg. per cent), Pangash (*Pangasius pangasius*) and Rohu coming next in potency. Rohu and Dhain fish livers contain 171 and 127 mg. per 100 gr.

The foregoing account offers ample evidence that fish is a very valuable food and its extensive use on the dietary is, therefore, specially desirable. There is plenty of scope for improving fish food industry in India. Considerable amount of edible fish is being wasted annually and there is ample scope for investigation on the possibility of converting the edible fish into valuable food materials. While it is certain that the potential resource of India is immense in the fish industry, these will become readily available only through well-planned investigation on the economic utilisation of fish products in food and other industries. The need to develop Fisheries as an important food industry in the country was emphasised in the Zoology section of the Jubilee session of the Indian Science Congress in 1938. A committee of foreign and Indian fisheries experts, who met in Calcutta in 1938, pointed out the need for an All-India Institute for research on problems relating to Indian Fisheries and resolved to urge the Government of India to take early steps to develop the fish

industry. The fishing industry in India is in a deplorable condition which needs immediate attention with a view to utilising the large potential source of good food to feed the increasing population.

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SYNTHESIS OF QUININE

D. CHAKRAVARTI,

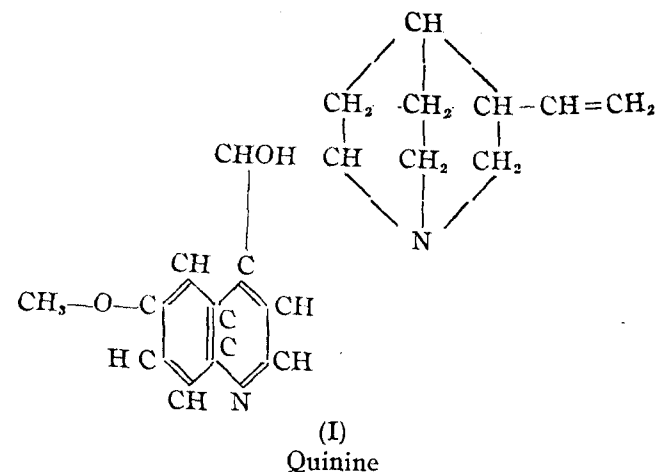
DEPARTMENT OF CHEMISTRY, CALCUTTA UNIVERSITY

IN his presidential address before the section of chemistry of the Indian Science Congress, Prof. J. N. Ray, speaking on the chemistry of antimalarials, remarked in 1937, "The organic chemistry of the 'test tube' has very little parallelism with the mechanism operating in the living cells. What molecular species and reagents Nature employs in building up these highly complicated beneficial products has not yet received complete solution in most cases. The chemistry of the test tube has so far failed to effect a synthesis of quinine and its allies."

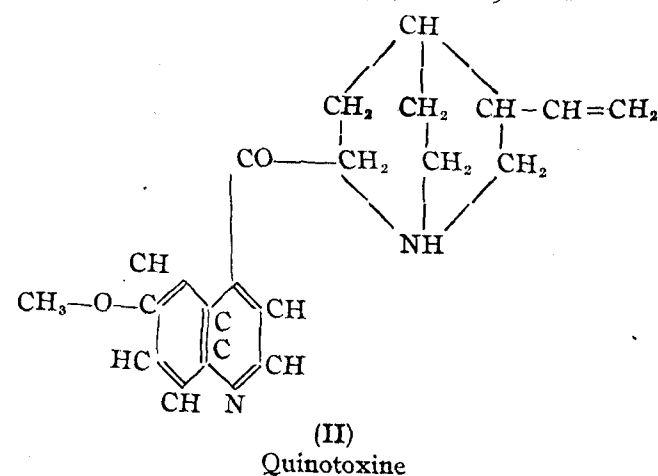
This long-cherished goal, the synthesis of quinine in the laboratory, which has been a challenge to the organic chemists, has at last been attained in 1944 by two young chemists, Robert B. Woodward who is an instructor in organic chemistry at Harvard University and has been chemical consultant to Polaroid Corporation since 1942, and William Von E. Doering who was working at Harvard for the doctorate degree at the time of the inception of the investigation and is at present instructor in organic chemistry at Columbia University. The plan for the synthesis of quinine was conceived by Woodward and incorporated in the basic research programme of Polaroid Corporation in early 1943. This remarkable achievement of Woodward and Doering is the outcome of an organized and planned attack on the problem during 14 months, and the synthesis of quinine was announced on May 7, 1944 by the Polaroid Corporation, Cambridge, Mass. The synthetic quinine is claimed to be identical chemically and clinically with the natural alkaloid isolated from cinchona bark. The synthesis of quinine adds a glorious chapter to the chemistry of synthetics, which can boast of the synthetic vitamins, the synthetic hormones, the synthetic pigments of the flowers and a host of other natural products.

The pure crystalline alkaloid quinine was isolated from cinchona bark as early as 1820. In 1855 Strecker proved the quinine molecule to be composed of twenty atoms of carbon, twenty-four atoms of hydrogen, two atoms of oxygen and two atoms of nitrogen and represented it as having the formula $C_{20}H_{24}O_2N_2$. In 1908 Rabe and Koenigs determined the structure of the quinine molecule and showed by degradative reactions that these forty-eight atoms are arranged in the quinine molecule as in the formula (I). It may be recalled that the preparation of the first synthetic dyestuff 'aniline mauve', which gave an impetus to the manufacture of synthetic dyestuffs, is associated with the attempt at synthesis of quinine by William Perkin, a young

boy of 18, in the year 1856. Though unsuccessful in his attempt to synthesise quinine, Perkin discovered the beautiful magenta dye by the oxidation of aniline with arsenic acid.



While experimenting with quinine, Louis Pasteur in 1853 obtained from quinine a related isomeric alkaloid having the same 48 atoms, known as *quinotoxine* or *quinicine*, in which the atoms are arranged as in formula (II). In 1918 Rabe was



successful to synthesise quinine from quinotoxine. Since the source of quinotoxine is quinine itself, this synthetic method is of little practical value. Woodward and Doering have been able to prepare quinotoxine from easily available materials, e.g., coal-tar itself, and hence their method constitutes a total synthesis of quinine. Starting from benzaldehyde, a common chemical available in unlimited quantities from coal-tar, they have obtained 7-hydroxy-isoquinoline which in its turn has been converted through a series of ingenious synthetic operations

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into N-benzoyl-homomeroquinone ethyl ester, the most important stage in these synthetic operations being the fission of the hydrogenated *iso*-quinoline derivative with sodium ethoxide and ethyl nitrite. N-benzoyl-homomeroquinone ethyl ester has been condensed with ethyl quininate to give quinotoxine. The conversion of quinotoxine into quinine has been effected according to the method previously described by Rabe.

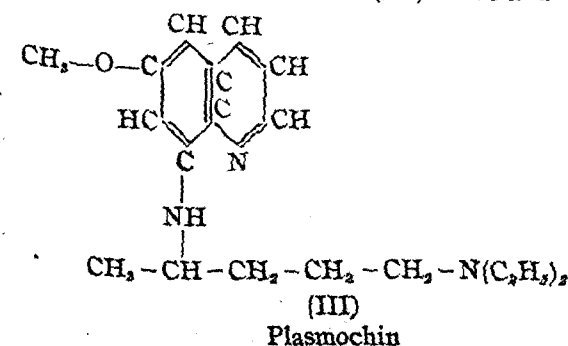
The possible mechanism of the synthesis of quinine in nature, as suggested by Robinson, remains still to be verified. 'It has been thought', as Robinson remarks, 'that plants have at their command enormously powerful reagents, which induce transformations impossible to reproduce in the laboratory. To a certain extent this must be true, but it is probable that this aspect has been exaggerated.'

The long and intricate process of the synthesis of quinine, developed by Woodward and Doering, will probably at present stand in the way of its commercial utilization, but in the near future sustained efforts in this direction might evolve simpler method, and natural quinine may meet with the same fate as natural indigo.

Extensive researches on the preparation of synthetic antimalarials have shown that the physiological action of the quinine molecule depends more or less on the following groups of atoms.

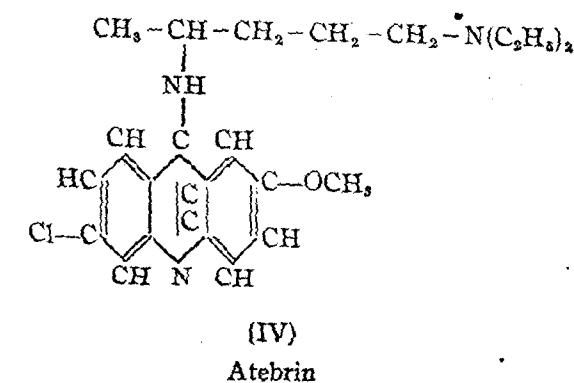
- (i) The quinoline ring with the methoxyl group;
- (ii) The quinoclidine ring; and
- (iii) The vinyl group and the secondary alcoholic group.

It has been demonstrated that the removal of any of these groups or alteration in their chemical nature results either in the diminution or the total inhibition of the activity of the drug. Importance has been attached to the quinoline nucleus as being the seat of antimalarial action in the quinine molecule, and a large number of quinoline derivatives have been synthesized and tested for antimalarial activity, the important of them being the much used *Plasmochin*, first introduced by Schuleman, Schoenhoefer and Winger, the arrangement of atoms in which is shown in formula (III). With a view to



synthesizing an ideal antimalarial, investigations have been carried in the plasmochin series (notably by workers led by Fourné in France, by Magidson and Kritchevskii in Russia and by Robinson and Kermack in England) dealing with the effects of (i) modification of the alkoxy group, (ii) variation of the alkylamino side-chain particularly regarding its length, degree of branching and the introduction of various other substituents, (iii) modification of the terminal dialkylamino group of the side-chain and (iv) change in the position of the attachment of the side-chain.

Various acridine derivatives have been studied for their antimalarial activity, and it has been found that *Atebrin* (or *Mepacrin*), first prepared by Mauss and Mietzsch, in which the atoms are arranged as in formula (IV), is the most suitable one comparable



to plasmochin. In the atebrin series also investigations have been conducted for the discovery of a superior drug by the variation of the atoms and groups of atoms at different positions of the nucleus. The Fourth General Report of the Malaria Commission of the League of Nations summarizes the works on the clinical usage of atebrin and plasmochin, and briefly it might be stated that atebrin is at least as effective as quinine as a schizonticide, though like quinine it has only a weak action on gametocytes, has weak schizonticidal activity and is especially effective as a gametocide.

Alkaloids other than quinine have also been tested for antimalarial activity. In this connection mention might be made of the bark of various species of *Alstonia* which is reputed to possess antimalarial activity, but curiously enough the alkaloids isolated from it have been found to be devoid of antimalarial activity.

Beside these drugs, other synthetic products which bear no structural resemblance to quinine, atebrin and plasmochin, e.g., diamidines, sulphanilamides, cotarnine derivatives, organo-metallic compounds, have also been prepared, and some of them have been found to be partially effective.

Researches in the search for synthetic anti-malarials are being vigorously continued. Warner W. Carlson from the Department of Research, in Pure Chemistry, Mellon Institute of Industrial Research, Pittsburgh, Pa, writes in the Journal of the American Pharmaceutical Association (April, 1944).

"Because of the quinine shortage resulting from the loss of the East Indies to the Japanese and more especially because of the inability of quinine, atebirin or plasmochin to act as safe and efficient prophylactics against the disease, the search for superior anti-malarial drugs has been intensified since the onset of the war. Under the leadership of the National Research Council and various Governmental agencies, a systematic program of research is in operation

involving the co-operation of many chemical and biological laboratories throughout the country. It has been revealed that testing laboratories, each capable of handling as high as 200 new compounds per month, are in operation. . . . The magnitude of the program can be visualized from the report that during the period from 1941-1943, more compounds were tested than the combined total number of all tried in previous efforts."

The production of synthetic quinine at this time has, therefore, been hailed by all, and people all over the world will welcome the synthetic quinine to save them from one of mankind's greatest scourges—malaria.

OBITUARY :

SIR RALPH HOWARD FOWLER

SIR RALPH HOWARD FOWLER was one of the most distinguished and versatile of the mathematical physicists of our times. He was only fifty-five at the time of his death. Fowler's work concerned almost every branch of contemporary physics and whatever he did he did it superably well. A great master of mathematical technique with almost a passionate fondness for details, he revelled in complicated and laborious calculations that would frighten many an accomplished mathematical physicist; his work informed by profound physical insight was always on a level of rigour characteristic of a pure mathematician. A mathematical physicist of the very first rank, Fowler was a great teacher (he had a large number of students from many countries carrying research under him) and a great man, both in body and in spirits.

Fowler was born on January 17, 1889 at Burnham (Somerset) in England. He received his early education at Winchester and later at Trinity College, Cambridge, where he became a Fellow in 1914. Fowler was in active service during the last war and was wounded at Gallipoli. On his return he joined what later came to be known as the Anti-aircraft Experimental Section of the Munitions Inventions Department where he was associated with A. V. Hill, E. A. Milne and the late W. Hartree (father of Prof. D. R. Hartree) in work on anti-aircraft gunnery and allied problems. After the war Fowler returned to Cambridge.

In December 1921, Fowler married Eileen Mary Rutherford, the only child of the late Lord Rutherford. "Rarely can a man have found a son-in-law so congenial in tastes and outlook. Fowler was a Wykehamist and a Fellow of Trinity. He was a man of great mathematical powers with a firm apprecia-

tion of what might be termed the right and wrong in physics, a master in summing up all the experimental evidence and then proceeding to a sound conclusion" (Rutherford by A. S. Eve, p. 288). Mrs. Fowler died suddenly in December, 1930 following the birth of her fourth child. They had four children, two sons and two daughters, the eldest Peter Howard Fowler was born in 1923.

The early work of Fowler was in the field of pure mathematics, and one of his earliest publications was the Cambridge Mathematical Tract on the differential geometry of plane curves. In 1919 Rutherford came from Manchester to Cambridge as the Head of the Cavendish Laboratory, and Cavendish began to hum with radioactive research. The same year Rutherford achieved the artificial disintegration of nitrogen by alpha-particle bombardment, an epochal discovery that marks a landmark in the history of science. (Rutherford commenced this work at the end of his Manchester period and completed it soon after his arrival at Cambridge). About the same time Saha advanced the theory of thermal ionization which provided the key for the elucidation of stellar spectra and which has proved of profound importance in the progress of astrophysics. Rutherford and Bohr had just laid the foundations of modern physics, and Fowler with characteristic energy and versatility entered the various fields of investigation that had opened up. He provided in a joint paper with Aston an exact mathematical theory of the mass spectrograph; the first mass spectrograph was constructed by Aston two years earlier. He, following the classical theory of Bohr, attacked the problem of the ionization and absorption of alpha rays in matter. To the theory of thermal ionization he, in collaboration with Milne, made many far-reaching contributions.

The ionization theory reduced the sequence of stellar spectral types to a linear temperature sequence. Saha originally suggested that the temperature scale could be deduced on the basis of the first and last appearances of spectral lines. The difficulties of this method were discussed by Milne, and Fowler and Milne showed that these were largely avoided if, instead of considering the 'marginal appearance' of a line, attention was directed to the place in the stellar spectral sequence where the line attained its maximum intensity. The complete theory of the formation of absorption lines was given later by Milne.

In 1925 Fowler was awarded the Adams Prize for his monograph on the Equilibrium Theory of Statistical Mechanics which, considerably expanded, appeared in book form as "Statistical Mechanics" in 1928. The second edition of this work, revised and enlarged, appeared in 1936. In the first edition, except for the last chapter entitled 'the new statistical mechanics', the language throughout is classical, but the second is entirely in quantal dress. The range of topics covered extends over the properties of crystals, dissociation and evaporation, chemical constants—Fowler's discussion of the Nernst Heat Theorem is most illuminating—interatomic forces, liquids and solutions, electrolytes, atmospheric problems, stellar interiors, fluctuations, Brownian motion, and order-disorder phenomena. Everywhere the presentation is systematic, stimulating, precise and profound, employing the elegant and powerful Darwin-Fowler method of 'steepest descents' where sums over accessible states are expressed in terms of contour integrals. The book will remain for a long time to come as the pre-eminent work on the subject. "Statistical Mechanics" has been translated into German. In 1939 there appeared "Statistical Thermodynamics", a joint treatise by Fowler and Guggenheim, being a 'version of statistical mechanics for students of physics and chemistry'. Mention may be made here of the contributions of Fowler, jointly with Nordheim, to the theory of emission of electrons from cold metals under the influence of intense electric fields, and of his beautiful theory of the photoelectric effect. He contributed to the elucidation of the structure of water in a paper with Bernal. What a large field of physics he commanded, and with a grip and penetration seldom equalled!

In 1926 Fowler made the first application of Fermi-Dirac statistics discovered independently by Fermi and Dirac. In a highly suggestive paper he showed how the peculiar difficulty pointed out by Eddington concerning the (possible) ultimate fate of a white dwarf star disappeared when it was realized that under the high density prevailing inside it the free electrons behaved not as a classical but as a Fermi-Dirac degenerate gas. The high density of a white dwarf can only be explained on the assump-

tion that the material in its interior is completely ionized, but the ionization is not due to temperature but to pressure. Stellar material would be completely ionized whether it is a white dwarf or a 'black dwarf'—a term due to Fowler to designate a 'white dwarf' at zero temperature. As Fowler said at one of his lectures, if one thrust his hand in ionized material, according to Eddington it would always be scalded but according to him it may sometimes be frozen. Fowler's work was the starting point of many investigations. The Fermi-Dirac statistics was incorporated by Milne in his extensive researches on stellar constitution. Milne's fundamental investigation led him to new solutions of the Emden's differential equation which attracted Fowler's attention, and he treated this problem with consummate skill in a paper in the Monthly Notices (1931).

Fowler, jointly with Kapitza, was editor of the International Series of Monographs on Physics (published by the Oxford University Press).

"Fowler had a forceful, even a masterful personality. As I once put it in a sketch of Fowler for the *Granta*, when Fowler was proctor at Cambridge, he had a short way with any committee he was chairman of, and a short way with the chairman of any committee he was a member of. He could be outspoken to the point of inducing tears, but his subsequent contribution was so endearing that he never left bitterness. He was a man who, starting his scientific career in a promising but by no means excessively distinguished way, went on maturing throughout his life, and attained a fame which surprised even his earliest admirers, but which was wholly deserved, and wholly earned. Had he lived, Fowler would have become one of the greatest scientific powers in the land. He had a tremendous capacity for personal friendships; to collaborate with him on a scientific paper was to embark on high adventure, and the thrill and 'agogness' of working alongside him, when results were being turned out quickly and one was on tip-toes as to what was round the next corner, were things never to be forgotten."*

Fowler was elected Fellow of the Royal Society in 1925 and was awarded the Royal Medal of the Society in 1936. Knighthood was conferred on him in 1942. In 1932 he was appointed Plummer Professor of Mathematical Physics at Cambridge. In 1938 Fowler was offered the Directorship of the National Physical Laboratory but on account of a serious illness he was unable to take up the appointment. For a time he was well but his illness returned, and his many friends in India were grieved

* Quoted from the Obituary Notice by Prof. E. A. Milne in *Nature*, August 19, 1944. We acknowledge the help we have received from it in preparing the present note.

to learn last winter that his condition was serious. He died on July 28th, 1944.

Fowler achieved much in his lifetime and he inspired all who came in contact with him. There

was no trace of pettiness or triviality about him. He was a great mathematician, a great physicist and a great man.

D. K. and R. M.

SIR ARTHUR STANLEY EDDINGTON

DURING the period of a year or so, Reuter and other agencies have brought us the sad news of the death of several scientific men of great renown. The latest one of this kind is the rather unexpected news of the death of Sir Arthur Stanley Eddington, the world-renowned Astrophysicist, and the greatest Natural Philosopher of England of the present age. We say *unexpected*, as Sir Arthur was only sixty-two, and was not also known to be ailing beforehand. Even the last number of the *Observatory* which we have received contains an account of his vigorous defense of his Cosmological Theory in a meeting of the Royal Astronomical Society held in June last. Sir Arthur Eddington's name was not only known to specialists, but was also a familiar one among laymen in all countries. To the ordinary man he was the philosopher who spoke about the mysteries of the universe. He (along with Jeans) has brought modern scientific thought almost to the door of every person by his exquisitely written popular books on modern science and astronomy. On this account the death of Sir Arthur Eddington will be mourned by the scientific and the non-scientific world equally.

Of his early life and career we only know that Eddington was born at Kendal on the 28th of December, 1882, and was educated at Owen's College, the nucleus of the present Manchester University, and at Trinity College, Cambridge. He was senior Wrangler (1904), the Smith's Prizeman of the year 1907, and a Fellow of the Trinity College, Cambridge. He started his career as Chief Assistant at the Royal Observatory at Greenwich in 1906, where he continued till 1913. In the same year he was called to Cambridge as the Plumian Professor of Astronomy, and in 1914 he became the Director of the Cambridge Observatory. He worked in these capacities till his death.

Eddington was a member of many British and foreign scientific societies and was awarded the Hopkins Prize of the Cambridge Philosophical Society (1918-21), the gold medal of the Royal Astronomical Society (1924), the Bruce medal of the Astronomical Society of the Pacific (1924), and the Henry Draper Medal of the National Academy of Sciences. He was knighted in 1930.

To recapitulate the entire work done by Eddington is not an easy affair. Nearly the whole domain of theoretical astrophysics was the field of his researches, and every branch of this science bears

the impress of his Roman hand. In 1919 he led the Solar Expedition to test if the straight path of a ray of light sent out by a star is curved while passing the neighbourhood of a massive body like the Sun, as was predicted by Einstein. The announcement of the positive result which he found rang through the world as a discovery of profound significance, and at once brought Einstein's Generalized Theory of Relativity to fame. Since then Eddington became one of the staunchest supporters of Generalized Relativity, and swang to and fro between Relativity and Astrophysics, earnestly discussing problems in both these subjects.

Eddington's *debut* in scientific life was made by his analysis of the *double star streams*. At the beginning of the present century our knowledge of the stellar world, and of the Milky Way was rather meagre. Astronomers were indeed only collecting data for their attack on the problem of the universe. Stars in the sky were long known to have motion in space. It was originally believed that these motions were entirely random, just like the motion of gas molecules. The Dutch astronomer, Kapteyn, from a deep study of stellar motions, suggested that the stars have a general motion, and there are two fixed directions in which the stars are streaming. Thus the stellar motion may be considered as a general motion along these streams, plus a haphazard motion like that of the molecules of a gas. Eddington analyzed this double stream mathematically. His researches in this line are embodied in his book 'Stellar Movement and Structure of the Universe', which was published in 1914. This pioneer work helped the construction of the present theory of Shapley, Oort and Lindblad, according to which the so-called Milky Way is a spiral nebula about 100,000 light years broad, and about 10,000 light years in thickness, rotating about an axis directed towards the star cloud of Sagittarius. Indeed this hypothesis makes the phenomena of star streams easily comprehensible.

The theory of the internal constitution of stars, as we understand it at present, is a creation of Eddington. The equilibrium of gas spheres was previously discussed by Ritter, Lane, and very fully by Emden. Emden has incorporated his researches in his '*Gaskugeln*', which is classic in astrophysical literature. But in all these previous discussions there was no attempt to correlate the results of mathe-

matical investigation with observational material. The real contribution of Eddington to this problem was twofold. He first realized clearly by bringing in his calculations the part which the pressure of radiation plays in this problem. In the interior of a gas mass the pressure at any point firstly is exerted by the gas itself. But owing to the intense heat the stellar bodies hold a huge amount of radiation, in all forms from heat to X-ray vibrations, pent up within themselves. This radiation also exerts a pressure in the same way as light exerts pressure, a fact which was first mathematically worked out by Maxwell, and later experimentally verified by Lebedew. This combined gas and radiation pressure in any part of the gas mass has to contend against the weight of this mass to keep the whole material in equilibrium. The next question which Eddington had to answer was "how does the pent up radiant energy flow outwards"? Realising the fact that under stellar conditions the energy flows mainly by radiation and not by the usual processes of conduction and convection, Eddington first worked out the equation of Radiative Transfer of Energy in the equilibrium state which obtains in stars. His mathematical theory enabled him to deduce in 1924 a relation between mass and luminosity of stars, which has been entirely supported by observational results. This is known as Mass-Luminosity relation in astrophysical literature. From this it is possible to predict approximately the mass of a star when its luminosity has been measured. Earlier in 1920 Eddington calculated from his theory the diameter of the giant star Betelgeuse. Michalsam and Pease in the same year succeeded in measuring by interferometer diameter of this star, and their measurement was in agreement with Eddington's calculation. Eddington's investigations of stellar structure landed him in a difficulty of fundamental nature. He deduced a numerical value for the degree of opaqueness called "opacity" of the star Capella by combining the results of his mathematical investigations with observational results, which disagreed with the value deduced from purely physical theories by a factor 10. This indeed led the way for further progress. Eddington himself showed that this discrepancy would disappear if the stars were supposed to be made predominantly of hydrogen. The astrophysicists now believe this suggestion to be correct, and all work at the present time in this line is made under this assumption. The recent theory of energy generation in stars by Bethe also supports this idea of the abundance of hydrogen in stellar material.

In his study of the internal constitution of stars Eddington came to the conclusion that the atoms within the star are stripped of almost all of their electrons, and move about almost naked devoid of their outer coverings of electrons. This reduces the

size of the atoms enormously, so that the stellar material should be capable of showing extremely high compressibility. Are there really stars in the sky which support this idea by possessing transcendently high density? Sirius, the brightest star in the sky has a dark companion (of very low luminosity) which was found to have the size of Uranus, but a mass nearly equal to that of the Sun. For these data the density of the companion of Sirius works out to about a ton to a cubic inch. Under terrestrial conditions this is an absurdity, but Eddington gave the correct explanation for the existence of such high densities in stars known as *white dwarfs*. He further predicted that the spectral lines of this star should show a red-shift according to the principles of Generalized Relativity. This prediction was indeed later verified by Adams. The theory of dense matter in stars, technically called matter in degenerate state, has subsequently been worked out in fuller details by many workers amongst whom are three Indian astrophysicists Chandrasekhar, Kothari and Majumdar.

The heat and light we receive from the Sun and the stars directly come from their outer envelope. In the case of the Sun it is called the *photosphere*. The radiation from the deep interior of the Sun slowly finds its way into the photosphere in which, specially in its upper part, the characteristic dark line spectrum of the Sun known as Fraunhofer lines is formed. Here in the photosphere we have a flow of heat and light energy of a definite amount which can be measured, from which atoms suspended in the envelope at different heights absorb light of certain frequencies, and give rise to the dark Fraunhofer lines on the otherwise bright background. The astrophysical problem is to explain the intensity distribution in the lines and in the background. Eddington worked at this problem and has made substantial contributions towards its solution.

A class of stars known as Cepheid variables present one of the most intriguing problems of physical astronomy. These are stars which change in brightness periodically. The brightness first increases rapidly, then slowly decreases, and a whole cycle is completed in a time between six hours to about six days approximately. Similar phenomena known before were explained as eclipsing of the main star by a much less bright companion revolving round it. The astronomer Shapley first proposed after a study of the phenomena that the Cepheid stars are of a different kind, and their periodicities in brightness are produced by the pulsations of the stars themselves. At this stage Eddington took up this problem and gave the mathematical theory of the adiabatic pulsations of stars. The problem of Cepheid variables is still awaiting solution, but Eddington has been at it continuously, and his last papers on the subject were

published in the Monthly Notices of the Royal Astronomical Society in 1941.

It must not be supposed that Eddington's work in different fields always led to unique conclusions which were universally acceptable. A large amount of the work was of speculative nature and give rise to heated controversies. Views diametrically opposite to his own are held by many astrophysicists on many issues. But it may safely be said that Eddington's speculations and the attendant controversies have generally led the way to our better understanding of the stellar phenomena.

We have already remarked on the part played by Eddington in spreading the doctrine of Generalized Relativity in the English-speaking countries. The internal beauty of the theory and the observational confirmations it received from time to time brought complete conviction in the mind of Eddington about the correctness of the theory, so much so that it entirely determined his subsequent outlook regarding the universe and the cosmos. He was a firm believer in Lemaitre's Cosmology, popularly known as the theory of the Expanding Universe, which he himself developed considerably. In a recent modification of his cosmological theory Eddington has put down the time scale for the evolution of the universe at something less than 9×10^9 years, and remarks, "I do not see much prospect of evading this limit". The writer has an experience of Eddington's unbounded enthusiasm for relativity. In December 1937, Eddington came out to India with other British scientists on the occasion of the Jubilee Celebration of the Indian Science Congress. Eddington was the guest of Prof. Saha at Allahabad for a couple of days. It was arranged that he should motor from Allahabad to Benares and join the main group of British scientists who were then taking a hurried tour through India. After a crowded programme over two days at Allahabad, Prof. Eddington accompanied by Saha and the writer started for Benares in a car. Saha whispered to the writer in Bengali "we must not talk but give the old man some rest". We tried to be discreet, but soon discovered we were mistaken. The "old man" was never tired of talking Relativity. In fact, we had a most stimulating discussion on Relativity and Cosmology for over an hour and a half in the car while the corn fields of that flat country were flying on both sides of us.

Eddington did not stop with the Relativity theory of the gravitational phenomena. He endeavoured to extend it to the theory of electrons and protons. His latest idea was the square of the ratio of the electric and gravitational forces between the electron and the proton is of the order of the number

of particles in the universe, which he put down at about 10^{79} . His theory aims at obtaining relations between the fundamental physical constants, such as the ratio of the masses of the electron and the proton (given by a root of a quadratic equation), or definition of the range of nuclear forces (given by $k = R_0/\sqrt{N}$, where R_0 is the radius of the Einstein Universe, N the number of particles in the universe, and k defines the potential of nuclear forces e^{-r^2/k^2}), and quantities of this kind. These speculations have not received support from the contemporary physicists and astronomers. But it must be admitted that a complete cosmological theory should in addition to a full description of the existing state of affairs also make attempts to pry into the mysteries of the universal physical constants and the relations amongst them, to which our attention has also been drawn by Dirac. Eddington attempted to arrive at conclusions regarding these questions by his own method. His views regarding his own attempt at a unitary theory of the physical world cannot be better expressed than by his own words as follows "A unified theory does not necessarily mean a unified formula". The latter kind of unification is exemplified by the theory of the "Generalized Astronomical Instrument", which combines in a single equation the theory of the altazimuth, meridian circle, prime vertical instrument, equatorial, and almucantor. We do not aim at producing a formula which shall include simultaneously the irregular gravitational fields of general relativity and the quantized energy of an atom. We seek instead the common meeting point from which the specialized developments and approximations appropriate to the gravitational and the atomic problem branch off (Relativity theory of protons and electrons).

For his grand attempt at a complete understanding of the universe we should call Eddington a philosopher. But his contribution to positive knowledge is not in any way meagre. By his "analytical boring machine" he has opened up the bowels of the stars, from which we have gained definite knowledge about their interior in several respects. He has raised mere speculations into the higher rank of mathematical theories through which contact with observational data has been made possible. He has disseminated the knowledge of the physical world which modern science has gained, among ordinary men through his charming English style and refreshing humour. He has also raised storms of controversies which when they blow over will clear up our horizon and enable us to see better the brilliance of his work, and appreciate what addition he has made to our knowledge.

N. R. Sen

Notes and News

FERTILIZER MISSION'S REPORT

THE Technical Mission headed by Mr G. S. Gowing of the Imperial Chemical Industries Ltd., which was appointed by the Government of India to investigate, and report on, the technical problems involved in the manufacture of ammonium sulphate in British India in quantities up to 350,000 tons per annum, has now submitted its final report. The Mission recommends that the establishment of a single factory, with a capacity of turning out 350,000 tons of ammonium sulphate annually, at a capital cost of 10.1 crores of rupees in Harduaganj near Aligarh in the United Provinces will be the most economic so far as their findings go. The cost of production per ton of the manufactured product from such single plant would be Rs. 114/- at factory and Rs. 126/- at the distributing centre on an approximate calculation.

The possibilities of setting up more than one factory have also been investigated, but the report shows that the larger the number of producing centres with smaller plant capacities, the greater will be the cost of manufacture, both capital and recurring. Thus, for two synthetic fertilizer factories, one near Aligarh with a production capacity of 250,000 tons and the other in the Cauveri area with 100,000 tons capacity, the capital cost is estimated at Rs. 12.7 crores and the manufacturing cost per ton at Rs. 127/- at factory and Rs. 135/- at the distributing centre. The establishment of three factories at three different places such as Dhanbad, Aligarh and Trichy, each having an output capacity of about 116,700 tons per annum, would involve a capital expenditure of about Rs. 15.7 crores and make available ammonium sulphate at Rs. 139/- per ton at factory and at Rs. 144/- at the distributing centre. For six factories in six different centres such as Dhanbad, Moghalsarai, Amritsar, Bombay, Trichy and Bezwada, five having a production capacity of 50,000 tons each and one with a capacity of 100,000 tons, the capital cost is likely to run to a figure as high as Rs. 21/- crores, and the cost of ammonium sulphate per ton is estimated at about Rs. 167/-. These considerations have led the Mission to recommend centralized production of synthetic fertilizer through one single factory to be located at Harduaganj near Aligarh, which is considered as the best site.

After due consideration of the raw materials necessary for the manufacture of ammonium sulphate and at the same time available in India in abundance,

the Mission concludes that the most economic process would consist in the production of ammonia from water gas made from coke and its subsequent conversion to ammonium sulphate by treatment with gypsum. The required coke will have to be obtained from Bihar and gypsum or anhydrite from Khewra in the Punjab. In view of India's limited reserve of coking coal, the Mission has suggested that the possibilities of utilizing non-coking coal for the production of water-gas should be fully investigated. The use of charcoal in place of coke has been discouraged, as its use, in the Mission's opinion, does not offer any advantage. Anhydrite, however, can be used in preference to gypsum, provided it is available in adequate supply, and for this a thorough survey of the Punjab Salt Range should be undertaken. If such a supply be not ensured, production of gypsum in Rajputana should be developed as a second source.

Granting that decision will be reached in favour of setting up a single factory, the Mission calculates that the allocation of capital expenditure between India and abroad will be Rs. 6.0 crores and Rs. 4.1 crores respectively. We are given to understand that the fullest use will be made of raw materials and labour available in India. Structural steel work and buildings, mild steel, construction work such as tanks, vessels, low pressure gas and air mains, gas holders and purifiers, cranes, cast iron water mains, cast iron tanks and vessels, a proportion of the mechanical equipment and refractory materials can be obtained in India.

As the Mission was primarily concerned with the manufacture of ammonium sulphate, it has not calculated the capital and operating cost of alternative nitrogenous fertilizer, such as ammonium nitrate. It has, however, stated that the production of ammonium nitrate will be definitely cheaper and that work should be instituted to determine the suitability of ammonium nitrate as fertilizer under Indian conditions. With regard to the question of technical personnel needed in the industry, the Mission recommends that a number of Indian chemists and engineers with good university qualifications and sound experience in some of the chemical works or ordnance factories in India should be sent overseas for training. Initially, the Mission suggests, the erection of the plant will be the responsibility of a main contractor who will be under obligation to provide a number of technicians. The training of Indian nationals who will ultimately

assume control of the plant will be best carried out by allowing them to be on the site to watch the erection of the plant.

THE UNIVERSAL DECIMAL CLASSIFICATION FOR LIBRARIES

We learn from a report in a recent issue of *Science* that the British Standards Institution has undertaken to publish a number of volumes on the Universal Decimal Classification for Libraries, of which the first four completed volumes have already appeared. This work presents a system for classifying library books, that can be applied to special subject libraries, as well as to general libraries all over the world. The elimination of language and its replacement by numbers have made possible the use of a library of any country by a librarian of any nationality with perfect ease and freedom.

The Universal Decimal Classification is, in fact, the improved and enlarged version of the Dewey Decimal system developed along somewhat the same principles. This classification was prepared by the Federation International de Documentation with the help of leading experts in many fields. The International Federation of the National Standardizing Associations adopted it for the classification of its documents. The present English edition of the Universal Decimal Classification followed the request of both the British Society for International Bibliography and the Association of Special Libraries and Information Bureau. French and German editions, however, appeared before. An abridged system formed by the major groups with simpler symbolic representation, which can be advantageously used for the classification of books in smaller libraries, is also available.

The Universal Decimal Classification, as is expected, is under the continual supervision of experts seeking to keep it up-to-date. The Commission and Secretariat of the classification of the Hague has the final decision for amendments and extensions. The classification is highly useful to experts and libraries in specialized fields owing to its detail and flexibility to accommodate an indefinite number of subdivisions. It is also well adapted for use in connection with various automatic card sorting machines.

SOVIET OBSERVATORIES UNDER GERMAN HANDS

Curiosity centres round the fate of observatories and scientific institutes of U.S.S.R., while under German hands, now that the German occupied territories of Soviet Russia have been liberated by the Red Army. *Nature* has recently published notes on the looting of Simeis Observatory in Crimea and the gallant saving of the valuable library of Pulkovo Observatory, now a heap of ruins, which make

interesting reading. Before the German occupation of the southern part of Crimea, the staff of the Simeis Observatory could carry with them the object glasses of the two astrographs and part of the laboratory equipment during evacuation. In May 1944, after the liberation of Crimea, Dr Shajn was sent by the Academy of Sciences to inspect, and report on, the remains of the Observatory. The investigations of Dr Shajn reveal that during September and October, 1943, German specialists dismantled all the Observatory's instruments and dispatched them first to Simferopol and thence to Germany. The instruments so removed include the 40-in reflecting telescope, the double astrograph, a new astrograph for zonal observations, a photo-heliograph, three steel spectrographs, a large coelostat, a long-screw measuring machine, a Repsold machine, a microphotometer and two astronomical clocks. Besides, the whole library collection of more than nine thousand negatives and the equipment of the power station and workshop were carried away. The wooden parts of the three Observatory domes, the wooden building which housed the spectro-helioscope and a number of other pavilions were destroyed. The main building of the Observatory caught fire on January 18, 1944, and nothing was done to bring it under control. This is another instance of Nazi vandalism in which the Germans have specially indulged in this war whenever there has been an opportunity.

The destruction of the valuable library of the Pulkovo Observatory was generally assumed when the Germans destroyed it in 1941 (*SCIENCE AND CULTURE*, Vol. 7, No. 12). This library contained many rare treasures, including the manuscripts of Kepler. According to an information of the *Moscow News*, it is learnt that the library has escaped destruction. The library was stored away in the basement of the building, and after the Germans shelled the Observatory for three weeks, decision was taken to save the library at any cost. The employees of the Leningrad Museums and Park Administration who undertook to remove the library worked under incessant artillery fire in the middle of October, 1941, until all the books were removed to a safer place. The act represents a heroic effort of the highest order that has ever been made to preserve the culture and civilization of men, accumulating through ages.

THE 1945 ART IN INDUSTRY EXHIBITION

THE fifth annual Art in Industry Exhibition will be held in Bombay at the J.J. School of Art early this year. The prospectus of the 1945 Exhibition, just issued, indicates that this year's exhibition is going to be far wider in scope than its predecessors. The exhibition will include sections

devoted to commercial photography, typography, handicrafts, interior decoration and all types of commercial art. The Outstanding Production section, a successful feature of the last exhibition, has also been included and proposes to show the best of India's wares judged from the criterion of pleasing appearance. The exhibits of this section will comprise the best furniture, cloths, glassware, pottery, printing, etc. The prize money allotted for this year totals Rs. 25,000/- and is reported to be the largest sum ever offered to artists and art students in any single exhibition in India.

We further learn with satisfaction that the proposed Indian Institute of Art in Industry will be registered this year and will take over control of the movement after the next exhibition. The Institute will be an All-India body with membership extending from the Central Government right down to students, the latter requiring to pay Rs. 5/- per annum. There are classes of membership for every type of firm, body or individual. The Institute further proposes to undertake educational work, bring out many publications concerned with applied art, and help India's industrial progress in many directions as soon as funds are available and conditions return to normal.

We have always advocated the importance of Art in Industry movement and are glad to note the steady expansion of the exhibition, first conceived and organized by the Burmah-Shell. The success of the 1944 exhibition, we are told, led the Information and Broadcasting Department, Government of India, to send to England the 300 best entries for display in London by the High Commissioner for India, which were highly appreciated. The fact that the organizers of the exhibition have found it possible to bring into existence the Indian Institute of Art in Industry within so short a period is a clear indication of the need of a like institute and of the deep appreciation of the movement on the part of Indian industrialists, and we entertain no doubt as to the significant role the Institute is destined to play in the industrial life of future India.

STORM OVER SUNSHINE D

UNDER this heading *Time* (30-10-44) has given an account of the intervention by the antitrust division of the U. S. A. Justice Department in a recent patent infringement suit brought by the Wisconsin Alumni Research Foundation.

The history of the starting of this Foundation is very interesting. Dr Harry Steenbock, the famous biochemist of the Wisconsin University, discovered a method of enriching the vitamin D content of many food products by irradiating them with ultraviolet light from a quartz mercury vapour lamp. This method is based upon the discovery that these

food products contained 'provitamins' which could be activated by ultraviolet radiation contained either in the sun's rays or by artificial means. In order to avoid unscrupulous commercialization of his discovery, Dr Steenbock decided to let the University utilize his patent and use the profit for research.

Nine alumni of Wisconsin started the Foundation in 1925, which has no direct connection with the University. In all, the Foundation has accumulated \$9,000,000 which will eventually go to the University. So far the University has received \$2,500,000. Dr Steenbock gets out of this only his usual salary of \$12,000. None of the Foundation members, each of whom subscribed \$100, nor any of the subsequent members have received anything out of this fund. The President of the Foundation, George Height, a well known Chicago patent lawyer, also gets nothing.

The change brought by the antitrust department against the Foundation is that it has conspired with 16 companies to suppress competition in the manufacture and sale of vitamin D. They are also charged with limiting the potency of vitamin D used in the widely advertised 'enriched' bread, milk and other foods, thus preventing such foods from competing with regular vitamin D products. It is stated that the cost of making vitamin D that sells for from \$3.35 to \$10.80 is 15 cents. The high prices charged are said to prevent the very people whose need of vitamin D is the most acute from obtaining it. This case brings up the very interesting problem of the ethics of profit making, when such profits are utilized for public utility purposes like the support of university research.

THE 27TH ANNIVERSARY OF THE BOSE INSTITUTE

THE 27th anniversary meeting of the Bose Institute took place on the 30th November, 1944, when the sixth Sir J. C. Bose Memorial Lecture on 'The Evolution of Life Form' in plants was delivered by Dr K. P. Biswas, Superintendent, Royal Botanical Gardens, Calcutta. The Director's report presented to the meeting describes the principal investigations undertaken in the Institute last year. We give a short summary of the report.

Sir J. C. Bose's investigations on motor organ of plants like *Mimosa*, *Desmodium*, etc. are being continued with a view to elucidating the biochemical processes underlying the motility of different plant organs. The energy of the pulsatory movement of the leaflets of *Desmodium gyrans* has been shown to be due to photosynthetically produced carbohydrates in the leaflets. The respiration of the leaflets under favourable conditions shows the same periodicity as their mechanical pulsations. Effects

on respiratory activities of co-enzymes like thiamin, nicotinic acid when added to various substrates like glucose, sodium salts of pyruvic, citric, malic acids have shown that the addition of a minute trace of indole-acetic acid increases by fifty per cent. the respiration in *Desmodium* leaflets with sodium malate as substrate, indicating that the fundamental function of the auxins in cellular metabolism is of a respiratory catalyst. Bose had already found that in the pulvini of these motor plants an active substance is present which, by microchemical tests, was identified as an unsaturated carbon compound which is neither a fat nor a lipid. This substance has now been identified as a carotenoid of the crocetin group, which has been recently found by Moewus, Kuhn *et al* to be responsible for the motility of the flagella of *Chlamydomonas eugametos*, and for its sex behaviour.

Cosmic ray investigations using photographic plates and Wilson chamber have led to a new method of determining the mass of meson and of its energy spectrum in cosmic rays. The mean life time of the spontaneous fission of the uranium nucleus has been determined by two independent methods, and it is found to occur one million times faster than the rate calculated by Bohr and Wheeler.

Photographs of nuclear fission and burst due to cosmic rays produced in the gaseous volume of a Wilson chamber have been obtained. *Applied investigations* deal with the production of new mutants in jute resulting from treatment of jute seeds to X-rays, γ rays and neutrons. Some of the mutants have desirable characters of economic importance. Breeding by selection and hybridization of cotton with a view to the evolving of long stapled disease resistant types is being carried out successfully. Retting of jute and other fibres by means of the enzyme Hiparol secreted by certain moulds and bacteria is being investigated with a view to devising an economic method of retting fibres under uniformly controllable conditions. Comparative studies on the production of butanol and acetone by moulds and bacteria are being carried out. Production and isolation of bacteriostatic substances like Penicillin from different species of moulds are being successfully investigated. The fungal infection of rice by *Helminthosporium* and methods of combating it have been studied. Fungal infection of tropical fruits are being studied from a similar point of view. Production of food and medicinal yeast and the breeding of suitable yeast strains by selection and hybridization are being worked out. Vernalization of rice for the production of early ripening varieties, propagation of potatoes from isolated 'eyes' are being investigated. The period of viability of stored 'eyes' is under investigation.

ELECTRICAL CONDUCTIVITY OF METALS

PROF. K. S. KRISHNAN, D.Sc., F.R.S., delivered his Ripon Professorship Lectures at the Indian Association for the Cultivation of Science in the last week of November. In course of four highly illuminating lectures, he explained the wave-mechanical theory of the electrical conductivity of metals from a new standpoint. The intensity of scattering of an electron beam by a metallic single crystal may be obtained by an extension of the method adopted by Einstein and Smoluschowski for the intensity of scattering of light by liquids. The method is readily applicable to the case of order-disorder alloys where the scattering resolves into two parts, (1) due to density fluctuation, (2) due to fluctuation in the relative concentrations of the atoms of the two constituents. The theory was shown to explain a large number of electrical properties of order-disorder alloys, so far unexplained. The lectures will be published in the form a memoir by the Association.

THE INDIAN DRUGS RESEARCH ASSOCIATION, POONA

WE welcome the recent formation of the Indian Drugs Research Association in Poona, a research organization which seeks to carry on investigations about Indian drugs from scientific and national point of view. The aims and objects of the Association include, among others, the following: attainment of self-sufficiency in the matter of medicinal drugs in India; collection and cultivation of all knowledge about Indian drugs, which term shall include drugs of mineral, vegetable or animal origin, natural to, or available in, India; undertaking of biological, chemical, pharmacological, pharmaceutical, clinical and other scientific investigations required and making all kinds of provision to that effect; collection and cultivation of medicinal plants in a museum and garden to be maintained for that purpose; maintenance of laboratories, hospital and a library; publication of papers and pamphlets and arrangement for discussions, lectures and conferences; co-operation with individuals and institutions interested in the Association's work etc.

It will take some time before the Association can have its own equipment and staff. But it has already succeeded in enlisting the active support of various experts and in securing facilities for investigations in the existing laboratories.

BASIC CHEMICAL INDUSTRIES IN INDIA

DR H. GHOSH, while delivering his presidential address at the 6th Annual General Meeting of the Indian Chemical Manufacturers Association held in Calcutta on December 8, 1944, made a special plea for the development of basic chemical industries in

India. He drew attention to the production of ammonia, cheap nitric acid and hydrogen, calcium carbide, urea, solvent, bye-products of coal tar industry etc. He laid special emphasis on the development of a powerful coal and coal tar distillation industry for which abundant raw materials exist and on which depends greatly the development of fine chemical and pharmaceutical industry. Referring to the Government's decision to establish the synthetic fertilizers industry, Dr Ghosh emphasized that the Government must not overlook the importance of the manufacture of bye-products of the ammonium sulphate industry and expressed doubts whether the proposed erection of a single fertilizer plant can fulfil the requirement of bye-products. In his opinion, the establishment of at least four units for the production of fertilizers is necessary. Dr Ghosh pointed out that during the discussion of the report of the Fertilizers Technical Mission no attention was paid to the possibility of a healthy combination between the fertilizer industry and the coal tar distillation. Such co-ordination among basic industries is, according to him, best calculated to promote the growth of basic industries. Dr Ghosh advocated that genuine research work is today the main foundation of a chemical industry and it will have to be so in our case if we are to develop a sound and powerful chemical industry. Most of the chemical and pharmaceutical industries in the present state can hardly afford to undertake research in their laboratories, and as such the encouragement of co-operative research on a wide scale appears to be the only solution of this difficulty. He expressed satisfaction at the attempts on the part of the Indian Chemical Manufacturers Association to start a co-operative organization for industrial research. Dr Ghosh bitterly criticized the Government's anti-national attitude of facilitating imports of drugs and chemicals which can be obtained from foreign countries at a cheaper price.

SCHEME OF INDIAN RESEARCH FELLOWSHIPS

At a conference of Chemical & Pharmaceutical Manufacturers and representatives of universities and research institutions, held recently under the auspices of the Indian Chemical Manufacturers Association, the following resolution was passed:

"This Conference of Chemical and Pharmaceutical Manufacturers and of representatives of Universities and Research Institutions in India considers that closer co-operation and co-ordination between the different Departments of the Government of India, Research Institutions and the Industry, are necessary for the commercial utilization of the research work carried out in the Universities and Research Institutions, and further development of Chemical and Pharmaceutical Industry. With that object in view the Conference recommends the establishment of Industrial Research Departments in every University and Research Institution with adequate financial aid from the State and the industrialists to be worked under the guidance and control of Research Councils comprising of the representatives of the Industry and Scientific experts. This Conference further urges the Indian Chemical Manufacturers Association to formulate a scheme of industrial research fellowships to be started for promoting industrial research in Universities and Research Institutions in the country."

ANNOUNCEMENT

THE University of London has conferred the Degree of Doctor of Science (D.Sc.) on Dr C. N. Acharya, Chief Biochemist to the Imperial Council of Agricultural Research, for his investigations in the field of biological decomposition of organic materials, with special reference to the preparation of farm and town composts.

ERRATUM

PLEASE read 'pared which records the population in the three age' for 'part in this period. Thus the table 11 has been pre-' on page 234, line 21 from top (column 1), in our December issue.

SCIENCE IN INDUSTRY

'LIGHTHOUSE' TUBE

THE General Electric Company's Electronic Laboratory has recently developed a new disc-seal electronic tube, known as the 'Lighthouse' tube. This tube is a megatron tube and is expected to make possible the radio relaying of FM radio and television programmes in future. According to a brief description of this tube, contained in a report of the *Science*

News Letter, August 19, 1944, the new disc-seal electronic tube eliminates the conventional type of grid, anode and cathode. Instead of components being fitted around one another as in the past, they are now constructed in parallel planes or layers, with glass and metal fused in rigid, inseparable units, capable of withstanding severe handling. A new family of ultra-high frequency electronic tubes,

circuits, and apparatus, specific information of which is not available for reasons of necessary military secrecy, operate in parts of the radio spectrum. Extremely compact in structure, the tube represents an important advancement in frequencies and power available for use in the electronics field.

The failure to produce electronic tubes and apparatus of sufficiently high power hitherto acted as the main obstacle in the way of using higher frequencies. The use of higher frequencies necessitates the use of smaller tubes with consequent reduction in power. The parallel plane construction of the megatron tube, it is stated, makes possible production of high frequencies at sufficient power. Besides, many high and ultra-high frequencies are also available, from which any one may be selected for a particular service, such as television, FM, radar etc., and used without interference by others.

MECHANIZING AUSTRALIAN VEGETABLE PRODUCTION

THE Bulletin No. 52 of the Australian Association of Scientific Workers contains results of a recent drive for vegetable production through mechanized farming in Australia. Nearly two years ago the Commonwealth Government introduced mechanized methods for the production of vegetables and secured the services of some American specialists in this field to take advantage of the scientific experience gained in mechanization in the U. S. A. The total vegetable acreage in Australia annually averaged about 250,000 acres during the pre-war period from 1935-1939. In 1943-44, as large an area as 468,000 acres, nearly double the pre-war figure, accounted for Australia's vegetable production. The principal vegetables whose production has been thus increased include potatoes, carrots, onions, tomatoes, peas and navy beans.

Tractors—row crop tractors, which are now imported from America under Lend Lease, form the basis of the mechanization scheme. The Australian technicians have redesigned all the attachments and accessories for row crop culture on the basis of pilot models brought in from the U. S. A., which are now being manufactured in Australia. This equipment has made possible quick change over from hand-hoe culture to multi-row vegetable culture. A grower equipped with one of the small 3 H.P. garden tractor can handle as many vegetables as 7-10 men could do with hand tools. Seeding, cultivation and crop dusting can now be done at the rate of 20-30 acres per day per man. The great increase in speed is better reflected in the production of green peas for canning and quick freezing. The old methods of hand harvesting required about 130 man hours per acre to pick the crop. The mechanical methods which have completely eliminated hand picking have reduced the

harvesting labour requirement to only 10-15 man hours per acre.

BIOCHEMICAL FOSSILS

PROF. D. L. FOX of the Scripps Institution of Oceanography in *Science*, August 11, 1944, reports the quantitative and qualitative carotenoid pigments encountered in marine sediments of hundreds or thousands of years standing. These highly labile compounds are capable of being preserved over vast ages of time, due to the lack of free oxygen, absence of light and perpetual temperatures of nearly 0°C in the buried strata of the Ocean floor.

Pigmentary compounds of the plant and animal porphyrin series have been encountered in petroleum, coal and shale oils. Similarly, other chlorophyll derivatives accompanied by carotenoids and sometimes associated with pigment common to petroleum occur in long and deeply buried marine sediments. These ancient deposits may be regarded as diagnostic features in the search for biochemical processes in the origin of petroleum and allied natural deposits.

Carotenoids have been reported in Moor soils, in muds from lakes, marshes, and underground caves.

In the present investigation attention is directed to the probable ages, history and biochemical significances of these pigmentary compounds in natural deposits.

PRODUCTION OF OIL FROM PLANT MATERIAL

THE plant conversion process puts liquid fuel at the disposition of all civilized nations. Any country which is not blessed with natural oil and which has or can develop an adequate agricultural or forest production can now produce an important part of its liquid fuel needs. Time is not far off when oil products should be obtained from sources other than natural oil, as the experts in the field are inclined to think. Prof. E. Berl of Carnegie Institute of Technology in *Science*, April 21, 1944, states that by a controlled internal combustion one can get from corn stalks, corn cobs, sugarcane, bagasse, sea weed, algae, saw dust, Irish moss, molasses, sorghum, grass or any other carbohydrate containing material a substance called "Protoproduct" which is semi-liquid at room temperature and liquid at higher temperature and contains about 60 per cent. of the carbon content of the original plant material. The "Protoproduct" is a hydrophobic substance and separates easily from the watery medium, and no further concentration is necessary. It can be used as fuel oil or in Diesel engines.

About 50 per cent of oxygen is contained in plant material, e.g. in dry sugarcane. Protoproduct made from sugar cane contains 20-10 per cent of bound oxygen which can be removed by hydrogenation as a result of which about 45 per cent of

the original carbon content of sugarcane, results as gasoline, kerosene, and lubrication oil—17.4 per cent of the original carbon content in sugarcane are found in this gasoline. Kerosene fraction contains 19.7 per cent. of the sugarcane carbon content. The remaining asphalt like material contain 15 per cent of the sugarcane carbon content and is derived mostly from

the liquid content of the plant and can be used for purposes where natural asphalts are used. From 100 long tons dry sugarcane result 2,980 gal. gasoline, 3,430 gal. middle oil, and 1,210 gal. lubrication oil.

It would be wise and practical to use more and more agricultural products for the production of liquid and semi-liquid fuels.

SOME ASPECTS OF FRUIT CANNING INDUSTRY

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(Continued from last issue)

TRANSPORT

The problem of transport is also of vital importance. Fruits may have to be transported over long distances either by road or rail. This has not only to be quick as fruit is a perishable commodity but it has to be efficient for if the fruits are transported and handled in a negligent manner spoilage may result. Inefficient packing, rough handling and dumping of different fruits together in closed wagons may spoil delicate fruits. The rates of transport are also going to affect considerably the price of the canned products. This applies both to the raw materials and the canned products. Government can help here in the initial stages of the industry by reducing the freight on canned products or fruits meant for canning. It can also improve upon the present transport facilities.

MARKETING OF CANNED FRUITS

The slow development of the fruit canning industry in this country is to some extent due to want of markets for the canned fruits. Low standard of living, prejudice against canned foods and a feeling that the Indian canned foods are inferior to foreign products have restricted the sale of Indian canned products and the Indian producers had to turn to foreign markets for the disposal of their products. The present war has given a fillip to this industry but this has been offset by the difficulty of getting the containers. The import figures for canned and bottled fruits for the two years just preceding the present war, given below, will show that the imports of such products in India were not inconsiderable.

In post war India it is difficult to visualise what exactly will be the difficulties of the fruit canning industry. Anyway if a large market has to be opened up in India it is imperative that the prices of canned fruits are lowered by efficient organisation and production and the quality of the products brought on

a par with the foreign products. As shown later, Government can help substantially in this matter. The Malayan Pineapple Industry succeeded because

IMPORTS OF CANNED OR BOTTLED FRUITS*

From	Quantity in cwt.		Value in Rupees	
	1937-38	1938-39	1937-38	1938-39
United Kingdom ...	2,994	2,261	1,64,898	1,40,108
Strait Settlements ...	20,075	21,991	1,98,296	2,05,350
Hongkong ...	217	116	5,394	2,891
Commonwealth of Australia ...	3,821	3,792	1,11,772	1,11,956
Other British possessions ...	314	562	5,838	9,033
France ...	143	65	15,290	5,003
Italy ...	668	629	24,423	25,181
Japan ...	239	421	5,368	7,356
U. S. A.				
via Atlantic Coast ...	1,761	680	64,083	23,713
via Pacific ...	16,260	13,192	6,09,576	4,68,688
Other foreign countries	133	172	6,660	10,034
Total ...	46,625	43,881	12,11,598	10,09,313

it marketed cheap products of good quality so that they could find a place in the budget estimates of a middle class family.

The exports of Indian canned fruits or fruit products prior to the war were not much and mango pulp and slices formed the bulk of the exports. If the exports are to be increased markets must be developed but it is not easy to oust countries with well established canning industry from the foreign and home markets and establish the sale of our products. A start must therefore be made with our exclusive fruits like mangoes canned both as pulp and slices. When these fruits establish their reputation in the foreign markets it will not be very difficult to introduce other common fruits on the

reputation of our exclusive fruits. High rates of tariff, food acts, standardisation specifications and last but not the least the prejudice against Indian goods are hurdles over which we shall have to jump successfully if our canned fruits are to sell in the world markets.

In the marketing of canned fruits it should be borne in mind that the fruits which have the widest appeal are those which are not easily obtainable in the fresh state or obtainable only at prices beyond the reach of the consumer with a small purse. If the product marketed is to be cheap it is necessary to reduce the number of middle men as far as possible. The fruit marketing board can very well undertake the marketing of canned fruits.

NEED FOR RESEARCH

There is constant need for scientific research in the canning industry. Numerous are the problems which crop up. New fruits to be canned require elaborate investigations if these canned fruits are to satisfy the markets. The canning of the usual fruits for which data is available also raise problems which have to be tackled. The variety growing at some place may not be quite amenable to canning conditions. The effect of storage under tropical conditions, the density of syrups for our fruits, the suitability of various colouring matters, the problem of spoilage, the possible means of holding over supplies of fruits for canning at a later date require study under the conditions prevalent in the various parts of this country. While every cannery which claims to be modern will have a small research laboratory to solve its individual problems there will still remain a need for one or more research stations to investigate broader and more fundamental problems of canning e.g., experiments on the corrosion of plates, substitution of newer types of containers etc. It should also be a centre for the dissemination of information on canning by means of bulletins and should attend to the inquiries of canners and advise them where such an advice is likely to result in an improvement of the product. It might also give a course of instruction in canning practice. No doubt at present some notable work is being carried out at a few experimental stations in India like Poona and Lyallpur but a big central station like the Fruit and Vegetable Preservation Station at Campden in England is a necessity. The station has from the beginning taken a broad view of all canning problems and has become famous the world over for its investigations into the fundamental problems and for its help to the canning factories in the United Kingdom. Now administered by the Department of Scientific and Industrial Research it is maintained partly by a grant from the Government and partly by contributions from the

canning and allied trades which are represented on the Technical Advisory Committee and on the Managing Committee. Apart from the pursuit of research and expert advice on technical problems, it also conducts courses of instructions in the principles of canning where students from different countries take training. The station also tests samples for the National Mark Scheme.

ADVANTAGES AND DISADVANTAGES OF FRUIT CANNING INDUSTRY ON A LARGE SCALE AND COTTAGE SCALE

There are conflicting views on the subject whether canning industry can be worked on the cottage scale or not. Due to lack of transport facilities and the excess of production over consumption, surplus fruit is left at times on the site of produce and needs some outlet. This can be canned if a small cannery with home canning appliances is set up at such places and this will result not only in the canning of surplus fruit but there will also be no trouble of transport of fruits over long distances to a big cannery especially during rainy season when it is difficult to do so. The canned products can be transported when conditions permit. The bulk to be transported is also thus reduced. Small scale canning will lead to the elimination of charges incurred over collection of big capital, registration, factory overhead, costly foreign machinery etc. The small scale manufacturers canning different products at different centres of fruit production should be brought together under one or more co-operative concerns for marketing the product. This body should buy the cans, bottles and other requirements and distribute to the manufacturers. It should then label the products under its own name and do the work of advertising and marketing. It may also maintain technical advisers, canvassers, research workers etc.

A large scale canning factory will be in a position to run profitably if it works at its maximum with resulting mass production and markets will have to be found for these products. Again such a factory must can different fruits or else close down for some months owing to the strictly seasonal supply of fruits.

Against the advantages of canning as a cottage industry may be listed its disadvantages. The products of different small scale canners will not be of uniform quality. Proper sorting and grading will be difficult for people whose main aim will be to dispose off their surplus fruit. Syruping, filling, sealing and processing may not be properly carried out and may lead to spoilage as has been observed in some countries, sometimes even to food poisoning. Proper hygienic conditions may not be maintained. If proper control can be exercised through food inspectors over small scale manufacturers, small scale co-opera-

tive concerns do deserve encouragement, especially in this country where any small addition to the income of the rural population is always welcome.

It has been estimated by the National Planning Committee's Sub-Committee on Horticulture that a fair sized canning factory requires a capital of Rs. 10 to Rs. 15 lakhs but at a conservative estimate Rs. 5 lakhs would suffice for a medium sized factory. The Committee was also of the opinion that "in so far as the household or local demands are concerned, small industrial units may be started with a capital of eight to ten thousand rupees on co-operative basis, but where production is large and is meant for preservation, either for interprovincial or international trade, it should be in the hands of big industrialists."

HOW THE GOVERNMENT CAN HELP THE INDUSTRY

Various measures have been suggested from time to time as to how Government can help the fruit canning industry. They may be briefly summed up. The Government can help the raising of capital for large canning ventures by an assured capital from Government or by a subsidy from the Government per can produced for the first few years and later only on cans which are exported. Import duties may be imposed on the foreign canned products which are likely to compete with our own. The duty on the materials used for canning like cans, sugar, canning equipment, etc. may be reduced or removed altogether for a few years. A reduction in freight and proper transport facilities for the transport of raw fruits for canning will go a long way to help the industry. The trade commissioners in foreign countries may be instructed by the Government to make propaganda for our products and get prominence for them in International exhibitions. The Government can put the services of the Agriculture Department at the disposal of the canning industry so that the canners may get expert advice on the availability of fruits and their keeping qualities and the cultivators on the improvement in the varieties of fruits with a view to get better results in canning and so on. Through its department of Industries the Government can give expert advice on technical matters. All this may be done efficiently by one or more research stations as mentioned before. The Government by enforcing a National Mark Scheme or some other measure which permits it to examine the products canned and prevent the export or local consumption of products found below mark will create a good reputation for Indian products locally and in foreign countries. Such a control is absolutely necessary because if in the initial stages of our industry spurious goods are exported or even allowed to be consumed locally and if this results in any deleterious effects on the health of the consumers

it will deal a staggering blow to the reputation of our products.

FRUIT CANNING INDUSTRY IN THE OTHER PARTS OF THE WORLD

The fruit canning industry has developed to a very great extent in the U. S. A., Hawaii, Malaya, Australia, Japan and Canada as will be seen from the following export figures.

SUMMARY OF EXPORTS OF CANNED FRUITS FROM PRINCIPAL SOURCES (quantity in thousand cwt.)

Country	Year 1936	Year 1937	Percentage for 1936
U. S. A. ...	2,306	2,397	48.5
Malaya ...	1,199	1,259	25.2
Australia ...	443	579	9.3
Japan ...	434	492	9.1
Canada ...	165	240	3.4
Spain ...	114	...	2.4
S. Africa ...	64	35	1.3
Belgium ...	12	8	0.3
France ...	7	8	0.2
United Kingdom ...	12	14	0.3
Total for 10 countries ...	4,756	5,032	100.0
<i>Shipments of canned pineapples not included above.</i>			
Hawaii to U. S. A. ...	4,893	5,057	...
Philippine Islands to U.S.A. ...	64	68	...
Formosa to Japan ...	330	...	...

The grand total of the export of canned fruit in 1936 amounted to over 10 million cwt. of which more than $\frac{2}{3}$ consisted of canned pineapple.

While the U. S. A. is the largest producer and exporter of canned fruits it loses this place in the case of other canned products. Prior to the present war, Italy stood first in the export of canned vegetables, Japan in the export of canned fish, Netherlands in the export of canned milk and Argentine in the export of canned meat.

The largest single importing market for most canned foodstuffs is found in the United Kingdom, the total being 41.6 per cent of the world exports of canned foodstuffs in 1937, fruit imports being as high as 72.8 per cent of the total world exports.

To just give an idea of the extent to which mechanical efficiency has been achieved in some of the foreign factories the figures published by one of the biggest pineapple canning factory in Hawaii a few years back may be given. The speed of the processing machines was 150 cans per minute and that of labelling 1400 cans a minute. On a record day this cannery packed 3,497,388 cans, giving an average of 2,776 cans packed per minute. Tin plates fed in

a machine give finished cans at the rate of over 300 cans a minute.

Other countries, like Egypt, Palestine, Eire, Kenya, Mauritius and Jamaica are not allowing the grass to grow under their feet and are actively trying to build up fruit canning industries.

FRUITS PRESERVATION INDUSTRIES OTHER THAN CANNING OR BOTTLING

It is not the purpose of this article to discuss the various methods of fruit preservation, however, a brief mention may be made here of the other fruit preservation industries. These are, salting of mangoes, drying of bananas, roasting of cashew nut, preparation of fig, guava, papaya, gooseberry and other jellies and marmalades, preparation of chutneys and pickles, candying of 'bor' and the two large industries *viz.*, sun drying of fruits and dehydration of fruits by artificial means.

Sun drying of fruits like dates, figs, jack fruits etc. is one of the oldest and most important food industries and there is scope for extensive development of this industry in this country as they are consumed for their distinctive taste which is in many cases different from that of the fresh fruits. Asia Minor, Greece, Spain and other Mediterranean countries and of late California produce most of the world's supply of sun dried fruits.

The imports in India of dried, salted or preserved fruits and vegetables, not canned or bottled, were valued at Rs. 1,09,51,059 in the year 1937-38 and at Rs. 87,66,296 in 1938-39.¹ Though these figures are for fruits and vegetables together the imports consisted in a large part of fruits like almonds, currants, raisins, daes and cashew nuts, coming mostly from Italy, Spain, Iran, Iraq, Bahrein Islands, Muskat territory, Greece and U. S. A. Apart from this a considerable quantity of preserved fruits are imported into India through the land routes like the Khyber Pass. The exports from India of dried salted or preserved fruits and vegetables, not canned or bottled, were valued at Rs. 19,47,867 in 1937-38 and at Rs. 32,00,866 in 1938-39.² It will thus be seen that there is plenty of scope for fruit preservation industries in India other than canning.

The dehydration of fruits and vegetables is an industry of recent times and was stimulated by the Boer War and the World War I. Enormous quantities of fruits and vegetables are dehydrated and shipped to the armies all over the world. The dehydration may be carried out by air, superheated steam, in vacuo, in inert gases or by the direct application of heat. Air, however, is the usual medium employed industrially. Dehydration industry is growing rapidly because of certain advantages it holds over sun dried products. Dehydrated fruits when cooked

more nearly resemble the cooked fresh fruits in flavour and colour than cooked sun dried fruits. They are produced under better sanitary conditions than sun dried products which are liable to be contaminated with flying dust and subjected to insect nuisance. Sun drying again cannot be carried out in the rainy season. These and other advantages have led to the establishment of dehydration industry on a large scale in many countries.

Preservation of fruits at low temperature is also employed where facilities permit and where the duration for which they are to be preserved is short.

If juices of citrus fruits like 'santra' and 'mosambi' and other fruits like 'jamboo' and pomegranate are bottled and made available cheaply will be popular and their increased consumption will be beneficial from the nutritional point of view. There is no reason why they should not replace aerated drinks.

India is an agricultural country. Malnutrition is widespread in this country. There should therefore be a strong impetus for the widespread development of fruit cultivation and fruit preservation industries so as to bring within the reach of the masses at least some fruits. May be, without adequate State support we may not be able to compete in world markets in canned fruits in which other countries also deal like say pineapple, but a fruit like mango is our own fruit and it should capture the foreign markets even as the Malayan canned pineapple captured many foreign markets.

It will indeed be a tragedy if foreign concerns take this trade out of our hands. Of late, numerous foreign manufacturers in various trades have established their factories in India. It may not be long before foreign canners come and establish canneries for canning of fruits in this country and with their home market in their hand, with enormous capital behind them, technical experience and reputation one single factory may be sufficient to oust small Indian concerns even from our home market. Before that day dawns let us hope we shall wake up to the realisation of the need for the establishment of fruit canning industry on a sound basis in this country.

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MEDICINE AND PUBLIC HEALTH

PENICILLIN FOR CIVILIAN USE IN INDIA

It is probably now a common knowledge that the American authorities have recently agreed to release limited quantities of penicillin for use of the civil population in India, and as a corollary they have stipulated that all use of it must be under strict Government control.

In order to ensure that the available supplies are equitably distributed throughout this country and reach patients to whom its administration is justified in the current medical practice, the distribution and use of penicillin is controlled by the Government of India through committee consisting of five members with the Director General, Indian Medical Service, as its chairman. This committee is known as the Central Penicillin Control Board, and it is imperative now on every importer of penicillin to comply with any control rules and regulations that may be issued by the Board from time to time. Publication No. 1 of the Board has already been published. This, besides giving the dosage and mode of administration of penicillin, includes also the diseases in which penicillin is indicated and contra-indicated. Copies of this pamphlet have already been supplied to the heads of the Government Medical Departments in Provinces and States.

Naturally the unusual healing properties of Penicillin have caught the imagination of the medical profession, so much so that often supply of this drug is requested for the treatment of indefinite cases where everything else has been tried and found to have had no results. One of the objects of the measures of control is to prevent this use of such a valuable drug. Its use is also prohibited in venereal diseases. It is as necessary with penicillin as with sulphonamide to know the nature of the infection to be treated. While some bacteria are extraordinarily susceptible to it, others are completely unaffected, and to use penicillin in an effort to eliminate them is a complete waste of valuable material. There are three groups of bacteria against which both the sulphonamides and penicillin are effective, with some important individual differences, and these account for most of the infections in which penicillin has been used.

Penicillin, in the first instance, will be supplied only to approved institutions, authorized to use this drug by or under the authority of the Board. Any stocks remaining over each month after the various Provinces have been allotted as much as they require

will be sold by importers direct to medical practitioners and non-Government institutions under the following control.

Every request for supply of penicillin in such cases must emanate from a medical practitioner and should be accompanied by a certificate that the case for which penicillin is required is suitable for treatment which should be signed by an Administrative Medical Officer, *i.e.* a Surgeon General, Inspector General of Civil Hospitals, Residency or Agency Surgeon, or any of the "assessors" nominated by him for the purpose. These assessors will ordinarily be surgeons or specialists who have access to a suitable bacteriological laboratory.

In order to judge whether the use of penicillin is justified the assessors will require particulars of the case which must include the diagnosis of the case, bacteriological findings, the doses, the mode in which penicillin is proposed to be administered and also the quantity required. If the assessors are satisfied they will sign a certificate that the case is suitable for penicillin treatment stating how much penicillin is to be issued. The importer on receipt of such a certificate will issue the amount of penicillin prescribed thereon. It is incumbent on every medical practitioner or institution obtaining penicillin to submit a case report through the Government Assessor on the prescribed Penicillin Chart, copies of which have been distributed to Provincial and State medical authorities.

A considerable portion of the quota allotted to India has already reached the hands of the importers. Stocks of penicillin at present are available with Messrs. Kemp & Co., at Bombay, Madras, Calcutta and Delhi, Messrs. Parke Davis & Co. at Bombay, Madras and Karachi, Messrs. T. M. Thakore & Co., Bombay, Messrs. Martin & Harris Ltd., Calcutta, Messrs. Volkart Brothers, Bombay, Messrs. D. M. Wadia & Co., Bombay and Messrs. Smith Stanistreet & Co., Calcutta.

INSULIN TREATMENT SIMPLIFIED

A synthetic product which is claimed to simplify the course of insulin injections for diabetes has been recently patented in America, according to a report of the *Liverpool Daily Post*. The patent arose out of the researches of Dr Johannes Buck, formerly a research chemist in Liverpool and now an American citizen. The synthetic product has the property of

slowing down the blood's ability to absorb insulin. Accordingly, it is claimed that it would be possible to give a diabetic patient a 24-hour supply of insulin in one injection. Ordinarily, an injection of this

calibre would result in severe and possibly fatal shock to the patient, but the patented method has the effect of releasing insulin gradually so as to maintain the right amount in the blood.

THE MINIMUM REQUIREMENTS OF A HOUSE IN RURAL AREAS

"RUSTIC"

HOUSING conditions in rural areas differ widely from province to province in a vast country like India. In some provinces the villages are compact and separated from one another by long distances. But village streets are not well laid out and houses are built any how. In some other provinces the villages are compact and the streets are well laid out around a temple or other place of worship or tank. But the houses are built as attached blocks and each house is like a long corridor with cross walls, and a backyard. In some provinces the village is a nebulous aggregation of hamlets without definite streets or roads, sprinkled among paddy fields, or interspersed with ponds. The house consists of an enclosed courtyard with cattle shed in a corner and a number of rooms on the side of the courtyard. There is one kitchen for several members of a joint family. The grain is stored in the courtyard. There is no latrine or well or bathroom. These are not considered essential to the house. Windows are mere peep holes opening on to the courtyard. Natural lighting is poor and there is no cross-ventilation.

In a previous article¹ the writer has mentioned the defects that can render a house insanitary. In this article, the minimum essential features of a healthy house suitable for a rural family are considered, and a design is put forward embodying these features. An estimate of cost is also given. This design may be altered to suit local tastes and materials available. If a person desires to build his house to larger dimensions, or provide more rooms, or better materials for walls etc., he is welcome. This design is meant for the poor family in rural areas.

The average family in India consists of $5\frac{1}{2}$ members (census of 1941). In Bengal there were 5.4 persons to a house in 1941 and 5.1 persons to a house in 1901. Hence the minimum design for a house must be suitable for 6 persons (consisting of a man, his wife, perhaps 3 children over 10 and 1 under 10) or $5\frac{1}{2}$ adults.

This family will require at least 2 living rooms. Three may be better but we are dealing with minimum standards. One living room is not sufficient, because (a) the room must be $5\frac{1}{2} \times 50$ or 275 sq. ft. to provide 50 sq. ft. per head. A room of 275 sq. ft. is rather large ($16' \times 17'$) and not easy to roof over, (b) if some member of the family is ill, it will be necessary to provide some isolation so that the patient may get some rest and the illness may not be communicated readily to the other members, (c) if a guest has to be accommodated, it must be possible at least to allot one room for the men and boys and one for the women and girls, for sleeping at night. This is ordinarily done in Indian families out of considerations of privacy, (d) the grown-up children of a family must sleep apart from the parents, as far as possible.

In the design (Fig. 1) two intercommunicating room $10' \times 12'$ and $12' \times 14'$ are provided. There are 2 verandas, one in front and one behind. In the hot weather a veranda is the nicest part of the house to sleep in or indulge in a chat. The front veranda can be used by the men folk and the back veranda by the women folk. The verandas will also prevent the rain from beating into the living rooms through the windows. The two rooms can be adequately cross ventilated. All doors must have ventilator openings above.

There is a separate kitchen adjoining the back verandah; with a window and a smoke flue. This is essential. Cooking in the living room makes it smoky and dirty.

The house has an enclosed backyard or compound. There is a well or tube well with proper platform and drain leading to a soak pit. There is a little enclosed bath room or bathing platform near the well and a latrine of the borehole or any other suitable type recommended in a previous article.²

If cattle and live stock are to be accommodated in a rural house a separate shed $12' \times 8'$ may be built in the backyard, and a manure pit may be provided as shown.

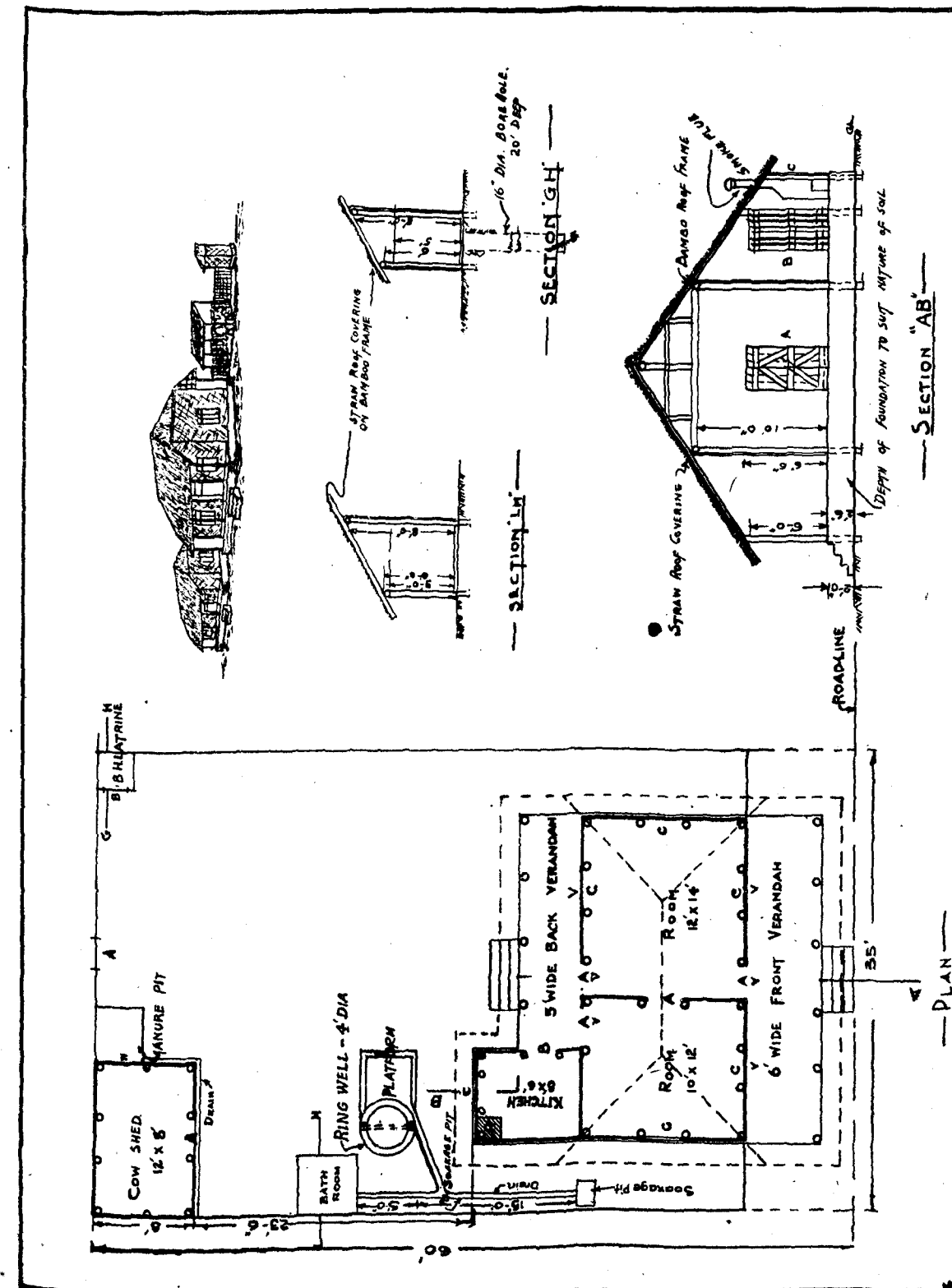


FIG. 1. DESIGN FOR A HOUSE IN RURAL AREAS

MINIMUM REQUIREMENTS: Foundation—To suit nature of soil. Walls—Bamboo or Darma mud plastered inside, white washed. Roof—Country wood or bamboo frame and covered with straw. Floor—Concrete, brick or earth floor finished with mud plaster. Doors—To have $4' \times 3'$ country wood frame with $1''$ thick shutters and with iron fittings, painted with tar. Type-A—Doors $3' \times 6'6''$ brace and battened, double hung. Type-B—Doors $2'6'' \times 6'$ brace and battened, double hung. Type-C—Windows $4' \times 3'$ battened, double hung, iron fittings, $4' \times 6'$ country wood frame. Type-D—Ventilators $2'0'' \times 1'3''$ over doors and windows with gratings, no shutters. Type-E—Window $2'6'' \times 3'0''$ battened, double hung, iron fittings, $4' \times 3'$ country wood frame. Latrine—Bore hole, $16''$ Dia. $20'$ deep with darma walls, bamboo frame, straw roof covering. Bath— $4'6'' \times 4'6''$ square, floor brick cement pointed or cement plastered over lime concrete.

The floor of the house must be raised at least 1' above the ground ordinarily, and 2' above ground in water-logged areas. It must be of concrete or brick plastered over with cement. A mud floor may be all right for a short time or in dry districts; but an impervious floor with damp-proof course over the walls at plinth level is preferable in wet districts or where the sub-soil water is high.

The walls may be of any material that the villager can afford. The cheapest will be bamboo matting, preferably plastered with mud or cement and white washed in the interior. These walls are common in some places in East Bengal and look very trim. Such construction will do away with the need for digging for earth for house building and thereby reduce the number of breeding places of mosquitoes. Mud walls and brick walls may be built if desired but the interior must be finished with a white wash to reflect light. The smoke flue may be built out of mud and earthenware pipes. The roof may be of straw or tiles or terracing as desired. The head room in the living rooms may be 10'-0". Such a house will have the following features:—

Floor space, including verandahs, rooms and kitchen 570 sq. ft. or 104 sq. ft. per capita.

Floor space in living rooms only 288 sq. ft. or 52 sq. ft. per capita.

Air space, including verandahs, rooms and kitchen 5852 c. ft. or 1062 c. ft. per capita.

Air space in living rooms only 5744 c. ft. or 680 c. ft. per capita.

The air space recommended per capita is—

500—540 c. ft. in European countries,
250—400 c. ft. in Great Britain and
20 cubic metres or 706 c. ft. by Fisher.³

The cost of this design depends upon the materials used. The initial cost can be kept low if

temporary materials are used; but the cost of maintenance will be low if permanent materials are used.

The land required is 35' × 60' for the house and the cowshed. This will be sufficient for building detached houses at the rate of 20 per acre. The cost of the site will be not more than Rs. 50 in rural areas.

The cost of this type of house is estimated as follows at pre-war rates:—

	Rs.	AS.	P.
1. Site 1/20 acre	50	0	0
2. Cost of cottage and kitchen 600 sq ft.	600	0	0
3. Ring well, pulley and platform, or 1/5 cost of tube well	40	0	0
4. Bore hole latrine, soakage pit etc	20	0	0
5. Fencing with live fence	20	0	0
	Rs.	730	0 0
6. (Add) for cattle shed 12' × 8'	70	0	0
Total	Rs.	800	0 0

If such houses are built by the villagers themselves nearly Rs. 250 can be saved on account of labour costs. If the elders of the village would influence those who build houses to build them on a regular frontage, leaving a width of 25' for the street, villages can look very pretty. The provision of one well or tube well for 1 to 5 houses will solve the water supply problem in many places. The provision of a latrine and manure pit will solve the problem of disposal of excreta and refuse in rural areas. The refuse and cowdung going into the manure pit will be composted naturally. This can be removed once a year and used in the fields.

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BOOK REVIEWS

Radio Waves and the Ionosphere.—By T. W. Benington. Published by Iliffe & Sons Ltd., London. Price 6 shillings net.

In modern times long distance radio communication plays an important rôle in our daily life. Nevertheless few people have more than a passing acquaintance with the ionosphere, the radio roof of the world, which is solely responsible for long distance radio wave propagation. The book under review is an excellent attempt to describe the essential

features of the ionosphere in all its important aspects. It appears to be the pioneer of its kind in giving a simple and concise account of ionospheric phenomena in connection with short wave propagation. Such a popular and connected account embodying in its small compass all the relevant facts and figures about the ionosphere has not, as far as is known to us, been published before.

The text has been divided into six chapters. In the first chapter the distinction between ground waves

and sky waves and their performance in relation to wavelength has been discussed. In the next chapter the effect of solar radiation on the atmospheric gases in connection with the origin and stratification of the ionosphere has been explained. The third gives a lucid description of the methods utilised for the sounding of the ionosphere and describes the nature of the data obtained from these soundings. The variations in the ionisation of the various layers of the ionosphere with time are discussed in the next chapter. Due emphasis has also been given to long period variations such as those associated with the solar cycle. In the next chapter the author explains the method by which the data obtained from vertical incidence soundings of the ionosphere are utilised for deriving the transmission characteristics for long distance radio communication, namely, the maximum usable frequency and skip distance. The last chapter embodies a nice description of ionospheric disturbances and other abnormalities and their association with magnetic storms, sunspots and aurorae.

The author has presented the subject with commendable lucidity. The scope of the book is quite comprehensive so far as the requirement of the man-in-the-street is concerned. The author says in the preface that anyone who is capable of reading a simple technical article should be able to read and understand this book, and if he understands it, there is occasion for hope that his knowledge of short wave problems will be considerably improved. On reading the book one feels that the hope of the author is amply justified.

J. N. B.

Beginnings of Modern Education in Bengal: Women's Education—By Jogesh Chandra Bagal. Published by the Ranjan Publishing House. Price Rs. 2/8.

Women's education has to-day a recognised and indisputable place in the educational scheme of this country. The early efforts of the missionaries and other distinguished educationists and public spirited men towards the cause of female education in Bengal during the first half of the nineteenth century make interesting history. Mr Bagal who has made his mark as the author of several books has done well to trace the early history of this development which has so largely contributed to the culture and general uplift of modern Bengal. He has mainly confined himself to the period from the formation of the Female Juvenile Society in 1819 up to the establishment of the Bethune School in 1849 and its reorganization in 1856 and has recorded the activities of such pioneer societies as the Female Juvenile Society, the Ladies' Society, the Ladies' Association and the Serampore Mission. The facts have been laborious-

ly collected from various scattered papers, journals, records and personal dairies of the time, most of which are now available with great difficulty. The incorporation of a number of important correspondence that passed between Raja Radhakanta, Deb and Mr J. Drinkwater Bethune and Mr Bethune and Dalhousie in the appendix has further increased the usefulness of the book. For the students of education the book will be highly useful.

S. N. S.

A Text-book of Botany (for junior students)—By B. C. Kundu. Published by Das Gupta & Co., 54/3, College Street, Calcutta. Pp. 402. Price 6/8.

The book is the outcome of a fairly long experience of the author as a teacher of elementary botany and it embodies the essentials of a first course in botany, designed to meet the requirements of students of different Indian universities preparing for the Intermediate Examination in science and for other examination of a similar standard.

The pages bear the impress of an experienced teacher who realized the difficulties of junior students and attempted to solve them.

The subject has been divided into a number sections, e.g., morphology, anatomy, physiology, ecology and systematic botany although the author believes that botany should be presented as one unit and hence morphology, anatomy and physiology should be studied together as far as practicable.

The subject matter has been treated in such a way that it may interest the young learners and with this end in view the text has been copiously illustrated, which have been either drawn from nature or from microscopic preparations made by the author himself; and in physiology simple experiments have been suggested with inexpensive apparatus, so that every pupil in a class would be able to perform these.

Since the publication of a text book of botany by W. H. Gregg of Hughli College, Bengal (1880) and Manual of Botany by G. C. Bose of Bangabasi College, Calcutta (1920), botanical teaching in Bengal, or for the matter of that in India, has developed in rapid strides. The accumulated observations of the Indian flora extending over this long period have all been incorporated in the book under review that has considerably enhanced its value not only to the students but also to the teacher.

Although, the author has taken infinite care in illustrating the chapters on morphology, and the families of flowering plants from the Indian examples, the life history of cryptogams are not similarly illustrated. It is high time, that text books on Indian botany should be written on the life history of plants

based on the studies of local types and not borrowed from sources outside India.

The author has preferred to follow Benthian and Hooker's system of classification, in spite of the fact that Engler's system has been recommended by several Indian universities. In citing examples, it is desirable that an uniform system is adopted and with a little more care, could the nomenclature have been brought-up-to-date.

It is hoped that like the author's previous work on "Text book of Biology" this book will also have a large circulation amongst the teachers and students of our Indian universities.

A. K. G.

A Source Book of Agricultural Chemistry.—By Dr Charles A. Browne, Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture. Published by the Chronica Botanica Company, Waltham, Mass, U. S. A., 1944. Pages 290. Price \$5.

This is a highly important and well documented publication dealing with the development of chemical science with special reference to agricultural chemistry from the time of the earliest Greek philosophers to the beginning of the modern period, *i.e.*, up to 1887. The book has seven chapters, the first dealing with agricultural chemistry in ancient times, the second covers the Alchemical and Iatrochemical periods, the third deals with the period of Robert Boyle, Hooke, Mayow, Hales and others *i.e.*, the period covering the establishment of the Royal Society of London, the fourth deals with the phlogiston period and the fifth with the notable period in which Black, Priestley, Ingen-housz, Senebier, Cavendish and Scheele flourished; the sixth deals with the period of Lavoisier, Chaptal, de Saussure, Davy, de Candolle. In this period chemistry was founded on a quantitative basis due to the establishment of the law of conservation of mass by Lavoisier and the true understanding of the phenomenon of combustion (slow and rapid) and its relation to animal respiration. The last chapter deals with the beginning of the modern period in which the quantitative methods of Lavoisier were introduced in agricultural chemistry by his country man Boussingault and its development by Mulder and specially by the great German chemist and teacher Baron Liebig. The author has achieved

remarkable success and has produced an excellent history of chemistry in which the life and the achievements of almost all the celebrated chemists have been recorded. He has quoted the original publications of these great men and hence this is a veritable source book containing an accurate record of the development of chemical science applied to agriculture. His estimate of the merits and achievements of Palissy, Bacon, Paracelsus, Van Helmont, Glauber, Boyle, Hooke, Mayow, Hales, Becher, Stahl Black, Priestley, Ingen-housz, Senebier, Cavendish, Scheele, Boussingault, Mulder, Liebig and others are very clear and impartial. The author has brought out the fact very conclusively that all the leading chemists of the past took a very keen interest in agricultural chemistry and advanced our knowledge on this subject.

Even the great chemist Liebig, whose writings deeply impressed agricultural science and practice in Europe did not realise the importance of supplying nitrogenous manure to the soils as is evident from the following lines taken from his publication in "Farmer's Magazine", 1874:—"If the soil be suitable, if it contains a sufficient amount of alkalis, phosphates and sulphates nothing will be wanting. The plants will derive their ammonia from the atmosphere as they do carbonic acid." A careful study of this important publication shows that success in agricultural chemistry and improvement in crop yield was effected when experimental and quantitative methods were adopted in crop production. In this respect the establishment of chairs of agricultural chemistry and agricultural botany in universities and technical high schools and the starting of experimental farms or stations have played a very big rôle. Food production is undoubtedly the biggest industry all over the world and it is high time that following the lead of U. S. A. and Europe professorships in agricultural chemistry and experimental stations and farms with qualified staff should be created all over this country.

The author and the publishers deserve our heartiest congratulations for this important and useful publication which should be widely read by chemists, botanists and agriculturists. The printing and the get up of the book are of a high order and the price is moderate.

N. R. D.

LETTERS TO THE EDITOR

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

SLOPES IN THE INDIAN ATMOSPHERE

ACCORDING to Kelvin and Rayleigh, a surface of discontinuity separating two fluids of comparable density is highly unstable except in the neighbourhood of the origin of the discontinuity. It is near this origin that the highest density gradient should be in evidence in horizontal sections of the atmosphere. The expression "comparable density" for the atmosphere does not appear to have been specifically defined.

On the average, the surface density¹ of the north subpolar region in the winter is about 25 per cent. higher than that of the equatorial region. The corresponding contrast in the southern hemisphere is no more than 5 per cent.

The reversal of the sign of the temperature gradient on the eve of the advent of the monsoon is no doubt due to the quasi-periodic advance across the equator of the monsoon current from the southern winter to the equatorial Indian Ocean in conjunction with the prolonged heating of the Indian sub-continent. The surface temperature gradient over the Indian region thus assumes a NW-SE orientation.

As to the conditions aloft, the diagram (Fig. 1) shows² that during the eight months, October to May, the temperatures over southern India are appreciably higher than those over northern India in every layer upto a height of about the 11 km. level.

In the monsoon, on the other hand, the atmosphere over southern India is found to be appre-

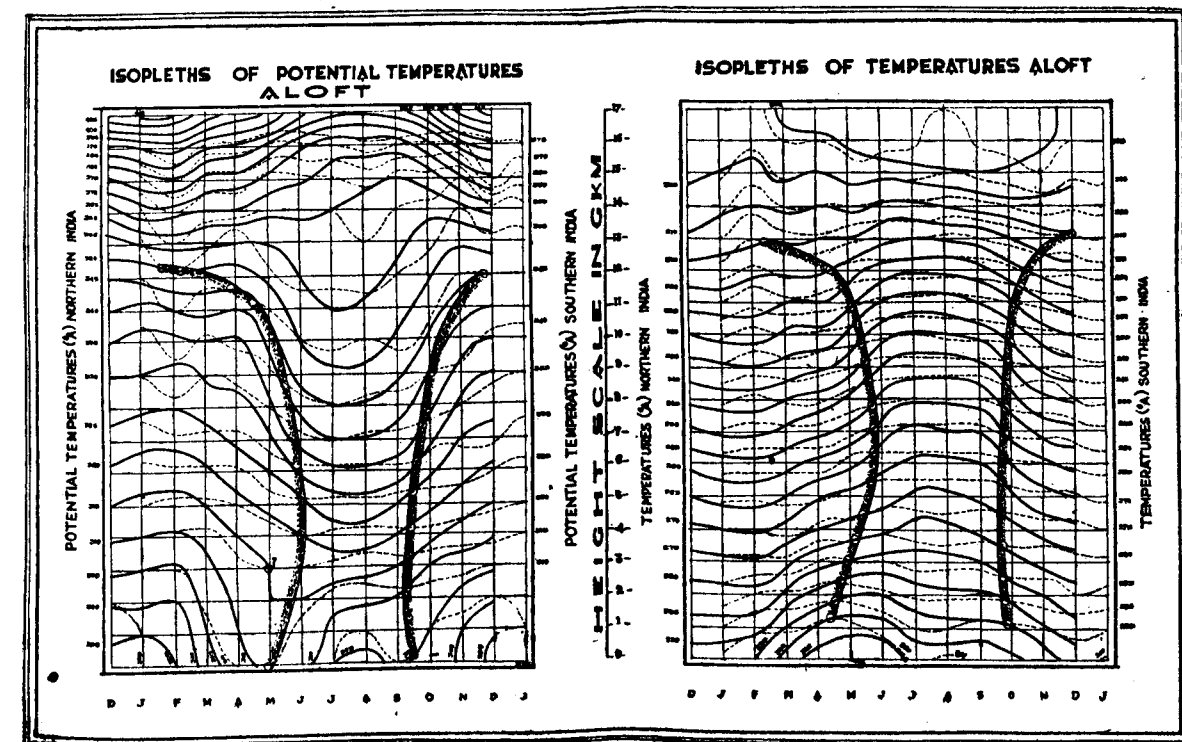


FIG. 1.

The horizontal temperature gradient in the Indian region² is approximately S-N in the winter. As summer approaches, this gradient gradually tilts to SE-NW. By May, however, a significant change takes place, *viz.*, the air over the Andaman Sea becomes somewhat cooler and therefore denser than that over Central India.

ciably cooler than that over northern India, level for level.

The average horizontal gradient of temperature in every layer is of the order of 2-3°C per 1000 km, the sign of the gradient changing twice a year. The average temperature gradient at the surface during

the two transition periods is about 4-5°C in 1000 km. along the east coast of India.

A study of the average horizontal gradients of air density at the surface⁴ in the Indian region is interesting. In the winter, for example, the contrast between the North West Frontier Province and Bengal, is of the order of about 20 gm/m³ per 1000 km, the density increasing towards the Frontier.

At the height of the monsoon, on the other hand, the corresponding average contrast is smaller, being of the order of about 10 gm/m³ per 1000 km, the density increasing towards Bengal. The distribution of density in the upper¹ layers do not show any strong gradients either. The significant fact is that, except during the winter, there are no locally strong gradients in the neighbourhood of those regions where cyclones usually form.

On individual occasions, a density gradient of as much as 50 gm/m³ per 1000 km at sea level may be found at the cold front of an extratropical cyclone. A density gradient of the order of 30 gm/m³ per 1000 km, which is frequently observed at the "cold front" of the extratropical cyclones, obtains also at the surface of the Indian Seas in the winter. In the monsoon and the transition months, however, the gradient over the Bay of Bengal is no more than 5 gm/m³ per 1000 km.

Of the annual output of cyclones⁵ in the Bay of Bengal, only about 20 per cent. is to be credited to the winter and 55 per cent. to the monsoon. As to the highest recorded number of cyclones in a particular month, the following table sets out the relevant frequencies for the Indian Seas for facility of reference.

Table 1: Highest recorded number of cyclones for the Indian Seas in several months.

	Months											
	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Frequency											
Bay of Bengal	1	0	1	1	2	4	5	5	5	4	4	2
Arabian Sea	1	0	0	1	2	2	1	1	2	2	8	1

The table shows that the cyclones are more numerous and pronounced at the time of the reversal of the wind and temperature fields than in the winter.

The shaded strips in the diagram show the period in which average temperatures over

northern and southern India are the same in horizontal layers. In the transition months, therefore, the entropy field of dry (tropical) and moist (equatorial) air tend to be uniform and the respective isentropic surfaces become horizontal.

It is significant that the shaded strips, by being almost vertical between the 2-11 km levels, mark out the pre-monsoon and post-monsoon transitions on land areas. In a horizontal layer in the equatorial over sea areas, on the other hand, the entropy field may be assumed to be fairly uniform in the equatorial belt on either side of the equator.

A temperature lapse, generally of 8°C/km and above, prevails in the lowest layer of dry air. The equatorial air is convectively unstable and this instability persists throughout the year. Again, Table 2 shows that "forced subsidence" (almost vertical isentropics) of dry air occurs practically throughout the non-monsoon period in the field A family echelon running over India and Burma. These are the warm anticyclones (with "heat lows" at the base) and migrate northwards or southwards with the sun.

The annual variation of the thickness of the nearly adiabatic layer is set out in the following table. The top of this layer is called the "free subsidence threshold" because dry air in this layer may occasionally subside freely to the ground. It may be added that "forced subsidence" occurs when forced downward flow is large compared with free upward flow (free convection), caused by gravity, in air of variable density owing to surface heating and other causes.

In the transition period, the atmosphere in the generative shell⁶ in the Indian region has a highly rickety structure because both vertical and horizontal stratifications are destroyed. The slow dissolution of the transition fields under impulses, on the other hand, suggests that a dilatation axis in a horizontal plane must be acting as roller bearings between the dry and the moist wind systems.

The "outburst" or "onset" of the monsoon is thus an event which clearly marks that point of time when the entropy field over practically the whole of the Indian region, both land and sea, becomes uniform below the directive⁶ shell. Similar conditions obtain at the time of the "retreat" of the monsoon. These fluctuations are large scale isentropic flow patterns, mostly in horizontal sections, governed by the pulsating monsoon current across the equator.

Let two distant air masses be set in motion under balanced forces, or approach each other in such a manner as to allow time for the necessary adjustments of the pressure field over the region in question. As each current develops its own transitional air masses on the way, they can contact each other

only through the transitionals of each. When the motions of the parent streams are steady, the contrast of density in the adjacent transitional air masses is necessarily small.

A large scale development of transitional air masses might be checked if two distant air masses could be made to move with an acceleration. The nor'wester charts of Bengal show that new motions may arise in a wind field to which the old pressure gradient fails to adjust itself.

Table 2: Free subsidence threshold for dry air—average thickness of layers in km, with nearly dry adiabatic lapse rates from the surface upwards.

	Months											
	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Kilometres											
Agra	1.5	2.0	3.5	4.5	4.5	3.5	1.5	1.5	2.0	3.0	1.0	1.5
Poona-Hyderabad	2.5	3.0	4.0	4.0	4.5	3.0	1.0	2.0	2.0	2.0	2.0	2.0

Briefly speaking, a vortex street may be generalized into a row of "sources" by the side of a row "sinks". The consecutive negative and positive "discs" of a "complex street" may be ruptured causing a distortion of the street. Moreover, translation may bring the smaller "source" and "sink" vortices closer together, forming doublets.

A doublet gives rise to a vortex ring or loop in a plane, say, at right angles to the axis of a westerly street, for instance. It then drifts away eastwards from the axis. The isochrones (earlier thunderstorms in West than in East Bengal and up the rivers than in the delta) of the pure nor'wester squalls support this view.

Either the positive or the negative vortex in a street may develop translatory motion of its own when certain conditions are satisfied. For example, a cyclone between two streets of small wave lengths, while moving out of its initial setting between two streets, might come in close proximity to its source anticyclonic vortex. Similarly, a moving anticyclonic vortex may encounter its sink cyclonic vortex. The vortex loops may, therefore, develop also in sea areas. As a matter of fact, *seclusion* of "source" and "sink" (trough formation) may occur through translation.

The "col-activity" may be in evidence well ahead of nor'westers in the isobaric charts of 1 mb interval and also in the distribution of upper winds. The dissolution of a doublet may mean a tornado.

The horizontal gradient of density at the surface (NE to SW) on a few occasions of nor'westers may even be of the order of 200 gm/m³ per 1000 km, which is about three or four times the hypothetical density gradient (average) in the winter between Siberia and India.

The occasional development of the exceptionally high density gradients in the nor'wester fields is no doubt due to dynamical causes. The squall fields, however, are extremely unstable and do not last for

more than a few hours. An acceleration of two distant air masses approaching each other, thus fails to produce the density contrasts of the type that might be necessary to increase circulation with time in a cyclogenesis field.

In regard to the process of a gentle flow of extra-tropical towards the equatorial along an isentropic surface, a glance at the diagram would show that cold air from northwest India, flowing southwards along the isentropics, would lose, on the average, a height of 1 km in a distance of 1000 km. On individual occasions, however, the cold air may descend to lower levels over the South Bay, the home of the transition period and winter cyclones.

The descending cold air, however, fails to establish, even in the winter, "cold" and "warm" fronts at the sea level in the same sense as those of extratropical cyclones. The reason is undoubtedly the "forced subsidence" of cold air into "heat lows" in the equatorial belt. The cold air is thus transformed into the tropical. The process persists⁸ practically throughout the whole of the non-monsoon period. A cold air supply, flowing at the surface and directed to the South Bay from Burma side, is likewise problematic. A katabatic flow of cold air seldom reaches South Bay.

The conclusion, therefore, is that the slope between dry and moist air masses in a small enough

block of the Indian atmosphere, away from the *origin* of the surface of separation (such as neutral points) is thus either almost vertical or almost horizontal. The dilatation axes of a deformation field in three dimensions lie in the former and hence it will be referred to as the vertical "flat plate".

Table 1, along with the charts of density and pressure distributions at the surface, brings out the outstanding fact that slightly over 80 per cent. of the cyclones in the Indian seas form in fields of feeble rather than in those of strong pressure and density gradients.

For the local intensification of circulation, therefore, both dynamical and physical causes have to be explored. An echelon of circumscribed areas, joined to each other by "bottle-necks", comes into existence when two opposite streets of comparable wave lengths lie side by side with a phase difference of 180° .

It is observed from charts that one of the circumscribed areas in the echelon shows signs of a local growth of circulation with the strengthening of the "undisturbed" streams of the streets. Briefly speaking, the strengthening of the undisturbed stream is important from the point of view of the growth of net vorticity (of one sign) in the circumscribed area. The important discharges of vorticity in a circumscribed area are as follows:

- round a "col-oval" (produced by the belting of the two core-cylinders inside the circumscribed area in a medium of U_0) which ultimately forms the core of a simple vortex.
- the vortex layer at the end of the vertical "flat plate".
- the vortex layer that may eventually grow at the periphery of the "col-oval" or at the Rankine joint between a forced and a simple vortex.

Incidentally, in a street astride the equator, rotation of the vortices in the same row remains unchanged, but the associated pressure field is reversed as the equator is passed.

It is evident from the preceding paragraphs that in the method of forecasting by fields and streets, advection has to be traced in the xy plane to detect regions of possible convection along the z axis.

The steps in this method of forecasting may often be summarised in such working rules as "dilatation axis in humidity wave". It may be recalled that the *outflow* axis is in *convergent* channels and the *inflow* axis is in *divergent* channels between two streets. This particular rule is being successfully applied to the prediction of unseasonable fog formations and to the location of the thunderstorm areas in the monsoon, even without the necessary statistical background.

Moreover, the longitudinal contractions and expansions of the cyclic fields may often be correlated with the isentropic slopes.

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Karachi, 1-5-1944.

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A NEW SPECIES OF DISCOMYCETES FROM BENGAL, *MITRULAAGHARKARII* SP. NOV.

Mitrula (Latin *mitrula*, a small turban) is a genus of the Discomycetes having tiny fructifications with fleshy, erect, stipitate, sub-globose, ovate or clavate, glabrous, fertile heads, usually sharply delimited from the stipe and often slightly free from below. The spores are short, cylindrical, narrowly elliptical or fusiform and hyaline. It is included in the section *Hyalospora* of the sub-family Geoglosseae, family Helvelleae by Saccardo¹. Lloyd², following the older idea of basing the genera on the most obvious microscopic features placed the genus under the second division *Leotieae* of the family Geoglossaceae. Only two species of *Mitrula* have so far been reported from India.³ The new species closely resembles the



FIG. 1.

Indian species *Mitrula rosea* Lloyd but differs from it mainly in having salmon-orange⁴ coloured head which changes to orient-pink on drying, while in *Mitrula rosea* both stem and head are of a fine rose colour. Besides, the spores are much longer in the new species than in *Mitrula rosea*.

Two little fructifications of this species were first collected by the writer from the Senchal range (8000 ft.), Darjeeling in October 1931. One of the specimens was sent to late Dr E. A. Burt of Missouri Botanical Gardens for specific determination. In October, 1941, several specimens of this species were again collected during an excursion conducted in the Sikkim Himalayas by Prof. S. P. Agharkar. It was growing in a wet situation on bare soil along slopes by the road side between Rimick (7500 ft.) and Batasi (6884 ft.) via Palmajua (7250 ft.). The writer, therefore, takes the liberty of naming this species after Prof. Agharkar.

The detailed morphological description of the species is as follows:

Fructifications fleshy, erect, stipitate, about 6-12 mm. high. *Head* distinct from stipe, with prominent convolutions, sub-globose to somewhat compressed or flattened, glabrous, shiny, colour salmon-orange when fresh but becoming orient pink on drying several heads often remaining confluent, dimension about $3.5 \times 3.5 \times 5.7$ mm. *Stipe* slender, slightly compressed, with a few longitudinal furrows, colour orient pink when fresh, not changing on drying, about 4-8.5 mm. high and 2-3.5 mm. broad. *Ascus* elongate-clavate, hyaline dimension about $84-96-108 \mu \times 5-6-8 \mu$. *Ascospore* elongate-fusiform to sub-fusiform, often slightly curved, continuous, hyaline, smooth-walled, dimension about $8-12-16 \mu \times 3-3.5-4 \mu$. *Paraphysis* linear, hyaline, septate, slightly exceeding the asci.

Type specimen has been preserved in the herbarium of the University College of Science, Calcutta.

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AUXINS AS RESPIRATORY CATALYSTS OR CO-ENZYMES*

THE term auxin is used as a generic term for substances showing growth promotion in the avena test. Went (1928) for the first time isolated auxin from the plant, devised the avena test for the quantitative determination of auxins. The chemical isolation and structure determination of auxin was accomplished by Kögl *et al* in 1933. At first they

found two closely related substances which they named auxin *a* and *b*. Later (1934) they isolated a third substance having auxin activity which they identified as indole acetic acid. Since that time other compounds mostly synthetic, were found to promote elongation. These active substances are found to produce other physiological effects, *e.g.*, they cause cell proliferation, nuclear division, cambial activity, root promotion, prevention of formation of abscission layer, development of carpels and ovules, bud promotion and protoplasmic streaming etc. Such active substances are compounds of phenyle, indole, naphthalene, anthracene and fluorine. There are, however, some quantitative differences in the responses with the most active compounds of different groups. Indole acetic acid is one of the most active substances for causing cell elongation of the avena coleoptile but as a root inducing substance, it is not as active as naphthalene acetic acid or indole butyric acid. The latter is particularly low in activity for cell elongation of avena coleoptile. There is another group of physiologically active substances, studied chiefly by P. W. Zimmerman (1942) which modify the pattern of leaves and other organs, which, however, do not relate to the present communication.

Because auxin affects so many physiological processes besides cell elongation, it appeared to many investigators that the auxin must have a fundamental function in the life of the plant. This consideration led many investigators to look for an increase in respiration due to auxin. Thimann and Commoner¹ showed that coleoptiles previously soaked in malate produced marked increase in respiration upon addition of auxin. From this and from other evidences they concluded that the auxin must play the part of a catalyst or co-enzyme in the succinic-fumaric-malic-pyruvic acid respiration cycle (Szent Gyorgy cycle). According to Avery (1942) the increase in respiration reported by the investigators is very small and that better proof must be found before any generalisation on the effect of auxin on respiration can be made. The present communication contains results obtained by us on the influence of the nature of the substrate solution in which the cut end of a motile leaflet dips, on the respiration of *Desmodium gyrans*. It will be seen that when the substrate solution contains 0.05% of sodium malate to which 0.0005% of indole acetic acid is added, there is an increase of respiration by 50%.

It is well known that when the cut end of a motile leaflet of *Desmodium gyrans* is dipped in tap water, the leaflet is seen to exhibit pulsatory movements. Investigations carried out in the Institute during the last three years have shown (1) that energy of pulsation is due to the break down of carbohydrates formed in the leaflet by photosynthesis; (2) the pulsation could be maintained continuously in the dark for a

few days when the cut end of the leaflet is immersed in one per cent glucose solution. Recently we have been engaged in the study of the influence of different substrate solutions on the respiration and pulsations of the leaflet of *Desmodium gyrans*. The apparatus used is a modified form of respirometer, which enables the simultaneous recording of both the pulsation and respiration of the leaflet. Under favourable conditions both show periodicities of similar form. The problem at present under investigation is to find out at which stage in the dissimilation of glucose, is the energy supplied for the maintenance of pulsations. Besides glucose, we have used as substrate, solutions of glucose-1-phosphate, sodium salts of pyruvic, malic and citric acids. So far we have found that glucose solution is most suited for the continued maintenance of the pulsations. We next proceeded to find out whether any of the respiratory co-enzymes like nicotinic acid and thiamin when added to glucose influenced in any way the pulsatory and the respiratory activity of the motile leaflet. Thiamin is a co-enzyme for carboxylase enzyme responsible for the break down of pyruvic acid to acetaldehyde and CO₂, while the amide of nicotinic acid is a component of the two dehydrogenases coenzyme I and coenzyme II. In one per cent glucose a considerable increase of the respiration rate of the leaflet was observed, but no significant change in this rate was noted when different concentrations of nicotinic acid and of thiamin were added to the glucose solution. The last named results are of a preliminary nature only and require repetition before definite conclusions can be drawn. At this stage we came across a report of the investigations of Thimann and Commoner, on the increase of the re respiratory rate obtained in malate treated coleoptiles to which a dilute solution of an auxin was added. We decided to test the

validity of the observations of the previous authors, using leaflet of *Desmodium gyrans* as test object. The results obtained are given in Table I. Section A, contains the results obtained with glucose solution on the rates of respiration, frequency and amplitude of pulsation of motile leaflet of *Desmodium gyrans*. In every case the normal rate of activity of the same leaflet when the cut end is dipped in tap water is taken as 100. In the sections B, C and D, similar data are given when the cut ends of leaflets are placed in (i) 0.05% of sodium malate, (ii) 0.0005% indole acetic acid and (iii) a mixture of (i) and (ii) respectively.

Discussion of results—In a solution containing 1% glucose there is a considerable increase in the respiration rate, some indication of increase in the frequency of pulsation, but no change in the amplitude of pulsation.

With 0.05% sodium malate there appears to be a diminution in the rate of respiration, as well as of amplitude of pulsation. With 0.0005% indole acetic acid there is some increase in the rate of respiration and diminution in the amplitude of pulsation. When treated with a solution containing both the malate and auxin a 50% increase in the rate of respiration is observed, with a slight reduction in the frequency rate.

The rate of chemical change taking place in a tissue at a constant temperature depends on the concentrations of the substrate and the enzymes acting on it and of its break down products. The measure of chemical changes involved in the present case is the respiration rate. If it is found that on increasing the concentrations of the substance or any of its break down products the respiration rate increases, the indication is that the concentration of the enzymes is more than sufficient to deal with the substrates avail-

TABLE I

Section	Treatment	Change in respiration Ratio bet. normal rate and after treatment.	Change in pulsation	
			Frequency Ratio bet. normal fre- quency and frequency after treatment.	Amplitude Ratio bet. normal ampli- tude and amplitude after treatment.
A	Glucose 1%	100 : 293.6 ± 15.9	100 : 104.3 ± 4.2	100 : 100
B	Sodium malate 0.05%	100 : 91.29 ± 4.6	100 : 96.76 ± 3.04	100 : 84.5 ± 5.6
C	Indole acetic acid 0.0005%	100 : 113.86 ± 9.65	100 : 95.81 ± 2.1	100 : 85.8 ± 8.03
D	Sodium malate 0.05% Indole acetic acid 0.0005%	100 : 152.19 ± 10.03	100 : 92.05 ± 1.6	100 : 99 ± 8.8

able in the tissue. Similarly if an increase in respiration rate occurs when the concentration of a co-enzyme is increased, that particular substrate is present in the tissue in more than sufficient quantity. From the results given in table I it appears (i) the enzymes with their co-enzymes responsible for the dissimilation of glucose in *Desmodium gyrans* leaflets are present in sufficient concentrations to deal with additional quantities of glucose. *Desmodium gyrans* appears to be auxo-autotropic so far as the respiratory enzymes are concerned. (ii) Indole acetic acid is a respiratory co-enzyme or catalyst for some substrate present in the leaflet of *Desmodium gyrans*, which appears to be a malate. It is not certain that the auxin is a catalyst in the Szent Gyorgy respiratory cycle, in which there is only a transfer of hydrogen from the substrate to oxygen without evolution of CO₂. Probably the auxin acts as a catalyst in an alternative cycle, e.g., like the one suggested by Krebs, in which evolution of CO₂ takes place.

Details of the apparatus used and of further results of the investigation will be published in the *Transactions* of the Bose Research Institute.

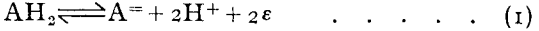
D. M. BOSE
B. K. DUTT
A. GUHA THAKURTA

Bose Research Institute,
Calcutta, 15-11-1944.

* Summaries of all the papers cited in the above communication including the one of Thimann and Commoner, (*Jr. Gen. Physiol.*, 24, 279, 1941) which was not available to us, are contained in the valuable reports contributed by Avery, Van Overbeek and Zimmerman to the Cold Spring Harbour Symposia (1942) "On the relation of hormones to development".

THE OXIDATION REDUCTION POTENTIAL AND CATAPHORETIC VELOCITY

FOR a system of a reversible reaction of the type



for the oxidation-reduction potential to be the same in different solutions of A⁺ at different pH values, the activity of the electrons a_e, and k must be the same,

$$K = \frac{A^+ H^2 + e^2}{AH_2} = k a_e^2$$

K in (2) and therefore E_{redox} is constant, since k, the dissociation constant of AH₂ and a_e are the same in different A solutions at different pH values.

Since the redox-potentials of the colloidal particles in contact with A⁺ solution, which have oxidation reduction potentials are the same as the redox-potential of A⁺ solutions at the same pH value and at the equilibrium concentration of A⁺ solutions, the adsorption and desorption of the A⁺ ions must be the same and cataphoretic velocities of the colloidal particles must be the same.

From the theory developed above it follows that in presence of different concentrations of electrolytes at different pH values, provided the electron ion activity, i.e., E_{redox} and k the dissociation constant of the electrolyte remain constant, the absolute values of the cataphoretic velocities should be the same assuming that the cataphoretic velocity depends on E_{redox} alone.

Ghosh and Basak's¹ results show that the absolute values of the cataphoretic velocities are close to one another when dissociation constants k of the dyes 'AH₂' and the electron ion activities, i.e., the redox potentials are close to one another.

S. G. CHAUDHURY

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92, Upper Circular Road,
Calcutta, 7-12-1944.

¹ Ghosh and Basak, *J. Ind. Chem. Soc.*, 17, 721, 1940.

“Give Science a Chance”

Sir Shanti Swarup Bhatnagar's General Presidential Address at the Indian Science Congress, Nagpur

INTRODUCTION

I am deeply grateful to the Indian Science Congress Association for the great honour they have conferred upon me by electing me as their President for this year. I had considerable diffidence in accepting this high distinction, particularly as after my election I received an invitation from His Majesty's Government to visit Great Britain, and I was not certain whether I could return from this trip and a subsequent visit to the U. S. A. in time to be able to preside over the annual general meeting in Nagpur in January 1945. I was, however, assured by the Government of India in April last that I would be able to return in good time to preside over the session of the Indian Science Congress, and that I should not refuse an honour which is offered only once in one's lifetime. My colleagues who have been visiting England and the U. S. A. with me advised me to send the Presidential Address in good time, so that it could be read on my behalf by some one else in case I was unable to reach India in time to preside over the meeting on the 2nd January 1945, and they strongly dissuaded me from resigning the Presidency. Several happenings, however, particularly the events connected with D-day and the advent of flying bombs and rockets, unfortunately so much delayed our visit to England that it now seems almost certain that I shall not be able to be present with you in body at the time of the general meeting. I shall, however, be present in spirit and I hope under the able management of the local secretaries at Nagpur and the secretaries of the Indian Science Congress Association the session will be celebrated with the usual dignity and keen interest. I am fully aware of the deep interest which His Excellency the Governor of your province has taken in making this session a great success. It is a great disappointment to me that I am unable to take advantage of His Excellency's gracious offer of hospitality during the session.

Before I begin my address I must refer to the sad loss which our country and the world of science has suffered by the passing away of our great Acharya Sir Prafulla Chandra Ray. He was President of the session when the Indian Science Congress first met at Nagpur in 1918. Men of his type are not born

every day and our motherland will not easily recover from the shock caused by the death of a son so highly distinguished for his scientific achievements and patriotic services in many fields.

VISIT OF PROFESSOR A. V. HILL

Perhaps the most outstanding event in the scientific life of India during the past year was the visit which Professor A. V. Hill, Nobel Laureate and Secretary of the Royal Society of London, paid to us at the request of the Government of India. The invitation to Professor Hill has been generally taken as an indication of the interest the Government of India is taking in securing the aid of science in problems of national development to which they are committed during the post-war period. It was largely owing to the insistence of the Council of Scientific and Industrial Research that more financial aid should be given to science, that such an invitation could be conceived even during the war. One must not forget, however, the part played by *SCIENCE AND CULTURE* which under the able editorship of our distinguished physicist, Professor M. N. Saha, always criticized the Government for lack of interest in matters scientific and for scanty provision of funds.

Several officials in the Government and the public outside thought they detected in this criticism motives of jealousy, as there is no doubt that the Council of Scientific and Industrial Research had achieved important results in spite of inadequate financial assistance from the Government and industries, and deserved the fullest support from all friends of science and industry. Nothing could be further from the truth than this suspicion. No more ardent supporter of science, and of national development through it, exists in India than Professor Saha and I take this opportunity of acknowledging the help I have always received from him in my lonely fights for better recognition of science in my country. Every form of unofficial support, on which alone one can finally depend for a democratic realization of the role of science in nation-building, always came unhesitatingly from him and his colleagues.

It is a happy augury that the report made by Professor A. V. Hill had an unusually short incubation period. Following his recommendations the

Government of India have already created a Department of Planning and Development and the Council of Scientific and Industrial Research has been transferred to this portfolio. Other research activities under the Government are likely to follow suit. I am sure the scientists assembled here have special reason to be happy in the fact that the choice of the Viceroy for the care of this new portfolio has fallen upon Sir Ardeshir Dalal who has been a past-president of the Indian Science Congress and who commands the confidence and respect of the scientists as well as of the business community of India. It is hoped that other far-reaching recommendations of Professor A. V. Hill will also be accepted by the Government of India. There is no better method of raising the standard of science and scientists in this country than that so ably developed and skilfully described in his address before the last session of the Indian Science Congress.

INDIAN SCIENTIFIC MISSION TO U. K., U. S. A. AND CANADA

Another direct outcome of Professor A. V. Hill's visit to India has been that a mission of scientific workers from our country has been touring the U. K. and has arranged to go over to the U. S. A. and Canada, to observe the scientific, industrial and agricultural developments which have come about in these countries during the war and then to make recommendations and suggest plans for a further interchange of information and knowledge for mutual help and co-operation. India has been cut off intellectually for more than five years from the rest of the world and that in itself is a disaster the magnitude of which is directly proportional to the vast strides science and research have made in the U. K. and North America.

My present visit to England has been the greatest eye-opener to me and I have now seen with my own eyes the high levels to which scientific invention and ingenuity have risen during the war. Not only has science helped in developing weapons and instruments which are essential for success in a mechanical warfare, but it has aided industry and agriculture in supplying the basic needs of humanity during a period of great difficulty. The results both in military and human terms have been most encouraging. The large-scale application of radio-location, the jet propelled planes, the numerous types of jettison tanks and unbreakable containers, the automatic weapons of offence and defence and scores of new alloys and novel metallurgical processes have had far-reaching consequences on the course of the war. The technique of operational research, the use of scientific methods of determining tactics and developing a national food policy, the discovery of peni-

cillin and D. D. T., all these have contributed much to the realization by the common man and the Government that organized science is one of the most important factors in national development. It is a tragedy that a ruthless war and almost universal bloodshed should be necessary for this new awakening, for it should have been obvious without it that science can play and must play an essential part for human advancement. In fact, unless opportunities are provided for science to explore these possibilities for human betterment, a better world cannot be created.

There is no doubt that England is sparing no effort to approach the Peace much better informed and equipped than after the last war and the signs of this new awakening are visible in the universities, the Government departments, in industry, the agricultural and medical institutions and in every other walk of life.

As representatives of Indian science, we have been welcome everywhere. The Government, the Royal Society and other learned societies, the universities, the Department of Scientific and Industrial Research and the Research Associations and the National Institutions associated with it, the agricultural and medical institutions, the clubs, the British Council and the industries and trades, the social and political organizations, the public schools and important private individuals have vied with one another to have us for teas, for luncheons and dinners and for speeches for which we have become notorious all over the country! Everyone seems to regard our visit as a prelude to better understanding and trade relationships between our respective countries and as a gesture of friendship from the British Government, British science and British industry to India. Even Ireland has not insisted upon isolation and strict neutrality and I had a most pressing invitation to address the University of Dublin on Scientific and Industrial Research in India, and this invitation was extended to my opposite number in the U. K., Sir Edward Appleton, as I pleaded that I was tied up with engagements with him and could not visit Ireland unless he also came with me. An important member of His Majesty's Government's Hospitality department told the Assistant Secretary of the Royal Society that even Kings visiting England did not receive such a warm welcome as the Indian scientists have received! All this is an indication of the keen interest people in England are taking in science and research.

SCIENCE IN THE BRITISH UNIVERSITIES

We found most universities denuded of their ablest workers. They were nearly all engaged in important war work and visited their departments

only occasionally. They were busy with meetings and committees and in special scientific work related to the war-effort: but all the same they are all devoting their attention to the future of science in British universities. The Association of Scientific Workers has submitted a memorandum to the University Grant Committee of the Treasury suggesting what reforms in teaching and research should be taken in hand immediately after the war and better provision for science should be made in the universities. Their report ends with the following strong plea:

'We reiterate, then, our plea for the utmost vision and flexibility in budgetting for the development of science in the universities. Where the flowering of intellect is concerned, any accurate prediction is impossible. We are convinced, however, that peace can see at least as rapid a growth in all fields of science as war has brought about in some special applications. The only proper attitude for an enlightened community is to make available the financial and material resources appropriate to each stage of development. We are far from being in sight of either the limits of science or the end of our reserves of intelligence. Bold and flexible thinking is therefore the prime necessity in framing post-war policy for the universities.'

Out of the many important recommendations made by the Association of Scientific Workers for the expansion of scientific activities in the universities, the following are quoted so that the Indian universities may take a lesson from what is now the train of thought in Great Britain:

- (1) Schools of fundamental research must be fostered in the universities, expansion proceeding as fast as talent appears.
- (2) All graduates with an aptitude for research should be offered full maintenance while working for a higher degree.
- (3) Research fellowships should be provided for those who have taken a doctorate degree.
- (4) When men are appointed mainly to do research they should have to have the same status and salary as those appointed mainly for teaching.
- (5) Research committees should be set up in every university to watch over the development of research, especially in borderline subjects, and prepare an annual research budget.
- (6) The education and training of laboratory technicians should be given immediate attention. Courses should be planned for general education and technical training.
- (7) The wages of technicians must be revised upwards forthwith if the universities are to attract the right type of personnel.
- (8) Centralized technical services and supplies for research should be established in each university. These should include facilities such as a typewriting pool and a statistical service.
- (9) Departments of applied science should be brought into being, as they are bound to play an important part in the university.
- (10) Industrial development work should be carried out in Research Association laboratories: but where these Research Associations do not exist the university laboratories may be employed.

(11) Academic scientists should be allowed to act as consultants or advisory directors of research to research associations and should be given leave to spend long vacations in industrial laboratories.

(12) Properly supervised research in selected Research Associations and Government laboratories should be allowed as part of or a full qualification for a higher degree.

Some of these recommendations involve capital cost and the memorandum referred to above estimates this to be not less than £30 million over a period of ten to twenty years. The actual expenditure of the universities would rise to £15 million per annum with five years and to £20 million over ten years at 1939 values. It has been suggested that most of this money will come from the State. Further, it has been strongly recommended that the Treasury Grant to the Universities should be doubled in the first academic year after the war and increased to quadruple, that is to £9 million, in the fifth year.

The future of science in the British universities would thus be assured. This must serve as an incentive to our Vice-Chancellors who should ask the nation and Government for more grants for technical education and development of sciences in the Indian Universities. I have been told that at least in two Universities in India, scientific research is now positively discouraged and (in the name of economy) admission to research students, in spite of the willingness of the professors concerned, is almost completely prohibited. I take this opportunity of drawing the attention of those who love their country and wish it well to see that the field of university education is kept as free from narrow communalism and politics as possible. Since politics has begun to play a part in the selection and election of Vice-Chancellors, the University standards in India have tended to deteriorate instead of showing an improvement and if these evils are not looked into by the Chancellors and the Courts of the Indian Universities, these institutions will cease to be real seats of learning and will turn into arenas for political ambitions.

SCIENCE IN BRITISH INDUSTRY

British industry in the past relied too much on tradition. It is now realised that the prosperity of Britain after the war will depend as never before upon the efficiency and progressiveness of her industries. Happily, for it is a most healthy indication of things to come, industrial and scientific research, is on almost everyone's lips now-a-days and it is certain that this will be one of the major features in post-war industry. In certain industries, such as the chemical industry, the application of science and research has reached such high levels already that even the Department of Scientific and Industrial

Research has not considered it an imperative necessity on their part to equip and maintain their Chemical Research Laboratory to the same level of efficiency as their National Physical Laboratory. They maintain that the Imperial Chemical Industries conduct research on such a large and liberal scale that the Government Laboratories need not compete with them. The Directors of the Company are progressive in their views on scientific development and at a luncheon which the I. C. I. gave to the Indian scientists at Claridges, Lord McGowan, the Chairman, reported that the Directors of the Company had offered to provide at nine Universities of Great Britain, eighty fellowships of the average value of £600 per annum to be held by senior workers in certain sciences. The research organisation of the Company itself consists of nearly nine hundred fully qualified chemists, physicists, biologists, engineers and other scientific men and more than a thousand skilled assistants. During 1943 its expenditure on research and development in its own work was approximately £2,200,000; and in addition, £12,500,000 became due from the Company to the British and Overseas Governments under the heading of Excess Profits Tax, National Defence Contribution and income-tax. We had the good fortune to see their vast factories and research organisations at Billingham, Blackly and Huddersfield, and our distinguished industrialists who are visiting England should go and see these signs of research-mindedness of the British industries.

When I replied to the toast proposed by Lord McGowan at the luncheon, I spoke of the I. C. I.'s partiality to their own country. They had at least two big factories in India and I pleaded for grants on a generous scale for scholarships for scientific research in India by the I. C. I. I urged that no feast given to the Indian Brahmins is complete without a gift, and that all scientists are Brahmins by profession. The plea went home to Lord McGowan and he promised to consider in a friendly way the question of endowing research fellowships in Indian Universities. He also assured us that the eighty fellowships in the British Universities were open to Indian scientists in free competition.

Besides the I. C. I., there are other industries in Britain which have large research departments, and we were particularly impressed by the efforts which had been made by such firms as Metropolitan Vickers at Trafford Park, Manchester, by the General Electric Company at Wembley, by Burroughs Wellcome, by Brown Firth & Co., by the B. T. H. at Rugby and by the Anglo-Iranian and Shell group organisation. In addition to the many private investigations carried out by individual firms, the interests of research by industry are safe-guarded by investigations carried out in twenty-four Industrial Research Associations, which are maintained jointly by

Industry and the Department of Scientific and Industrial Research.

We are aware of even more outstanding organisations of this kind in the U. S. A. and Canada and look forward with eagerness to visiting the Bell Telephone Laboratories in New York in which the American Telegraph and Telephone Company employ over 4,000 scientific workers and technical men. The General Electric Company at Schenectady, N. Y., the Eastman Kodak Company at Rochester, N. Y., the Mellon Research Institute, Pittsburgh, and the various Petroleum Companies in the U. S. A. have fully equipped laboratories which work day and night on problems of fundamental and applied interests.

If Indian industry has to rise, and rise it must to its proper stature in time, it must begin to devote more attention to expenditure on research. There is hardly any industrial organisation in India except Tatas which provides even reasonable facilities for scientific and industrial research. Lately Mr G. D. Birla and Sir Shri Ram have shown some interest in scientific research, but much has yet to be done by science to save the existing industries in India from extinction by outside competition after the war.

The newly started industrial units of India should join together and form Industrial Research Associations and the Council of Scientific and Industrial Research and the Government should subsidise the organisations so that they may blossom forth into hopeful industries of the future India.

Now that expenditure on research, both capital and recurring, is likely to be free from the Excess Profits Tax, Indian industry should give a real impetus to science. Nothing will help industry and science more than if our firms in India become research-minded. Even before my visit to England I strongly advocated the formation of Research Associations in India and I am glad to hear that the chemical and pharmaceutical industries of India are about to give a lead in this matter and have apprised the Council of Scientific and Industrial Research of their intention to form a research association. After seeing the work of Research Association Laboratories here, I have become convinced that we must work hard to get our small and big industries in India research-minded so they may gain knowledge and strength to produce goods of the best quality and performance.

INDUSTRIALIZATION OF INDIA ESSENTIAL FOR WORLD PROGRESS

Perhaps the most important factor which will have world wide implications will be our attempt to raise the standard of living in India. Politics does play an important part in all events. It is obvious that the best and quickest way of bringing about

national development is for India to have a National Government representative of the people. The present absence, however, of such a Government does not justify that the thinking men and women of India should not devise ways and means of bettering the lot of their fellow-beings to the best of their ability under present circumstances and in view of the future. I am not convinced that the rich and the wise in the land have done all they can for agricultural and industrial development of India.

It has been urged by some that the problem of India is largely biological, that health, food and population are our real bottle necks. Those who know India intimately are fully aware of the facts that attention to agriculture alone cannot solve the problem of India's poverty. Biology must be helped by physics, chemistry and engineering, even by mathematics. India cannot be healthy, prosperous and self-respecting, and education, medicine and agriculture cannot play their impotent role, unless a good bit of India's population is devoted to pursuits other than agricultural.

In a previous paper I have described the orders of priority for some of the industries essential to India's development. In that paper the first place was given by me to the development of power and there seems to be now a general consensus of opinion that India must develop her hydro-electric and other power resources as her coal resources are already severely strained. This project will have to be largely financed by the State, as it is far too big for any private enterprise in India. The State will also have to help big basic industries and heavy engineering. We should, by all methods of persuasion and even threats, appeal to the existing industries in India to develop the bye-products industries associated with them. For example, the great jute industry in India should take immediate steps to manufacture such things as jute-boards, Brattice cloth, jute felt from jute waste, jute containers, and jute cloth for wearing purposes. The State and the public should insist upon these industries being developed by the jute industry itself. Similarly it should be the duty of the sugar industry that their bye-products such as molasses and bagasse should not be used wastefully as at present. Power alcohol, furfural and its derivatives, acetic acid and all sorts of plastics and solvents can be made from these bye-products and these should occupy the immediate attention of the promoters of our sugar industry. They have sufficient money to invest in these ventures which may not start paying dividends all at once, but they will eventually be all very worth-while in national planning and development. If I would not be misunderstood, I would make a suggestion to those European and Indian friends who are interested in the industrialization of India not to fight for less or more to either side, but

to come to terms honourable for both and do something to help Indian industry. It is obvious that European friends in India will have to yield to the natural aspirations of India, namely, that industry in India should be largely managed by Indians themselves. Indian businessmen should see that co-operation with the allied powers is the quickest method of developing India. The energy spent in fighting may be better spent in co-operative development. If the bye-product industries of coal-distillation, the petroleum industry, the textile industry, the woollen, cotton, sugar and jute industries and the metallurgical and chemical industries are developed, the country will have a different complexion altogether and a co-ordinated programme of development in all directions will become a possibility. This plea I am entitled to make as President of the Indian Science Congress, as I am convinced that science has no future in India unless its agriculture and its industries are fully developed: more food and more health are dependent upon these factors. Scientific and industrial research thrives best when it is applied to material benefit to human kind and to existing industries and existing agricultural enterprise.

LEGISLATION AND SCIENTIFIC AND TECHNICAL PROGRESS

We were invited to a luncheon at the House of Commons by Captain L. Plugge, M.P., and were later invited to a meeting by an influential unofficial organisation known as the Parliamentary and Scientific Committee. This body consists of a large number of members of both Houses of the British Parliament, together with representatives of many important scientific and technical institutions and societies. It has no official authority but it commands great influence. Its President, Lord Samuel met us at lunch and its Chairman, Mr E. W. Salt, M.P., presided over the meeting which we attended. It was a great gathering: Professor A. V. Hill himself, as M.P., introduced the members of the Indian Scientific Mission one by one and each one of us made a short speech on our special subjects. We were subjected to numerous questions of a searching nature and the Chairman assured us that, through their influence in Parliament, they will advocate the cause of scientific and industrial research and development in India. It is my considered opinion that the members of the Council of State and Assembly in India could well form such an organisation as the Parliamentary and Scientific Committee. This would keep them in touch with all the problems of modern interest such as technology, science, agriculture, food and health. They could help by talking over matters with Honourable Members privately or by asking questions on the floors of the two Houses. Such an

organization would enable our legislators to take an intelligent interest in the terrific task of reconstruction which faces our country. This would also lead them to appreciate the special rôle of scientific men in modern society.

TRAINING OF PERSONNEL

As a result of our visit it may be possible to persuade the Government to have scientific liaison officers in Washington and London, and possibly Moscow, so that the Indian scientists and the Indian Government departments may be in touch with the rapid strides which science and technology are making in these countries. These offices will have to be staffed by scientific men of some standing in India. It is also likely that we may be able to get admission for a large number of scholars and technicians from India both in the Universities and industries. We found many Universities eager to have good students for post-graduate studies. Lord Eustace Percy was particularly anxious that good-class Indian students should take advantage of medical and dental studies in their well-equipped faculty of medicine at Newcastle. Similar assurances were given to us by the authorities of Cambridge, Oxford, London, Sheffield, Leeds, Glasgow and Manchester Universities. There will be a great paucity of space immediately after the war in these places of learning, but they hope to have a great deal more space later on. We should increase the availability of technical talent in India by sending our young and brilliant students to England and America. India needs not only scientific researchers but also technicians—persons of the foreman type who can help in the running and repairs of machinery so essential for industrialisation. Such firms as the Imperial Chemical Industries, Metropolitan Vickers and the non-ferrous metal industries in England are quite willing to train young men from India and even pay them as apprentices: we need a very large number of men with these qualifications, and we shall have to look for such training in Canada and the U. S. A. as well.

FACTORY AND FARM

In England great emphasis is being laid on equalising the standard of life in the cities and the villages. Agriculture still retains in England too much of its primitive character. Modern methods of application of energy on the farms, conditioned transport and proper storage of agricultural produce are still in their infancy. Canada and the United States are ahead

in this field and the tractor, the motor vehicle and electric power have contributed a great deal in those countries for a better standard of life on the farm. On a value basis at present about 88% of the world's agricultural produce is used as food, 8% as textiles and 4% for other industrial purposes. The last two together form roughly one-third of the raw materials of industry. There is an increasing tendency to look to agriculture for a larger proportion of these raw materials, but these materials can only be used profitably if the factory becomes an adjunct of the farm. Industry is moving towards that ideal particularly in the U. S. A., and this may be a lesson which we in India may learn in our planning for the future. We are so primitive in our farming that this would be an idle dream unless we first improved our transport and communications and provided better methods of storage and marketing, power-driven machinery and the use of proved fertilisers.

After studying the great strides which science has made in England, we are expecting to visit the U. S. A. and Canada. As a young boy, my classmates used to tease me for being a day-dreamer. I used to think of great things which science could do for India and the part I, myself, should play in it with the rest of my friends. The improbabilities of my dreams coming true used to be the principal subject of jokes when I was a student. If I had not possessed a sense of humour and had taken those jests seriously I should have been a physical wreck. But, God be thanked, I have survived to see some of my dreams fulfilled. Failures have been many and successes rather few, but with an inborn optimism and faith in my country's future I pursue on. We shall now go from Billingham, Leeds, Sheffield, Coventry, Lancashire, from the Royal Society of London and from our beloved Hill and Dale to the land of Niagra Falls, the Boulder Dam and the Tennessee Valley. The tale of the Tennessee Valley is the romance of a wandering and inconstant river, now become a chain of charming and lovely lakes which have contributed much to the enjoyment of life of the people, on which move, without any dangers of accidents, barges of commerce which nourish American industries. It is a fairly story of wild waters controlled by human ingenuity creating electrical energy which has been America's Alladin's lamp.

I dream of the Tennessee Valley, but not without hope: for all this may happen to any river valley in India, to the Damodar, to the Ganges, to the Sutlej, to the Nurbadda, to the Sone, if the people and the Government just give science a chance.

SHORT LIFE SKETCHES OF THE General President and Sectional Presidents

SHANTI SWARUP BHATNAGAR

General President

Born at Bhera (Shahpur) in 1895, Sir Shanti Swarup Bhatnagar had his early education at Dayal Singh High School and Forman Christian College, Lahore. He took his



M.Sc. degree of the Punjab University in 1919 and proceeded to England as Dayal Singh Scholar to work in the laboratories of Prof. E. G. Donnan, F.R.S., of the University College, London. He carried on important investigations in the field of Colloid Chemistry, which brought him early distinction in the shape of a personal grant of £250 by the Privy Council,

Department of Scientific and Industrial Research. In 1921, he was awarded the D.Sc. degree of the London University in recognition of his work on emulsions and emulsification. He worked for sometime at the Kaiser Wilhelm Institute in Berlin and at the Sorbonne in Paris.

On his return to India, Dr Bhatnagar was appointed Professor of Chemistry at the Benares Hindu University. In response to the invitation extended to him by the Punjab University, he became the University Professor of Physical Chemistry and the first Director of the newly created University Chemical Laboratories. Here he carried out a series of important investigations on magneto-chemistry and designed the Bhatnagar-Mathur magnetic balance, which soon earned him wide recognition.

Dr Bhatnagar's investigations in connection with the coagulation of mud at the request of the Attock Oil Company which was then faced with great difficulty in drilling operations deserve more than a

passing notice. His successful researches resulting in the solution of those difficulties led Messrs. Steel Bros. & Co., to inaugurate a scheme of research on petroleum technology, under the auspices of the Punjab University, at a cost of Rs. 1½ lakhs for five years, which was later extended to ten years at a cost of Rs. 4 lakhs.

Dr Bhatnagar became the first Director of the Board of Scientific and Industrial Research, created in 1940 by the Government of India to promote industrial research in this country. With the establishment of the Council, he became the Technical Adviser of the Council and Director of Scientific and Industrial Research. The great progress this Government organization on industrial research has made during the last four years is largely due to his untiring energy and superb organizing abilities.

Professor Bhatnagar was honoured with the title of O.B.E. in 1936 and knighted in 1941. He was elected to the Fellowship of the Royal Society, London in 1943, a singular honour accruing for the first time to an Indian chemist. He is a Fellow of several universities and scientific societies. He has held the position of the President of the Indian Chemical Society, has presided over the deliberations of the Chemistry section of the Indian Science Congress on two occasions, the last one being at the Jubilee Session, and has recently been nominated an Honorary Member of the Society of Chemical Industry, a rare distinction conferred so far on only eleven scientists of the world. He is an Honorary Professor of Chemistry at the Benares Hindu University and the Universities of Punjab and Delhi. He is the author of "Principles and Application of Magneto-chemistry", which is the first book on the subject in English, and has been highly appreciated.

B. N. PRASAD

President, Section of Mathematics and Statistics

Born in 1899 in the district of Azamgarh (U. P.), Dr Badri Nath Prasad received his education in the Patna College and the Benares Hindu University. After a brilliant school and college career culminating in a first class first M.Sc. in Mathematics in

1921 from the Benares Hindu University, he worked there as a research scholar for a year with the late



Professor Ganesh Prasad and was subsequently appointed in 1922 as Assistant Professor of Mathematics. Since July, 1924, he has been on the staff of the Mathematics Department in the Allahabad University.

In 1929 he proceeded to Europe where he remained for three years. He obtained the Ph.D. degree from the University of Liverpool and State D.Sc. (*Tres honor-*

able) from the University of Paris. He studied mainly with Professor E. T. Whittaker of Edinburgh, Prof. E. C. Titchmarsh of Oxford, then at Liverpool, Profs. Denjoy, Borel and Goursat at Sorbonne and Profs. Lebesgue and Hadamard of College de France. During his stay in Europe he visited most of the important centres of mathematical researches in Great Britain, France, Germany and Italy. He was invited to read papers before the London Mathematical Society, Edinburgh Mathematical Society, Societe Mathematique de France and Mon Hadamard's Seminar at College de France. Professor Borel's remarks about the superior quality of Dr Prasad's researches are couched in highly appreciative terms ("Le Temps", Paris, June 5, 1932, p. 6).

Dr Prasad's researches lie in the domain of Pure Mathematics comprising in particular, theory of Functions of a Real and Complex Variable, theory of Fourier Series, Summability of Infinite Series, Non-differentiable functions, Fourier Integrals and theory of Conjugate Fourier series and allied topics. His long memoir on the Conjugate Fourier series (*Journal de Mathematique*, 9, pp. 153-205, 1932) has attracted considerable attention. Dr Prasad's pioneer work on Absolute Summability (A) of trigonometric series has opened a fertile field of research inasmuch as it has at once given rise to a number of papers on this subject which have been published by numerous workers in various countries. His papers have been reviewed in scientific journals in appreciative terms, and some of his results have been already incorporated in the well-known treatises on

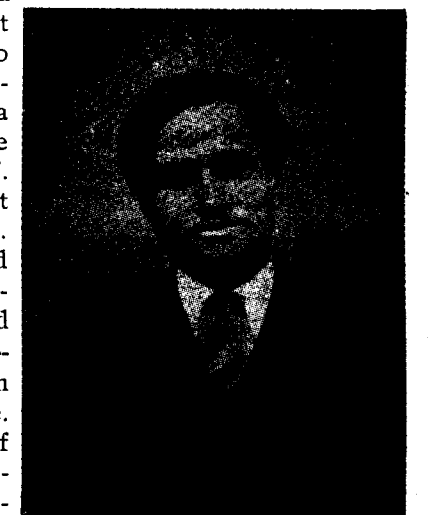
"Trigonometrical Series" by Zygmund and "Theory of Fourier Integrals" by Titchmarsh. Working under his guidance a number of research students have also published papers. Recently Dr Prasad has published a text-book on "Hydrostatics" for the use of B.A. and B.Sc. students of the Indian Universities.

Dr Prasad is a Fellow of the National Institute of Sciences of India and of the National Academy of Sciences, and a member of the London Mathematical Society, Societe Mathematique de France, Indian Mathematical Society and Benares Mathematical Society. He is connected with most of the Indian Universities in some capacity or other. At several University centres he has delivered lectures both on higher Mathematics and on popular subjects. Dr Prasad takes keen interest in University affairs inasmuch as he is a member of the Court, Academic Council, Faculty of Science and Board of Studies in Mathematics in the Allahabad University and of the Executive Council, Court, Senate etc. of the Benares Hindu University.

R. C. MAJUMDAR

President, Section of Physics

Dr R. C. Majumdar was a student of the Calcutta University and having obtained the Premchand Roychand Scholarship he went to Germany in 1930 as Carl Zeiss Fellow of the Jena University. He worked with Prof. A. Sommerfeld at Munich, Prof. H. Vogt at Jena and Prof. W. Heisenberg at Leipzig and received the Doctorate degree with Summa Cum Laude.



In recognition of his works Dr Majumdar was awarded Sir Rashbehari Ghosh Travelling Fellowship for two consecutive years by the Calcutta University, which enabled him to visit and work at different Universities of Europe, particularly at the Cavendish Laboratory at Cambridge and Institute of Theoretical Physics of Niels Bohr at Copenhagen. During his stay in Europe Dr Majumdar made important contributions to statistical mechanics and astrophysics. An account of his work on relativistic statistical mechanics has been given in the book "On the Introduction to Stellar

Structure" written by Prof. S. Chandrasekhar. Dr Majumdar has recently joined the Physics Department of the Delhi University.

K. VENKATARAMAN

President, Section of Chemistry

Born on June 7, 1901, Dr Venkataraman was educated in the Presidency College, Madras and received his Master's degree in Chemistry from that University. He carried out further studies and research in the University of Manchester and received its M.Sc. Tech., Ph.D. and D.Sc. degrees. He worked under the distinguished chemist Sir Robert Robinson on problems of Organic Chemistry. He has published about 100 papers on flavones, netting agents, synthetic dyes, oxycellulose and hydrocellulose antiseptics and anthelmintics, etc. in the journals of a number of learned societies, foreign and Indian. He was Professor of Organic Chemistry, Forman Christian College, Lahore (1929-34), and reader in the Department of Chemical Technology, University of Bombay (1935-38). In 1938, he became the Mody Professor of Chemical Technology and Director of the Department of Chemical Technology in which capacity he has since then serving the University of Bombay. He became F.I.C. in 1932 and A.M.I. Chem. E. in 1939.

N. N. CHATTERJEE

President, Section of Geology and Geography

Mr N. N. Chatterjee, in his early days, was educated in the Dhubri Government High School, Assam, and subsequently in the St. Xavier's College and in the Presidency College, Calcutta. He obtained his M.Sc. degree in 1922 from the Presidency College, Calcutta having been placed first in the first class and was awarded the University Gold Medal. He had training in coal mining for some period and in 1926 he joined the Post-Graduate Department, Calcutta University as a Lecturer in Geo-

logy and since then he has been working in that capacity. He has an intimate knowledge of the coal deposits of various places of India and has also gathered experience in several important economic mineral deposits of this country by frequent visits to those places. Mr Chatterjee has been doing research work on various topics of coal and petrology as a result of which a good number of original research papers has been published.

Mr Chatterjee has also been working as one of the Joint Honorary Secretaries of the Geological, Mining and Metallurgical Society of India.

G. P. MAJUMDAR

President, Section of Botany

Born in 1894 Professor Girija Prasanna Majumdar was educated in Calcutta. He joined the Presidency College, Calcutta in 1914, and as a part-time lecturer of the University of Calcutta in 1922. He worked under Prof. Priestley of the University of Leeds, England, and has specialized in the study of the Developmental Anatomy of Plants. Dr Majumdar is a Griffith Prize holder of the Calcutta University and is the author of "Botany in Ancient India". He has edited and translated the "Upavana Vinoda",—an ancient text of Arboriculture in India, and has also published a book on "Some Aspects of Indian Civilization in Plant Perspective". He is writing a volume on the "History of Botany in India" for the *Chronica Botanica*, Massachusetts, U. S. A. Many of his original contributions to pure botany have been published in British and Indian Journals.

Dr Majumdar is a fellow of the National Institute of Sciences of India and also of the Academy of Sciences in India. He is the Secretary of the Indian Botanical Society and also its Treasurer.



A. AIYAPPAN

President, Section of Anthropology and Archaeology

Dr Aiyappan was educated at the Presidency College, Madras and in the London School of Economics



where he studied under the late Prof. B. Malinowski and Prof. Raymond Firth. In 1929 he was appointed Curator for Anthropology and Prehistoric Archaeology in the Madras Government Museum and was promoted to be the Superintendent of the institution in 1940. He attended the International Congress of Anthropology in London

in 1934 and was nominated as one of the two national secretaries for India of the Copenhagen session of the Congress. Among his publications are *Social and Physical Anthropology of the Nayadis of Malabar*, *Iravas and Culture Change*, *The Manley Collection of Stone Age Tools (Memoirs of the Archaeological Survey of India)*, and several papers on the megalithic monuments of S. India. For the last few years he has been engaged in field work on the tribes of the Wynad Plateau of S. India. He helped also in bringing to the notice of the public and scholars the importance of the ancient town site at Arikamedu near Pondicherry where pottery of Mediterranean type has been discovered. As Chairman of the Madras University Board of Studies in Anthropology, he is helping in the organization of anthropological studies and research under the auspices of the Madras University. He is also one of the very few Indians to have obtained the Diploma of the Museums Association of London and to have undergone training in modern methods.

S. W. HARDIKAR

President, Section of Medical and Veterinary Sciences

Born on November 24, 1894, Dr Hardikar qualified as Assistant Surgeon from the Medical School, Hyderabad-Deccan in 1911. He began his career as a private practitioner and was for some time in the

Government service as probationary assistant surgeon. He was awarded the Government Foreign Scholarship for study in Britain in 1916 and proceeded to Edinburgh. In 1920, he received the M.B. and Ch.B. degrees of the Edinburgh University and carried out Post-Graduate work in Pharmacology under the late Professor A. R. Cushny, F.R.S., in the same University. In 1924, the University conferred on him the degree of M.D. (Edin.) with a gold medal for his thesis on "The action of Quinine on Protein Metabolism, Respiratory Exchange and Heat Function." He was made M.R.C.P. (Edin.) in 1925. From 1922-1923, he was the University Assistant in the Department of Materia Medica and the Chrichton Research Scholar in Materia Medica and thus had the honour of being the first Indian to be on the teaching staff of the Edinburgh University.

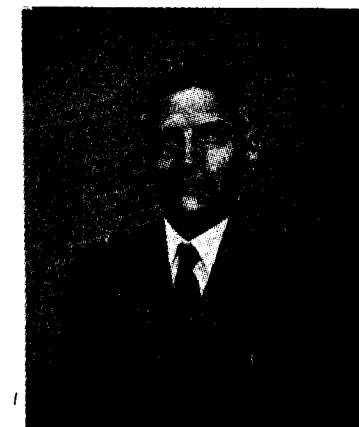
On his return to India, he became chemical examiner to the Nizam's Government and Professor of Pathology, Osmania Medical College, Hyderabad-Deccan, in 1924. In 1926, he was Civil Surgeon, in Nalgonda and Hyderabad. He became the Professor of Physiology of the Osmania Medical College in 1928 and Professor of Pharmacology and Honorary Physician of Osmania Hospital in 1930. In 1943, he was officiating Principal of the College for a short time. In 1944, he became Vice-President of the Hyderabad Medical Council.

Professor Hardikar has been a member of several learned societies in Great Britain and in India, such as the Physiological Society of Great Britain (since 1927), British Medical Association (1924), Hyderabad Medical Association and Hyderabad Branch of Indian Medical Association (since establishment). He is one of the representatives elected by the Universities on the Governing Body of the Indian Research Fund Association. He has published several important papers in foreign and Indian medical journals.

N. V. JOSHI

President, Section of Agricultural Sciences

Prof. N. V. Joshi came from the district of Ratnagiri in the Bombay Province. He was born in 1885 at Basni, a village near Ratnagiri. His primary education was completed in the primary school



in the same village. For Secondary education he was sent to Bombay. After matriculating in 1900 he joined the Elphinstone College in Bombay and



graduated in Arts with Physics and Chemistry as optionals in 1904. Next he joined the Agricultural branch of the College of Science, Poona and was the first graduate in Arts to take this course. After taking the full course in Agriculture he got the Agricultural degree in 1907. After a few months he was employed as a Demonstrator in Chem-

istry at the Poona Agricultural College, which was by that time established as a separate Institute, independent of the College of Science. While engaged here as a demonstrator, he studied for the Science degree with Chemistry and Geology as his subjects and got the B.Sc. degree of the Bombay University in 1908. After this, he was awarded the Mangaldas Nathubhai Scholarship by the University of Bombay; but owing to some family mishap, he had to give up the scholarship and forgo the advantage of further education in western countries. In 1910, he was taken up as first assistant to the Imperial Agricultural bacteriologist at the Pusa Agricultural Research Institute. The name and prospects of this post have changed twice but he continued to hold it as assistant agricultural bacteriologist till the time of his retirement.

While in service most of his time was devoted to research work in the different branches of agricultural bacteriology, e.g., decomposition of organic manures in soils, green manuring, nitrogen conservation, etc. Preservation of fruits and vegetables also occupied his attention. His work on the root-nodule organisms of the leguminous plants formed the subject of his thesis for the M.Sc. degree of the Bombay University.

He has contributed several papers at the successive sessions of the Science Congress and was recorder of the Agricultural Section of the Science Congress for two years.

After retirement from Government service, he has been recognized as a University Teacher in Microbiology and Biochemistry by the University of Bom-

bay, and at present working as an honorary professor at the Fergusson College guiding the post-graduate students in their research work.

B. MUKERJI

President, Section of Physiology

Born at Barrackpore, 24-Parganas, in 1903, Dr B. Mukerji received his education at the Shyam-bazar Vidyasagar School, the Scottish Churches College and the Medical College, Bengal. After a brilliant school and college career, he obtained his 'Bachelor of Medicine' degree in 1927 from the Calcutta University with honours in Pharmacology and in Midwifery and Gynaecology, standing first in order of merit from the Calcutta Medical College. After nearly a year of resident House-Surgeonship in the Eden Hospital, he joined the School of Tropical Medicine, Calcutta, as a research worker on Indian indigenous drugs under Colonel Sir Ram Nath Chopra. Here he distinguished himself early as a keen scientist and a capable lecturer and in 1930 was selected for the post of the Assistant Secretary to the Drugs Enquiry Committee of the Government of India. In this capacity, Dr Mukerji toured extensively all over India and gained first-hand information about various problems pertaining to drug industry and drug trade in India. In 1931, he rejoined his duties as a research worker in the School of Tropical Medicine and during the next two years carried out promising investigations and published several papers on the pharmacology and therapeutics of Indian santonin, ephedra, squill, ipecacuanha, yellow oleander, narcotine, etc. On the merit of his work on the Pharmacology of 'Indian Indigenous Drugs' he was awarded in 1933 the Rockefeller Foundation Fellowship and under its auspices, he studied modern methods of advanced pharmacological and biochemical research in various seats of learning in China, Japan, America, Great Britain, France, Belgium and Germany, spending the major part of his time in America (Michigan University), London and Munich.

After his return to India in 1937, Dr Mukerji was appointed pharmacologist to the Bio-chemical Standardisation Laboratory (nucleus of the Central



Drugs Laboratory) of the Government of India, and has since been responsible, along with Sir Ram Nath Chopra, in the proper functioning, for the first time in this country, of a drug standardization and control laboratory, undertaking chemical, pharmaceutical, biochemical and biological assays under one roof. Since 1941, Dr Mukerji has taken over charge as the Director of the Laboratory at Calcutta and its branch at Kasauli (Simla Hills).

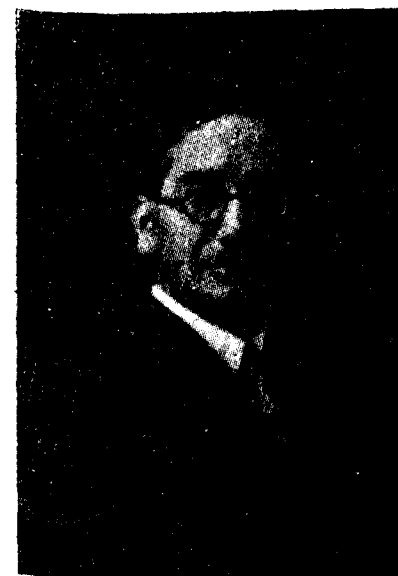
Dr Mukerji is the recipient of several prizes, scholarships and medals from the Medical College and the Calcutta University and is a Member or Fellow of many learned societies in India, Great Britain, Germany and America. He is associated with the post-graduate teaching of Applied Physiology and Pharmacodynamics of the Calcutta University and has served in many Governmental Committees concerned with drugs and pharmacy. He was elected a Fellow of the National Institute of Sciences of India and the American Society for Pharmacology and Experimental Therapeutics between 1941-1943.

A. N. KHOSLA

President, Section of Engineering and Metallurgy

Born in December 1892 at Jullundur in the Punjab, Rai Bahadur A. N. Khosla had a distinguished career both at school and college. He graduated from the Punjab University in 1912 and topped the list of successful candidates. He received his technical training at the Thomason Civil Engineering College, Roorkee, from where he passed out in 1916 with high distinctions both in sports and studies.

He joined the Punjab Irrigation Department in September, 1916, and



was employed on the Bhakra Dam Surveys. He served with the Mesopotamia Expeditionary Force during the last Great War in Mesopotamia and on return home was engaged for over 4 years on the construction of the Suleimanke Headworks. He was then posted to the Marala Headworks where he initiated his studies on sub-soil water flow in relation to the stability of structures resting on permeable foundations. These studies were continued by him at Punjab Headworks where he was previously able to instal a large number of pressure observation pipes. In this period he wrote several papers on the subject for the Punjab Engineering Congress which won for him the Congress Medals for the years 1930 and 1936 and the Kennedy Memorial Medal for the year 1936.

Subsequently he was employed on the reconstruction of the Khanki Weir. On completion of this work (1936) he was able to write his *opus magnum* "The Design of Weirs on Permeable Foundations", which introduced a new theory of sub-soil flow under masonry structures and which has now replaced all old theories on the subject. This he did jointly with Drs Bose and Taylor. This was published by the Central Board of Irrigation and won for Mr Khosla an international reputation as well as the Kennedy Memorial Medal for the second time.

The biggest and the most important engineering work so far constructed by him is the Headworks of the Haveli canals at Trimmu which he completed in a period of about two years—a record achievement for a work of this magnitude. The design of this work is wholly based on the theory and principles enunciated in his "*opus magnum*".

The Punjab Government deputed him to the United States of America, Canada and other countries of the world to study the technique of the design and construction of high dams in 1931 and again in 1939.

In August, 1943, he was appointed Chief Engineer and is since then engaged in the preparation of projects for the construction of three major dams for storage and hydro-electric development in the Punjab, two of which dams will be almost as high as the Boulder Dam—the highest dam in the world.

NAGPUR AND ITS SURROUNDINGS

THE Indian Science Congress Association will hold its 32nd Annual meeting at Nagpur, under the auspices of the Nagpur University, in January, 1945 and will be presided over by Sir Shanti Swarup Bhatnagar, F.R.S. The congress previously held its sessions at Nagpur in 1920 and 1931, presided over by the late Sir P. C. Ray and Lt.-Col. R. B. Seymour Sewell, I.M.S., respectively.

Nagpur, a district in the Central Provinces (3,840 sq. miles) lying between 20° 36' and 21° 43' N and 78° 17' and 79° 43' E is bounded on the north by Chhindwara and Seoni, on the east by Bhandara and on the south and south-west by Chanda district and river Wardha. The sudder station, Nagpur has a municipal area of 4 sq. miles.

LEGENDERY PERIOD

According to tradition, Nagpur was included in the kingdom of Ajodhaya, when the divine Rama ruled over it. The Ramayana recounts how Rama traversed the forest of Dandaka, extending from the Jamuna to the Godavari river on his way to the hermitage of Sutikshna at Ramtek.

THE AHIRAS (4-5 CENTURY A.D.)

The oldest architectural remains in the district are believed to be the circles of stones which are found in a number of villages.

These were constructed by an unknown race but are ascribed by the people to the pastoral gaolis or Ahirs. Fragments of pottery, flint arrow heads, iron implements, evidently of great antiquity have been found beneath these stones, that are said to be the encampments or burial places of Gaolis. According to Hislop these are vestiges of a race of nomad shepherds—a branch of the Scythian tribes, who overran India from the Central Asian steppes in the 4th and 5th century A.D. The remains of the fort of Parseoni are also ascribed to the Gaolis and the calendar in common use in the Marattha districts is named after them.

VAKATAKA DYNASTY (6TH CENTURY A.D.)

Little is known of this Rajput dynasty, whose dominions included the Satpura and Berar.

SHAIL KINGS (8TH CENTURY A.D.)

From an undated copper plate and on paleographic grounds which is referred to the 8th century, a line of kings who possessed the whole of Vindhya is traced. Their family name was *Shail* which means "a mountain".

THE RASHTRAKUTA DYNASTY (750 A.D.—1000 A.D.)

This dynasty dates from 750 A.D. A copper

plate found at Deoli in Wardha, dated 940 A.D. indicates the reign of the King Krishna III and even at this period Nagpur gave its name to a district, which included Wardha and South of Chhindwara. The supremacy of the Rashtrakutas (Rathor Rajputs), lasted for about two centuries and during their pre dominance the Kailasa temple at Ellora was built. This period was remarkable for the bitter rivalry of Hinduism and Jainism—Buddhism being a declining religion in the Deccan.

PONWAR KINGS (11TH CENTURY A.D.)

By the end of the 11th century, Nagpur country appears to have passed out of the hands of the Rashtrakutas, into those of Ponwars of Malwa. Their territories extended to Berar and the Godavari and even to the Carnatic. The existing Ponwar caste of Nagpur are a relic of this dynasty.

GOND PRINCES—JATBA (16TH CENTURY A.D.)

Nothing is known definitely about the history of Nagpur from this time until the rise of the Gond* Kingdom towards the end of the 16th century. Deogarh, the headquarters of the old Gond dynasty of Chhindwara and Nagpur is a fortress about 24 miles south-west of Chhindwara and picturesquely situated on a crest of the hills.

The semi-mythical Gond hero, Jatba, founder of this dynasty is said to have built the Deogarh fort. But according to local tradition, Deogarh was originally a Gaoli Kingdom, and later conquered by the Gond King, Jatba, being eighth in descent from the founder of the dynasty. It is said Emperor Akbar came to Deogarh when Jatba ruled and the latter visited Delhi. The existing remains at Deogarh are in the Muhammadan style, and were no doubt constructed by Bakht Buland.

BAKHT BULAND (1700 A.D.)

Bakht Buland was the 3rd or 4th in descent from Jatba. The prince entered the services of Emperor Aurangazeb at Delhi. He gained the favour of the Emperor, who induced him to adopt Muhammadan faith, and was acknowledged as Raja of Deogarh under the name Bakht Buland. He appreciated the advantages of the civilization which he witnessed at Delhi and determined to set about the development of his own territories. To this end he employed,

*The name "Gondwana" in Geology is derived from the "Gonds" as these formations were first known from the Narbaddas and later discovered in other parts of the Southern continent, viz. "Gondwanaland". The name was first introduced by H. B. Medlicott in 1872 and later revived by O. Feistmantal (1876).

Hindus and Mussalmans of ability and agriculture and industries made considerable advances.

Much of the success of the later Marattha administration was owing to the ground work established by him. He extended his territories and established the modern city of Nagpur.

FALL OF DEOGARH DYNASTY (1743 A.D.)

Bakht Buland's successor Chand Sultan removed his capital to Nagpur, which he made a walled town. Continuance of the liberal policy of his predecessor, led to increased wealth of the country. On Chand Sultan's death in 1739, an illegitimate son of Bukht Buland usurped the throne. Chand Sultan's widow invoked the aid of Raghuji Bhonsla, who was governing Berar, on behalf of the Peshwa—in the interests of her sons. Raghuji, on being called in by the contending Gond factions, replaced the two sons of Chand Sultan on the throne from which they had been ousted by an usurper and retired to Berar with a suitable reward for his assistance.

This was the first direct connection of the Bhonsla family with Nagpur. Dissensions however broke out between the brothers in 1743. Raghuji again intervened at the request of the elder brother and drove out his rival and he took all power into his own hands. Burhan Shah, the Gond raja, though allowed to retain the outward insignia of royalty became practically a State prisoner and all real power passed to the Maratthas.

THE BHONSLAS—RAGHUJI I (1743—1755)

Bold and decisive in action, Raghuji was a perfect type of a Marattha leader and was the first and most distinguished of the Bhonsla rulers of Nagpur, where he reigned nominally as the representatives of the Gond prince from 1743 to 1755. He saw in the troubles of other States an opening for his ambition and did not even require a pretext for plunder and invasion. Twice his armies invaded Bengal and he obtained the cession of Cuttack Chanda, Chattisgarh and Sambalpur. He died in 1755. The countries under his dominion or paying him tribute extended east and west from Bay of Bengal to the Ajanta hills and north and south from the Narbadda to the Godavari.

The reign of Raghuji I is important in the history of Nagpur, because with him came an influx of different Marattha tribes, which altered the face of the country, the administration as well as the language of the people.

JANOJI (1755—1772)

Raghuji was succeeded by his son Janoji, to the sovereignty of Nagpur. He and his kingdom became relatively stronger than other Marattha provinces. He took part in the wars between the Peshwa and Nizam and after he had in turn betrayed both of them, they united against him and sacked and burnt

Nagpur in 1765. He died in 1772. During his reign the country of Nagpur, except on two occasions had perfect peace.

MADHOJI (1772—1778)

After Janoji's death, his brothers fought for the succession until one shot the other on the battlefield of Panchgaon, 6 miles south of Nagpur. Madhoji succeeded to the regency, on behalf of his infant son Raghuji II, who was Janoji's adopted heir. In 1785, Mandla and the upper Narbadda Valley were added to Nagpur by treaty with the Peshwas.

Madhoji the regent courted the favour of the British and he assisted the march of British troops through his province, when a force was being sent from Bengal against Haidar Ali. The regent died in 1788 leaving the Nagpur State in a state of tranquility and prosperous conditions.

RAGHUJI II (1778—1816)

Raghuji II, now assumed charge of the State and took up his residence at Nagpur. He ceded several districts and forts and the Nagpur kingdom was now at its greatest extent and included practically the whole of the present Central Provinces and Berar, besides Orissa and some Chotanagpur States. Up to 1803, Marattha administration was on the whole successful.

During this time, the connection of Nagpur with the British Government had been growing firmer and in 1798 a British resident was appointed to the court of Raghuji, who had to withdraw in 1803 from Nagpur as Raghuji united with Scindhia against the British Government. The two chiefs were however, decisively defeated at Assaye and Aragaon and by a treaty of Deogaon, Raghuji ceded to British Cuttack, Southern Berar and Sambalpur. Nearly one-third of the Kingdom of Raghuji was shorn off and the Raja had to receive permanently a British resident at Nagpur and Monstuart Elphinstone, the eminent historian, was appointed to the post.

A period of misrule prevailed from 1803-1818. Raghuji attempted to make up the loss of revenue from the remainder of his territories and many new taxes were imposed. The pay of the troops was in arrears and they maintained themselves by plundering cultivators. At the same time, commenced the raids of the Pindaris, who became so bold that in 1811, they advanced to Nagpur and burnt the suburbs. It was at this time that most of the numerous village forts, were built,—remains of which stud the whole district,—to which on the approach of these marauders the peasant retired, and fought for bare life, and all they possessed outside the walls, being lost to them.

On the death of Raghuji II in 1816, his son Parsoji, an imbecile succeeded to the throne, but he was soon supplanted and murdered by the notorious

Madhoji or Appa Saheb, the son of the late Raja's younger brother.

A treaty of defensive alliance providing for the maintenance of a subsidiary force by the British was signed this year, a resident having been appointed since 1798.

APPA SAHEB (1816—1818)

In 1817, on the outbreak of war between the British and the Peshwa, Appa Saheb threw off his cloak of friendship and accepted an embassy and title from Peshwa. His troops attacked the British and were defeated in the brilliant action at Sitabaldi and for a second time round Nagpur city.

The hill Sitabaldi, (Fig. 1) consists of two eminences, joined by a narrow neck of ground of lower

quently to the Punjab. He died in Rajputana in 1860.

RAGHUJI III (1818—1853)

On the final deposition of Appa Saheb, in 1818, a grand child of Raghuji II, was placed on the throne. He was recognised as Raja Raghuji III, on the terms granted to Appa Saheb in 1816. During the Raja's minority, the State was administered by Baka Bai, the widow of Raghuji II, under the British resident till 1830. The young raja was actually permitted to assume government from this year and all these years was a period of tranquillity.

Raghuji III died in 1853, without heirs, and Marquis of Dalhousie, the then Governor General, applied his policy of the "Doctrine of Lapse" and



FIG. 1. Sitabaldi Hill and Fort.

elevation. The British troops occupied these positions and succeeded in resisting the onset of the Marathas.

The regent demanded unconditional surrender of the Raja and the disbandment of his troop. Appa Saheb feigned to surrender and when the British advanced to take possession of guns an action took place, over the ground lying between the present jail building and Sakandara gardens. The Marathas were totally routed.

As a result of these battles, the remaining portion of Berar and the territories in Narbadda valley were ceded to the British and an engagement was drawn up, re-instating Appa Saheb on the throne.

Shortly afterwards, it was discovered, Appa Saheb was again intriguing and was deposed and forwarded to Allahabad in custody. On the way, he corrupted his guards and managed to escape in the dress of a Sepoy first to Mahadeo hills and subse-

declared that the State of Nagpur has lapsed to the paramount power.

BRITISH RULE (1853—1861)

During this period the dominion of the Bhonslas were administered by a Commissioner of the "Nagpur Province" and the even course of affairs was broken by events connected with the mutiny at Nagpur.

During the mutiny a scheme for a rising was formed by a regiment of irregular cavalry in conjunction with the disaffected Muhammadans of the city but was frustrated by the prompt action of the civil authorities, supported by Madras troops from Kamptee. Some of the native officers and two of the leading Muhammadans of the city were hanged from the ramparts of the fort and the disturbances ended.

The aged Bhonsla princess, Baka Bai, exerted all her influence on the side of the British and did her

utmost by her example to keep the Marattha districts loyal.

The formation of a new province *viz.*, Central Provinces took place in 1861 and this actually represented the Bhonsla kingdom at its greatest extent. From 1901 till 1920 they were governed by a Chief Commissioner, and in the latter year became a Governor's province.

In 1903, Berar was transferred by a treaty by the Nizam of Hyderabad to the British Government, and granted a perpetual lease of the assigned districts of Berar, as he was often irregular in paying the money he owed to the Company for maintaining a

The temple with the citadel at Ramtek is of great archaeological and historical importance.

The temple at Parseoni belongs to the Jains and there are also a few traces of Buddhist buildings.

Several villages contain the ruins of old forts. In the Nagpur museum there is a collection of sculptures obtained from several districts including inscriptions engraved on stone slates and copper plates. Among them is the Sitabaldi sanskrit inscription of the 11th century, recording the fact that Nagpur was then held by Ponwar rajas.

Some Muhammadan tomb stones with Persian



FIG. 2. Temples on Ramtek Hill.

British contingent in his State. Berar still remains a State territory.

ARCHAEOLOGY

The oldest remains in the district are the circles of rough stones found in a number of villages, already referred to in the beginning of this article.

The most important architectural monuments are the temples (Fig. 2) of Ramtek, 24 miles north-east of Nagpur by road and lies round the foot of a detached hill. The name signifies "the hill of Rama". On the hill, standing about 500 ft. above the town are a number of temples, the most important being the shrines of Rama and Lakshman on the crest of the hill and the latter contains an inscription of 14th century. The whole area within a radius of 10 miles of Ramtek is held to be holy and there are *Asht tirtha* or eight sacred places which are all visited by most pilgrims.

inscriptions removed from Sitabaldi fort are also found in the museum.

Near the flag staff on the ground of Government House lie the bronze guns with Persian inscription, which have been brought from Asirgarh. The inscription indicates that the gun was made in 1663 A.D. in the reign of Muhammad Husain Arab.

GEOLOGY

The primary formation of the rock is sandstone, associated with shale and limestone. The sandstone is now covered by a trap and broken up by granite. This juxtaposition of trap, sandstone and granite rocks invests the Geology of Nagpur with special interest. It is also of interest as it is one of the great manganese producing centres of the world. There are also well developed coal, bauxite, fuller's earth, iron ore, laterite and ochre.

FORESTS AND VEGETATION

Forests are mainly situated in a large block on the Satpura hills, while isolated patches are dotted near the hills. The forest growth varies with the nature of the soil—*Terminalia tomentosa*, *Buchanania latifolia*, *Diospyros tomentosa* being characteristic on the heavy soils and *Tectona grandis* on good well-drained slopes and *Boswellia serrata* on the steep hill sides and ridges. The forests yield a substantial revenue, by the sale of timber, firewood and from grazing. One-fifth of C. P., excluding the feudatory States is Government reserved forest.

Being one of the hottest places in India, Nagpur does not exhibit a luxuriant vegetation. The presence of large water reservoirs around the city, a rainfall of about 50 inches during monsoon and characteristic geological formation met with in the area, render the place interesting from the standpoint of a botanist.

crops of India—wheat, rice and cotton. Black cotton soil cover Berar and parts of C. P. and this soil is best suited to grow deep rooted crops notably Indian strains of cotton which is the staple crop of this area. The remaining districts contain both wheat producing plants and extensive hills and forests. Industrially, Nagpur is a flourishing textile centre.

PEOPLE AND THEIR LANGUAGES

The province is linguistically distributed between a Marhatti speaking and a Hindi speaking population. In the whole of Berar and the districts of Nagpur division, the prevailing tongue is Marhatti, in the remaining districts it is Hindi. There are a number of hill tribes, of which the principle are the Gonds, many of whom still retain their own language and their own animistic religion. In the whole province, Hindi speakers are 56 per cent., Marhatti

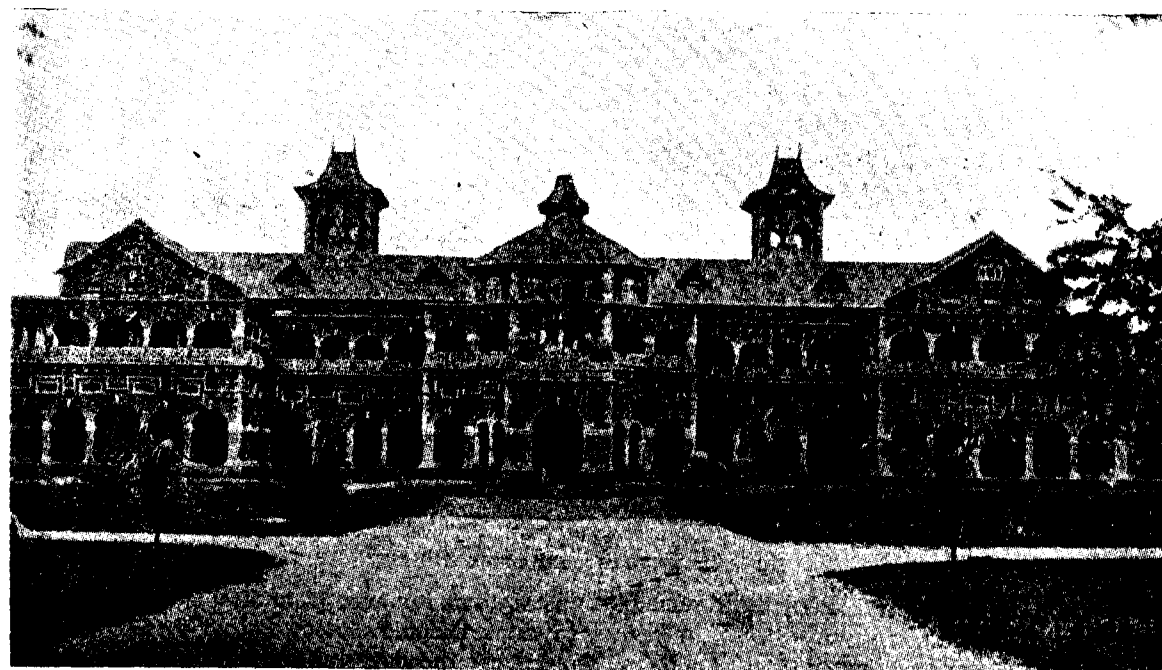


FIG. 3. Victoria Technical Institute.

The typical formations (plant communities) met with in this locality are as follows ; (a) Black clay soil vegetation, (b) Trap soil vegetation, (c) Hedge vegetation, (d) Waste land vegetation, (e) Aquatic vegetation, (f) Marsh vegetation, (g) Dried mud or pit vegetation.

The area belongs to the Deccan region of Hooker and the dominant elements in its distribution are the *Malayan* and *Australian* (?). There are about 76 endemics and the number of introduced plants is about 34.

AGRICULTURE AND INDUSTRY

Agriculturally, the province is of special interest in that it is the meeting place of three great staple

speakers 31 per cent and Gond speakers 7 per cent of the population.

EDUCATIONAL CENTRES

The University of Nagpur was inaugurated in 1923 and the College of Science was opened in 1929. There are facilities for study of applied science as a result of the very generous bequest made to the University by the late Rao Bahadur D. Laxminarayan.

Besides the University has affiliated to it the old colleges, Hislop College and Morris College. There is also an Agricultural College, a Medical School and a Technical Institute. (Fig. 3).

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SCIENTIFIC EDUCATION AND RESEARCH IN RELATION TO NATIONAL WELFARE—I

RECENTLY a great deal of attention has been directed to the urgency of large scale expansion of agriculture and industry in this country as a means of improving the standard of well being of the people. Such expansion will involve, besides question of finance, importation of plants and machinery, also that of obtaining a sufficient supply of trained personnel to man the industries. It is also recognized that under present conditions of international competition no industry can maintain itself without the aid of applied research. It is, therefore, necessary to establish laboratories where such problems may be investigated and also to train up research workers of required qualifications. To meet the immediate demands for trained personnel it is proposed to send a large number of graduates from this country to Great Britain and the U. S. A. At the same time schemes are being formulated for strengthening the teaching and research departments of the Indian universities and also to open up new institutions for applied research.

This training will require provisions for (i) higher standard of teaching in pure and applied sciences than is available in this country at present, (ii) opportunity for research to a large body of able graduates, which will qualify them to hold the posts which will be available when the proposed schemes for the establishment of a large number of research institutions in this country materializes. At present attention is concentrated chiefly towards the expansion of industrial research in this country. An Industrial Research Planning Committee have been considering this question during the last few months. The Committee have already submitted an interim report in which they recommend that certain facilities should be given in the shape of remission of fiscal burdens

on firms proposing to engage in industrial research. The Committee is now touring the different parts of the country with a view to acquainting themselves with the facilities available for such training and research and how far they can be utilized and expanded to meet the increased demand which will arise when the scheme recommended by the Committee is put into operation. We understand that the Committee's recommendation will include a large initial grant for equipment of university laboratories and research institutes whose services will be utilized for the furtherance of applied researches, and a recurring annual grant for the maintenance of a large number of research scholarships and junior and senior fellowships.

It is not known to us whether the Committee propose to earmark a portion of the grant for the purpose of improving the facilities for research in fundamental subjects, which it is supposed to be the function of universities to undertake. It must also be realized that industrial research is one of the means to be employed for bringing about a planned economic development of this country, whose aim is the improvement of the general well being of the people. All schemes of planned economy envisage a considerable increase not only in the output of industries but also of agriculture. The latter involve investigations on problems of fertilizers, soil erosion, forestry, plant ecology, plant diseases, animal husbandry etc. Moreover, the material well being of the people depends also upon satisfactory solution of problems of sanitation and the provision of adequate medical facilities. Further it is getting clear from a study of recent world happenings that, however great may be the advances in the industries by the application of physical methods, sustained social and

economic research is necessary to secure more effective use of the results. This will require a more equitable distribution of our research efforts between the social, the biological and the physical sciences than is contemplated by our present engrossment in schemes of advancement by means of industrial research.

Thus we see that all schemes of national planning will involve, besides question of legislation, tariff, finance, priorities in the development of basic and consumption goods industries, the problem of obtaining an adequate supply of trained personnel and research workers required in all branches of science and for industry, for Government institutions and departments. It will also be necessary to provide for the supply of leaders in all walks of society competent to apply scientific knowledge to the service of industry or of the country as a whole. Lastly, it will be necessary to provide for some scheme of adult education through which alone can we hope for a society in which policies and plans based upon scientifically ascertained facts can be assured of reasoned and general support. In advanced industrialized countries of the West, as in England, it is generally accepted that "we live in a world in which science lies at the very root of the community, and a mastery of scientific thinking grows more and more indispensable for the successful practice of the arts of life. The culture of the modern age, if it is to have any meaning, must be deeply imbued with scientific ways of thought".

In this country with its diversities of religions and philosophical traditions and outlooks we are entering into a period of transition from a mediaeval state of society to one based upon mechanized industrial development. Many of us are at present prepared to accept science, as an aid to industrial development, but whether we desire it or not, the impact of the industrial civilizations from the West is acting as a solvent of many of our cherished religious beliefs and social customs. It is for our philosophers and sociologists to study these problems and to suggest how it will be possible to incorporate in the essentials of our religious and ethical traditions and in our social organization, the implications of the recent views of life in this universe, arising out of the development of science. It will be generally accepted, however, that the education given in our schools and colleges must be such that every pupil receives an adequate knowledge of the principles and methods of science.

Returning to the immediate subject matter of discussion we shall in this review be concerned principally with (i) the place of universities in modern society, (ii) their function as source of supply of research workers and administrators in industry and elsewhere, (iii) this brings up the question of im-

proving the status and conditions of employment of scientists and research workers employed in universities, Government laboratories and departments, and in industries. Considerations will be given to the suggestion of introducing uniformity in conditions of pay, leave and superannuation in all these services, which will enable an interchange of personnel between the different services; it is expected that this interchange will act as a stimulant to freshness of outlook and to new ideas, (iv) further it has to be considered how the research work undertaken in the different kinds of organizations may be coordinated so that redundancy may be avoided and also serious gaps in the entire research front may be discovered and rectified.

As an introduction to the study of the conditions existing in this country and of proposals for improving them, it would be worth while our obtaining some idea of how similar problems on scientific education and research in relation to national welfare are being considered in Great Britain. Discussions on similar lines are proceeding in other countries, but in view of the fact that the majority of educational and research organizations in this country are based upon British practice, we shall only consider the British proposals here. Many of these proposals have been made available to us in the form of a booklet published by the Government of India and to which a preface has been written by Prof. A. V. Hill. In addition, we have a series of six leading articles published in *Nature* (August 26 to September, 30, 1944) entitled 'Scientific and Industrial Research.' The whole subject has been considered from a comprehensive standpoint. It appears to us that much of the criticisms and suggestions contained in the articles are pertinent to Indian conditions.

In these articles, a distinction has been drawn between the strategy and the tactics of research, i.e., between the long term and short term aspects of the problem. The former deals with the broad lines of the research problems and the qualities they will demand in the personnel responsible for their execution. The articles have in view a society which is not organized on a totalitarian basis, in which both freedom of enquiry and of expression of such enquiry are safeguarded. Even in such a society the maximum of social good obtainable from the activities of a group of scientific workers will depend upon a measure of organized planning. The question of the degree of control of research, which it may be allowable to the State or to the industry, depends upon our views on the relation between fundamental and applied research; it is usually in the latter type of research that the State and the industry are mostly interested. Here the following lines quoted from a letter written by Lord McGowan announcing on behalf of the Imperial Chemical Industries a scheme

for the provision of eighty fellowships in science at nine British universities will be found relevant. "Nearly three generations of experience of the administration of research have convinced us that academic and industrial research are interdependent and complementary and that it is useless to expect substantial advances in industry without corresponding advances in academic science". Thus if conditions under which fundamental research or investigation concerned purely with the advancement of scientific knowledge are found to be best promoted can once be established, we shall have advanced far in determining those under which applied research will also flourish. We are concerned with discovering the factors which stimulate research as well as those conditions which are restrictive or repressive. The community must seek first to find and train the men who have the ability and impulse for scientific enquiry and then it must create the most favourable conditions for their work and give them tools they need. A necessary link between the two aims is to secure competent direction of research. Creation of senior research fellowships in science may help to bring up men of the requisite outlook and calibre for the direction of research. It is also necessary to have in addition efficiently trained laboratory technicians in order to fully utilise the services of the qualified research workers. Attention is drawn to the restrictive effect which often terms of endowments have in depriving the investigator of his primary right of choosing a subject to be studied. Too rigid compartmentalism in science often acts as an impediment to effective team work between workers in one or more sciences. Further it is imperative that provision must

also be made on the basis of relevance to social needs for the organized study of particular and urgent problems, both in the development of natural resources, as of fuel and power supply, and agriculture, and their effective utilization in the service of the community, and of nutrition and health. Such organized study must make provision not only for many lines of industrial research but for systematic fundamental research, planned so as to assist the advancement of science on an even front by filling up gaps left by individual initiative and with special regard to the border lines of science which are so often overlooked. Such organized study of sciences will inevitably lead to the study of a whole range of allied social sciences. Without adequate attention to social biology and of biological factors in human relations, to population changes and vital statistics, to psychology and allied subjects, we shall be without the basic knowledge required for the evolution of a better social order and the establishment of better human relations.

The attempt to formulate and apply an adequate strategy of research can only be possible when it receives the necessary support of the community. The problem involved is both the education of the adult community to the value and significance of scientific research, as well as the general education of the community and that not merely at the university level. But we are in the first instance concerned with the place of universities as the source of supply, both direct and indirect of the type of personnel required. We have thus further to consider the question of their place in, or relation to the organization of research. These questions we shall deal with in the next issue.

THE MAGNETIC CURRENT

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THE theory of magnetic current¹ has recently been sponsored by Prof. Felix Ehrenhaft, former Director of the Physical Institute at the University of Vienna, who now carries on his research in New York. It challenges the time-honoured concept of Magnetism as a static force, which is always associated with a magnetic dipole—unlike electric current in which electrons flow along a copper wire. The theory that magnetic current can be generated by a so-called permanent magnet, if proved correct, would mean the establishment of an entirely new source of power. It promises practical applications as far-reaching as have stemmed from Faraday's fundamental research on Electricity.

The hypothesis of electric current was founded

chiefly upon three facts: the existence of electric ions, the decomposition of water (electrolysis), and the circulation of the single magnetic pole around the constant electric current. Ehrenhaft finds an exact analogy in the realm of Magnetism. His experiments appear to prove the existence of magnetic ions, the decomposition of water through magnet (magnetolysis), and a circulation of a single electrostatic charge around the constant magnetic current. In fact, by introducing the terms for the magnetic current to the equations of Electrodynamics, he makes these equations entirely symmetrical concerning H and E.

The three experiments upon which the new ideas are based may briefly be described as follows:

"MAGNETIC IONS" EXPERIMENT

In 1269, using a loadstone, Peter Peregrinus first demonstrated that a magnet had two equal and opposite poles. Since then, nobody has been able to detect any excess of north or south magnetism. Substituting microscopic particles of iron or other magnetic materials in a homogeneous magnetic field, Ehrenhaft finds them move in the direction of the lines of force, the direction of motion reversing with the reversal of the field. In collaboration with L. Banet, he also observes similar movements of colloidal particles of nickel in a liquid medium. These experiments lead him to conclude that there must be an excess of north or south magnetic charge on the particles. Expanding the terminology of Faraday, he calls the particles *magnetic ions*.

"MAGNETOLYSIS" EXPERIMENT

For this experiment, Dr Ehrenhaft uses the simplest apparatus. Two rods of pure Swedish iron are sealed in holes through opposite sides of a U-shaped tube containing acidulated water (1—4 per cent H_2SO_4). Instead of connecting the rods to the customary poles of an electric battery, he connects them to the poles of a permanent magnet. Bubbles of gases rising through both the columns are collected and analyzed. When the poles are not connected to the permanent magnet, only hydrogen is liberated according to the usual chemical interaction between the iron rod and the dilute sulphuric acid. When, however, the magnet is inserted in place, oxygen (2—12 per cent) is also liberated in both the columns, more oxygen being liberated at the North Pole. After rigorous precautions, including short-circuiting the magnet poles with a wire, so that the poles are kept at the same electric potential, Ehrenhaft concludes that the oxygen can only come from a decomposition of water by the magnet.

There is an interesting side-light to this experiment. Ehrenhaft observes a marked loss of strength (about 10 per cent in 24 hours) of the alnico magnet and attributes the same to the loss of magnetic ions that had flowed from the poles into the solution. The loss of pole strength per second gives the average intensity of the magnetic current flowing between the pole-faces in absolute magneto-static units.

"ELECTRIC FIELD AROUND THE MAGNETIC CURRENT" EXPERIMENT

For this experiment, a small glass cell is used, fitted as before with pole-pieces of pure iron, that dip into acidulated water (1 per cent H_2SO_4), and connected by an iron wire. An electromagnet energizes

the poles. From a projector, a powerful beam of light converges upon the narrow gap between the pole-pieces, and a low-power microscope mounted horizontally reveals the new phenomenon. As soon as the magnetic field is on, there is observed an electric vortex, or whirl of electric ions around the wire. Positively and negatively charged ions spin in opposite directions depending upon the strength of the magnetic field. Ehrenhaft suggests that the electric action of magnetic current represents the third force in Nature besides the force of gravity and the well-known force of magnetic action of electric current.

Unfortunately, the life of the magnetic current hypothesis has been very brief. The staggering implications of Dr Ehrenhaft's observations have led several renowned scientific firms to duplicate these experiments under rigidly-controlled conditions. Hitherto, the results have been uniformly negative.

Hopper² has attempted to verify the existence of magnetic ions, using a horizontal magnetic field, instead of vertical one as used by Ehrenhaft. Fine particles of nickel are drawn by an air current between the poles of the magnet and then allowed to settle under the combined action of vertical gravitational and horizontal magnetic fields, their path being observed by means of a microscope. In the centre of the magnetic field, all the particles fall vertically downwards, thus disobeying the "magnetic ion" hypothesis.

Goldman³ of the Westinghouse Research Laboratory has repeated the magnetolysis experiment carefully. When the pole-pieces are covered with paraffin and boiled acidulated water is used, no gas bubbles are evolved. When the paraffin coating is removed, there is liberation of only hydrogen gas. In neither case there is a loss of pole-strength of the magnet, although they are exposed to "magnetolytic action" for about 60 hours.

Hoff, Naughton, Smoluchowski and Uhlig⁴ of the General Electric Co. Research Laboratory have examined the gases evolved by the action of dilute sulphuric acid (prepared from boiled distilled water and cooled in a nitrogen atmosphere) and magnetized iron. They have failed to detect any oxygen within 0.2 per cent per volume of the total gas evolved.

Ehrenhaft's reply to the above refutations of his theory has not yet reached us. In any case, it must be admitted that his theory is remarkable for its striking originality and boldness of conception. Let us hope that it will at least serve to stir the imagination of the scientific world for exploring new pathways into the mysteries of magnetism which has undeniably received scant attention compared to its sister science of electricity.

Ehrenhaft was responsible in the past for stirring up two similar controversies which, without substantiating the deviations from the accepted views claimed to have been observed by him, have produced a large number of new and critical experiments which placed the accepted views on surer experimental foundations. These were: (i) the discovery of sub-electrons, and (ii) observation of negative radiation

pressure effect produced on certain kinds of microscopic particles.

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THE ORIGIN OF THE SOLAR SYSTEM

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ON May 24, 1943, the world of science celebrated the fourth centenary of the passing away of Nicholas Copernicus, the Polish savant, who effected a revolution in man's ideas and processes of thinking, a revolution, the full effect of which has not yet been realized in any country except Soviet Russia. What was this revolution?

From time immemorial man had believed that the Earth was the centre of the world, the seat of the Creator, and he was the special object of favour of God and was born in his own image; that the Sun and the Moon were created to give him light, and the planets to the tune of the mysterious number seven, including the Sun and the Moon, by their mysterious motions, indicated the decree of the Creator regarding the fates of individuals, nations and countries. These ideas were further worked out into a system by the astronomer Ptolemy who flourished in Alexandria about 140 A.D.

In the Ptolemaic System the earth was regarded as stationary, and the Sun and the planets moved round the Earth. It was firmly believed that the Sun really rose each morning in the east, climbed overhead, and then set in the west.* On the other hand, Copernicus showed that the phenomena of planetary motion are explained far more easily if we regard the Sun as stationary and make the earth and the planets move round it in orbits, which he believed to be circular. Mercury and Venus revolved in orbits inside the earth's orbit, and the rest outside it. The mysterious retrograde motions of planets, which were the basis of astrological superstitions, then come out merely as the effect of relative positions and relative

motions of the planets with respect to the moving earth.

Copernicus was the first to suggest that the Earth moved round the Sun completely in one year and rotated round its axis once a day. The daily rotation of the Earth explains quite simply the phenomena of rising and setting of the Sun.

Copernicus left the work unfinished, and it was left to Galileo, Kepler and Newton to complete it. Kepler showed from observational data that the planets move in elliptical orbits with the Sun at the focus, and Newton explained it mathematically with the help of his famous law of gravitation. The retrograde motions of planets could be explained as merely an effect of perspective due to changing positions of two moving bodies, and hence the bottom was taken out of the pretentious claims of astrologers.

LAPLACE'S THEORY

The above explanation of planetary motions by Newton brought to the forefront another set of questions. What is the origin of the Solar System? Does life exist in any other planets except the Earth?

An answer to the question of the origin of the Solar System was first attempted by Immanuel Kant, philosopher of Königsberg in Germany, and Marquis de Laplace, mathematician of the French Revolution. They thought that the solar universe started as a huge nebular mass, which contracting on account of gravitational attractions of its parts, developed rotation and began to throw out fragments in the form of rings. The fragments condensed as planets and satellites and the central mass condensed as the Sun.

Laplace's theory was able to explain many of the regular features of the Solar System, viz.:

- (a) The planets are revolving in their orbits in the same direction and almost in the same plane.
- (b) The satellites are revolving round the planets in the same sense as the planets moving round the Sun.

* This idea which Ptolemy inherited from antiquity, was questioned earlier by Aristarchus of Samos, who thought that the phenomenon of rising and setting could be much better explained by making the earth move like a top round its axis. But this hypothesis was not accepted by Ptolemy. Six hundred years later Aryabhata in India also gave the same explanation independently; but his followers, Brahmagupta and others ridiculed the idea.

- (c) The rotations of the planets and their satellites about their respective axes are in the same direction as their revolutions in their orbits. The Sun is also rotating in the same sense.
- (d) The eccentricities of these elliptic orbits are small, *i.e.*, the orbits are very nearly circular in shape.

One of the chief objections to Laplace's Theory was that if the fragments of the rotating nebula were given out in extended tenuous rings, the rings could not be condensed into single planets, but into many bodies like the asteroids or the rings of Saturn, which would be stable as proved mathematically by Maxwell in 1859.

The most fatal difficulty, however, which the theory had to meet is the distribution of the angular momentum between the planets and the Sun. The angular or rotational momentum may be roughly described as the "quantity of rotation" in any dynamical system, as Newton spoke of ordinary momentum as the "quantity of motion". Its importance lies in the fact that the whole momentum should be *conserved*. No internal forces in a system can alter its total amount, though they may transfer it from one part of the system to another.

It is found that almost all the angular momentum of the Solar System—98% of the total—is obtained from the orbital motion of the four major planets. The four minor planets provide less than 0.1% of the whole, and the rest is contributed by the Sun's rotation. It cannot be explained by Laplace's theory how 98% of the total angular momentum can be segregated into less than 1.5% of the total mass. It can also be mathematically proved that if the outer parts of the primitive nebula had got so much of angular momentum, they could not have condensed at all. So it is natural to imagine that the angular momentum of the planets must have been obtained from outside. In the language of Spencer-Jones (1940) we may, therefore say that the origin of the Solar System "must be sought in the swift catastrophic action of forces from outside".

THE HYPOTHESIS OF DYNAMIC ENCOUNTER

The catastrophic action was supposed to have been brought about by a very close passage of another star to the Sun. This assumption has been made in the Planetesimal Theory of Chamberlain (1901) and Moulton (1905), and in the Tidal Theory of Jeans (1919) and Jeffreys (1929). In both these theories, the Sun was once an isolated star without any planet. At a remote epoch, another isolated star moving through space happened to come very near the Sun. These two stars swung about one another and separated again. They came so near together that tide raising forces became great, and huge quantities of matter were ejected from the Sun.

According to the Planetesimal Theory, most of the ejected matter was in the form of small solid particles revolving round the Sun and the present planets have grown by gradual accretion of these small bodies. Chamberlain believed that the planets, except perhaps the largest, were solid throughout, practically from the beginning. In Jeffreys' opinion, the ejected material must originally have been gaseous and very hot. If ejection was continuous, the ejected matter would form a filament and lie within a long narrow range. Its shape will resemble that of a boomerang which is a hard wooden missile used by the primitive races of Australia. Due to radiation the filament began to cool; condensation would begin when the length of the strip already ejected reached a certain value. The ejected portion would then get detached from the main body, and it would

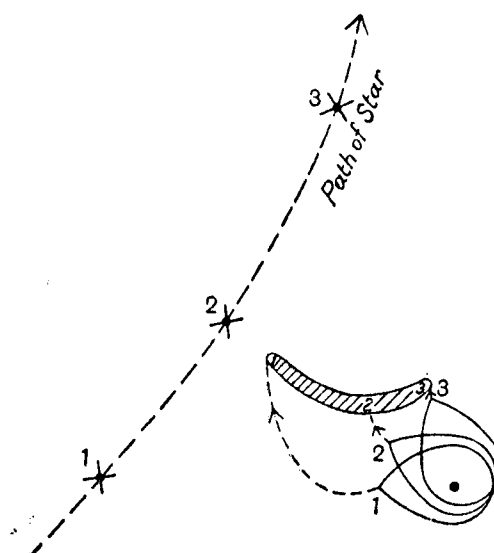


FIG. 1. Diagram of the changes in the form of the solar envelope and the paths of portions of the ejected matter during the passage of the star. ('The Earth'—H. Jeffreys).

then begin its independent existence as a planet. If ejection continued, a second planet would be formed, and others would successively be born until ejection ceased. As the disturbing stars receded, the early planets would retain their identity whereas those which were formed last would fall back into the Sun.

Russell has pointed out a great difficulty which arises in the Tidal Theory when we consider the distribution of angular momentum per unit mass of the passing star, the Sun, and the planets. In order to produce tidal eruptions, the star must have almost grazed the Sun. If it was of the Sun's size and mass, its nearest distance from the Sun could not have been much more than a million miles. Based on these figures if we take the angular momentum per unit mass of the earth to be unity, that of the star is found to be 0.25, and the average angular momentum per

unit mass for the planetary system is found to be 2.63. This is more than ten times as great as that for the star. So it is inconceivable how so much angular momentum can be put into the ejected material by the passing star. This is indeed a fatal objection to the Tidal Theory.

THE "ENTICEMENT" THEORY

On Russell's suggestion Lyttleton (1938) advanced the "Enticement" Theory of the Solar System. The Sun was pictured primarily as a binary star, and its companion had a tidal or "side sweeping" encounter with a third star, and ultimately escaped from the Sun. The visiting star had a large mass (much greater than the Sun) and velocity so as to provide enough energy for the shearing of the planetary material. The Sun was supposed to have been just so far off as to avoid capture by the visiting star, but nevertheless near enough to capture chunks of the planetary ribbon formed between the Sun's companion and the visiting star.

The validity of this assumption has been questioned by Luyten (1939) who showed that if the Sun comes near enough to capture chunks of this planetary material, it will itself be captured by the more massive visiting star.

Bhatnagar (1940) has shown that even under most favourable conditions there would be a catastrophic collision between the three bodies, if they come near enough for a planetary ribbon to be formed.

From astrophysical considerations, Spitzer (1939) has drawn the conclusion that the planetary ribbon, if formed, would dissipate into space in an hour at the most at stellar temperature. Lyttleton (1941) has, however, pointed out that Spitzer has neglected an important factor, *viz.*, the gravitational field of the stars concerned. By taking the attraction of the stars into account, it can be shown that the temperature required to give escape velocities to the particles in the filament would be greatly in excess of the usual stellar temperatures.

OTHER THEORIES

It has also been suggested that our Solar System originated from a heterogeneous nebula of irregular shape. In this case we can suitably select our initial motion and configuration to get our final arrangements of the planets and the satellites in the solar system. The possibilities of such a hypothesis are rather too many and it would be begging the question if we make any assumptions, without giving reasons for them, as any assigned final arrangement can be obtained by making suitable premises about initial motions and configurations.

Nölke (Russell, 1935a) suggested in 1930 that the Sun and the planets were formed almost at the same time from a wisp of a filamentary nebula which had one large condensation and a large number of smaller knots. There is no doubt that certain diffuse nebulae have got wisps or filaments, but their composition is not known. Nor can it be said whether such filament is twisted or lies in one plane, or whether the motion of its parts are coplanar or not. It would not be justifiable to make *ad hoc* assumptions for reasons given in the last paragraph.

Ross Gunn (1941) supposes the planetary system to have been formed out of a rapidly rotating star which would break up by fission preferentially in the vicinity of another star. The difficulty with this theory is that such close encounters in which one of the approaching stars is rapidly rotating with angular velocity almost equal to its critical value for fission are highly improbable.

Recently, Lyttleton (1941) has also considered the question of planetary formation resulting from the break-up of a single stellar mass from rotational instability. He regards the Sun as the distant companion of a close double star whose components had at first merged into a single body, and later on, this mass broke up into a pair of stars due to rotational instability, and a planetary filament was produced between them as they were separating from each other. Lyttleton supposed that the process of coalescence was brought about by accretion of inter-stellar matter. It may be mentioned here that Atkinson (1940) had earlier questioned the possibility of such a coalescence.

THE FREQUENCY OF PLANETARY SYSTEMS

It is worthy of remark that all these theories have one feature in common, *i.e.*, the birth of the planetary systems must be an exceedingly rare event. Moreover, as Spencer-Jones (1940) has said, in these theories "so many special assumptions are involved that the Solar System had a very narrow escape from never coming into existence." According to his older theory, Jeans (1929) estimated that in the whole of the galactic system, planetary systems come into being at the rate of about one in five thousand million years.

Two different time-scales have been proposed for the age of the Universe. Those who believe in the long-time scale maintain that the evidence provided by the physical conditions and the distribution of stars in the galaxy suggest an age of at least 10^{12} years for these bodies. We may call them "trillionaires". Others believing in a short-time scale argue from the theory of relativity that the age of the Universe must be between 10^9 and 10^{10} years. They may be called "billionaires". Whittaker (1942, *Beginning and End*

of the World, Riddel Memorial Lectures) has recently suggested an intermediate time-scale, *viz.*, 5.10^{10} years for the age of the Universe.

As a rough estimate we may say that the chance of forming a planetary system for a given star of ordinary size is one in 5.10^{17} . If we allot an average age of 5.10^{12} years to stars on the "trillionaire" scale, we find that only one star in 100,000 can have found a planetary system in the whole of its life, so that only about one star in 100,000 is at present surrounded by planets. If we take an average age of 5.10^9 years, on the other hand on the "billionaire" scale, we see that only one star in a hundred million can have a planetary system in the whole of its life, so that only one star in a hundred million is at present surrounded by planets. On the Tidal Theory, planetary systems are, therefore, "freak formations" of nature.

It is believed that our galactic system, which comprises the whole of the Milky Way, is a spiral nebula, rather bigger than the Andromeda Nebula. If viewed from outside, the coils of the Milky Way will give the same spiral appearance to our system as the coils of Andromeda Nebula. It is also believed that our galactic system contains stars of the order of one hundred thousand millions in number.

With Jeans (1929) we may regard that roughly the stars of the galactic system consist of about a hundred million packed as closely as the stars in the neighbourhood of the Sun, and a far greater number scattered far more sparsely in space. In the former group of the hundred million stars, under the long-time scale for the age of the Universe, there can be about a thousand stars surrounded by planets, and on the short-time scale, there can be only a single star surrounded by planets. In the latter group of stars of the galactic system, the stars are so sparse that the chance of planetary systems coming into being may be almost neglected.

It need be hardly mentioned that the encounter between two stars is much less probable on Lyttleton's "Enticement" Theory (1938), and the chance for the birth of a planetary system is practically nil.

JEANS' NEW THEORY

Recently Jeans (*Nature*, June 20, 1942) completely changed his faith. He now believes that a far larger proportion of stars than what was imagined before must be accompanied by planets. Life may be incomparably more abundant in the Universe than what was thought before. Out of the vast total number of stars, there must be millions which are almost exact replicas of our Solar System, and that millions of their planets must be almost exact replicas of our earth. According to Jeans, there must have been a time in the remote past, when the Sun, then

rapidly contracting, extended to thousands of times its present radius. It was still a semi-nebulous mass. If the original radius of the Sun was n times its present radius, then the chance of planets being generated by a tidal encounter of the type contemplated by Jeans' new theory would be n^2 times as great as that given by his older theory. According to the new theory of the various planetary systems of the sky, the vast majority were formed when their Suns were still in the semi-nebulous state.

If the original Sun extended up to the orbit of Uranus, a little calculation will show that the chances of planetary formation would be seventeen million times as great as now. Then, according to our former calculations, in the long-time scale, all the stars of the galactic system would have planets 170 times over, and each star must have experienced encounters at least 170 times since its birth. This is inconceivable. On the short-time scale, one out of every six stars should have a planetary system. This, too seems to be over-generous.

THE CEPHEID THEORY OF THE ORIGIN OF THE SOLAR SYSTEM

It has also been suggested that the raw material which ultimately formed planets was shot out of the Sun by powerful internal forces. If there were sufficient initial impulse, the planets could easily have been formed at their present distances, while the attraction of a passing star would set them revolving in their present orbits. In a recent paper, the writer (1942) has shown how a state of dynamical instability can be brought about in a star which would result in the ejection of matter to planetary distances and in the formation of planets.

The Sun is supposed to have been originally part of a Cepheid Variable of about nine times its mass, oscillating with small amplitude. The Cepheid Variables form a class of stars which vary periodically in brightness owing to an actual pulsation, or periodic change in the size of the star, the period being anything from a few hours to a few weeks. Delta-Cephei (δ -Cephei) star is a typical star of this class with a period of a little over five days.

The near-by passage of a star of about the mass of this Cepheid increases the amplitude of the Cepheid oscillation. The passage of this second star need not be grazing or very near, but only sufficiently near to produce appreciable tidal protuberances in the original Cepheid. So long as the amplitude remains small the pulsation of the Cepheid is stable, but if the amplitude increases, due to the tidal protuberances, the pulsation remains no longer stable, and matter comparable to the Sun's mass may be ejected from the parent Cepheid, as the writer has shown. It has also been shown that the visiting star can have sufficient

angular momentum to impart the necessary amount to the planets. It has been calculated that the Solar System will have to take about two-fifths of the energy of the parent Cepheid to escape from the latter. The parent Cepheid will also get a planetary system of its own. As the visiting star need only pass at a moderate distance from the Cepheid, the birth of a planetary system is much more probable on the writer's theory. In fact, his theory has been wound up with the following remarks, "one conclusion seems to be irresistible, if the theory be correct in its essentials, there may be more planetary systems than at present supposed."

ELECTROMAGNETIC AND NUCLEAR THEORIES

Alfven (1943) has recently suggested that the planets were formed out of interstellar matter which had probably originated from a gas cloud once surrounding the Sun and fallen towards it through its attraction. As soon as this matter became ionized by heating due to gravitation, it was stopped by the action of the Sun's magnetic field. The main portion of the matter accumulated at a distance r from the Sun when the gravitational energy balanced the ionization energy. It is found by calculation that this distance is approximately equal to the mean distance of Jupiter from the Sun. It is also claimed that this theory accounts satisfactorily for the distribution of angular momentum among the various planets of the Solar System.

Fesenkov (1944) has suggested that at different intervals in the life history of the Sun various energy-producing nuclear reactions occurred at critical periods and caused sudden contraction of the Sun resulting in the ejection of material from which planets were formed.

DISCOVERY OF NEW PLANETARY SYSTEMS

Theory has thus given us conflicting verdicts on the question, "Are there other planetary systems than our own?" Observation had not so far disclosed any. In fact, Russell (1935) said that even if there be any planetary system in some of the distant stars, they would not be visible even through most powerful telescope we can construct. Proxima Centauri, the star nearest to the Solar System, is at a distance of 4.3 light years, *i.e.*, about 24 trillion miles from us. The light year is the distance which light travels in one year at the speed of 186,285 miles per second. It is equivalent to 5.88×10^{12} miles or 5.88 trillion miles. Kothari has shown that Jupiter probably represents geometrically the largest piece of cooled matter that can in principle exist in the Universe. So no star can have a planet bigger (geometrically) in size than Jupiter. But there is

nothing to prevent a planet from having a mass greater than that of Jupiter. Proxima Centauri has a mass approximately equal to one-seventh of Sun's mass. It is a faint star whose intrinsic brightness is much less than that of our Sun. It has a visual magnitude 10.5. The apparent brightness of a star is described by the term "visual magnitude". A star having a lower "magnitude" is brighter than one having a higher "magnitude". A star of the first magnitude is 2.512 times as bright as a star of the second magnitude. Stars and heavenly bodies very much brighter than stars and of the first magnitude will have negative magnitude. For example, it may be mentioned that the visual magnitude of Sirius (Dog-star) is -1.6; of Venus, about -4; of the Full Moon, -12.5; and of the Sun -26.7. A standard candle at a distance of one metre is of magnitude -14.2. Faint stars up to 21st magnitude and not more can be photographed with the hundred-inch telescope at Mt. Wilson. The visual magnitude of Jupiter as it appears to us is -2.2. If Proxima Centauri has a planet equal to Jupiter in size and brightness as it appears to us, a little calculation will show that it will have a visual magnitude 22. So such a planet cannot be photographed by the Mt. Wilson telescope. Nor can it be seen through such a telescope which can barely show stars of the nineteenth magnitude. Even if there be a brighter planet whose visual magnitude is less by two or three integers it cannot be detected either visually or photographically through the most powerful telescope in use now through the close proximity of the parent star which is relatively a much brighter body.

It is, therefore, both romantic and most welcome that news has come from America of the discovery of two planetary systems outside our own Solar System. From the study of parallax observations, Dr K. Aa. Strand (February, 1943) has detected the presence of a planetary body in the 61 Cygni system. 61 Cygni is a well known double star of the fifth magnitude in the constellation of Cygnus. This star is historically important as in 1838 Bessel made the first reliable measure of its parallax and obtained its distance from the Sun. Its distance from the Sun is 10.9 light-years.

Generally the two members of a double or binary star are of unequal brightness. The brighter star is called the primary and the fainter is called the companion. The orbit of a binary star is defined to be the elliptic orbit which the companion will describe relative to the primary. In 61 Cygni system, the primary star has the visual magnitude 5.57 and the companion has the visual magnitude 6.28. Both the star and its companion have mass about half of that of the Sun. The period of this binary star is 740 years and the length of the semi-major axis is 84 astronomical units, an astronomical unit being the

semi-axis major of the earth's orbit or 9.29×10^7 miles approximately.

Measurements were made by Dr Strand on a large number of photographic plates of 61 Cygni taken over a dozen years. The measures on the newer plates, if reduced on the assumption that the system consists of only two components, and statistical calculations based on them reveal certain features which show that the orbit of the visual pair has deviations from Keplerian motion which can only be explained by assuming that a third invisible body of small mass, which may be designated as 61 Cygni C, revolves round one of the two main components. It is not yet known to which of these components this small body 61 Cygni C, or the planet is attached. As both the main components have closely similar masses, so whichever is used as the primary star or the Sun for the planet in computing the elements of its small orbit, the same result will be obtained. It is found that this planetary body has a remarkably small mass, only one-sixtieth that of the Sun, or approximately sixteen times that of Jupiter. It has mass about one-tenth that of the lightest known star, Krüger 60 B. It has also a very low luminosity. It revolves in a highly eccentric orbit ($e=0.7$) of semi-axis major 2.4 astronomical units. This is the first time that a planetary body belonging to a system other than our own Solar System has been detected.

In January 1943, Reuyl and Holmeberg announced the discovery of an even smaller planetary body in the system 70 Ophiuchi which is also a binary star in the constellation Ophiuchus at a distance of about 17 light years from the Sun. The semi-axis major is about 23.5 astronomical units with a period of about 18 years. Measurements were made on a large number of plates. It was observed that deviations from the binary orbits were markedly periodic both in right ascension and declination; a period of about 17 years was deduced, amplitudes being 0.014. The visual magnitudes of the two main components are 4.3 and 6.0 and their masses are also different. It has not yet been found out to which of the two components the planet is attached. If it be attached to the primary having a mass 1.1 times that of Sun, its orbital radius would be 6.8 astronomical units, and its mass will be 12 times that of Jupiter. If the planet be attached to the companion having a mass 0.7 times that of the Sun, its orbital radius will be 5.9 astronomical units and its mass will be 8 times that of Jupiter. In 70 Ophiuchi, the size of the binary orbit is about 3.5 times that of the planetary orbit. So the stability of this planetary orbit in the above star seems to be a little doubtful.

It may be mentioned here that a theory of the origin of the binary stars has recently been advanced by H. K. Sen (1941-2) on the lines of the writer's Cepheid Theory (1942) of the origin of the Solar

System. A Cepheid which had originally a uniform density is supposed to have broken up into a double star system on account of increase of angular velocity brought about by contraction due to radiation of energy. The recent observational fact of two binary stars being endowed with planets seems to corroborate the Cepheid Theory of the origin of the binary stars. It may not be out of place to mention here that Cepheids are found in both the Constellations of Cygnus and Ophiuchus.

LIFE IN OTHER WORLD

To the other question set at the outset—about life in other worlds, we can scarcely say a conclusive word. Life, as we understand it, can exist only in those parts of the Universe where existence of matter in all the three states *viz.*, solid, liquid, and gaseous, is possible; and the temperatures and physical conditions are very similar to those observed on the surface of our Earth. Let us first examine the possibility of existence of life in the planets of our Solar System.

Of the inner planets, Venus appears to be the best suited to be the abode of life such as exists on the Earth; yet for some reason life has never developed there. The absence of oxygen in the atmosphere of the planet is perhaps mainly responsible for non-existence of life there. On the dark side, Venus may have a temperature of about -23°C , and on the bright side 57°C . These temperatures are not unsuitable, however, for the existence of some kind of life.

Among the outer planets, Mars is the only one where it may be possible for some form of life to exist. Jupiter has a mean surface temperature of -138°C , and it is too cold for any sort of life to exist there. Saturn and the other planets are still colder.

Mars is colder than the Earth, but the warmest portions during summer in Mars may have a temperature as high as 25°C at mid-day, but the temperature is likely to fall so low that everything must freeze up hard every night. These conditions, therefore, would be very unfavourable to most of the forms of life that have developed in the more genial climate of the Earth. But it is very probable that some sort of vegetable life similar to that of our Earth might exist in Mars. That animal life may exist in Mars is not wholly impossible as some low forms of life can endure the Martian temperature and physical conditions.

There is no doubt that Mars has got an atmosphere. Recent observations show that there are only traces of oxygen in the Martian atmosphere. Clouds and fogs, though comparatively rare on Mars, have been observed many times in its atmosphere. Many of the surface markings of Mars show seasonal changes. Polar caps or the brilliant white patches

over the poles of Mars shrink considerably in Martian summer and become extended in winter. It is quite possible that these caps are composed of snow or frozen water; much of it melt in summer. The temperature of the polar cap in winter may become as low as -70°C . Dark regions are also observed on the surface, which undergo seasonal changes in shade and depth of colour from greenish to yellow. It is quite possible that these regions indicate vegetation. A large number of more or less linear markings are also observed on the planet's surface. The American astronomer Percival Lowell and the Italian astronomer Schiaparelli thought that these markings are straight, narrow, uniform in width, and connected with one another in definitely geometrical arrangement. They called these the "canals" and suggested that these canals must be the products of intelligent design whose execution required engineering skill of a high order. There are also many small dark regions at the intersections of these canals.

There is progressive darkening of the canals and oases, in summer, after the melting of the polar caps. Lowell, therefore, thought that they were irrigating channels along which water was conducted in all directions from the poles to the equator and beyond in summer. This water must have been propelled artificially, and intelligent beings who constructed the canals were still operating it. Other astronomers like Barnard and Antoniadi believe that these so called canals are not canals, but they comprise a number of irregular patches. The appearance of linear markings arises from the integration, by the eye, of details too delicate to be seen well singly.

The absence of oxygen in the Martian atmosphere beyond traces conclusively shows that higher forms of life are at present non-existent in Mars. In some

remote past, when the amount of oxygen in the atmosphere was adequate to maintain life, intelligent beings with highly developed civilization might have existed there.

In accordance with recent theories, there may be many more planetary systems in the Universe and there may be many planets which are almost exact replicas of our earth. Life might have developed on these, as it has done here, and it might have followed the same path as our terrestrial life. Life in some of these planets may be much more highly developed than ours, and who knows that even four hundred years after Copernicus "we may be the most ignorant cosmogonist in the whole of space."

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DR. BURNS ON AGRICULTURAL DEVELOPMENT IN INDIA

IN pursuance to the agreement arrived at by the Committee of Agriculture, Forestry and Fisheries of the reconstruction committee of Council, this comprehensive memorandum "on the technological possibilities of agricultural development in India" is prepared by Dr W. Burns, D.Sc., Officer on Special Duty, Department of Education, Health and Lands, Government of India. This document forms the basis of an "All-India Policy of Post-war Agriculture" and forms the raw materials for discussion by the reconstruction Committee.

The subject-matter dealt with is divided into two sections: (1) crops and (2) livestock. So far as the crops are concerned the report has taken into

consideration both (a) the food crops and (b) cash crops. The past and present crop production data of the principal crops mainly in British India over the last three decades is fully illustrated by means of tables and graphs. These graphs deal with (a) acreage and production of principal crops in India, (b) total area and total production of major food grains and population of India, (c) acreage and production of particular crops in the provinces, where they are most important, and (d) production of major food grains for each province with the population of the province. The graphs and tables are important not only as showing actual production, seasonal effects and trends but also as data for the

discussion following. In every case years of maximum and minimum production and acreage with the causes of any violent fluctuations are indicated. Fluctuations are most marked on crops which depend on rainfall. The cash crops are affected by the prices prevailing in the previous year.

In India, as a whole, population is increasing more rapidly than the production of food crops. This tendency is most marked in Madras and least so in the C. P. Many Indian States do not prepare agricultural statistics at all, excepting a few that represent only 56 per cent. of the area and 67 per cent. of the population of all the Indian States.

Dr Burns has tried to assess the technological possibilities of increasing the crop yields per acre which research has shown to be possible (1) by using improved varieties of seed, (2) by application of manure and, (3) by protection from pests and diseases. He has actually estimated the extent to which the present average yield per acre could be raised if all these known methods of improvement are put into effect.

Thus in the case of rice, the average outturn of rice per acre during the last five years was 738 lbs. At a conservative estimate, this yield can be increased by 30 per cent, *viz.*, 5 per cent by using improved varieties, 20 per cent by increasing manure and 5 per cent through protection against pests and diseases, or even up to 50 per cent, *viz.*, 10 per cent by variety and 40 per cent by manuring. This would raise the production of rice to 959 lbs. per acre and Dr Burns suggests that India should aim at an average of 1000 lbs. of rice per acre—an average already achieved in some provinces of India.

It is significant that in one province of India, *e.g.*, Coorg, the ordinary cultivator manages to produce about 1,254 lbs. of rice per acre and a certain well-managed Indian State in Coorg produces 2,608 lbs. per acre. In addition to suitable soil and climate, the main factors for this high yield are (1) use of a high yielding variety and (2) manure and water.

Similar estimates of increased yield of other principal crops, *viz.*, wheat, jowar, bajra, maize, gram, pulses, linseed, brassica oil seeds, ground nuts, castor, sugarcane, cotton, jute and tobacco are given. No statistics of acreage and yield for fruits, vegetables and potatoes are as yet available. Given disease-free seed-potatoes and suitable manuring, the production of potatoes on the existing acreage can be doubled.

In 1941, the I. C. A. R. attempted to introduce improved seeds of rice and better cultural practices, so as to increase the outturn per acre and gradually increase the acreage by bringing more land under cultivation in Madras, Bengal, U. P.,

C. P., and Orissa. But this scheme has been somewhat overshadowed by the "Grow more food" drive, which aims at increasing acreage and yield of any variety whatsoever.

The effect of the "Grow more food" campaign of 1942-43 is summarized. Of the main food grains, *viz.*, rice, wheat, millet and maize, the acreage was increased over previous year by 8,400,400 acres and the production by 3,856,000 tons. In addition to increase in area of cultivated lands, a large portion of land under cotton cultivation was diverted to food production.

Propaganda, financial assistance by the Government, a favourable monsoon and conditions favourable for sowing and maturing are the factors responsible for this large increase in the area under food grains, and Dr Burns suggests that a combination of persuasion, concessions, and compulsion is best calculated to bring more lands under cultivation.

LIVE STOCK

An estimate is made of milk production by cattle, buffaloes and goats, production of eggs by poultry and the annual production of cattle manure. As in the case of food crops, the technological possibilities of increasing milk production, which scientific method has shown to be possible, are indicated. Milk production can be increased by 75% *viz.*, (a) 30% by feeding, (b) 15% by breeding, (c) 15% by management, and (d) 15% by control of diseases.

Making full allowances for the fodder available at present, there is a deficiency in both (a) *concentrates* consisting of oil cakes, seeds, brans and pollard and (b) *roughages* consisting of special food crops like jowar, natural grasses available and straws of food crops. Available supply of concentrates and roughages are sufficient for only 29.14 per cent and 78.53 per cent, respectively of the existing cattle population.

There are 85,000 sq. miles of forest grazing in India, but this is accessible to only a small percentage of animals. This source should be developed and reserves of fodder built up against famines.

THE SHAPE OF THINGS TO COME

In agricultural development, two objects must be clearly held in view *e.g.*, (1) abolition of the poverty of the cultivator and (2) abolition of the poverty of the soil.

To achieve these objectives it is necessary to save all wastage of fertilizing material, water, soil, etc. and utilizing these to the maximum capacity. It is further necessary to strengthen the provincial and State departments of agriculture and a collective action in such matters as soil conservation, control of pests and diseases and wild animals.

Dealing with manures, Dr Burns observes that Indian soils have become stabilized at a comparatively low level of production. It is not difficult to ensure increased yield specially by manuring with nitrogen from its various sources, *viz.*, (1) farmyard manure, (2) compost made of vegetable matter, with a small amount of cowdung, (3) urine earth from cattle byres, (4) compost made from town refuse, utilising town night soil, (5) green manuring, (6) oil cakes, (7) bones, (8) molasses, (9) other types of industrial waste such as cotton mill waste and (10) artificial manures, specially sulphate of ammonia. An estimate is made of the different kinds of manures available, many of which, *e.g.*, compost, is very inadequately utilised. "If the Chinese cultivator can apply to the land every scrap of available fertilizing material, so can the Indian cultivator. It is only a matter of discovering the best way to do it."

A rough calculation is also made for the quantity of manure which would be required for each of the main crops requiring such manurial treatment as is advocated by Dr Burns himself. So far as nitrogen is concerned, the total required for the principal food and cash crops, is estimated to be about 2.6 million tons every year and this could be had from 13.2 million tons of sulphate of ammonia (N=20%) or 526 million tons of farmyard manure (N=0.5%). He has however not stated the requirements for phosphates or other major plant nutrients.

India is maintaining about 200 million heads of cattle, which can be expected to produce 500-600 million tons of farmyard manure—which amount is quite sufficient to meet the manurial requirements of all our crops. The present position, is however, not so satisfactory, since more than half of the dung is being used as fuel, in farms, villages and towns. The present annual production of farmyard manure in British India is estimated to be about 250-300 million tons, and is enough to supply 1.0 ton of this manure per acre of cultivated land. We are at present deficient by about 250-300 million tons of this manure.

The answer to the ravages of insects, pests and diseases is the production of resistant varieties of crops where possible, but so long as that ideal method is not achieved, the use of more insecticides and fungicides is advocated.

The memorandum is concluded with some remarks on mechanization. For certain special operations, *e.g.*, original clearing of land under jungle, the eradication of deep rooted weeds, anti-erosion work and for cultivation on large estates, the use of power machinery in India is economical, but bullock-drawn implements must continue to constitute the main weapon of cultivation in this country.

A. K. G.

THE PROBLEM OF REHABILITATION

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A survey was carried out by the Anthropology Department of the Calcutta University during 1942-43, regarding the effects of the famine and the lines on which rehabilitation work should proceed. It was pointed out in a statement issued on the basis of the data collected that in many of the affected areas about thirty per cent of the small peasants had lost their land and that the proportion of fishermen who had lost boats, nets or fishery rights came to about twenty per cent. The estimates were prepared on the basis of a limited survey and are therefore subject to some revision. But they indicated the lines on which rehabilitation work should proceed, even though more exact figures available from an extended sample survey might modify the percentage. The complete results of the survey on a wider scale now in progress are not yet available for publication. But the earlier data, and what has been available

since then regarding the economic condition in the affected areas permits us to indicate certain requisites for rehabilitation which have to be mentioned now in view of decisions already taken in this regard. Apart from short term relief, the principal requisite for the peasant who has lost part or whole of his small holding, is the restoration of his land. By an ordinance, now regularised by legislative measures, the Government have authorised restoration of land, distributing repayment of it in ten annual instalments. In the original note issued by the Anthropology Department it was pointed out that an ordinance or a law simply permitting restoration of land is inadequate. A peasant sells his land by which he lives, only when he has used up all his reserves—the few silver ornaments his womenfolk may have, the brass or porcelain pots and pans, and even his livestock. It is not possible for such a person who has thus

thrown himself on the labour market, as an unskilled labourer, to save up enough funds to deposit a sufficient amount to repurchase the land. According to the enquiries conducted by Kantungoes for the Floud Commission, nearly three fifths of the cultivators are small peasants with holdings of less than three acres, and the large majority of them do not possess even two acres of land. As a family cannot live on the land unless the farm is at least five acres in area, most of these families have to try to supplement their earnings by agricultural labour and subsidiary occupations. Estimates of income by the Bengal Banking Enquiry Committee as well as by Honourable Sir Azizul Huq (man behind the plough) indicate that these agriculturists cannot live by what they earn. The intensive work in the villages of Bogra (unpublished) by Mr Ramkrishna Mukherjee as a research scholar of the Anthropology Department, and his later work in Noakhali in connection with my limited survey (published in *Science and Culture*) support these conclusions and clearly bring out the chronic poverty and progressive deterioration of the condition of the peasantry even in what are held to be normal times. The poorer peasants have been steadily losing land in favour of the non-cultivating owner and this tendency has been accelerated, by the inflation and famine. In such circumstances, a permissive measure, without State help will be of very little use. The upper limit of the value of the land—Rs. 250/- is also too low. It will exclude from even the little benefit the special legislation can confer, the peasant who has parted with more than half an acre of land. The only real help that can be offered and be of use, will be available if the State comes forward to help with interest free loans on a long term basis, as a relief measure. Otherwise even the beginnings of rehabilitation cannot be made. It should be clear, that such relief should be for the poorer peasants, in the main. Our enquiries among the peasantry suggest that the Government loan has formed less than one tenth of the total borrowings for food, and even the little help given has not been in favour of the most needy.

From the point of view of permanent restoration of villages to an economic level in which they can live, much more has to be done besides restoration of land. Seeds, cattle and manure are now beyond the means of most small peasants; later on they may be able to pay for these or obtain plough cattle by hire. But owing to their marginal position on the borderland of want, they have to pay more for all their requirements, and get very hard terms when credit is needed. The only remedy for this is to encourage the formation of co-operatives for production as well as for purchase of necessities. Another important need is protection from superior landlords. At present, if the landlord gets *khas* possession of any

land, he is at liberty to settle it on any one. Often the choice goes to non-cultivating owners who are better off. The result is that the genuine cultivator can get land only as a *bargadar*, with half share of crops. Lack of protection in this respect can render inoperative beneficial land laws. Thus the land laws in the Punjab have to a great extent been rendered abortive owing to the failure to discriminate between cultivators and non-cultivating owners who employ labour to till their land or use the *bargah* (crop sharing) system. Even where the land has been actually reclaimed by the peasants, from the waste by co-operative drainage or embankment, with help from other sources (such as relief organisations) the local zamindar has been found to settle the land with other persons. In the old Hindu period the man who reclaimed the land had the first right to it, and the State or landlord received the rent only for protection and care of the peasant. Neither of them had the right of absolute disposal of such reclaimed land. Only if the fields were left fallow *i.e.*, practically not used could any interference take place. In the period of Muhammadan rule, these principles were not violated. They have continued to operate under British rule among our tribal people like Khasis and Mundas, and have been enforced by special legislation by the Government of India in the excluded areas like Santal Parganas or Kolhan. Our ordinary peasantry of the so-called advanced social groups are equally in need of similar protection. Land revenue officials who have administered partially excluded areas are well aware of this necessity. In an official report (which is now forty years old) on the need of protection of tribal people, it was stated very frankly by a British Director of Land Records that the great majority of Indian cultivators required to be protected, just like tribal people, in the matter of land tenure and transfer. In the Punjab, some protection has been given by the Land Alienation Act which prevents the transfer of land from the possession of one agricultural group to another or to outsiders. The consequent lack of credit is however a disadvantage to the small peasant who cannot earn enough to lay by for emergencies. The only remedy for this lies in the formation of co-operatives of cultivators with guarantee of a certain amount of Government loans at a low rate of interest. Otherwise, the peasant will have to go to a money-lender and suffer the evils consequent upon it. Legislation preventing transfers to non-agriculturists will merely lead to the growth of a class of money-lenders drawn from the richer peasantry. This has actually happened in the Punjab and it has been stated that this defect in Land Alienation laws in that province "has created a class of agricultural moneylenders who are even more rapacious than the non-agricultural moneylenders and that it has allowed the big land-

holders to buy up the small holders, who are the very men that stand in most need of protection".

Even in the so-called protected areas, considerations of revenue override that of welfare. In the Damin-i-Koh the Santal cultivator holds his raiyati land so long as he pays the rent and keeps the holding in a proper state of cultivation. No eviction can however occur without the sanction of the Deputy Commissioner. When a raiyati holding falls vacant for any reason, it has to be settled as follows, preference being given in the order mentioned.

- (a) with a resident jamabandi raiyat of the same community;
- (b) with the headman if no resident jamabandi raiyat is available;
- (c) with a non-resident jamabandi raiyat only if no one of categories (a) and (b) are available.

While the solidarity of the village community and some protection of the rights of the tenant are thus ensured, certain other difficulties remain. It so happens that in the Santal and other Reservations, sufficient uncleared forest land is still available for cultivation. Hence an industrious peasant can make a living. Arrears of rent should not therefore normally occur. But in the developed areas, and among non-tribal peasantry, there is no such margin of land. Until long term rehabilitation can be effective, there must be provision for periodic help to the poorer peasantry. To evict such a peasant for failure of rent in a bad year is to turn him out to beg or to die.

The problem of the poor peasant can be temporarily and partially solved if the land laws are basically amended and certain other provisions made. It should be made compulsory to settle all vacant holdings with a resident cultivator of the same village, and not with non-resident cultivators or non-cultivating owners. If there is any co-operative of cultivators, it should receive preference. As landless agricultural labourers like to settle down as cultivators, there will be no dearth of suitable tenants. Regarding arrears in bad years, there should be a system of insurance against eviction. The incidence of the land rent on the actual cultivator is already high enough and should not be enhanced any further. But the unearned increment which goes now to the Zamindar and jotedar owing to the Permanent Settlement, as the result of clearing of uncultivated waste, and higher prices of crops, can certainly be tapped for this purpose. The State now gets about three crores of rupees as revenue and cess from land, and the landlords about seven crores and a half, after deducting expenses of management. Of this amount,

at least two crores may be considered to be a fair estimate of the unearned income, which would have been available to the State if permanent settlement had not been adopted. An insurance fund may be created by imposing a cess on the Zemindari revenue, so long as the present system is in force. A portion of the ordinary Government revenue being the realisation of the State's share from the cultivator, should also be contributed for this purpose. The actual incidence of rent in different parts of Bengal should be mentioned in this connection. The incidence of rent in the less fertile tracts of Western and Central Bengal is much higher than in the more productive areas in Eastern Bengal. Often they are three times as high as the rent in the more favoured areas. A revision of the rent on rational lines on a uniform basis will not it is believed, affect the revenue of the State.

All these are however temporary devices. Permanent improvement can come only if (a) the land is made more productive and (b) the pressure of population on land is less. Co-operative agriculture, with manuring, and irrigation can increase the yield by at least fifty per cent. But large tracts in Western and Central Bengal cannot be irrigated unless the State takes up a planned project. More than twenty years ago, engineers of the Government Irrigation Department recommended the building of huge irrigation reservoirs to store the vast volume of water that drain into the Damodar and Barakar, during the rainy season, from the Chota Nagpore division and flood Western Bengal. Such a project can save Western Bengal from inundation and also provide irrigation facilities during the dry months to a large tract of otherwise fertile land, where no second crop can now be grown. There is some talk of constructing dams for irrigation and power now in connection with the plan for building up of an industrial belt in Chota Nagpore on the lines of the Tennessee Valley scheme. Every attempt should be made to expedite the irrigation project for Western Bengal in this connection.

The second desideratum, of reduction of pressure of population on land can be attained only if other sources of income are opened up for those who have had to fall back on land or work on land owing to failure to make a living in their traditional occupation. Artisan castes and artisan families like potters, oilpressers, and weavers have been thrown on the land steadily during the past hundred years owing to competition with machine made products and substitutes. Only a small proportion of these people have been absorbed in industry.

The remedy is obvious—industrialisation. Some hardship is of course inevitable during transition from a culture based on individual production of

handmade goods to an industrial regime. It will however be much less than the chronic long drawn out agony of universal poverty due to lack of modern development. In our country, unfortunately, industrialisation has been deliberately hampered to favour the business interests of foreigners. This is happening, even now, during the present war, when the undeveloped industrial organisation of India is a handicap to war supplies for the far eastern front. An influential section of Indian political opinion is also against industrialisation; mainly on the ground of the evils brought in train by uncontrolled machine production. Unless however we have a sufficiency of goods of various kinds produced in our country to meet our requirements, the problem of poverty cannot be solved. At the same time, the production and distribution must be in the interest of the actual producer and the consumer. This can be ensured by control over big industries and by encouraging artisans' co-operatives for production. Competition between large scale factories and producers' co-operative will also have to be replaced by co-ordination through control over industry. If these steps are taken, many of the evils of industrialisation found in Western Europe will be avoided.

In connection with the question of rehabilitation I have so far dealt with the case of peasants. Special mention should however be made of another community, as their case in one respect is comparable to that of peasants, or is even worse. It is that of fishermen. This community is in a very precarious economic condition owing to lack of legal protection of their proper rights. The fishery rights in small rivers or *beels* or even bigger waters is permanently settled areas belong to the tenure holders or Zemindars who lease them out to others. It appears from the Report of the Special Fishery Officer that "there is no limit to what can be exacted" of the actual fishermen, for fishing rights. Even the humble earnings made by fisherfolk in these circumstances was hard hit as the result of the denial policy of 1942-43 which led to over twenty thousand boats being put out of commission. The occupation of fishing, as well as of working as boatmen ceased to be possible in a very large number of cases. These men who had never done any agricultural labour were thrown on a market already glutted by labourers. Yarn needed for nets increased four or five fold, or even more in price, and was impossible to obtain for fisher families, acting in small groups of two or three. Even as late as December 1944 yarn at controlled rate was not available to fishermen in many areas. The Government have authorised, it is understood free grants of rupees fifty or so to a limited number of individual families to help them to re-equip themselves for work. But this will only meet the need as regards nets.

Boats are essential for fishing all the year round. Otherwise, fishing has to be limited only to the rainy season and a couple of months following it when fish abound in shallow pools by rivers and *beels*, and nets can be used from land for moderate catches. Large number of fishermen in Bengal, who used to fish throughout the year have been reduced to such limited work and forced to supplement their earnings as best as they can as agricultural labourers. It is true the Government are building boats in their yards to send to fisherfolk and boatmen. The quality of timber used is however reported to be unsatisfactory. Even if the boats are of good quality, the price of these will have to be recovered on a long term basis with subventions by Government. Here again co-operatives and co-operative guarantees will be found helpful. Purchase of yarn can also be satisfactorily made through such organisations. A third point which has so far been neglected by Government, is the question of fishery rights. Many fishermen have lost even the little right they enjoyed in these respects, through failure to pay rent during the famine year or even earlier owing to rising prices of food grains and yarn, without a corresponding rise in the price of fish. Restoration of such fishery rights is essential. Another measure in this connection is equally necessary. Zemindars generally settle fishery rights by auction to the highest bidder, who is often a person who employs others to work the *beels* or rivers, or sublets them to actual fishermen at an exorbitant rent. The practice is similar to that of settling vacant holdings with non-cultivating owners, and is even more unjust as there is no legal limit to the fishery rent. These evils ought to be removed by legislation which should enforce priority in the matter of leasing of *beels* and rivers to local fishermen, and failing them, with other fisherfolk. Where there is a local co-operative organisation of fishermen, preference should be given to it.

We have so far discussed the problem of rehabilitation. But it was mentioned in the beginning that the discussion was being carried on apart from the question of short term relief. Owing to the death of a much greater number of able bodied men than of women (roughly twice the number of women), a large section of the population of women and children have been deprived of the earners who supported them. The incidence of sickness has also been high—nearly fifty per cent in the course of a little over a year, and often lasting for months. As the earners have been affected as much as dependants, it is evident that a large section of the population is left without means of support during a good part of the year. Relief, especially for women and children will therefore have to be continued. Medical help also has not so far proved adequate in spite of the work

done by non-official as well as official agencies. It should be extended. Failure to provide sufficient medical relief will accentuate the economic distress and increase sickness in its turn. The disintegration of family life in the more affected areas and the increase in the number of helpless women who are

taking to a life of shame, will not be stemmed unless all these measures are seriously taken in hand, and the official and non-official agencies apply themselves to the work, in collaboration. It will be a hard job even then, in the present conditions. But like many other hard jobs it has to be tackled and put through.

NEW NOBEL LAUREATES IN PHYSICS

PROF. OTTO STERN

THE award of the Nobel Prize in Physics for the year 1943 has been made to Prof. Otto Stern of the Research Laboratory of Molecular Physics, Carnegie Institute of Technology, Pittsburgh, for his contribution to the development of the molecular ray method and the discovery of the magnetic moment of the proton. He developed the technique of the method in the Institute for Physical Chemistry in Hamburg before 1933 when he had to leave Germany due to unfavourable political situation. Although beams of neutral molecules moving with thermal velocities were first produced by Dunoyer in 1911, the full realization of the distinctive features of the molecular beam method is due to Stern. To obtain a collision free molecular beam we have to work at very low pressures and the intensity of the beam is very low. Also the energy of the thermal molecules is not sufficient to affect a photographic plate, and the methods available for detecting charged particles cannot be used for detecting neutral molecules. Special methods have, therefore, to be devised for detecting molecular beams. One of the earliest methods is to place a cold target in the path of the beam, the molecules condensing on the target. This was the method applied by Stern and Gerlach in the celebrated Stern-Gerlach experiment which demonstrated the space quantization postulated by quantum theory. The same method of detecting the beam was used by Stern in his experiment on the verification of Maxwell's distribution law, and to detect the pressure of light on a beam of sodium atoms.

The condensation method, however, is not quantitative and does not allow a survey of the intensity within the beam. Stern, therefore, developed very sensitive manometers. A chamber is placed in the path of the beam which is allowed to enter it through a narrow opening. An equilibrium pressure is developed in the chamber, which is measured either by a Stern-Pirani gauge, a surface-ionization detector, or by a space charge detector. From the equilibrium pressure in the vessel, the intensity of the molecular beam is calculated. The equilibrium pressure developed is of the order of 10^{-5} mm. or lower, and the sensitiveness of the Stern-Pirani gauge

is so great that it can detect changes of 10^{-9} mm. at a pressure of 10^{-5} mm.

These detectors have been used by Stern in studying the diffraction of molecular beams and other experiments. As is well known, the de Broglie wavelength of a particle of mass m and velocity v is h/mv . This had been experimentally confirmed in the case of electrons by G. P. Thomson and others. Some experiments by Stern and his collaborators on the scattering of hydrogen and mercury beams indicated that the scattering cross-section is much larger than the values obtained on the kinetic theory. This is to be expected if the molecules behave like waves. Direct confirmation of the wave nature was difficult because the molecules from a source do not possess the same velocity and, therefore, do not form a monochromatic beam. Stern and his collaborators managed to select a beam of helium atoms of fairly uniform velocity by passing the beam through narrow slits in two parallel circular discs placed 3 cm. apart and rotating about their common axis. Atoms of the 'correct velocity' arrive in time at the second disc to pass through the succeeding slit, while faster or slower atoms are stopped. The beam then fell upon the surface of a lithium fluoride crystal by which it was specularly reflected and diffracted. It was observed that in addition to the reflected beam there was a strong diffracted beam. It was found that the measured wavelength lies within 1.5 per cent. of the calculated value.

This brilliant result was followed by Stern's measurement of the magnetic moment of the proton and deuteron by passing a beam of molecular hydrogen through a strong inhomogeneous magnetic field. Hydrogen consists of parahydrogen and ortho hydrogen in the ratio 1:3. In parahydrogen the nuclear spins are antiparallel, and since the two electrons in the molecule also have their spins antiparallel, in a parahydrogen molecule the moment must be due to the rotation of the molecule as a whole. At liquid air temperatures, almost all the para-molecules are in zero rotational state (the rotational quantum number $m=0$) and should, therefore, have zero moment. This was experimentally found to be the case, the beam being undeflected in a magnetic field in which the gradient was $\sim 2 \times 10^5$ gauss/cm. At higher

temperatures some of the molecules will be in the rotational state, $m=2$, and hence the deflection experiment at room temperatures allows the determination of the rotational moment per unit quantum number.

If now we perform the experiment with ortho hydrogen in which the nuclear spins are parallel and the lowest rotational quantum number is one, we can allow for the contribution to the moment due to rotation and calculate the magnetic moment of each proton. Stern and his co-workers found this to be 2.46 nuclear Bohr magnetons. A similar experiment with heavy hydrogen enabled them to calculate the magnetic moment of deuterium which was found to be 0.85 Bohr magnetons.

PROF. ISIDOR ISAAC RABI

ISIDOR ISAAC RABI, Professor of Physics, Columbia University, New York, who has been awarded the Nobel Prize in Physics for 1944 for his resonance method for the registration of the magnetic qualities of atomic nuclei has been endowed with the rare gift of combining great experimental skill with remarkable theoretical insight. This is amply borne out by his work on the determination of the mechanical and magnetic moment of the atomic nuclei.

Rabi's early work was concerned with the determination of the magnetic susceptibilities and application of quantum mechanics to certain eigenvalue problems. But lately he has devoted his attention to the development of the technique of molecular beams and its applications to molecular scattering and determination of nuclear moments. In contrast to Stern, Rabi has generally used a weak inhomogeneous magnetic field as the analyzing field. In a very strong field when the coupling between the electronic and nuclear moments is destroyed we get $(2J+1)$ beams, each beam having the same intensity which is proportional to $(2I+1)$. J defines the extra-nuclear moment of the atom and I the nuclear spin. In weak fields, *i.e.*, fields which are at atomic distances, smaller than those produced by the nuclear magnet the coupling is retained, and we have $(2I+1)(2J+1)$ beams of equal intensity. A knowledge of J , therefore, enables us to calculate I by merely observing the number of beams. Also the spacing of the beams enables one to calculate the nuclear magnetic moment. This method was first applied to the hydrogen atom.

The net deflection of an atom by the inhomogeneous magnetic field is inversely proportional to its kinetic energy. Since the atoms issuing from source (oven) obey a Maxwellian velocity distribution, there results at the detector an overlapping of beams instead of the formation of sharp lines. To avoid the inaccuracy due to this Rabi developed a

magnetic velocity selector. This method was applied mostly to alkali metals. A strong inhomogeneous field first splits the original beam into two (J being $\frac{1}{2}$ in the case of alkali atoms). A slit then selects the slowest of these atoms and passes them on to the weak inhomogeneous field where the coupling between I and J is retained. After this the beam is focussed by a field similar to the first, but having the opposite gradient, and it is detected by a surface ionization detector used ballistically to increase the sensitivity.

Another method which was developed at the same time was what we might call the method of zero moments. As we pass from a weak-field pattern to a strong-field one, at certain field values some of the beams pass through the undeflected position. To understand this we shall consider the energy of the atomic magnets in a magnetic field. Confining our attention to the alkali atoms, it can be shown that this energy is a quadratic function of the field, except for the total magnetic quantum numbers equal to $\pm(I+\frac{1}{2})$. The effective quantum number which can be defined as the negative rate of increase of the energy with the field depends, therefore, not only on the magnetic quantum number but also on the field. For each beam there is a certain value of the fields for which the effective quantum number vanishes. If the detector is in the 'no-deflection position' and the magnetic field is increased, we can get the number and spacing of the critical field value. This enables the mechanical and magnetic moments to be calculated.

A further development along these lines has led to the discovery of what is known as "Radio-frequency spectroscopy". The method resulted from an attempt to find whether the magnetic and mechanical moments of the deuteron have the same direction or opposite directions. A beam is passed first through one field and then through another which has the opposite gradient to the first and is of such strength that its deflection is equal and opposite to that of the first. (When this is so the ratio between the effective moments is given by the ratio of the two field strengths. Also, since the effective moments are known functions of the fields, we get two equations between the effective moments which can be calculated.) If a homogeneous field H_0 is produced between these two fields, the atomic magnets will precess about this field with the Larmor frequency. If a small (weak) oscillating field of frequency equal to the above Larmor frequency is applied at right angles to the homogeneous field H_0 , resonance occurs and the atomic magnets will change their magnetic quantum number. This change is observed at the detector by a falling off of intensity, because the effective moment in the field just preceding the detector changes due to a change in the magnetic

quantum number, and the field does not therefore, exactly counter-balance the deflection produced by the first. A knowledge of the frequency of the oscillating field and the strength of the homogeneous field then enables one to calculate the nuclear Lande g factor and hence the nuclear magnetic moment. An analysis which it is not possible to go into here shows how from the fact whether the transitions to a different magnetic quantum number take place or not one can calculate the direction of the magnetic moment of the nucleus.

The frequency of the oscillating field of course depends upon the intensity of the homogeneous magnetic field and, in actual practice, is of the order of a few thousand magacycles. This new field of 'micro-spectroscopy' can measure energy intervals

which are 10^{-5} of the smallest intervals measurable by ordinary optical spectroscopy. By this nuclear magnetic moments have been measured by Rabi and his co-workers with an accuracy of one in a thousand. An important result of the experiments with the hydrogen, deuterium and hydrogen-deuterium molecules has been the discovery that the deuteron is not spherically symmetrical in shape but elongated along the spin axis (*i.e.*, has an electrical quadrupole moment).

Prof. Rabi was awarded the 'Thousand Dollar Prize' by the American Association for the Advancement of Science in 1939 in recognition of his brilliant work in throwing light on the properties of the sub-atomic units.

R. N. R.

GOVERNMENT SCHEME FOR TECHNICAL TRAINING OF STUDENTS ABROAD

IN response to numerous enquiries being received from students desirous of proceeding overseas for courses of study in the near future, following the recent announcement, by the Hon'ble Member for Planning and Development, of the Government decision to send abroad about 500 students for training in technical subjects directly related to the various plans for post-war development, the Department of Education, Health and Lands has just issued a press communique to which we draw the attention of our readers. Some of these students will be selected direct by the Central Government; others will be selected in the first instance by Provincial Governments. In the former case the Central Government will provide the financial assistance required to enable the students to complete an approved course. In the latter case the cost of such financial assistance will be shared equally between the Central and Provincial Governments. The selected students will be required to give an undertaking that on completion of the course abroad they will enter such employment in this country as may be indicated by the Central or Provincial or State Government as the case may be. Although no guarantee can be given, every effort will be made on the student's return to this country to find him employment on terms commensurate with the qualifications which he may have obtained.

A special selection committee will be established by the Central Government to deal with applications received. It has been suggested to Provincial Governments to appoint similar selection committees in Provinces. Special arrangement will also be made to place the students selected in suitable universities or similar institutions abroad and to look generally after their welfare while they are overseas. Free passages

and reasonable travelling expenses from India to the institution selected will be provided as well as return passages on the satisfactory completion of the prescribed course. The main courses for which awards will be available are set out below:—

1. Agricultural Subjects (including Animal Husbandry).
2. Educational Science and Practice.
3. Mechanical Engineering.
4. Electrical Engineering.
5. Civil Engineering.
- *6. Chemical Engineering.
- *7. Aeronautical Engineering.
- *8. Marine Engineering.
- *9. Architecture, Regional Planning, Building Construction.
10. Applied Chemistry (including preservation and distribution of food stuffs).
11. Applied Physics.
- *12. Geology.
- *13. Metallurgy.
14. Other forms of Applied Science.
15. Technical subjects not covered above.

Courses other than those set out above will be considered only if directly related to probable post-war needs.

(N. B.—Separate arrangements are being made by the Central Government in consultation with Provincial Governments in the case of students who may be sent abroad, for courses in Medical subjects. These will be announced shortly.)

The numbers selected for each course will be strictly limited and will be determined solely by post-war requirements. Preference will normally be given to students who have already completed a degree at a university in India or elsewhere, but this will not apply to students who possess special qualifications or experience that would make them suitable for one of the courses specified above. Advertisements inviting applications will shortly be issued by the Government concerned, and applicants residing in a Province are advised to comply with the

instructions which will be contained in these advertisements as to the method of submitting applications. Applicants resident in the Centrally administered areas or areas administered by the Crown Representative (or those for awards for courses starred above) should submit their applications to the Secretary, Education, Health and Lands Department, Government of India, marked "OVERSEAS STUDENTS".

The subjects starred on the above list at present concern the Central Government only, but there are other subjects in which both the Central and Provincial Governments are interested. Applicants for courses in these subjects may submit their applications either to the Central Government or to their Provincial Government.

In the case of students desirous, as in the past, of proceeding abroad for study at their own expense, and of those likely to be sent by firms, private bodies or persons, the Government of India are anxious to provide advice and guidance on a much larger and wider scale than they did hitherto. With this end in view, the Central Government have asked Provincial Governments and universities to set up Students Advisory Bureaux as soon as possible with

a view to affording such advice and assistance. It is also Government of India's intention to establish machinery for helping these students to obtain admission to university and other institutions abroad and for looking after them generally during their stay in the foreign country. It is, therefore, suggested that all students who desire to proceed abroad at their own expense for courses of study as soon as travelling conditions permit, should ascertain from their Provincial Governments or from their universities whether such Advisory Bureaux or Committees have been established, and if so, should take full advantage of the facilities offered. It is intended that these Advisory Bureaux should deal with all students, other than sponsored students, whatever the nature of the studies they may intend to pursue abroad.

It should be emphasized that the arrangements set out above apply only to British Indian subjects and not to subjects of Indian States. It is understood that a number of Indian States contemplate making similar arrangements. So far, however, as the placing of students in institutions abroad and looking after their general welfare are concerned, the machinery referred to above will be available for those students from Indian States who desire to take advantage of it.

Notes and News

INDIAN SCIENCE CONGRESS

THE 32nd annual meeting of the Indian Science Congress Association was opened on Tuesday, January 2, 1945, by His Excellency Sir Henry Joseph Twynam, K.C.S.I., C.I.E., I.C.S., Governor of Central Provinces and Berar and Patron-in-chief of the Congress at the College of Science, Nagpur, in the presence of a large gathering of delegates, members and visitors.

Lt. Col. the Hon'ble Justice W. R. Puranik, B.A., LL.B., Vice-Chancellor, Nagpur University and Chairman of the local reception committee, requesting His Excellency to inaugurate the sessions, extended a cordial welcome to the delegates and visitors at Nagpur. Referring to gifts of science and its application in the present world conflagration, Justice Puranik said:

"Numerous and variegated weapons are raining destruction on the human species. Machine guns, submarines, flame-throwers, torpedoes, incendiary bombs, delayed action bombs, rocket plane, and V-1, V-2, etc.,—these strike our

bodies and confuse our minds and even depress our spirits. But the gifts of science, like gifts of Heaven, are always double-edged. Their value depends on the purposes which they are made to serve. So far, therefore, as any charge of responsibility for the horrors of the present war is concerned, the scientist deserves, in my judgment, an honourable acquittal. If the gifts of science have been abused, should science not ponder over the ways and means of preventing that abuse in future? This takes us to the problem of the relation of science to society. If science could impart something of its objectivity to our politician and diplomats and administrators, who so largely make or mar the fortune of man on the globe, many of our problems would not only be solved but would not even arise."

"The material problem for our country in the immediate future is not so much to reach the maximum that man is capable of; it is rather to reach the minimum below which no man in the twentieth century should be expected to live. In the midst of all the manifold plans that are being unfolded before us from day to day, the central fact remains that the standard of living in India has to be pulled up and pulled up with an enormous concentrated vigour; that effort will require both good will and wealth but it will also require wisdom, and for this we confidently look forward to Indian Science. To devise the most economic ways of using the resources that are already being tapped and of tapping the resources still untapped, and thus to enable us, one and all, to live a richer life—these

are the tasks that await us and, I have no doubt, that they will be duly discharged at your hands."

H. E. Sir Henry Twynam, addressing the meeting, said:

"The present war has been rightly described as a revolution rather than a war. It is a revolution which challenges all old established outlooks, and both conflicting ideologies of Fascism and Communism have been largely influenced by the scientific approach. Mankind is looking earnestly towards a future in which sentiment and romance will be superseded by science and technology."

All of us, he added, were keenly aware of what had been achieved in Russia by the application of science and technology to countries which until recently were living in the bullock-cart age. Even in Central Asia, in Bokhara, and Samarkhand the tractor and mechanical transport had taken the place of the bullock-drawn plough and bullock-cart.

Since war, the Governor went on, the pragmatic approach to the problems with which we are confronted has completely driven *laissez faire* from the field of human thought, and the conferences which have taken place at Dumbarton, Hotsprings and elsewhere indicate the extent to which scientific method is all along the line.

"We are groping our way towards a planned economy not only in the fields of agriculture and industry but also in the wider field of human relationships generally."

"I, for one, welcome the discarding of old shibboleths and the substitution for them of new ideals based on principles of not so much the greatest happiness of the greatest number as the greatest material well-being of the greatest number."

The Governor then read a cable from Sir S. S. Bhatnagar from Washington, regretting his inability to attend and hoping that the experiences gained in the United Kingdom and the U. S. A. by his delegation would result in recommendations likely to lead to great scientific developments in India.

Prof. S. N. Bose then read the presidential address of Sir Santi Swarup Bhatnagar (see *Science and Culture*, January, 1945, "Science Congress Supplement").

HARNESSING THE DAMODAR

"THE Government of India have very much in their mind the Tennessee Valley scheme operating in the U. S. A. . . The Damodar Valley is the first project along this line. The authority which will be in charge of this project after it is completed will be more or less modelled, as far as it may be possible, on the Tennessee Valley Authority." Thus observed Dr B. R. Ambedkar, presiding over the conference of representatives of the Central, Bengal and Bihar Governments, held in the first week of January at Calcutta to consider how best to give effect to the proposals of the Damodar River Flood Enquiry Committee appointed last year by the Government of

Bengal. The recommendations of the Committee that the rivers of India should be made the concern of the Central Government and that the Government, while undertaking the project of damming the Damodar, should have a multi-purpose policy so as to include provision for irrigation, electrification and navigation found favour with Dr Ambedkar. He referred to the improper and erroneous distinction between railways and waterways, as a result of which the railways are treated as a Central, and waterways as a Provincial subject. Like railways, the waterways in most cases flow through more than one province, but limitations of Provincial Autonomy have often prevented utilization of valuable water resources, as such endeavour would involve two or more disagreeing provinces. A province requiring electricity and intending to utilize its water resources 'cannot do so because the point at which water can be dammed lies in another province which being agricultural does not need electricity and has no interest in it or money to finance the project, and would not allow the needy province to use the site'. Further, the Government's waterways policy has so far been one of irrigation, but henceforward generation of electricity and promotion of navigation should also be the purpose of waterways policy.

The Government's intention to revise their waterways policy has been somewhat reflected in their recent creation of a central organization called the Central Technical Power Board. They are further contemplating the creation of another to be called the Central Waterways, Irrigation and Navigation Commission. The Government of India, as Dr Ambedkar revealed, are keen on following the example of T. V. A. in harnessing the Damodar river, which will be a co-operative undertaking in which the Centre and the provinces of Bihar and Bengal will be partners.

At the conference the representatives discussed a note circulated by the Government of India about the procedure for collecting necessary information. It was suggested in the note that the three Governments should prepare an inventory of facts and figures in consultation with Central Government's technical experts. This would then make possible the preparation of a preliminary memorandum setting out the prospects for a co-ordinated scheme for the multi-purpose development of the Damodar Valley. The Governments involved can then give necessary instructions to technical experts for framing a project. The representatives generally agreed to the desirability of making the Damodar scheme a multi-purpose project and also endorsed the lines set in the note, along which investigations should start, representatives from Bengal, however, emphasizing the primary importance of flood control in the scheme.

It was decided that such investigations would start under Mr Man Singh, special engineer (Irrigation) with the Government of Bengal.

INDUSTRIAL PANELS

We learn with satisfaction that the Department of Planning and Development will find it possible to bring into existence a number of industrial panels within a short time. The panels which are expected to be set up soon include iron and steel (major), sugar, alcohol and food, and heavy chemicals, light chemicals and electro-chemical industries. While creating these panels, an 80% to 100% increase in the production of iron and steel, 50% in textiles and 100% in cement are aimed at in course of the next five years. The panel for iron and steel, which, it is understood, will include Sir P. Ginwala (Chairman), Sir J. J. Ghandy, Mr Bashir of Cawnpore and Mr Parr, Steel Commissioner, will have the following for its terms of reference: alloy steel, special steel, tools steel, re-rolled products, fabricated and structural steel, forgings, castings, tubes, tin plates, wire, nails and screws, nuts and bolts. For the textile industry, the existing Textile Board will function as the panel.

Each panel will be required to report on the scope and extent of development and suggest whether the industry should be State-owned, either on grounds of national interest or because of the unwillingness of private capitalists to undertake it. It should further advise on the capital required for development, the extent to which foreign technical advice may be necessary, the manner and degree of co-operation with foreign firms both as regards capital and management, the location of the industry, the nature of assistance required from Government in the form of protection duties, bounties, research grant, expert advice etc., the control Government should exercise in the case of private ownership, whether the industry should cater for the export market, and finally whether it should develop, as in Japan, on the cottage industry basis and if so, to what extent.

The panels will be supplied with all possible factual information by the Government regarding existing industries as well as new ones. It is understood that joint meetings of the panels will be held, whenever necessary, to secure co-ordination, particularly where some connection exists between the processes and products of two or more industries.

INSTITUTE OF FERMENTATION TECHNOLOGY

The *Journal of Scientific and Industrial Research*, in its December (1944) issue, made a strong plea for the establishment of the Institute of Fermentation Technology, now under contemplation. One of the

primary objects of the Institute will be in the training of fermentation technologists and industrial microbiologists capable of undertaking research and development work and ultimately taking charge of industrial operations. The existing industries are in need of a large number of fermentation specialists whose demand will steadily grow with the expansion of the industry. Similarly the pharmaceutical and food industries which are now being established will require the services of industrial microbiologists for whose training facilities are now almost non-existent. According to an estimate, several industrial organizations of the country can at present absorb some 250 such specialists with advantage. The Fermentation Technology Section of the Indian Institute of Science, however, trains up specialists of this type; but in view of its limited facilities it is unable to cope with the great demand which can alone be met by an institute of the type now contemplated. In addition to the training of fermentation specialists, the Institute should have to undertake study and research on the fundamental aspects of fermentation biochemistry and microbiology. It is further suggested that the Institute should also be provided with a chemical engineering laboratory and a pilot plant house.

The Council of Scientific and Industrial Research have encouraged study of industrial fermentations from its very inception and also allotted funds, early in 1940, for the organization and maintenance of a National Collection of Type Cultures at the Indian Institute of Science, Bangalore. They also constituted a research Committee to attend to all scientific questions connected with fermentation processes.

The Institute of Fermentation Technology, when it comes into existence, will provide a great fillip to the fermentation industries in India. Only two such industries, namely the brewing and the distillation industries, producing alcoholic beverages and industrial alcohol respectively, have so far been established, which are far from meeting the demands of Indian market, either in quantity or in quality. Alcoholic beverages worth 2.5 crores of rupees are annually imported to this country, while we have to largely supplement indigenous production of industrial alcohol with supplies from Australia and South Africa. This is a pointer to the great possibilities and prospects of these industries in India. In Europe and America, fermentation industries which provide industrial solvents, organic acids, vitamins and vitamin concentrates, yeast and protein foods, penicillin-like drugs and a large number of other commercially valuable chemicals have come to assume a unique place in their industrial structure. We hope that the question of an early establishment of the Institute will receive the most urgent consideration of the Government of India.

COSMIC RAY EXPEDITION TO THE PAMIR

ACCORDING to *Science*, October 13, 1944, an expedition of a group of scientists from the Lebedev Institute of Physics of the U.S.S.R. Academy of Sciences, under the direction of Professor D. V. Smobeltsyn, has recently been led to the Pamir Mountains to study cosmic rays at high altitude. The expedition was sponsored to continue studies that had been carried on for several years at the Atomic Nucleus Laboratory on Mount Elbrus, the highest mountain in the Caucasus. Located in Southern Russia, the Pamir Mountains extend both into Afganistan and India. The principal investigations of these scientists will include the study of the composition of cosmic radiation at high altitudes and of the role played by heavy particles and secondary mesons. The expedition will make use of a perfected proportional counter telescope and improved methods developed in the Atomic Nucleus Laboratory.

METEORITE EXHIBITION IN MOSCOW

A REPORT of *Sky and Telescope*, prepared from a cablegram received from the Soviet Scientists Anti-Fascist Committee, informs that a permanent meteorite exhibition has been opened in the Karpinska Geological Museum, Moscow. The meteorite collections of the Academy of Sciences, consisting of more than 1,200 specimens obtained from some 200 meteorites which have fallen both within and outside Russia, have been exhibited. The exhibits include the 10 largest of the meteorites, of which the pallasite iron specimen weighing upwards of half a ton was found in 1734 on the banks of the river Yenisei in Siberia. There is also on display the Kainzas meteorite, the largest of about 20 stones which were found after the meteorite shower of September 13, 1937. It weighs 102.5 kilograms, while the smallest stone of this shower weighs 7 kilograms. The largest iron meteorite in the world—two pieces, one weighing 199 kilograms and the other 58 kilograms, are also exhibited. Small specimens illustrating the shapes of meteorites and types of crusts and surfaces are exhibited in a special case. Particular interest attaches to the meteorite's streamlined shape resulting from the melting and flowing of its forward surface as it collides with the resisting atmosphere. This has been illustrated in the case of Karakul stone meteorite which fell on May 9, 1840, in Semipalatinsk province, and in the Repeyev Khutor iron which fell on August 8, 1933, in the Stalingrad region. The meteorite structure and composition constitute the attraction of another case. About 100 stones with a total weight of 65 kilograms were found after a shower in the Ivanov region on December 26, 1933. These exhibits are associated with tables showing the chemical and mineralogical compositions and with

diagrammes, illustrating the process by which meteorites break up into showers by atmospheric friction.

WARDHA BASIC EDUCATION CONFERENCE

A FOUR-DAY conference of educationists, professors and teachers was held at Sewagram, Wardhaganj, under the presidentship of Dr Zakir Hussain, to review the progress made in the past years in the experiment on basic education in various provinces and states of India, and recommend future course of action. The scheme of basic education which seeks to educate the young boys and girls of ages between 7 and 14 through craft and manual labour and mother tongue started in 1937 through the institution of Hindusthani Talimi Sangh. The main feature of this education is that the students are simultaneously required to take up profit-yielding vocation to enable them to pay for their dues through the products of their labour. This serves, according to the promoters of the scheme, the useful purpose of developing the whole man through the vocation learnt at the school. The conference expressed satisfaction at the progress made in the basic education experiments and recommended that the Hindusthani Talimi Sangh should give full consideration to the question of undertaking both pre-basic and post-basic education in order to make the scheme of basic education complete in itself and much wider in scope. It recommended that the Sangh should appoint a committee to draw up a scheme of pre-basic education for boys and girls below 7 years of age, which will serve as foundation for basic education. In its recommendations for post-basic education, the conference drew attention to the urgency of (1) drafting a suitable syllabus for part-time continuation of courses for those intending to live a fuller life and acquire further proficiency in their craft, and (2) devising a diversified system of institutions to provide whole time education for various aptitude types, keeping in view the needs of national life. The conference was of opinion that educational institutions in the villages should produce articles which are useful and at the same time of true educational value in order to enable the adult pupil to earn wages enough to defray his cost of education. This implies that the economic order of the country will have to be simultaneously revolutionized so as to make possible an all-round increase of wages. The primary object of production should be internal self-sufficiency of the nation, and, to achieve this, technical research should be undertaken to make decentralized and small-scale production economically successful.

HYDRO-ELECTRIC PROGRESS IN CANADA

CANADA has, during the last few years, made a gigantic stride towards developing hydro-electric power whose utilization has given her a status as an industrialized country, hitherto unknown in her his-

tory. According to a review of her hydro-electric progress in the *Beama Journal* (June, 1944), we learn that Canada's total installation stood at 10,214,513 h.p. at January 1, 1944. For Canada's total of 11,812,000 (June 1, 1943), this amounts to an average installation of about 865 h.p. per 1000 population. And yet this development accounts for only 20 per cent of the country's estimated water power resources, leaving 80 per cent. for future development as demand increases. Distribution of power installations is mainly indicated under three headings, e.g., central electric stations, pulp and paper mills and other industries. Central electric stations which account for 9,221,599 h.p., or 90.3 per cent. of the total hydel installation represent the power developed for the sale of electricity to meet general, industrial, commercial, municipal, domestic and agricultural demands. More than 98.5 per cent. of all electricity produced for sale in Canada or for export to the United States is generated from water power.

Pulp and paper industry comes next as an important consumer of electricity. The industry has an aggregate hydraulic installation of 642,576 h.p. or 6.3 per cent. of the total. The industry further provides the greatest individual peace-time market for the power produced by the central electric stations. Canada is a leading newsprint manufacturing country, her production of newsprint being 3 times that of the U.S.A. and constituting about 72.1 per cent. of the total North American production (1942). The great consumption of electricity by the industry will be realized from the fact that a mechanical power installation of nearly 100 h.p. is required per ton output of newsprint. 95 per cent. of the power used by the industry is hydro-electric.

The remaining 350,338 h.p., or 3.4 per cent. of the total hydraulic installation account for mineral industries, electro-chemical plants, electric railway plants, and the large number of saw, grist, and grinding mills and other manufacturing industries. Although some mining and metallurgical industries have their own installations, these industries generally use power supplied by the hydro-electric central stations owing to the low cost and dependability of their power. More than 80 per cent. of the power requirements of her metal mining and metallurgical industries is met by purchased electricity. Canada leads the world in the production of several metals, such as asbestos, nickel, platinum and probably radium; she is the second largest producer of gold and comes third in the production of silver, copper and zinc and fourth in lead. Canada's abundant water power resources make available power at a cost which permits of economic mining of large quantities of comparatively low-grade ore and the application of large-scale electro-metallurgical processes for the recovery of the metals.

TECHNICAL INSTITUTES AND POST-WAR DEVELOPMENT OF INDUSTRY

'THE place of the Technical Institutions in the Schemes for Post-War Development of Industry in India' formed the subject of the presidential address of Mr R. A. MacGregor, the retiring president of the Mining, Geological and Metallurgical Institute of India, at its thirty-ninth annual general meeting held in the rooms of the Royal Asiatic Society of Bengal on January 12, 1945.

He explained that the Government of India, through the Department of Scientific and Industrial Research, had made a grant of a crore of rupees, supplemented by a considerable sum from private sources, for the establishment of a number of research laboratories throughout India. The ones most particularly interesting to the Institute were the National Metallurgical Research Laboratory at Jamshedpur and the Fuel Research Station at Dhanbad. He suggested that the same arrangement holding good in U. K. and U. S. A. should be adopted in India. The results of research work issuing from the National Laboratories should be presented to technical institutions throughout India. In this way the greatest publicity would be obtained for the work done, and mutual advantages would accrue to the research workers as well as the industrialists.

Unfortunately, in India, the technical institutions have not yet grown to such a size that they can afford to run their business on anything but voluntary lines, and, as a consequence, there are distinct signs of lack of continuity of policy. Therefore, in view of the advantages to be gained by the research laboratories and the country as a whole, it was suggested that the D. S. I. R. should appoint permanent secretaries in the Delhi, Calcutta, Madras and Bombay areas, who would carry out the routine work of Government recognized technical institutions in their areas. Permanent secretaries of this nature would ensure continuity of policy and would act as liaison officers between the research laboratories and the technical institutions. The professional status of the institutions should, however, remain as heretofore. It was pointed out that the rise of modern industrialization in the West could be traced very largely to the British Royal Society founded in 1663. From the Royal Society many highly specialized technical institutions have branched off in succeeding years, but over the last thirty years there is a decided tendency, both in U. K. and U. S. A., for the specialized institutions to link together again. The reason for this is that the interests of all branches of engineering are overlapping more and more, as a higher state of development is reached.

At the beginning of her drive towards industrialization, India now has a unique opportunity of

linking her research organizations and technical institutions and so of bringing about that desirable state wherein the course of research is guided into channels of greatest value to the new industries. Further, industry has every opportunity of correctly informing itself on current scientific development. Not the least of the advantages to be gained from this linkage is the kind of post-graduate education of the student members who will have the chance of hearing, or joining in discussions between the research-worker and the mature professional engineer.

The new Council was elected at the meeting, and following are the office-bearers for the ensuing year: *President*: Mr B. Wilson Heigh; *Vice-Presidents*: Mr L. J. Barraclough, Dr H. Crookshank and Mr B. Sen; *Honorary Treasurer*: Dr H. Crookshank; *Honorary Editor*: Mr E. J. Bradshaw; *Honorary Secretary*: Mr A. Reid; *Local Secretaries of branches*: Dr C. Forrester, Dhanbad Centre; Mr J. H. Paterson, Asansol Centre; Dr J. Sanjana, Jamshedpur Centre; and Mr T. A. Wellsted, C. P. Branch.

POLLEN BANK

At the 24th annual meeting of the Indian Botanical Society held at Nagpur on January 3, 1945, Dr P. Maheshwari, Vice-President of the Society, in delivering his presidential address entitled "The Place of Angiosperm Embryology in Research and Teaching", referred to the development of embryology as an experimental science during the last two decades. This branch of science includes the study of such problems as the storage of pollen and its germination, the receptivity of the stigma, fertilization and fruit-setting, and the optimum conditions required for this.

He envisaged the possibility of opening one more "Pollen Bank" in each country where pollen of almost every important plant of economic value could be stored under optimum conditions and supplied to recognized workers, free of, or on a moderate charge. It is said that the Arabs put aside the pollen of date palm from year to year so as to ensure a supply of dates even in the possible event of the male flowers failing to develop or the female flowers developing precociously.

Experimental embryology is full of promise; for a scientific explanation of his successes and failures, the breeder must turn to the cytologist and embryologist. The work on the effect of X-rays, heat, chemicals etc. on the artificial induction of mutations is still in its infancy, but it opens up vast possibilities before us. "Hear the breeder, the cytologist, the embryologist and the physiologist must all join hands, so that not only do we get the maximum results from what we have but we may evolve new and still better

varieties of plants and add to the health and happiness of the world."

The following were elected to the various offices for the year 1945: *President*—Dr N. L. Bor. *Vice-Presidents*—Prof. H. Chaudhuri, Dr B. P. Pal. *Secretary*—Dr S. N. Das Gupta. *Treasurer and Business Manager*—Dr A. C. Joshi. *Elected Members of the Ex. Council*—Dr P. L. Anand, Prof. F. R. Bharucha, Prof. M. O. P. Iyengar, Dr T. S. Mahabale, Prof. G. P. Mazumder, Prof. R. L. Nirula, Dr P. Parija, Dr T. S. Raghavan, Prof. L. N. Rao, Prof. M. Sayeed-ud-din. *Editorial Board*—Prof. S. P. Agharkar, Prof. H. Chaudhuri, Dr S. N. Das Gupta, Prof. M. O. P. Iyengar (*Editor-in-Chief*), Dr A. C. Joshi, Dr P. Maheshwari, Prof. G. P. Majumder.

NEW DIRECTOR OF INDUSTRIES, BENGAL

Dr Ali Karim, Ph.D., D.I.C., A.I.C., A.M.I. Chem.E., whose appointment as the Acting Director of Industries, Bengal, has been recently announced, has a remarkable career. A graduate in science of the Calcutta University, he went to England in 1923, after receiving a Government scholarship, to prosecute higher studies in the Department of Chemical Technology of the Imperial College of Science and Technology, London. He carried on research in oils and fats, in theoretical and practical fuel technology and in chemical engineering. The London University conferred on him the Ph.D. degree in Chemical Technology. On his return to India in 1927, Dr Karim was appointed Chief Works Chemist in the Shalimar Paint, Colour and Varnish Works. In 1933, he again proceeded to England for a further period of 3 years to conduct research on lac and allied products in a scheme sponsored by the Imperial Council of Agricultural Research, Government of India, and worked in the British Paint Research Station at Teddington. In 1937, after his return from England, he was appointed Deputy Director of Industries and Industrial Engineer, Bengal. We wish him a successful career in his new post.

LADY TATA MEMORIAL TRUST RESEARCH SCHOLARSHIPS FOR 1945-46

The Trustees of the Lady Tata Memorial Trust are offering eight Scientific Research Scholarships of Rs. 150/- each per month for the year 1945-46, commencing from 1st July 1945. *Applicants must be of Indian Nationality and Graduates in Medicine or Science of a recognized University.* The subject of scientific investigation must have a bearing, either directly or indirectly, on the alleviation of human suffering from disease. Applications must reach by March 15, 1945. Further particulars can be had from the Secretary of the Trust, Bombay House, Bruce Street, Fort, Bombay.

SCIENCE IN INDUSTRY

SUGAR-BEET EXPERIMENTS IN RUSSIA

In a recent issue of *Discovery*, Prof. Valentine Ditiakin has briefly reviewed the experiments conducted in the U. S. S. R. on the cultivation of sugar-beet in the northern latitudes. Although the southern regions of the U. S. S. R. constitute the basic sugar-beet areas, attempts have been made to push the beet cultivation increasingly to the northern regions with conspicuous success. One hundred and fifty years ago, it was difficult to produce beet with 6 per cent sugar content; beets with sugar content of about 20 per cent have now been produced in Archangel, Vologda, Leningrad and Molotov and the Sverdlosk regions, the yields per acre averaging from 20 to 28 tons. The yield, however, declines beyond the Arctic circle, and at Naryanmar, at the mouth of the Pechora River, yields of 6 tons per acre have been obtained, while in the Snoloversk Islands (Lat. 65°N), there was no difficulty in raising an yield of 18½ tons per acre with 17 per cent sugar content. The Tula and Ryazan regions are, however, regarded as the northernmost limit of the sugar-beet areas, as its successful cultivation requires 5 frostless months.

The results of investigations indicate that special importance attaches to timely planting. Monthly sowing, although it involves arduous labour, is recommended mainly for the northernmost districts and small gardens. In the north, beet grows and sugar continues to accumulate till October 1st, and as such the crop may be safely harvested early in October, as it does not sustain any loss due to the incidence of early cold. Timely planting is particularly important in the case of spring crop, since even a small delay may appreciably affect the yield. It has been observed that a delay in planting by 20 days may lead to a decline in yield by 1.6 to 1.8 tons per acre.

Constant digging of the soil between the rows to keep it mellow during summer is calculated to maintain the high level of sugar content in beet. The northern soils are generally poor and acidic and as such favourably responds to organic fertilizers and lime treatment. An increase in the yield by 1.6 to 2.4 tons per acre results from the application of manure (8 to 16 tons per acre), and treatment with lime frequently doubles the return. The mineral fertilizers have been employed with great advantage. Sub-feeding with nitrate fertilizers, which increases the yield from 1.2 to 2 tons per acre, has been found to be the most effective.

INFRA-RED LAMPS IN INDUSTRY

The application of infra-red lamps for heat treatment in industry is a very recent development. The experts are inclined to attach great importance to this new application which has remarkably speeded up industrial heating. The disadvantages of convection heating employed for paint drying and other industrial processes are well-known, the chief of which consists in its having an unusually long drying time. For paint drying, for instance, the stoving time often extends to an hour or more. In marked contrast to this, heat treatment with infra-red lamps has reduced this time to a few minutes. Owing to its great gain in speed, the new process of radiant heating has now been employed for drying paints and varnishes, foundry moulds, and powders used for plastics, and also for the softening of plastic sheet with great advantage. This, however, does not exhaust the list of its applications, which is steadily growing.

Resembling tungsten filament lighting lamps in appearance, the infra-red lamps differ in construction and operate at a lower filament temperature so that the maximum energy may lie in the infra-red part of the spectrum. An efficient source of radiant heat, the lamp has a small filament and contains inert gas which protects the filament and also reduces the convection loss. The lamps are provided with reflectors of infra-red rays, whose design and construction deserve mention. Originally, lamps used to be individually provided with round reflectors plated with pure gold which reflects infra-red rays with great efficiency. The individual reflectors have now been replaced by trough reflectors which permit of closer lamp spacing with the consequent increase in heating intensity. Further, trough reflectors are now plated with rhodium instead of with gold,—an improvement which has the advantage that, compared to gold, rhodium is a hard metal highly resistant to wear and abrasion.

One type of the paint-drying unit manufactured by the G. E. C. consists of six trough reflectors, each having 9 Osram infra-red lamps, with a total consumption power of 13.5 kW. Another much larger infra-red heating plant designed for drying paint inside and outside petrol containers by the same manufacturer employs more than 2000 lamps and operates on a total load of 450 kW. The Osram infra-red industrial lamps are rated at 250 watts.

In radiant heating, the article absorbs energy at or immediately beneath the surface receiving heat,

and consequently surface conditions greatly determine the temperature to be attained by the article. The conductivity of the material of which the article is made also has a part to play in the attainment of temperature. Maximum temperatures of the order of 600°F are easily attainable by metal articles in a few minutes in the new process employing infra-red lamps. With convection heating, on the other hand, the articles may even fail to reach the maximum oven temperature at all, not to speak of the comparatively long heating time involved in the process.

As already mentioned, the various industrial applications of infra-red lamps include paint drying, coil drying, drying foundry moulds, softening plastics, accelerating setting of adhesives and many others. Paint drying, however, represents by far the most important application of radiant heating. The drying time depends on the nature of the article and of the paint used, but in all cases, with infra-red heating, ten minutes are regarded as a long time, many paints drying up in less than a minute or two. Reversible paints, such as spirit varnishes and cellulose derivatives where the solvent vaporizes, dry up relatively quickly. Irreversible paints, including synthetic resin, which undergo chemical reactions during drying, may require a slightly longer time.

Coil used for electrical appliances, such as small transformers and motors, require to be coated with insulating varnishes which may be advantageously dried with infra-red lamps. Drying time for such varnishes necessitating a maximum temperature of about 300°F is greater than that for paint drying. But whereas a full day may be needed in processes employing convection heating, infra-red heating requires only 2 to 3 hours.

Various methods, including convection ovens and gas torches, are available for drying sand moulds for metal castings. While some are slow, others require skill on the part of the operator. Infra-red heating may be particularly recommended for such moulds as require surface heating and possess a configuration favourable for direct irradiation. The drying time ranges from 5 to 45 minutes, depending on the nature of sand, its moisture content etc.

Plastics, such as bakelite, perspex and cellulose acetate, require to be softened by heating before moulding and punching and lend themselves to infra-red heating which does the job within a half to a few minutes. Radiant heat has been applied with great advantage in drying synthetic glues used in the pre-fabrication of wooden assemblies in the aircraft and furniture industries. By raising the temperature of the glue line to 160°F, drying may be effected in

about 15 minutes compared to 5 to 6 hours for the glue to set at room temperature.

Numerous as the applications of infra-red industrial lamps are—and many more are being added to almost daily—it must not be supposed that radiant heating lends itself to all problems of heating, for which better processes indeed exist. (References: *Discovery*, September, 1944; *Beama Journal*, June, 1944).

S. N. S.

PARIS GREEN

THE two Russian chemists, G.P. Luchinskii and V. F. Churilkina, (*Russian J. Appl. Chem.*, 13, 367) have recently devised a method of preparing Paris green, the important insecticide and also known as Schweinfurth green, which has been abstracted in *The Chemical Age*, September 23, 1944. The insecticide is now prepared by dissolving white arsenic in soda lye and then mixing the solution with acetic acid and copper sulphate. This process involves the waste of whole of the soda employed in the form of sodium sulphate. No such waste takes place in the method evolved by the Russian chemists, which is reported to have passed the pilot-plant stage.

In the new process the starting chemicals are acetic acid, copper oxide and arsenic trioxide, and the reaction takes place according to the equation: $4 \text{CuO} + 3\text{As}_2\text{O}_3 + 2 \text{CH}_3\text{COOH} = 3 \text{Cu}(\text{AsO}_2)_2 + \text{Cu}(\text{CH}_3\text{COO})_2$. Theoretically, 1000 parts of Paris green are obtained from 314 parts of copper oxide, 586 parts of arsenic trioxide, and 118 parts of acetic acid. In practice, 236 parts of glacial acetic acid are mixed with 2800 parts of water in a pot provided with a reflux. 314 parts of copper oxide are added and the mixture is heated to boiling. 586 parts of finely ground arsenic trioxide are introduced into the boiling liquid and the mixture is continuously stirred. Cooking takes place for about 2 hours, after which the mixture is cooled for one hour and then filtered. The filtrate contains some copper and arsenic which should be taken into consideration when the filtrate, after addition of more acetic acid, is used for further preparation. The crude paste thus obtained is washed and finally dried when Paris green is obtained.

It is suggested that copper oxide should be prepared by heating copper powder in air at a temperature below 300°C. It is further observed that copper oxide prepared at a higher temperature is not sufficiently active. The oxide must not, however, be made by allowing an alkali to react with copper sulphate, as it would defeat the very purpose for which the sulphate has been replaced by the oxide.

SODIUM CHLORITE AS A REAGENT FOR THE ESTIMATION OF CELLULOSE

P. B. SARKAR and H. CHATTERJEE,

INDIAN CENTRAL JUTE COMMITTEE, TOLLYGUNGE, CALCUTTA

THREE different methods are commonly employed for the estimation of cellulose in plant materials, namely, Cross and Bevan's, Schmidt's, and Norman and Jenkins's. None yields 'pure' ('true' or α -) cellulose,—the product in each case being associated with varying amounts of hemicelluloses, including uronic anhydrides and pectin. Highest yield of cellulose is obtained by the ClO_2 method of Schmidt; Norman and Jenkins' method comes next, and Cross and Bevan's method last—so far as yield of cellulose is concerned (vide Table II). The amount of α -cellulose (calculated on the raw material) prepared from the latter two celluloses is, however, practically the same, showing that the resistant or α -cellulose portion of the cellulose is not affected by the reagents employed. That from Cross and Bevan's method is somewhat lower.

The composition and structure of the hemicelluloses are not yet definitely known; far less definite is our knowledge regarding their mode of combination, if any, with pure cellulose. In recent years, xylan (and in some cases, also mannan, etc.) has been considered by Norman and others as an 'integral part' of true cellulose on account of the difficulty of their isolation, while polyuronides are regarded as incrustants, like lignin. Norman and Jenkins' designate xylan and other polysaccharides intimately associated with true cellulose as 'cellulosan'. Their method of estimating cellulose is apparently based on the removal of lignin and polyuronides from plant materials, what is left behind is believed to consist of true cellulose and cellulosan. From their results, it is found that very few samples of isolated cellulose (from straw and wood) were completely free from lignin. No figure for CO_2 is given for any of the celluloses isolated by their method. Thus it is not possible to say how much, if any, of the uronic anhydrides still remained associated with the celluloses. Even a mild alkali treatment, hot or cold, removes a portion of the hemicelluloses (including polyuronides). The figure for Cross and Bevan's cellulose is generally low, mainly on account of the pre-treatment with 1% boiling NaOH , and partly due to the strong oxidizing action of moist chlorine on cellulose. Boiling with 3% Na_2SO_3 solution (which is alkaline) also removes some of the hemicelluloses. This is common to Cross and Bevan's as well as Norman and Jenkins' methods.

The ClO_2 method of Schmidt (in modified form) is better in that it gives a much higher yield of cellulose, most of the hemicelluloses remaining intact. But

the oxidizing action of ClO_2 for a prolonged period affects the cellulose to some extent. This is evident from the high loss the cellulose suffers in an alkaline boil as well as from its high copper number. Furthermore, some other constituents besides lignin are removed during the estimation inasmuch as the figures for cellulose and lignin never make 100 but fall short by about 5 in the case of jute.

In view of our incomplete knowledge regarding the mode of association of the hemicelluloses (including polyuronides) with the true cellulose in plant materials, it would appear more rational to regard all polysaccharides (*i.e.*, pentosans and hexosans) and polyuronides as jointly comprising 'total cellulose' (and in the case of fibrous materials, 'fibre cellulose') than to include 'cellulosans' alone. Besides fat and wax, traces of mineral and colouring matters, plant materials may then be considered broadly to consist of total cellulose and lignin. The ideal method of estimation of cellulose should aim at the complete removal of lignin without affecting the other portion in any way. In such a case, the percentage figures for lignin and total cellulose should make 100 (within limits of experimental error), and, also the cellulose should have a low solubility in alkali and have a small copper number. None of the current methods gives such a result. We have tried all these in the case of jute and examined the cellulose obtained by each method. The polyuronides are removed to a larger extent by Norman and Jenkins' method (as will appear from the CO_2 values in Table II), no doubt, but a fairly large portion (nearly 50%) still remains with the cellulose. From the CO_2 value of raw jute, it is found that jute fibre contains 5.20% of uronic anhydride. The particular sample (a very good white jute, free from bark and speck) under investigation has 11.80% of lignin and 5.20% uronic anhydrides. The figure for Norman and Jenkins' cellulose (it was completely free from lignin) being 77.77%, it would

appear that 7.83%, that is, $100 - (77.77 + 11.80 + \frac{5.20}{2})$, of the hemicelluloses (other than uronic anhydrides) or 'cellulosans' of Norman and Jenkins have disappeared. So far as jute is concerned, the method seems unsuitable; some poly-saccharides as well as some polyuronides are lost* though the removal of lignin is complete, differing from most straws and woods examined by the authors. The above calculations are based on the facts that (i) uronic anhydrides alone yield CO_2 on boiling with 12% HCl but not

* Presumably during the treatment with 3% boiling sodium sulphite solution which is alkaline.

polysaccharides, (ii) the yield of CO_2 is quantitative unlike that of furfural (which is derived from uronic anhydrides as well as pentosans), (iii) lignin gives only a little CO_2 (about 1.5%) which may be neglected in view of the small p.c. present in jute.

Sodium chlorite has been found to be an excellent reagent for the estimation of cellulose in jute fibre. Previous work in this laboratory has shown that jute can be bleached to full white with NaClO_2 under suitable conditions with very small damage to the cellulose. Jute yarn bleached with NaClO_2 maintained as much as 70% of the wet strength while that bleached with ClO_2 , had practically no strength when tested wet. The lignin content of the bleached yarn was extremely low (1.3%) while the fibrous structure remained intact. This at once suggested that hemicelluloses which are the real binding material for the tiny, ultimate cells of jute, are not removed or materially affected by NaClO_2 during the separation of lignin. One could, therefore, employ this reagent for the estimation of total cellulose in jute. This has been done under different conditions and the results obtained are described here.

Preliminary experiments have shown that in presence of fat and wax, jute fibre cannot be bleached fully—a pale yellow colour persists up to the end. Defatted jute (extracted with alcohol-benzene mixture) on the other hand is readily bleached white. So, in all our experiments on delignification, we have used solvent-extracted fibre. By trial, it has also been found that 60°–70°C is the most suitable temperature for the removal of lignin from jute without degrading the cellulose. At boiling water-bath temperature, the reaction is more vigorous; the yarn is bleached more quickly but it suffers appreciable loss in strength, and degradation of the cellulose probably takes place. NaClO_2 liberates ClO_2 rapidly and is quickly spent at 100°C. So this temperature was avoided. At room temperature the reaction is very slow and hence unsuitable for practical purposes. Then again, neutral or alkaline NaClO_2 solution is no good for bleaching jute. Slightly acid solution is the most effective. We have found pH 4–5 to be the most suitable for estimating cellulose. It has further been observed that a weak acid such as acetic acid when used to lower the pH of the chlorite solution (our NaClO_2 solution was always alkaline—as we prepared it by passing ClO_2 gas into NaOH solution) gives much better results than strong mineral acids *e.g.*, H_2SO_4 . So we have always used glacial acetic acid to bring the chlorite solution to the required pH. From table I, it would be seen that the strength of sodium chlorite required for complete delignification is fairly high, that is, 3.5% and above. There is nothing objectionable in it provided such treatment does not affect constituents other than

lignin. From the analytical data, it will be seen that the cellulose obtained with the fairly high concentration of chlorite is not appreciably degraded. Four hours have been found to be just sufficient for complete separation of lignin from the fibre; a shorter exposure under otherwise optimum conditions usually leaves some residual lignin in the fibre.

The New Method: 2 gms. of finely cut and defatted fibre were taken in a conical flask (200 c.c.) of the NaClO_2 solution of pH 4–5 (using acetic acid to lower the pH) and known strength were added. The fibres were spread out into the liquid with a glass rod and the whole placed on a water-bath maintained at 60°–70°C for 4 hours, with occasional stirring with a glass rod. An air condenser was placed on the conical flask. After four hours, the contents of the flask were filtered through a Jena glass filter (1G3), thoroughly washed with cold water until free from chlorite (starch-iodide paper moistened with acetic acid turns blue with NaClO_2). The fibre was next antichlorinated with a 3% solution of NaHSO_3 and again washed thoroughly. The crucible was dried on a water-bath under reduced pressure (using a water pump and finally, Cenco pump), for when heated at 105° in air, the cellulose turns light yellow. The crucible was kept overnight over H_2SO_4 under vacuum and weighed. The heating was continued until the weight was constant.

The cellulose obtained is milky white in the first four cases (Table I) using 3.5 to 5.2% NaClO_2 . The residual lignin was estimated in the cellulose by 72% H_2SO_4 method after preliminary boiling for 1 hour with 5% H_2SO_4 , following Norman and Jenkins' procedure.² In the first four cases the small residue left after the dissolution of cellulose with 72% H_2SO_4 was not lignin (for it was not dissolved by ClO_2 solution) but cuticle (scales were visible to the naked eye). For each estimation, duplicate experiments were made. The mean values are given below. Sodium chlorite was estimated by adding excess

TABLE I

Expt. No.	% Strength of sodium chlorite	% Fibre cellulose (calculated on dry raw jute)	% Residual lignin (calculated on fibre cellulose)
1	5.2	88.02	0.20
2	4.5	88.93	0.42
3	4.0	89.16	0.38
4	3.5	90.03	0.60
5	3.0	92.90	2.04
6	2.5	93.62	2.50
7	2.0	95.41	4.51

of KI to the acidified solution, and then titrating with thiosulphate the I_2 liberated.

² Biochem. J., 28, 2147, 1934.

¹ Biochem. J., 27, 818, 1933.

The sample of jute used in these experiments has a lignin content of 11.80%.

Cellulose has been prepared by the three current methods, and the new method, from the same sample of jute strictly following the recommended procedures in each case. The celluloses thus obtained have been analysed for their quality in the usual manner. The results are shown in Table II. The distillate from pure glucose or α -cellulose with 12% HCl gave a ppt. with phloroglucinol, in all probability, due to hydroxymethylfurfural from hexoses. This was almost wholly soluble in 95% hot alcohol. So in the estimation of furfural, we have in all cases washed the phloroglucide with 95% hot alcohol.

Mathieson Alkali Works of New York have developed the manufacture of NaClO_2 (which they call Textone). It is quite likely that after the war this chemical will be available at a reasonable price for industrial bleaching. So the present laborious method of its preparation in the laboratory will be avoided. Then it will be much easier to estimate cellulose with NaClO_2 than now.

Compared with the other existing methods, the new method is far less time-consuming. Furthermore, it requires the least amount of attention. Unlike Cross and Bevan's or the ClO_2 method, it does not involve the application of obnoxious gases which are troublesome to work with. One has to be

TABLE II

Method	% Cellulose* (on dry raw jute)	% Lignin (on 'Cellu- lose')	% CO_2 (on 'Cellu- lose')	% Furfural (on 'Cellu- lose')	Copper num- ber (on 'Cellu- lose')	% α -Cellulose (on 'Cellu- lose')	% α -Cellulose (calculated on raw jute).	% 'Cellulose' + % Lignin (on raw jute)	% Loss on alkali (2% NaOH) boil (4 hrs.) on 'Cellulose'.
Cross & Bevan's	72.55	.02	1.04	8.94	1.03	78.01	56.61	84.35	14.59
Chlorine dioxide	84.96	.20	1.67	9.27	4.70	70.88	60.22	96.76	41.01
Norman & Jenkins'	77.77	.18	0.86	7.20	2.69	78.65	61.15	89.57	30.35
Sodium chlorite	89.03	.40	1.46	9.85	1.48	68.15	60.43	100.83	30.23

* 'Cellulose' refers to fibre-cellulose, that is, α -cellulose together with hemicelluloses.

Copper number was determined by the Schwalbe-Braidy method.

The analytical figures for the sample of jute (J-161) employed are given below for comparison.

J-161 defatted fibre :

- (1) Lignin .. 11.80%
- (2) Copper number 1.91%
- (3) Loss on alkaline
boil .. 18.40%
(2% NaOH for 4 hrs.)
- (4) Furfural .. 9.05% (the phloroglucide
was not washed with
hot alcohol)
- .. 8.50% (the phloroglucide
was washed with
hot alcohol)
- (5) CO_2 .. 1.30%

extremely active throughout the whole working day in giving alternate treatments with sodium hypochlorite and hot sulphite, transferring a good number of times quantitatively and so on, in the case of Norman and Jenkins' method. Nothing of the sort is required here. No hot alkaline treatment (with NaOH or Na_2SO_3), before or after, is necessary in this case. We have not tried this method as yet in the case of straw or wood, but so far as bast fibres are concerned, the NaClO_2 method for the estimation of cellulose appears to be neat, simple, quick and accurate.*

* Our grateful thanks are due to Mr C. R. Nodder, Director, for his kind interest in the work.

MEDICINE AND PUBLIC HEALTH

MALARIA IN BENGAL

THE 25th Annual General Meeting (Silver Jubilee Session) of the Central Co-operative Anti-malaria Society Ltd., and the annual conference of representatives of rural societies in Bengal, was held on the 17th December, 1944, in Calcutta, Mr L. K. Elmhirst, M.A. (Cantab.), B.Sc. (Cornell), Agricultural Adviser to the Government of Bengal, presiding.

In presenting the annual report of the Society for the year ended the 30th June, 1944, the Secretary stated that the Central Society claims the credit of having organised nearly 3000 societies in the villages of Bengal during the last 25 years. These rural societies are purely voluntary organizations and carry on anti-larval measures on approved scientific principles to the best of their power and resources.

The present epidemic of malaria is due to intermixture of the people due to war conditions and not to the only factor of mosquitoes, as supposed.

The Society has found more and more truth in the extensive application of naturalistic method of malaria control such as by the introduction of larvivoracious fish in tanks. The malaria problem of rural Bengal is a question of *tank malaria* mainly due to the presence of innumerable insanitary pools. By inducing and encouraging the people to free their tanks properly of aquatic vegetations, predatory fish, overhanging jungles around their edges etc., in order to get their supply of fries, or spawns of carps, free of charge from the fishery department of Bengal, it was expected the malaria could successfully be controlled in many villages, as these tanks would no longer become hotbeds for the breeding of mosquitoes. By adopting this policy of the fishery department, it might be possible to do away with a large number of mosquito-breeding places in the rural areas.

Mr Elmhirst, in his presidential address, stressed the need for collaboration between Government and the people in eradicating malaria. He suggested that the proper treatment of tanks, *beels*, and rivers in Bengal was essential before malaria could be successfully fought. In the treatment of water he included the scientific cultivation of fish. With more water available, more crops could be grown and better balanced nutrition would result. The building and maintenance of roads must also engage the attention of co-operative workers, for without a good system of communications there could be little improvement in the economic position of villages.

General education and better housing and hygiene, including clearance of slums, rural, urban,

and industrial were other vital factors in rooting out disease. "Through the combined operations of scientists, economists and villagers alone can the malaria-carrying mosquito be overcome".

H. E. Mr R. G. Casey, Governor of Bengal in a message to the Central Society said, "By mobilising popular support in the fight against malaria, and by stimulating interest in preventive measures, you are undertaking a task which is in accordance with the highest ideals of Public Service, and I wish you every success in your future efforts".

"I hope the Society will succeed in expanding the sphere of its activities in the mofussil and so help Government in combating the scourge of Bengal malaria."

ROLE OF CAFFEINE IN ULCERS

Gastroenterology, April 1944, contains a paper by J. A. Roth and A. C. Ivy on their recent experimental studies regarding the role of caffeine in ulcers. As pointed by Roth and Ivy, few clinicians restrict the use of coffee in their management of the peptic ulcer patient. The experiments recorded in this paper were devised to determine the effect of caffeine in experimental ulcers in an attempt to obtain prolonged and continuous caffeine action. The technique of embedding caffeine in a beeswax-mineral oil mixture was used. The caffeine mixture was prepared in batches consisting of 22.5 grams of anhydrous caffeine alkaloid, 15 c.c. of melted bleached beeswax, and 60 c.c. of hot mineral oil. The final mixture gives approximately 300 mg. of caffeine base per cubic centimeter. This mixture was injected alternately into the shoulder, thigh, calf and back muscles of a series of 22 cats. Injections were made daily. A control series of 10 cats received an equal quantity of a warmed mixture of mineral oil and beeswax in the same proportions as used in the caffeine preparation. The prolonged administration of the caffeine mixture was found capable of producing gastric ulcers in these animals. The period of time varied from 3 to 38 days, although not all animals developed erosions. These results suggest that the *excessive use* of caffeine-containing beverages may play a controversial role in the pathogenesis of gastro-duodenal ulcers in man. In view of these observations and the marked stimulation of gastric secretion in man by the oral or parenteral administration of caffeine, it is suggested that the use of caffeine beverages may be best restricted in the management of the patient with peptic ulcer.

CONTROL OF MALARIA IN U. S. A.

AN account of the successful control of malaria in the U.S.A. has been given by Major O. R. McCoy, Director of the Tropical Disease Control Division, at a recent meeting of the American Association for the Advancement of Science in Cleveland (*Science News Letter*, September 30, 1944). In 1943, malaria cases in the Army stationed in the Continental United States dropped to a record low figure of only 2 per 10,000. Major McCoy traced the cause primarily to the ten-million-dollar campaign against the

mosquito breeding places which has been continued for the last three years. In addition to the customary measures of drainage and oiling heavy use has been made of various larvicides, of which DDT, the new insecticide, has proved most effective against larvae as well as adult mosquitoes. Great success also attended the aerosol 'bomb' method attacking mosquitoes. Major McCoy further expressed his opinion that complete suppression of mosquito breeding would, however, be impossible in the tropics and accordingly reliance must be placed partly on personal defences and on anti-malarial drugs.

RAT CONTROL

GAURCHANDRA GHOSH,
CHARTERED CIVIL ENGINEER

PUBLIC attention has recently been drawn to the subject of rat control by the Bombay Government's offer of half an anna per rat killed. It is estimated that in India nearly one million tons of food grains are destroyed by rats every year. In a given community the rat population is said to be roughly equal to that of its human habitants. In U. S. A. the annual cost of feeding a rat is estimated to be two dollars. The Americans are certainly much better fed than the average Indians, and on that count the standard of food for the American rats may be expected to be much higher than their Indian colleagues. Taking the standard to be, say, one-third for India, the cost of feeding an Indian rat may be taken as two rupees per year. Assuming 388 millions of rats living side by side with 388 millions of India's human population, the annual cost of feeding our rat community amounts to 776 million rupees. Besides this, they destroy materials worth ten times the cost of feeding them. There are instances of rats completely destroying the harvest, which led to food shortage and famine. Control of rats has thus a very great economic significance.

PUBLIC HEALTH IMPORTANCE

Control of rats is also an important public health problem. Rats are responsible for the transmission of plague, a very dangerous disease. Besides plague, rats spread directly or indirectly many other diseases. Rat-bite-fever, though a very rare infection, is said to be due to bites of rats. Rats are responsible for infectious jaundice caused by a spirochete infection. The spirochetes are excreted in the urine of infected rats, and thereby food, water and soil may become contaminated. Human infec-

tion takes place either through skin or mouth. *Trichinosis* is quite common among rats which get infected by eating each other or infected pork. Swine get infected by eating infected rats and offal, and men get infected almost exclusively by eating pork or boar meat not thoroughly cooked. Rats and mice are carriers of *B. enteritidis*, and they also transmit certain types of tape worms and parasites which concern man.

RATS AND THEIR HABITS

Distinction between rats and mice are largely based on size. The following are the common types:—

- (1) The common house mouse (*Mus musculus musculus*).
- (2) The black rat (*Rattus rattus rattus*).
- (3) The Egyptian or roof rat (*Rattus rattus alexandrinus*).
- (4) The brown rat, also variously known as grey rat, barn rat, wharf rat, sewer rat, and Norway rat (*Rattus norvegicus*).

Rats live on an average for two years. They are prolific breeders and on an average produce annually five litters of six to nine rats each time, sometimes as much as twenty-two at a time. Starting with one pair of rats and assuming no casualties, it may be possible to have as many as two crores of rats in three years. The black and roof rats are expert climbers and jumpers. They do not burrow, but live in hollow spaces and roofs, or nest in trees. Empty metal can two feet deep is not sufficient to retain the black rat. Both black and roof rats are rather clean in their habits and prefer grain and clean, fresh food. Brown rats are not good climbers, but are provided with good gnawing mechanism and generally make

burrows 1½ to 1 foot deep (some-times two feet or even more) where they live. They can gnaw holes in lead pipes, slate, wooden beams to a depth of two or three inches. They are good swimmers and can remain in water for a long time. They eat just anything, fresh or rotten.

Rats are also migratory in their habits and often leave dwellings for barns and fields and after a period again return to their usual abodes.

CONTROL OF RATS

There are two types of control, (a) destruction, and (b) suppression.

(a) *Destruction of rats*.—Various measures may be adopted, such as trapping, fumigating, poisoning, starving or annoying.

Extermination of rats is, however, a biological impossibility. To be effective, these measures must be continued and constantly watched. When conditions become intolerable for them the rats usually leave the area but soon return if the control measures are stopped. There are various types of traps that are used. It is difficult to catch black rats in cage traps; the more effective types against them being snap traps and dead falls. The quality of the food offered in the trap does not matter much. The most important point to ensure is that the food offered in the bait is the only food easily accessible to the rats.

Fumigation is effective in enclosed spaces and is widely used for destruction of rats in ships and ware houses, hydrocyanic acid gas being generally used for the purpose. As the gas is lethal to human beings it should be used only by experts. Various types of poison baits made from yellow phosphorus, arsenic, strychnine, and most commonly barium carbonate, are used. Their efficacy in the control of rats is debatable. These poison baits are also dangerous to human beings and should be used with caution.

Starving out the rats by separating them from their usual food supply is a very effective method, as rats require a large amount of food for their existence. All food stuff should be kept inaccessible to rats, and garbage should be kept in rat proof containers.

Employment of cats and other animals who feed on rats does not generally prove to be effective.

(b) *Suppression and Control*.—In buildings and structures, rats live in enclosed and hollow spaces, under floors, inside pipes, holes in walls, in various types of furniture and fixtures, in heaps of trash, old discarded equipments, boxes and similar materials. For preventing rats from invading buildings and structures they should be designed in such a manner as to eliminate unnecessary enclosed spaces and where this is impossible we must use materials impervious

to rat gnawing and install them in a rat proof manner. To achieve this objective several engineering principles must be observed. Foundation walls should be built of rat-proof material, plastered to a smooth surface and should extend at least 3 ft. below ground level. Walls and floors should be of solid construction without intervening spaces. Double walls should be avoided as far as possible. All openings around pipe lines passing through wooden floors or ceilings should be fitted with metal rat proof collars, and openings through walls for pipes and beams should be fitted in with cement or concrete. Openings in ventilators, space over wall plate roof rafters etc. should be fitted with sheet metal having perforations not exceeding ½ inch in diameter or width, these being better than wire mesh or expanded metal. In case of rectangular, horizontal or vertical openings, as in louvers or between sliding doors and building walls, the maximum width of opening should not exceed ⅜th inches to prevent rat ingress. If floors are made of wood or other non-rat-proof material, they should extend to rat proof base-board and the protective rat-proof material, like sheet metal, must extend to the side walls and be fitted thereto.

Furniture and equipments in houses, if badly designed, may harbour rats. Show window display counters should have walls of rat proof material. Store counters, wall cabinets, filing cabinets, desks etc. should be either of the elevated type in which there is an intervening space of 10 to 12 inches between floor surface and undersurface of bottom drawers etc., or they should rest flat on floor and against walls without any enclosed spaces. Metal flashings should be installed along the lower edges of the fixtures to prevent gnawing by rats. Storage bins should preferably be of metal sheets and should be either elevated about 12 inches from floor or should rest flat on floor so as to avoid any enclosed spaces. Refrigerators should preferably be constructed of metal and should be installed on such a manner as to avoid any enclosed spaces at the bottom or sides between floors and walls. Ventilating ducts and air conditioning trunk lines should be constructed of approved rat proof material, preferably hard sheet metal, and they should be installed in a manner which will eliminate flat surfaces on the top which can be utilized for rat harborage.

By applying the above principles, defects in existing buildings and structures can also be rectified. Walls and floors should be repaired, and all interstices, crevices, and holes should be filled up with cement and plastered to a smooth surface. All enclosed spaces between walls, floors and other fixtures should be eliminated, failing which they should be closed with rat proof metal flashing.

Grain stores should be properly designed to prevent ingress of rats. The foundation walls should be

extended at least 3 feet below ground level. Floor should be of solid construction, such as concrete. At

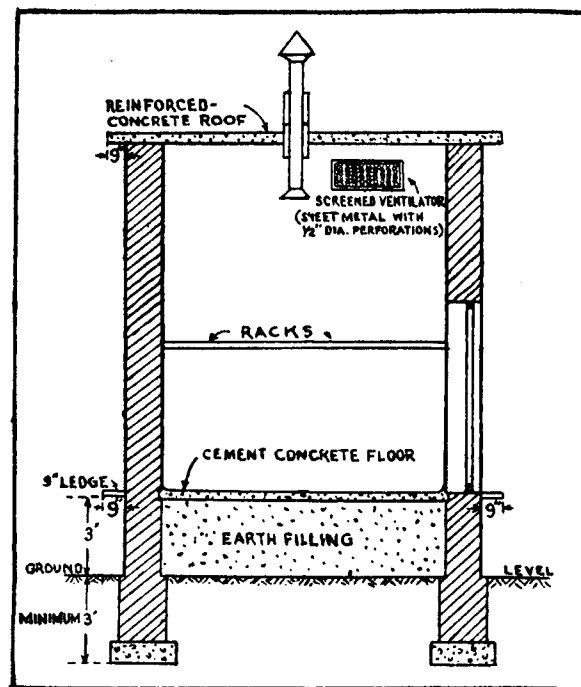


FIG. 1. Rat proof store (with top ventilation)

a height of 3 feet above the ground level there should be a projecting ledge all round, 9" wide to prevent entry of rats from outside. Steps should be avoided. The openings and ventilators should be fitted with sheet metal screen with perforated holes not more than 1/2 inch in diameter.

To ensure control of rats in buildings and structures, there should be rat proofing ordinances for all cities. These ordinances should require buildings to be constructed in a rat proof manner. Plans must first be approved before actual construction may be allowed to be undertaken. The local health authorities should be empowered to make rules for enforcing these ordinances and to inspect buildings during and after construction. The health authorities should lay down rat proof designs and fundamental approved methods of construction for the guidance of the public.

The problem of rat control in rural areas in India is difficult owing to the use of non-rat proof materials such as mud, bamboo, wood, straw etc., for house construction. The problem is important both from the public health and from the economic point of view. For devising effective measures of control, the public health workers must closely co-operate with the engineers.

BOOK REVIEWS

The Loom of Language—a guide to foreign languages for the home student—by Frederick Bodmer, edited and arranged by Lancelot Hogben; Pp. 669; George Allen & Unwin Ltd., London, 1943. Price 15 Shillings.

The editor says in his preface: "because this book is a successor to *Mathematics for the Million* and *Science for the Citizen*, its motif is social and its bias is practical." Now language—as distinct from mere word-sounds—being a purely social phenomenon the motif of a book like this cannot but be social; but there is ample reason to doubt whether there is anything substantial in the book to justify its claim for the bias for the practical. Is it "practical" to tell a man who wants to learn Russian to take the precaution of being born and brought up in Russia (p. 415)? Is it practical to burden the book with obscure and ill-defined rules of Teutonic and Roman languages? I doubt if any practical man to-day will devote any time to Swedish, Danish, Dutch, Spanish and Portuguese—to which our author has given so much of the space at his disposal.

From the consideration of the science of language and also from the practical point of view, the book will appear hardly impressive. Yet the noble purpose with which the book has been written cannot be admired enough. The author rightly says that international peace and understanding cannot come without an international vehicle of ideas. And with a view to that end he has here—without trying to figure out in all its details such a vehicle—attempted heroically to beat down the linguistic barriers separating even in this fast contracting world country from country and nation from nation.

B. K. G.

The Aborigines—"So called"—and their future.—By G. S. Ghurye, Ph.D. (Cantab.) Professor and Head of the Department of Sociology, Bombay University Publication No. 11 of the Gokhale Institute of Politics and Economics, Poona, Pp. XVI + 232. Price Rs. 8/-.

In a country like India, with a vast primitive population, estimated to be well over twenty millions,

and by some put even higher, the question of acculturation is bound to loom large in any plan of national welfare. The surprising fact remains that even now only a very limited number of persons—mostly anthropologists (including sociologists) and administrators, have taken any interest in the matter. Dr Ghurye has performed a useful service in collecting together a large mass of relevant information regarding the subject in the work under review.

Dr Ghurye has limited his survey mainly to the tribes of the great Central Indian plateau or as an earlier writer puts it, of the Western and Central belt of primitive people in India. Such a limit has presumably been observed as this group has been in more intimate contact with Hindu India than is, for example, the case with Assam tribes.

In the earlier chapters Dr Ghurye considers the distribution of the tribal folk and the effects of the contact with Hindus on them. The good effects of such contact, in the way of spread of more advanced methods of food growing and materials, arts in general as well as the evil effects that have followed through the rapacity of money lenders and land grabbers, are noted. Dr Ghurye seems to think that the balance of good over harm is favourable in most cases. In drawing such a conclusion Dr Ghurye has relied entirely on the work of others, in the absence of personal experience. He has quoted in this connection administrators and anthropologists who have been in fairly intimate touch with the primitive people.

In the later chapters Dr Ghurye has summarised the various administrative measures and legislative action taken by the Government of India and the British Parliament regarding the "so called" aborigines. In this connection he has brought out clearly the contradictions involved in the policy of an imperial power in their contact with backward people. Dr Ghurye quotes the forest reservation policy as an example of a measure which has injured tribes like the Korwa and the Birhor. If Dr Ghurye had had first hand acquaintance with the tribes of the Central Indian Plateau, he would have found that there has been a constant clash between measures designed to safeguard or increase revenue, and measures intended to protect the primitive tribes. More often than not, the interests of the revenue department have prevailed.

Dr Ghurye next discusses the views of anthropologists like Rai Bahadur S. C. Roy, Dr Elwin, and Mr Grigson regarding the problem of culture contact and culture assimilation. Dr Ghurye has rightly criticised what may be termed the romantic view of tribal culture. Primitive people are considered by some administrators and anthropologists to be like children and they recommend that the tribal people should be treated as such and separated from the rest of the Indian population, and allowed to express

themselves through their primitive full blooded tribal culture. The mistake of the up holders of this view is that they ignore that (a) the tribal culture has large elements borrowed from the Hindu culture, which in its turn has assimilated many traits of the primitive culture and (b) a culture which does not change with the alterations in its cultural environment will assuredly perish. Any period of transition is bound to cause hardships to those who stick to the old ways. This fact should not however lead the sociologists to speak against social change. On the contrary, it should be their duty to indicate the best way to accomplish the transformation with the minimum amount of travail.

It would be a mistake at the same time to ignore the immense amount of harm done by persons of advanced culture who seek out the primitive folk only with the intention of making a profit out of them. The injury such a person inflicts in the process is of the same type, on a miniature scale, as that brought on colonial people by imperial rulers in the course of their economic exploitation. Any benefit that may accrue, incidentally, such as the spread of more advanced methods of material culture, does not justify the harmful effects, in either case, and cannot lead any scientific student of culture to approve of the continuation of such modes of contact, whether on an imperial scale or in the domain of culture contact of advanced people with primitive folk.

Dr Ghurye argues that the economic problem of our peasantry and artisans are comparable to that of the aborigines. He notes that "the problem regarding land . . . is very largely the same for a large section of our population whether aboriginal or non-aboriginal". All this is quite correct in a general way. But he offers no solution which will help to save both sections of the people, while taking due note of the differences in their cultural condition. Dr Ghurye's view seems to be that general measures of protection such as the Money Lenders' Acts, or Tenancy Acts passed in the different provinces will be adequate. Dr Ghurye has fallen into the opposite error to that of the romantic school and has overlooked the fact there are definite and valuable elements in the social and mental make up of the aboriginal, which are likely to be destroyed by lack of protection. A Santal, for example, is essentially freedom loving and has a sense of self-respect, which makes him feel himself the equal of any other man. In his social and economic life again, a Santal places the interest of the village above that of the individual. It would be a tragedy if he became just a caste man in Hindu society or a subservient unit, among the followers of any other creed. It would also be a great pity if he ceased to care for the village and pursued his calling, impelled mainly by the profit motive. Dr Ghurye's apprehension seems to be that

protection would make tribal man a hostile misfit in the future Indian population. There is no doubt that the activities of missionaries interested mainly in evangelisation and of politically minded administrators has done this harm to some extent. The remedy is however not the opposite evil of absorption into Hindu or any other advanced society.

Our duty, as sociologists and well wishers of all sections of our countrymen, should be to place the best that world knowledge has to offer, at the service of all; to approach the humbler and the backward, without any motive of profit or of inflicting our tutelage, neither to look at them with patronage nor admire them through romantically coloured glasses, but to treat them as normal human beings who are entitled to live according to their own ways of life. We should remember that economically they need safeguards—much more than what they are getting now. Culturally they should receive education in the scientific outlook and scientific methods and then left free to develop their own culture not in isolation but in touch with modern conditions.

K. P. C.

Your Food—By M. R. Masani (Tata studies in current affairs). Published for Tata Sons Limited by Padma Publications Ltd., Bombay. Pp. 82. Price Re. 1/-.

"Your Food" is the first of the series of "Tata studies in current affairs" and deals with the pressing problem of food and nutrition in India. It is meant to educate and stimulate public interest in this vital problem of India, which in course of time may influence policy and action.

The author belongs to the Public Relations Department of Tatas and among his varied qualifications is the fact that he is the Chairman of People's Provincial Food Council, Bombay. The book is

written with the idea to appeal to a very wide circle of readers rather than to a select few and Sir Homi Mody in his foreward to the book rightly observes that the subject matter has been treated in a "popular" 'more in the nature of a fireside chat than an elaborate treatise on the subject'.

A new feature of the book is that it is suitably illustrated on modern lines, that makes it highly intelligible. The writer has discussed the problems arising out of the shortage of food production in India, and suggested ways and means for increasing the production to cope with the growing population of India. Useful data is to be found with regard to a 'balanced diet' and in the author's opinion it is poverty and not ignorance or habit that is the main factor why the diet of our people is not properly balanced and deficient in nutrient elements. A domestic diet survey according to income carried out at Jamshedpur among the employees of the Tata Iron and Steel Works, illustrate that the quality and quantity of food improves as the income rises. It is depressing to note that well-balanced diet is beyond the means of the majority of our people. A rise in the income of our people, whether from agriculture, industry or trade would in itself ensure a better food. Food problem is thus bound up with the problem for the abolition of poverty.

If the book is found to have a wide appeal, it is intended to have translation in some of the leading Indian languages. Tatas will further endeavour to respond to requests for free copies from rural development centres and educational and other institutions which would not otherwise be able to obtain them.

A. K. G.

LETTERS TO THE EDITOR

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

ON THE AVERAGE LIFE OF THE PLATINOCYANIDES IN SOLUTION

VERY recently we have investigated in detail the polarisation of the fluorescent radiation emitted by the different platinocyanide compounds in solution at different temperatures and concentrations under the excitation by light of various wavelengths. We have also calculated the average life of the excited molecules from the aforesaid polarisation measurements, the results of our calculations being given here.

TABLE I
AVERAGE LIFE OF THE PLATINOCYANIDES EXCITED BY λ 3131 Å
AT DIFFERENT VISCOSITIES

Viscosity of the solution	Sodium platinocyanide Conc. = 5×10^{-5} gm/cc.	Potassium platinocyanide Conc. = 5×10^{-5} gm/cc.	Barium platinocyanide Conc. = 5×10^{-5} gm/cc.
4.56	—	—	1.80×10^{-9} sec.
1.65	1.20×10^{-9} sec.	1.24×10^{-9} sec.	1.91×10^{-9} "
61	1.51×10^{-9} "	1.24×10^{-9} "	—

TABLE II
AVERAGE LIFE OF THE PLATINOCYANIDES EXCITED BY λ 3131 Å
AT DIFFERENT TEMPERATURES

Temperature in °C.	Sodium platinocyanide Conc. = 5×10^{-5} gm/cc.	Barium platinocyanide Conc. = 5×10^{-5} gm/cc.	Potassium platinocyanide Conc. = 5×10^{-5} gm/cc.
28	—	1.8×10^{-9} sec.	—
40	1.3×10^{-9} sec.	1.75×10^{-9} "	1.4×10^{-9} sec.
50	1.4×10^{-9} "	—	1.35×10^{-9} "

Thus it shows that within the limits of the experimental error the value of the average life is independent of the temperature and viscosity of the solution; but depends on the concentration of the fluorescent compounds in solution. We have also calculated the average life of the compounds when excited by lights of various wave lengths. In the case of excitation of sodium-platinocyanide by λ 3131 the life was observed to be 1.3×10^{-9} sec.; whereas, for λ 2537 excitation it was 1.32×10^{-9} sec. This shows that the life is also independent of the exciting wave length.

Further, it was observed that all the three platinocyanides have the same average life, which was of the order of 10^{-9} sec. In the case of the solid platinocyanides, which are intensely luminescent the average life was of the order of 10^{-5} sec. as measured directly. This difference is rather remarkable as the $\text{Pt}(\text{CN})_4$ complex is obviously responsible for both the processes.

S. M. MITRA
A. K. M. SIDDIQ

Physics Laboratory,
Dacca University,
Dacca, 8-11-1944.

ON THE EXTRA REFLECTIONS IN THE LAUE PHOTOGRAPHS OF PHLOROGLUCINE DIHYDRATE CRYSTALS

I

In a recent note Dr S. C. Sirkar¹ has drawn attention to a point about the highly interesting results obtained by C. R. Bose² in his investigations on the secondary extra reflections from phloroglucine dihydrate crystal. The point is whether these reflections are of the same nature as the secondary extra reflections from diamond. The apparent dissimilarity pointed out by Dr Sirkar will easily disappear if one considers the result from the standpoint of the reciprocal lattice.

In the case of phloroglucine dihydrate the break-up of the lattice is along the c^* axis. The direction of the reflected beam as determined by the intersection of the sphere of reflection with the linear extensions of the reciprocal lattice points along c^* direction will easily be seen to be affected very slowly when the crystal is rotated from the position where the X-ray beam is incident along the c -axis and the Bragg angle is not large. In the setting of Lonsdale and Jahn,³ it will be seen similarly from considerations of the reciprocal lattice that the variations will be much greater.

The simple explanation of this effect suggested by Dr Sirkar cannot unfortunately explain the observed facts. It is a well-known fact that the type of misorientation postulated by him would give rise to arcs which in the ideal dis-orientation of the powder photograph would become circles. However, it is possible to think of such preferred disorientation that would give rise to a sharp reflection even for a large deviation from Bragg angle, but it is impossible to explain all the sharp spots on the phloroglucine dihydrate photograph by any such postulate of preferred orientation. In fact the only conclusion that can be obtained from the positions of the spots on the photographs is that mentioned in a paper by Bose and the present author⁴ that the lattice is broken up along the c -axis while retaining regularity along the a and the b axes so as to simulate a two dimensional grating. A structure based on extremely thin but extended mosaic blocks also cannot explain the observed absence of this type of extra spots on the equatorial or the meridial lines.

As regards the explanation of the secondary extra reflections in diamond as due to internal strain apart from other difficulties it is untenable for the simple reason of the high magnitude of strain that has to be postulated, to explain the observed large deviations from the Bragg angle, upto which, the secondary reflections have been observed.⁵

K. BANERJEE

Indian Association for the Cultivation of Science,
210, Bowbazar Street,
Calcutta, 9-11-1944.

¹ Sirkar, S. C., SCIENCE AND CULTURE, 10, 215, 1944.
² Bose, C. R., Proc. Nat. Inst. Sci., 10, 201, 1944.
³ Jahn, H. A., and Lonsdale, K., Nature, 147, 88, 1941.
⁴ Banerjee, K. and Bose, C. R., Nature, 153, 28, 1944.
⁵ Lonsdale, K., Proc. Roy. Soc., 179A, 315, 1942.

II

The arguments on which the explanation regarding the origin of the extra spots in the Laue photographs of phloroglucine dihydrate offered by me¹

has been based consist mainly of two points, *e.g.*, (1) that the spots do not move appreciably while the crystal is rotated through large angles and (2) that probably these spots occur in the directions making angles $2\theta\beta$ with the incident beam. Prof. Banerjee's argument regarding the first point is not convincing, because according to his argument the spots ought to *move slowly* with the rotation of the crystal, but actually it has been observed by Bose² that they *do not move appreciably* even when the crystal is rotated through large angles. As regards the second point, Prof. Banerjee has not stated anywhere whether the directions of extra spots make angles $2\theta\beta$ with the incident beam or not. The explanation offered by me will be proved to be wrong only if the extra spots are observed to occur in directions other than those mentioned above. But if they are actually observed to occur in those directions the correctness of the explanation can never be challenged. Hence a definite statement regarding this point from Prof. Banerjee would clarify the matter.

S. C. SIRKAR

Physics Department,
92, Upper Circular Road,
Calcutta, 22-11-1944.

¹ Sirkar, S. C., *SCIENCE AND CULTURE*, 10, 215, 1944.

² Bose, C. R., *Proc. Nat. Inst. Sci.*, 10, 201, 1944.

III

Dr Sirkar bases his theory upon the single qualitative visual observation mentioned in the paper by Bose¹ that the positions of these spots do not alter appreciably and overlooks the results of the accurate quantitative measurements mentioned by Banerjee and Bose² that the positions of the spots accurately obeyed two of the Laue equations *viz.*,

$$a_o(\alpha_o - \alpha) = h\lambda \text{ and } b_o(\beta_o - \beta) = k\lambda$$

The deviations from the fixed positions as given by these equations, though small have been actually verified from the accurate measurements. Hence the second point of Dr Sirkar also does not arise for if the angle is not strictly constant it cannot be equal to $2\theta_B$ for all angles of incidence.

K. BANERJEE

Indian Association for the Cultivation of Science,
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Calcutta, 7-1-1944.

¹ Bose, C. R., *Proc. Nat. Inst. Sci.*, 10, 201, 1944.

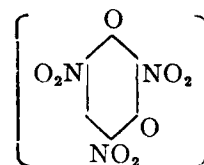
² Banerjee, K. and Bose, C. R., *Nature*, 153, 28, 1944.

COLOUR OF SOME NITRO COMPOUNDS

STYPHNIC acid is described in the literature as a yellow compound. On the contrary, we have found that:—

- (i) Styphnic acid, when crystallised from hot kerosene, is almost colourless, although it subsequently becomes yellow by picking up moisture. It could also be crystallised from other non-aqueous solvents like petrol-ether or CCl_4 in a colourless state, the solubility in these solvents, however, is very limited.
- (ii) Aqueous solution of styphnic acid, which is yellow, becomes colourless when strongly acidified with concentrated HCl .
- (iii) The colourless crystals become yellow on melting.

The results indicate that pure, dry styphnic acid is colourless and that the yellow colour it normally exhibits is due to the dissociated anion:



The above observations raise the question of colour, in general, of nitro bodies which are assumed to be yellow inherently.

Picric acid and tetranitroresorcinol, which are closely allied to styphnic acid, are known to exhibit a colour behaviour now observed with styphnic acid; in other words, they are yellow only as the result of picking up moisture.

Trinitromethane or nitroform $\text{CH}(\text{NO}_2)_3$ is known to form colourless crystals, but turns yellow in water.

It has been possible to crystallise T.N.T. from water in an absolutely colourless condition, and also from CCl_4 . This colourless compound, however, slowly turns brown under the influence of light. It is, therefore, reasonable to assume that the slight yellow colour commonly associated with T.N.T. is an induced effect, and that inherently this compound is colourless.

Nitroso compounds are usually colourless, crystalline bodies in the solid state when they exist as dimers; these dissociate by heat or solution into the intensely blue monomolecule. This behaviour is exhibited by many complex nitroso bodies; tertiary-nitrosoisobutane $(\text{CH}_3)_3\text{C} \cdot \text{NO}$, for example, forms colourless (dimolecular) crystals, but melts to a blue (monomolecular) liquid.

The authors are grateful to Dr H. R. Ambler, Ph.D., F.I.C., Chief Inspector of Military Explosives

sives for helpful suggestions and to the Director of Armaments in India for permission to publish the note.

B. N. MITRA
M. SRINIVASAN

Inspectorate of Military Explosives,
Kirkee, 15-11-1944.

PURIFICATION OF AMMONIUM SULPHATE FROM PYRIDINE

AMMONIUM sulphate of coal tar origin is invariably contaminated with a considerable amount of pyridine. Pyridine would, therefore, persist as an impurity in the ammonia liberated from such ammonium sulphate, and would act deleteriously on the catalyst in the manufacture of nitric acid. Further, this base would appear as an impurity in the ammonium nitrate finally manufactured, which is required to be pyridine-free for ordnance use. It is, therefore, incumbent to ensure that the stock of ammonium sulphate for generating ammonia to be converted to nitric acid should not contain pyridine. In normal practice an oil scrubber is used for affecting the removal of pyridine from ammonia.

An alternative method has been worked out on a laboratory scale as would enable the elimination of traces of pyridine from ammonium sulphate by a preliminary treatment of the material with relatively small quantities of lime. The method is simple in that it does away with the oil scrubber, the use of which entails the installation of additional equipment for washing and recovery of the oil.

100 gm. ammonium sulphate were dissolved in 200 c.c. water in a beaker. Depending upon the pyridine content and the acidity of the material, milk of lime equivalent to 0.25 to 0.5% CaO on the weight of ammonium sulphate was prepared; the higher the pyridine content, the greater the quantity of the milk of lime required. One-fourth of the milk of lime was added to the ammonium sulphate solution in the cold, air blown in and the mixture maintained at about 90°C . with agitation. At 10-15 mins. intervals, small additions of lime were made, so as to maintain the alkalinity between pH 7-8 (*i.e.* between methyl red and phenolphthalein). Under these conditions pyridine was removed with the loss of negligible quantities of ammonia. With pH higher than 8, however, the elimination of pyridine was found to be rapid, though with some loss of ammonia.

By this method it is possible to reduce the pyridine content to about 0.01% and it takes one to two hours to complete the elimination of pyridine

from the ammonium sulphate before it can be used for the generation of ammonia.

Our thanks are due to Dr H. R. Ambler, Ph.D., F.I.C., Chief Inspector of Military Explosives, for his kind interest in the investigation, and to the Director of Armaments in India for permission to publish the note.

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A FURTHER INSTANCE OF THE POSTERIOR CARDINAL VEIN IN BUFO MELANOSTICTUS SCHNEIDER

POSTERIOR cardinal veins may normally be present or absent in Salientia; they are generally absent in the two well-known families Bufonidae and Ranidae.⁵ Records of persistence of these vessels are too numerous in *Rana temporaria*,^{5,6} but those in other Salientian genera are only a few, *viz.*, two cases in each of *Bufo*^{2,11} and *Limnodynastes*⁵, and once in *Xenopus*⁵ and *Bombina*⁵ (= *Bombinator*). In 1929, the present author recorded a case of persistence of the left posterior cardinal vein, attended with some other minor venous abnormalities, in *Bufo melanostictus*.² Since then, the only other report from this genus, so far as I am aware, is Al-Hussaini's record of the persistence of the left posterior cardinal in *B. regularis*.¹

The present case turned up in course of my dissection of some two hundred toads for studying numerical variations in the dorsolumbar veins (in preparation) of which a preliminary note has already been published.⁴ It was a fairly full-grown female toad, measuring 82.0 mm. from snout to vent, and was, as far as could be ascertained, normal in other respects.

Observations.—The postcava is entirely absent save in its inter-renal portion, and is functionally replaced by the left posterior cardinal vein which is situated in front of the left kidney. The inter-renal vein is represented by a short vessel and situated mainly over the left kidney. It is formed by the union of two main revehent veins from the kidneys, the right one running superficially and receiving in its course arteriad well-marked factors from the kidney, ovaries, fat-bodies etc., while the left one proceeding embedded on the ventral face of the left kidney and much obscured by the deposit of suprarenal tissue except in its anterior portion. The inter-renal vein after receiving a separate small revehent factor from the cephalic end of

the left kidney, continues on to the left and becomes the posterior cardinal. The posterior cardinal pursues craniad lying by the outer side of the left systemic arch and the vertebral column, and tilting gradually to the left, it courses further forward dorsal to the subclavian artery and the brachial plexus. It then turns ventro-mesial at its anterior end, and after separately receiving the subscapular and the internal jugular veins, it takes part in the formation of the left precaval exactly at the place where the innominate vein would have joined. It is a fairly stout and prominent vessel of almost uniform calibre and

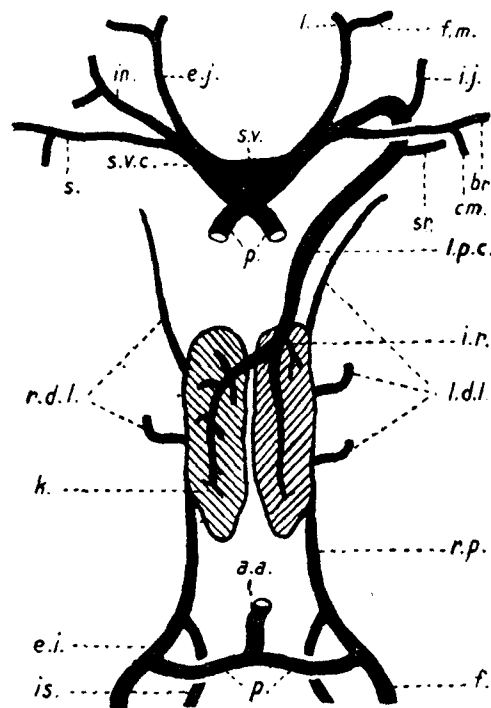


FIG. 1. Diagrammatic representation of the principal veins viewed from the ventral side with heart removed to expose the sinus venosus in *Bufo melanostictus*.

a.a.—anterior abdominal vein; br.—brachial vein; cm.—musculo-cutaneous vein; e.i.—external iliac vein; e.j.—external jugular vein; f.—femoral vein; f.m.—facio-mandibular vein; h.—hepatic vein; i.j.—internal jugular vein; i.—innominate vein; i.r.—inter-renal vein; i.s.—ischialic vein; k.—kidney; l.—lingual vein; l.d.l.—left dorso-lumbar veins; l.p.c.—left posterior cardinal vein; p.—pelvic vein; r.d.l.—right dorso-lumbar veins; r.p.—renal-portal vein; s.—subclavian vein; sr.—subcapular vein; s.v.—sinus venosus; s.v.c.—superior vena cava (precaval).

shows no dilatation anywhere in its course as observed in some frogs.⁵ The subclavian vein, however, does not open opposite to the external jugular, as is usually the case, but instead, it opens a little apart directly into the cardinal vein. The right precaval system is normally constituted.³

The two hepatic veins open directly into the hinder end of the sinus venosus.

The renal-portal vein (*v. iliaca communis* and *v. Jacobsonii*) is constituted in the ordinary ranid manner⁴ and the kidneys are almost equal in size. Each renal-portal enters the corresponding kidney by means of the *venae renales advehentes* in the usual manner without establishing a direct connection with any portion of the inter-renal or the posterior cardinal. It is to be noted that there are three dorso-lumbar opening into the left renal-portal (*v. Jacobsonii*) as opposed to two on the right side.⁴ Attention may here be drawn especially to the disposition of the anteriormost dorso-lumbar of the left side which runs parallel with the posterior cardinal (cf. O'Donoghue, 1931, Exs. 28, 34 and 35). With the arrangements of the veins in the kidneys it can safely be observed that both are portal.

It is well known that instances of the persistence of posterior cardinal vein are readily explained in the light of the developmental history of the postcava in the Amphibia. This has been elaborately dealt with by O'Donoghue.⁵ A passing mention may, however, be made that the present case appears to be a bit more primitive in that the inter-renal portion is not fully formed as in normal frogs and toads.

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Department of Zoology,
University of Calcutta,
Calcutta, 24-11-1944.

- ¹ Al-Hussaini, A. H., *Anat. Anz.*, 88, 416-420, 1939.
- ² Bhaduri, J. L., *Proc. Zool. Soc. London*, Pt. 2: 177-180, 1929.
- ³ Bhaduri, J. L., *J. & P. Asiat. Soc. Bengal*, (N. S.), 27, 101-110, 1931.
- ⁴ Bhaduri, J. L., and K. C. Ghose, *J. Roy. Asiat. Soc. Bengal (Sci.)*, 9, 55-62, 1943.
- ⁵ O'Donoghue, C. H., *Trans. Roy. Soc. Edinburgh*, 57, 179-224, 1931.
- ⁶ ———, *J. Anat. London*, 70, 159-176, 1935.

ATMOSPHERIC AMMONIA AS A SOURCE OF NITROGEN FOR SOILS

IN a recent contribution Abhiswar Sen¹ had adduced some evidence to show that ammonia in the atmosphere is a useful source of nitrogen and should, by itself, be capable of accounting for the maintenance of level of fertility—though rather low—of unmanured Indian soils. This concept, though highly fascinating, would require rather critical examination in the light of the various known facts.

There is no doubt that there is some ammonia in the atmosphere. How does it arise? There is no known mechanism by which the atmosphere can produce ammonia. On the contrary, a good deal of

ammonia is released from the soil, the sewers, manures, industrial wastes and so forth. Added to this, there is ammonia given off during the manufacture of coal gas, burning of coal under certain conditions and so forth. These evolutions would account for practically for whole of ammonia present in the atmosphere of large cities like London, Glasgow and Manchester which the author has referred to.

As for the soil itself, it is more capable of giving out ammonia than of receiving it. When the soil has a reaction of pH 7.0 and above, it invariably gives off small quantities of ammonia. Application of chalk or burnt lime hastens this evolution. Ammoniacal fertilizers applied to such soils tend to decompose and to steadily give off ammonia, though in small quantities at a time. This is a well known phenomenon and it is partly with a view to minimising this loss that ammonium salts have to be applied as top dressings to crops. All organic manures lose some ammonia during storage and further quantities are lost during their decomposition in the soil, whether it is under dry or wet cultivation.

The Indian Institute of Science has long been interested in the subject of loss of nitrogen from the soil.²⁻⁵ The evidence so far accumulated would show that a large part of nitrogen lost from dry as well as wet soils, as also from manures, is in the form of ammonia. The retention of ammonia beyond a point is difficult and, in fact, the agriculturist is hard put to keeping it in the soil.

A very simple demonstration of the evolution of ammonia from the manure heap would be to hold a piece of moistened red litmus paper over it on a moderately warm day. The litmus will turn blue in less than a minute. Similarly, evolution of ammonia from soils can be demonstrated by placing the soil properly moistened in a petri dish and sticking a piece of red litmus paper to the bottom side of the cover. In the case of some of the Punjab, U. P. and Central Indian soils, the evolution is pretty rapid and especially after the addition of ammoniacal fertiliser, the change in the colour of the indicator can be observed in less than a minute. The evolution is continuous and can be quantitatively estimated.

There is no doubt that the atmosphere contains some ammonia, but it would be seen from the above that a useful part of it comes from the soil itself. The soil has the capacity for retaining some ammonia, but it also gives off a good deal of it so much so that both the processes have to be taken into account. From our experience, we may state that the net result will be found to be one of loss rather than one of gain to the soil.

The author refers to sea water as a possible source of ammonia. He has no proof to show that

the land gains by it in the form of rain. The rain water, if carefully collected, is usually free from ammonia.

Taken on the whole, there is a strong need for reinvestigating the whole problem of nitrogen recuperation of soils. The subject is one of much scientific as well as practical interest and it is hoped that it will be possible for the Imperial Council of Agricultural Research to initiate some systematic work on the subject.

V. SUBRAHMANYAN
S. C. PILLAI

Department of Biochemistry,
Indian Institute of Science,
Bangalore, 24-11-1944.

- ¹ Sen, A., *SCIENCE AND CULTURE*, 10, 191, 1944.
- ² Sreenivasan, A. and Subrahmanyam, V., *Jour. Agri. Sci.*, 25, 6, 1935.
- ³ Subrahmanyam, V., *Nature*, 139, 884, 1937.
- ⁴ Sreenivasan, A. and Subrahmanyam, V., *Proc. Nat. Inst. Sci.*, 3, 219, 1937.
- ⁵ Bhaskaran, T. R. and Pillai, S. C., *Science*, 90, 595, 1939; unpublished data.

AMMONIA OF THE AIR

IN my article¹ an attempt was made more to convey a suggestion as to one possible cause of recuperation of nitrogen in Indian soils rather than to make a final conclusion. Careful and patient observations can alone bring out results which can settle the points on the other side of the question, i.e., as to which of the two, gain and loss of ammonia is dominant. In fact, some work on the problem is already in progress at the Institute and the results will be published as soon as available.

In the meanwhile the points raised above by V. Subrahmanyam and S. C. Pillai need be considered in the light of observations we have already in hand. The authors themselves point out that sources of ammonia in the atmosphere other than the soil (if we take it for granted) are numerous. It need not be concluded that an "useful part" comes from the soil. It is well known that electric charges in the air cause formation of ammonia in the air itself.² Then, considerable quantities of ammonia come from volcanic eruptions and good amounts of ammonium chloride and ammonium sulphate have been known to occur in volcanic districts; ammonia occurs with boric acid presumably formed by the decomposition of boron nitride.³

It is also doubtful if soils are more capable of giving out ammonia than of receiving it. Careful experiments are necessary to make any conclusion. If escape of ammonia nitrogen from the soils had been so continuous and quantitative as envisaged by the authors, there would have been a huge depletion of soil nitrogen every year by this agency alone and on this it would be very difficult to explain the ad-

vantages of following. As regards retention and release of ammonia from soils, Ingham's results with pulverised soil which he exposed in the air in the open for 18 months, are quoted below:⁴

Period (months)	Total Nitrogen %	Ammonia Nitrogen p.p.m.	Nitrate Nitrogen p.p.m.	Organic Nitrogen %
0	0.308	15	0.70	0.307
1	.315	54	11.0	.308
2	.321	97	12	.309
3	.318	157	23	.301
4	.322	172	23	.303
5	.330	234	29	.304
6	.339	280	30	.308
18	.350	418	30	.305

Thus it is seen that the remarkable increase in nitrogen was in the ammonia form and even during the period of 18 months there was no loss. Even if we imagine that there had been some loss by evolution of ammonia, it appeared that the net result of absorption and evolution was retention and not loss of ammonia from the soil. The possibility of bacterial fixation in the above soil was nil since soil organic matter underwent very little loss during the time (theory required destruction of half the organic matter) and the pH was 5.1, a very unfavourable one for azotobacter to thrive and function normally.

Another example can be found in Pusa drainage records which had been kept for about thirty years. Pusa soil with a huge amount of natural lime and a pH well above 8.0 (not to speak of 7.0) which grew wheat for a period of about 30 years did not show any remarkable loss of nitrogen when a balance sheet of nitrogen in the soil was prepared. The following were the results obtained.⁵

	Average annual loss of nitrogen from Pusa soil in lbs. per acre.
Nitrogen in drainage ...	9.95
Nitrogen in crop ...	21.58
Annual average loss ...	31.53
Annual average loss (from difference of initial and final nitrogen content of the soil) ...	32.00

All this go against the assumption that soils are more capable of giving out rather than receiving ammonia. The soils that are considered here were all unmanured ones and a very large portion of Indian soils grow crops without any kind of fertiliser. Studies in the losses of nitrogen from soil treated with heavy dressings of ammonium sulphate are of little value to actual agriculture in India.

Evidently the seat of absorption of ammonia is mostly the colloidal complex which is capable of absorbing ammonia in the gaseous form from the atmosphere and ammonia need not always be washed down in rain water to be absorbed by the soil.

However, it is really felt that the explanations in hand for natural recuperation of nitrogen of Indian soils are entirely inadequate. Studies of South African investigations on soils gave me impetus to make the bold suggestion without much experimental evidence to support it except for a few stray facts here and there. Naturally careful experiments are necessary and they alone will give us a clear picture of the natural process.

Subrahmanyam and Pillai's suggestion is welcome and we hope before long, to gain many valuable informations from their tried and experienced hands.

I thank them and my professor Dr S. V. Desai for the kind interest they have in the problem.

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¹ Sen, Abhiswar, *SCIENCE AND CULTURE*, 10, 191, 1944.

² Arrhenius, S. A., *Chemistry in Modern Life* of Dr. Leonard's Translation, 157, 1926.

³ Partington, J. R., *Text Book of Inorganic Chemistry*, 3rd Edition, 546.

⁴ Ingham, G., *South African Journal of Science*, 46, 161, 1939.

⁵ Sen, Abhiswar and Viswanath, B., *Ind. Jour. Agric. Sci.*, 13, 537, 1943.

ATMOSPHERIC AMMONIA AND NITROGEN RECUPERATION OF SOILS

THERE is no doubt that a certain amount of nitrogen recuperation of soil is going on. A number of theories have been put forth, but no conclusive evidence is yet forthcoming. There is strong need, therefore, for a critical study of the problem in all its aspects. The subject is one of very considerable fundamental as well as practical importance.

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ON THE THEORY OF ADSORPTION INDICATORS

FAJANS, Kolthoff¹ and their collaborators have developed theories on the action of adsorption indicators. It has been shown by Chaudhury and Indra² that these theories are not in complete agreement with experimental results on cataphoretic velocities of silver halides under the conditions of titrations.

From Langmuir's adsorption isotherm, we have

$$\frac{x_H}{x_{Ind} + k_1 a_H} = \frac{1 + k_2 a_{Ind}}{k_2 a_{Ind}}$$

where x_H and x_{Ind} are the amounts of the halide and the indicator ions adsorbed; a_H and a_{Ind} are the activities of the halide (and indicator ions) and k_1 and k_2 are constants.

vities of the halide (and indicator ions) and k_1 and k_2 are constants.

Neglecting $k_1 a_H$ and $k_2 a_{Ind}$ in comparison to unity, we have

$$\frac{x_H}{x_{Ind}} = \frac{k_1 a_H}{k_2 a_{Ind}} = k \frac{a_H}{a_{Ind}}$$

i.e., the amounts of the ions adsorbed are proportional to the activities of the halide and the indicator ions. When $\frac{k_1}{k_2} = K = \text{unity}$, the ratio of the adsorbed ions is equal to the ratio of the activities of the ions in the solution.

The adsorption of the halide and the indicator ions should depend on the activities of the halide and the indicator ions in the bulk of the solution, on the adsorbabilities of the respective ions by the precipitates (say silver halide), and on the solubility of the precipitates.

For an indicator ion to be precipitated at the equivalence point, i.e., for an ideal titration:

(1) The activity of the indicator ion used should be equal to that of the halide ion in the intermicellar liquid of the colloidal precipitate formed as a result of reaction between equivalent quantities of the reactants.

(2) Also the solubility of the silver-indicator compound should be equal to that of the silver halide compound since the adsorption of the indicator and halide ions depends on the solubilities of the silver halide and silver indicator compounds.

In very dilute solutions, the activities of ions may be taken to be equal to their concentrations.

In agreement with the theory developed above, the concentrations of the indicator ions used by different authors are found to be of the order of the concentrations of the halide ion.

The adsorption of the indicator ion which brings about the colour change, with which we are concerned in titrations, is very probably immediately followed by chemical combination.

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¹ Fajans, K., *Radio-elements and isotopes; Chemical Forces and optical properties of substances*, p. 96, McGraw Hill Book Co., New York, 1931; Kolthoff, *Chemical Review*, 16, 88, 1935.

² Chaudhury, S. G. and Indra, M. K., *J. Ind. Chem. Soc.*, 16, 81, 1939.

STUDIES IN THE CYCLOPENTANE SERIES—PART III

IN continuation of the investigations^{1, 2} we intend to record some of the more important results in the following short note.

Pure trans-1-methylcyclopentane-1:2-dicarboxylic acid was esterified to give the diethyl ester

(110°/6 mm). The half-ester of this, obtained on partial hydrolysis, was converted into acid-chloride which reacted smoothly with cadmium dialkyl to give the 2-methyl-2-carbethoxycyclopentyl methyl ketone (103°—05°/8 mm; semicarbazone: 200°—2°). The keto-ester reacted with β -bromo-propionic ester in presence of magnesium in toluene solution to give a lactonic ester (175°—85°/9 mm). This was reduced according to Clemmensen and the free acid was isolated as its diethyl ester (160°—65°/8 mm). Methylmalonic ester condensed with ethyl α -bromoglutarate to give the corresponding tetra-ester (185°/5 mm). This underwent ring-closure with sodium and the β -ketonic ester was partially hydrolysed with water-containing glycerol to give 2-methyl-2:3-dicarbethoxycyclopentanone (115°/4 mm, semicarbazone, m. pt. 240°).

The condensation product obtained from ethyl propionate and oxalic ester was brominated. The bromo-compound condensed under some modified conditions with the sodium salt of acetoacetic ester to give the keto-tetra-ester (132°/1 mm), which solidified in the receiver. This on dehydration with P_2O_5 gave the desired cyclopentenone derivative (133°/2 mm), which on catalytic reduction gave 2:3:4-tri-carbethoxy-3-methylcyclopentanone (126°/2 mm).

The lactone,³ obtained by the action of α -bromopropionic ester on ethyl δ -isoheptyl- γ -keto-hexanoate in presence of zinc, gave the ethyl ester of the unsaturated isooctyl-methyl-cyclopentenone carboxylate (145°/4 mm), on treatment with P_2O_5 . This on catalytic reduction gave 3-isooctyl-2-methyl 2-carbethoxycyclopentanone (150°—55°/8 mm). It was converted into cyanhydrin in the usual way and the latter was dehydrated to give the corresponding unsaturated nitrile (145°—50°/2 mm). This was hydrolysed in a sealed tube to the desired dicarboxylic acid which was stereochemically impure to a slight extent.

The lactone (136°/6 mm) obtained by the action of α -bromopropionic ester on lavulinic ester was distilled over P_2O_5 to give the ethyl ester of dimethyl cyclopentenone carboxylate (90°—95°/6 mm; semicarbazone decomposes at 212°—14°). This smoothly took up hydrogen catalytically to give the corresponding saturated ester (90°/6 mm). This was hydrolysed to 2:3-dimethyl-cyclopentanone (B. P. 145°—50°, semicarbazone 179°—80°).

My grateful thanks are due to Prof. P. C. Mitter, M.A., Ph.D., for his kind help and encouragements during the course of this investigation.

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¹ Dutta, J., *Ind. Chem. Soc.*, 611, 1940.

² *Ibid.*, 79, 1942.

³ Mukherjee, *SCIENCE AND CULTURE*, 7, 58, 1941.

ON VARIATIONS IN THE NUMBER OF GONADS AND
SHAPE OF DORSAL TUBERCLE IN THE MONASCIAN
STYELA AREOLATA HELLER

WHILE working on a collection of ascidians from Madras the author came across such a case in *Styela areolata* Heller, a monascidian that shows wide variations not only in the number of gonads but also in the shape of the dorsal tubercle, both of which have been considered as standard specific characters.

Heller¹, while erecting the species *S. areolata*, gave a very brief description without publishing any illustrations showing the structure. Herdman² while redescribing the species, states that in the few (4 on the right and 2 on the left) prominent gonads on each side of the body, this species recalls the arrangement seen in Shuter's eastern species *S. oligocapa* and *S. sedata*. My specimens although agreeing with Herdman's specimens in general, differ from them in the number of gonads on each side of the body. After studying a large number of specimens, I have come to the conclusion that this variation is individual and intra-specific. Similarly, the shape of the dorsal tubercle, which is considered as a standard specific character, shows variations in the turning of the free ends of the ciliated ridge, the ends of the horse-shoe being turned either in or out in different specimens.

The gonads in *S. areolata* are elongated, tubular structures that lie in the substance of the mantle, their ducts being directed towards the atrial aperture. The right side has more of these tubes than the left, and the tubes remain separate throughout their course, no junction or anastomoses occurring in neighbouring gonads. The right side has 3 gonads at the least; and I have found specimens with 4, 5, 6 and even 7 gonads on the right side of the body. As each gonad has its separate duct, the gonoducts also number from 3 to 7 on the right side. It is characteristic, however, that all these gonads, even when the number is 7, lie clear of and above the long tubular heart. The left side of the body, i.e., the side bearing the loop of the intestine, bears the gonad in the intestinal loop in cases where only one gonad is present. But more usually the number on the left side is two, when the second gonad lies over or a little anterior to the dorsal limb of the intestinal loop. In a few specimens, however, a third gonad may be found lying clear of the intestine and the other two gonads. All these gonads are similar in structure to those of the right side and open separately by ducts at the base of the atrial siphon.

Each gonad consists of a central tubular straight or sinuous ovary, narrowed to a neck at its dorsal end, where the opening for the discharge of the eggs (oviducal aperture) is situat-

ed at the base of the atrial siphon. Each ovary contains a large number of ova in various stages of development. The testes consist of a number of caeca surrounding the ovary, except towards the dorsal end where they are absent. They are distributed around the ventral end of the ovary and along its sides, the characteristic feature being that the testicular caeca lie attached to the mantle a little apart from the central ovary. Each testicular caecum is irregular in outline and leads into a small spermatic duct, which unites with the others and forms a common spermatic duct, which opens separately near the oviducal aperture.

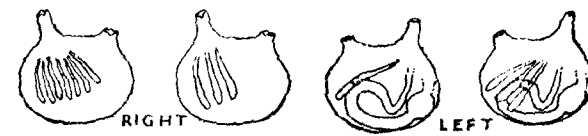


FIG. 1. Views of four specimens of *Styela areolata*, after removal of test, to show variations in the number of gonads.

The horse-shoe shape, characteristic of the dorsal tubercle of many ascidians, is specially recognizable here on account of the free ends of the horse-shoe being turned in, although not forming a spiral coil as seen in species of *Herdmania*.³ I have, however, found in a number of specimens, the horns of the U being turned not in but outwards. In still other specimens only one horn is turned in or out while the other remains straight (Vide Fig. 2). Such a great



FIG. 2.—The dorsal tubercle of six specimens of *Styela areolata*, to show variations in their shape.

variation in the shape of the dorsal tubercle in *S. areolata* precludes, therefore, its inclusion in the chart of specific characters.

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SCIENTIFIC EDUCATION AND RESEARCH IN RELATION TO NATIONAL WELFARE—II.

IN the previous issue we have started a discussion of the place of scientific education and research in effecting an improvement in the standard of well being in this country. In considering the various suggestions which have been made, it was found necessary to distinguish between the strategy and the tactics of research. As a preliminary to discussion of our own problems we began with a short account of the discussions which have recently taken place in Great Britain on similar problems. We started with the assumption that conditions which are favourable for the promotion of fundamental research will also favour the advance of applied research, and that the necessary conditions for the promotion of the former are to (1) discover and train people who have the ability and impulse for scientific enquiry and also create conditions most favourable for their work and provide them with tools they need, (2) secure competent direction of research, (3) make provision on the basis of relevance to social needs for the organized study of particular and urgent problems, planned to advance science on an even front. These led us to consider the general problem of education of the community, including that of the adults and also of the rising generation. The former should be made to appreciate the value of scientific research as an instrument for national welfare; also it was necessary that provision be made for adequately trained and broadly educated workers for scientific research. Such education must provide a balance between the immense needs for scientific and humanistic studies. We are here particularly interested in considering the place of universities as a source of supply, both direct and indirect, of the type of personnel required, as also of their place in organized research.

TRAINING AND RESEARCH IN UNIVERSITIES

In a recent report on university development by the Association of University Teachers in Great Britain, the functions of a university have been set forth as: the pursuit of knowledge not controlled or dominated by any private or corporate interest; the dissemination of knowledge and culture; further universities are schools of communal living in which the development of students as individuals and their development as social beings are equally important. Lastly universities are a part of society, both materially and intellectually, and bear a direct responsibility, and must, therefore, study the application of organized knowledge to practical problems and train men and women for particular tasks. While it is not the function of the university to inculcate any particular philosophy of life, it is assuredly an essential part of its work to assist its students to formulate adequate philosophies of life for themselves.

The first aspect of the function of a university may be further elucidated as a place for the advancement of science, and not merely for its conservation or diffusion, where different branches of knowledge are brought into contact and harmonious combination with one another, where education and research advance side by side.

It is necessary at times to undertake a certain amount of clear thinking on the restrictive influences which threaten the free development of advanced teaching and research. Two of them may be stated here. (I) There is a growing departmentalism of science, which tend to become more restrictive; boundaries of teaching departments have insensibly created artificial barriers to free enquiry. It has to be decided from time to time, how far it is necessary

to retain some of these compartments for administrative convenience, and at the same time also to realise the limitations they impose on the character of the training we give to our future investigators. (II) There is also a great danger in our preoccupation with specialists, which lies not in doing that job too well, but doing it exclusively. Professor Sigerist remarked, "If the German academic world surrendered so readily to reactionary forces, it was due largely to the fact that it consisted of men who were specialists and nothing else. If we wish to educate a citizen to be able to think in terms of science, and a scientist prepared to participate in social action, we must change our teaching." This brings up the relation of technological and other professional studies to university studies.

PLACE OF TECHNOLOGY IN UNIVERSITIES

Technological studies have significance not only in regard to the survival of the nation and the needs of the individual, but also in the advance and unity of knowledge. The danger which lies in carrying out specialized professional or technological training and research in separate institutions was recognized about a generation ago by Professor Smithells who advocated the embodiment of professional and technical education in the universities for the reason that a wider outlook may thereby be promoted. In some quarters it has been suggested that development of technical colleges into institutions of university rank, independent of universities, should not be encouraged. Rather they should be associated with their regional universities, like the Imperial College of Science and Technology in London. But according to others, the aim should be to develop such institutions on lines similar to the Massachusetts Institute of Technology, with strong post-graduate schools, and providing under-graduate teaching. Such institutes, it is suggested, have advantages from the point of view of applied research. If it is found necessary to establish such technological institutions, care should be taken to supplement the specialized training imparted in them with humanistic studies.

Other questions of importance to be considered refer to the quantitative aspect of the university expansion, the size of the university population necessary to produce the required number of research workers and teachers, and the number of universities required to cater for them. Additional grants will be necessary for this purpose and for improving the conditions and standards of existing departments. As an offset of some of the increased expenditure, it is suggested that there should be closer co-operation between the universities, particularly in regard to the development of schools of research and teaching, elimination of redundancy, and the planning to cover existing gaps. Another point on which attention may

be directed in fixing the target of the number of students to be admitted to universities is the capacity of the society to utilize the students when qualified. There is also the danger of too rapid expansion when there is not a sufficient number of first class trained men to staff them. There must also be such relation between the financial rewards in a university career, whether of teaching or of research, and those elsewhere as to ensure that a due proportion of the ablest minds of each succeeding generation are attracted to such careers.

RELATION BETWEEN TEACHING AND RESEARCH

There are other problems in the basic strategy of research we have still to consider. One of them is the relation between the teaching and research in universities. It is accepted that teaching must be in vital touch with research, but we have to consider how far the two functions may be combined in the same staff. There is consensus of opinion that all research workers should be given the opportunity of expounding to others the significance of the field in which he is working, but we should also see that really great teacher with a genuine talent for exposition and for inspiring others should be given full scope. Such teachers are not necessarily great investigators also. Sir J. J. Thomson has urged that greater regard should be paid in making appointments to teaching posts, to the power of candidates to present a subject in a clear and attractive way. Those who have had the opportunity of attending courses given by J. J. Thomson and C. T. R. Wilson will appreciate the point in the suggestion.

There is further the question as to what provision is to be made to assist in bringing to the fore directors or managers of research of the requisite calibre. According to our views, universities should not be regarded as forcing houses for the production of leaders in industries or in other spheres. It is sufficient that training in universities is such that there are no impediments to originality and to those who possess creative and imaginative minds. There could be no greater blunder than to introduce into the selection of scholars to the universities considerations other than those of intellectual ability, originality and independence of mind. If the conditions in the schools and in the universities are right, character will be developed as a matter of course. Its selective influence will be felt when the graduate enters the larger world in so far as its importance is recognized by the community, just as physical fitness is recognized as important.⁷ Provision of senior research fellowships may be helpful for encouraging men of the right type for responsible positions in the direction of research.

We next come to the consideration of conditions by which the supply and quality of the men required

for positions of research, administration and production adequate to our needs may be maintained. This belongs to the purview of tactics of research.

The first requirement is that conditions of service must be made sufficiently attractive in all services in which scientists are employed, including the government services, industry and universities. In the universities there must be a reasonable balance between standards of remuneration and status between teaching and research posts. In addition to the improvement of salary scales, we have also to consider other factors which affect the attractiveness of a scientific career to men of outstanding abilities. Some fore thought is necessary in planning the extension of supply of personnel so as to keep a balance between supply and demand. Violent fluctuations with consequent intermittent, and perhaps wide spread, graduate unemployment can have a detrimental effect on recruitment. Some attempt on the part of institutions to formulate quantitatively, as far as possible over a period of years, their requirements for scientific and other academically trained personnel is highly desirable. It is also desirable, as pointed out before, to equip the scientific workers with more adequate supply of equipment and apparatus, and also to train up a sufficient number of laboratory technicians and to award diplomas to them. These technicians should be given improved status and pay. Next in importance to provision of adequate remuneration and equipment is the question of status. It usually happens that higher status is given to administrative posts, and research workers of proved administrative ability should not be debarred from holding such posts. There may be other workers of outstanding research ability who are ill fitted to hold such posts; but this should not be considered as debarring them from obtaining equivalent status. Another factor which may increase the attractiveness of an industrial career in research is a liberal policy of freedom to publish the scientific aspects of applied research undertaken in industrial concerns. Publication of the scientific aspect of his work is the legitimate ambition of every research worker. Experience has shown that such ambitions are not inconsistent with the interests of firms engaged in competitive industry.

INTERCHANGE AND MOBILITY OF RESEARCH WORKERS

We have next to consider the factors which are best calculated to promote favourable conditions for creative work. Interchange and mobility of research workers is an invaluable stimulant to freshness of outlook and new ideas. Increase in the mobility of research workers, whether between one branch of industry and another, or between the universities and the Government departments, or between the industry and the universities, is not only essential

to ensure the best possible distribution of the available supply of research workers, but is also a stimulant to creative thought and further makes possible corporate attack on common problems, especially on border line problems. There should be systematic provision for research workers engaged in industry to return to university or to spend a period at a specialized research centre, both to keep their fundamental equipment up to date and to derive refreshment from day to day contact with colleagues engaged in other fields of research.

Adjustment of the conditions of work so that they are more comparable with those in different fields is one of the means of facilitating such mobility and interchange, one of the most important of which is the institution of a common system of superannuation. One such means of interchange, particularly at the universities, is the sabbatical year, which will enable scientific workers to give undivided attention to research problems for a long period. The other is the granting of leave for purposes of original work and investigation. The second method is specially suitable for employees in Government department and in industry. This will enable easier interchange between industry and the universities. Such facilities for interchange will bring up the question of the choice of subjects taken up for investigation, and bear particularly on the question of freedom of science and of publication.

RELATION BETWEEN INDUSTRY AND UNIVERSITY RESEARCH

It is argued that universities should avoid all association with industrial research, of which the results cannot be freely published and made generally available. This attitude is taken up in regard to work performed wholly or partly in a university laboratory, both on the grounds that scientific work at the university ought to be carried out without profit motive and that secrecy always interferes with the free exchange of ideas among research workers and creates the wrong atmosphere for fully successful fundamental research and for teaching. The primary task of universities is for advancement of knowledge combined with teaching work of high standard, and nothing should be permitted which may to any considerable extent direct them to undertake the work which they would not undertake on its own merits. It is, therefore, necessary from the point of view of personnel as well as of organization to exercise caution in using university laboratories or research workers for applied research which would involve any restrictive conditions or slackening in the pursuit of knowledge. While it is right to guard against the danger of university departments falling too much under the influence of particular firms or industries to the detriment of their main task, the pursuit of

applied science in university institutions should not be limited, when this arises naturally out of the more fundamental work and can be carried on with full freedom to discuss the problem and to publish results.

The question of permitting research in university laboratories on behalf of the industry appears to be looked upon from a different point of view in several American universities, as can be judged from the following quotation taken from remarks made by A. R. Oplin in a recent discussion:

"Manufacturers are inclined to be generous in subsidizing research projects in universities and institutions. They are making available large sums of money for this purpose with few strings attached. The investigations are established under contracts with only enough patent protection guaranteeing the donor to ensure willingness to develop the findings in useful directions. . . .

Most industrially sponsored investigations are conducted for a specific purpose under a project system. This often leaves gaps in scientific data, and it becomes the responsibility of universities and foundations to foster the less spectacular research needed to fill in the gaps so that the broad frontier of knowledge may constantly expand."

Thus in many American universities research foundations or administrative agencies are being established. These are non-profit making agencies established either to exploit patents arising out of university research or for undertaking under project system investigations on behalf of manufacturers. That the activities of such foundations may lead to undesirable results from public welfare point of view was pointed out by us in an account which appeared in the January 1945 issue of SCIENCE AND CULTURE under the heading "Storm Over Sunshine D".

PRESENT NEGLECT OF BIOLOGICAL AND SOCIAL SCIENCE

We have been discussing the relation of physical sciences to industrial research. According to many competent authorities, the future impact of biological advances in agriculture, medicine, nutrition and sociology may be of the same order of importance as that of physics and chemistry during the past fifty years. The demand for biologists in the post-war period is bound to be large, and this requires that biology should be given a more important place in the curriculum. A special survey is necessary for the expansion of research and the creation of additional chairs in such related subjects as genetics, ecology, biochemistry, veterinary sciences, etc. Closely related to these subjects are those of social biology and of social and preventive medicine. There is a further field of investigation where our research effort has been inadequate and where our technique is just being only developed, because limitations of scientific method in situations involving judgments of value have not been fully recognized. These refer to fields of social and economic surveys.

Thus it appears that for a proper use of our available resources in men and material an over-all

survey should be undertaken at an early stage of the main objectives, as distinct from detailed or particular subjects of industrial and the chief branches of pure and applied sciences. Until this has been done we are neither in a position to make the intelligent allocation of priorities of grants, etc., which in post-war periods will be essential. From the point of view of the scientific workers themselves also, it is necessary that some attempt to sum up the requirements of research from a national point of view and to indicate the broad fields to be developed is equally important. It provides the universities with a rough basis on which to estimate the number of trained workers required both in total and in different branches of knowledge. Demands for workers in the natural sciences can then be balanced with those for workers in the growing body of statistical, economic, sociological and psychological studies of no less importance to the community and to the industry. But beyond this it brings to the research workers in any field a growing awareness of the relations of their problems to those of students of other fields. That consciousness, with the more intimate contact with research workers who are asking other questions and employing other methods, which should flow from the new and fuller integration of our research effort should help to breakdown the isolation with which scientific workers have surrounded themselves in the past.

ORGANIZATION OF RESEARCH AND TRAINING IN GREAT BRITAIN AND U. S. A.

We shall in this section give an account of how research is organized in Great Britain and also how such research and training for research is financed. A short account will then be given of the functions of similar organizations in the U. S. A.

At present research in Great Britain is carried on in five main groups of establishment *viz.*, (i) laboratories of the universities and technical colleges, (ii) research stations of the Department of Scientific and Industrial Research (D. S. I. R.) and of the Agricultural and Medical Research Council, (iii) Research Associations, (iv) research laboratories maintained by private firms and (v) research establishments of the Fighting Services.

I. *Universities.*—In relation to science the universities have a dual function of training scientific workers and of conducting fundamental research. According to recent estimates the university income of the U. S. A. (population 130 millions) is now more than ten times that of Great Britain (population 40 millions) and her research expenditure £70 millions a year is at least ten times as large.

Direct Government assistance to the universities in Great Britain now takes the form of annual grants from the Treasury amounting to £2½ millions, and is allocated through a Treasury Committee, called the

University Grants Committee. In addition, local authorities and other Government departments provide over one million pounds approximately. For the training of research personnel, the D. S. I. R. gives grants to 100 students. It is felt that both the number and the amounts of the grants should be increased as well as the range of subjects they cover. The medical and agricultural sciences should be similarly provided for.

Research work undertaken in the universities comprises (i) fundamental research, (ii) research on behalf of individuals and firms and at their expense, (iii) research on behalf of some of the Research Boards who do not maintain their own laboratories, but place their work at universities and elsewhere.

A need has been felt of relating the universities more intimately with the research effort of the country as a whole so as to facilitate the planning of that effort more effectively. Preliminary to that it is necessary to co-ordinate the research activities of the universities themselves. Proposals have been made to establish a universities' advisory council entirely free from Government control, whose function will be to advise, through its sub-committees, when and where new departments will be needed for investigations of newly opened fields of knowledge. The University Grants Committee which is a purely Government Committee will act normally on that advice and provide funds accordingly. Each university will have its own research committee to watch over departmental activities and present a total research budget to the university for transmission to the Grants Committee. Such research committees will also maintain contact with the relevant sub-committees of the Advisory Council.

II. *D. S. I. R. and its Research Stations, including those maintained by the Agricultural and Medical Research Councils.*—The work undertaken in the Government research stations deal with, the maintenance of accurate standards of length, time and weight, the conduct of researches in subject like astronomy and geology. They also undertake specialized forms of industrial research as factory lighting, ventilation as well as on industrial safety; other investigations deal with problems of soil erosion, forestry, plant disease, water supply and many other problems in the domain of agriculture and health which have social as well as economic bearing. The programme of each research station is drawn up on the advice of a research board consisting of outside scientific men and industrialists, with representatives of the interested Government Departments. All of them are placed under the Lord President of the Council.

III. *Research Associations.*—These organizations were started about twenty five years ago, and include co-operative firms belonging to particular industries.

Their essential feature is that they are to be organized by the industry concerned, who frame the programme of work to be followed and appoint the staff. The income of each association consists of subscriptions and donations from subscribing firms which is taken into account in fixing the Government contribution which is paid through the D. S. I. R. All results arising from the general programme are the property of the Association and its members, including patents, and no benefit accrues to the State from the financial advantages earned thereby. Some of the investigations are carried out extra murally in universities. The total expenditure of the grant aided association was estimated at £8,50,000 in 1943.

IV. *Social Sciences.*—These cover a wide field and are on the whole less well organized than the natural sciences. There is at present no organization which can act on behalf of the social sciences like the Royal Society on behalf of the natural sciences. Again there is no organization financed by the Government to assist research in social sciences parallel to the D. S. I. R., the Medical and Agricultural Research Councils. Subjects which come under this group includes Demography, Anthropology, Social Surveys, Economics, Administration, Education, Psychology.

Need has been felt for the organization of research carried out under direct Government auspices, for ensuring a wider view and of effectively correlating the work of the Advisory Councils of Scientific and Industrial, Medical and Agricultural Research. The organization should cover the whole social and economic field and provide the Government with the best impartial scientific advice on all matters of industrial development and on the application of scientific knowledge.

ORGANIZATION OF RESEARCH IN THE U. S. A.

The National Academy of Sciences was established by Abraham Lincoln during the time of the civil war for the purpose of advising the Government on technical scientific matters. When the first World War broke out there was such a tremendous volume of war research referred to the Academy that need for extra help was pressing. The Academy then established the National Research Council (N.R.C.) consisting partly of members of the Academy and partly of non-members to assist with its work. The two organizations formed a science and research advisory division for agencies of the Government. After the war the Council devoted itself to the furtherance of research in general but continued its co-operation with the Government scientific bureaus. When the present war broke out many people realized that much scientific research was needed by the War and Navy Department, and that the scientific effort should be organized under the Academy and the N.R.C.

After some discussion it was decided that a civilian research agency should be set up in the executive department for the duration of the war, which would be supplied with money to work on "new instruments and instrumentalities of war". This led to the creation of the Office of Scientific Research and Development (O.S.R.D.) The latter operates entirely by contracts with existing academic institutions, industrial organizations and government agencies. The method is designed to utilize to the utmost available facilities and personnel and to avoid as far as possible the construction of new large laboratories. Approximately 200 industrial laboratories and 100 colleges and universities are at work on O. S. R. D. projects.

The position of O. S. R. D. in the post-war period is at present under discussion. In a recent paper contributed to a N. R. C. Conference of Physicists, R. C. Dunn has a valuable paper on "To what extent is Government financial aid for training and research desirable?" Starting with the basic assumption that fundamental research is a public need and public responsibility, Prof. Dunn analyzes the sources of support of research and training in the U. S. A. These are (i) from funds of foundations and endowments, given either directly by them or through universities and research institutions acting as agents to foundations, (ii) research supported by industry and (iii) Government. The amount spent by the Government during the present war period is variously estimated to be between 400 to 600 million dollars per year. The question is raised whether the private foundations like the Rockefeller Foundation will be able to support fundamental research to the extent they did before the war, as many of them are self-liquidating organizations who will distribute their funds by the next generation. Of the remaining two sources it seems inevitable that Government will supplement and ultimately replace the foundations as supporters of fundamental research in science because the magnitude of many of these projects will be so large that private sources or industry cannot be expected to amass the sum required or take the risks involved. These research projects by their nature cannot be expected to yield immediate returns, and it is primarily to the foundations and to the universities they have turned for support and to the Government they must turn in future.

It is suggested that a Government granting agency should be started to replace or to continue the

support which have been furnished by the O. S. R. D. and other research supporting committees, except that the type of support must be broadened to include all sciences, and that it should act as a clearing agency through which all sciences can communicate. In answer to the question 'who is going to own the results of research', two alternative answers are suggested. One that it shall be the primary requirement of those receiving public funds for research, that all research should be freely published, and that Government should be required to defend infringement suits brought against users of processes discovered and developed in projects supported by public funds. The other answer is the creation of a public non-profit patent authority like the research corporations of some of the American universities to own and administer the processes discovered and developed by public grants. Another question which has also been raised is how should training for research be financed? All advanced training is post doctoral and is open to very few persons at present. It is obvious that more fellowships for advanced training are necessary. Two possible ways of implementing this is suggested. First the creation of advanced study institutions maintained like State universities at public expense and second a Government fellowship board to be set up which will award fellowships and scholarships tenable at research institutions and universities.

Prof. Dunn then asks whether the chief problem is in the method of financing training and research or whether it is not the fundamental question of the divorce of support and control of research, *i.e.* the freedom for research workers and the prevention of interference and favoritism which every one fears as Government enters new fields of science. An obvious remedial mechanism is to interpose between the source of funds and the recipient, an independent board of scientists like the grant in aid committees but with some public representation.

It will be noticed that all the questions involved in the provision of greatly increased support of training and research in sciences by Government and industry in this country have been considered both in Great Britain and in the U. S. A. In the next issue we shall consider the application of the principles elucidated from the above discussions to conditions prevailing in India.

SOME FOOD AND NUTRITION PROBLEMS OF THE PRESENT AND THE POST-WAR PERIOD

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FOOD is one of the foremost necessities of the human race, and in spite of the frequently cited philosophic contempt for it, good and nourishing food has always been of considerable interest to the great majority of mankind.

Scientific interest in the subject is, however, only of recent origin and although much valuable work has been done, especially during the past few decades, many of the outstanding problems still remain unsolved. A fresh approach is also needed in some important lines.

About eighteen months ago, representatives of forty-four nations met at Hot Springs, Virginia, and evolved what is now popularly known as the 'International Yardstick' for nutrition. The Conference laid down that, depending on age, profession and other conditions, every man, woman and child would require certain quantities of the essential food ingredients for the maintenance of normal health. Thus, the adult would require food with a calorific value of 2,500 and containing about 70 gms. of protein, about 1 gm. of calcium, about 12 mg. of iron, 5,000 International Units of vitamin A, about 2 mg. of vitamin B₁, 15 to 20 mg. of nicotinic acid, about 75 mg. of ascorbic acid and about 400 units of vitamin D. There are also small requirements of other vitamins, minerals, etc., but these are usually found in the common food. It is only occasionally that one comes across gross deficiencies of copper, iodine and such other elements.

The task of the nutrition expert is a very difficult one, and while prescribing standards such as the above, he is painfully conscious that he has to compare hundreds of substances which come in the same category. He has also got to prescribe for different economic levels and in this he has only the gross composition to go on.

Starting from only the gross analytical figures, it should be possible to evolve a cheap diet consisting exclusively of cereals, pulses and related products, greens, oil and salts and containing the same food essentials as an expensive diet consisting of meat, fish, milk, eggs, butter and vitamin concentrates together with adequate amounts of carbohydrates and minerals. Even animal experiments may evoke nearly the same response from the two sets of diets, but they are still not strictly comparable as articles of human food. The diet prepared out of the second group of food materials leads to much faster growth, protects against a variety of diseases and is, in every

way, superior to the one prepared out of former group. It is here that the International Yardstick fails; gross chemical composition and even animal experiments are not sufficiently dependable in so far as human response is concerned.

To cite a few instances, substances possessing the same calorific value are not burnt to the same extent by the human body. Proteins from different sources are not utilized to the same extent. In spite of their high biological values, some of the pulses are highly indigestible and cause serious disorders if taken in more than moderate quantities. Mineral and vitamin deficiencies are not uncommon among people eating plenty of leafy vegetables and fruits. These and other items of evidence would suggest that there is a further factor that determines the utilization of foods, and that all foods must be evaluated from a new angle.

The significance of the foregoing will be further realized when we compare the food of man with those of animals. Taking for instance, the domestic animals, such as the cow, the buffalo and the pig, we find that they eat fairly coarse types of food which man cannot ordinarily hope to digest. They utilize this food to build up their body materials which are ultimately utilized as a good form of human food.

Let us now turn to another side of the picture. The sewage, as represented by a mixture of domestic and other wastes is of a composition which cannot be used as food even by the common animals. It is, however, utilized by some of the lowest forms of animals (the protozoa) which, in presence of air, build up their body materials out of the conglomerate of waste materials represented by sewage. The protozoa are, in turn, utilized by worms and insects and the latter are used by fish and other fauna as their food. The fish makes a high class article of human food. A somewhat similar series of changes takes place in the sea, where the lowest forms of life build up the starting materials and these, in turn, are utilized as food by the higher forms.

The foregoing observations would show that the lower forms of life are endowed with digestive mechanisms which enable them to utilise a variety of forms of organic matter. The higher animals have also got efficient digestive systems and are able to break up and build their tissue materials out of a variety of coarse materials. Man requires softer forms of

food and that in a cooked condition. Speaking comparatively, his digestive system is far less efficient than those of the lower animals.

It is true that persons in certain walks of life are able to utilize even very coarse food materials. They can even stand a certain amount of pollution of the drinking water. These are, however, only exceptions. The average man—especially one in a sedentary occupation—is unable to make proper use of coarse food materials. He requires soft and prepared food in a readily assimilable form. From this point of view, animal foods are usually more readily utilizable than the coarser vegetable food materials. This difference must be made up if vegetable food materials are to rank in the same class as animal products.

Every form of life is described by the physiologist as being made up of a number of autocatalytic systems. Once the framework of life is granted, the living cells are capable of transforming food materials into more living cells, and thus building up bigger and bigger systems until a certain limit is reached. In other words, if the food substances contain all the principles that constitute the cell materials, the living matter will automatically transform them into more cell material and thus build up a bigger and healthier system.

There is no doubt that vegetable food materials contain all the principles required by the animal body; but the human system is unable to make as good a use of them as the lower animals can. The tissues of the same animals (which are closely allied to the human tissues) represent a concentration of the essential ingredients collected out of vegetable food materials. In this manner, the animal serves as a useful intermediary in collecting concentrated food for man.

In recent years, a great deal of work has been done on the chemistry of the muscle and the active principles contained therein. It is now realized that apart from being a rich source of protein and minerals, the muscle tissue consists of a number of living systems which are responsible for many of the important transformations in the animal body. Such systems are usually made up of combinations of proteins, minerals and vitamins. The essential hormones can also be built up out of animal tissue material. It would thus be seen that animal body material would constitute some of the best food materials out of which more animal tissues can be built up.

The above facts, though of profound scientific interest, are not universally applicable for a variety of reasons. Firstly, not many can afford a rich diet containing a suitable blend of animal and food materials with vitamin concentrates. Secondly, not many will eat such a diet because of religious and

sentimental considerations. The position will continue to be the same and, if anything, it will become worse with the passage of time, especially, in thickly peopled countries like India.

It is well known that even under favourable conditions, agricultural production can increase only by about 30%, whereas human population can easily double itself in a few decades. With improved health and sanitary measures, protection against epidemics and so forth, the population in a country like India will increase enormously and will soon outstrip agricultural production. No amount of improvement of agriculture during the post-war period is going to keep pace with the requirements of the growing population of the country. Sooner or later, there is bound to arise fresh difficulties in the matter of food over different parts of India. There will be very little of food for man and still less for animals. In such a competition, the animals will be the first to suffer and then man will follow.

Such a problem has already arisen in China where the animals have been steadily disappearing. A large section of the people do not eat any meat; they do not even get any milk, so much so that they have gone off the habit of using milk. They have evolved a system of using purely vegetable food materials which are raised primarily for meeting the needs of man. In course of time, the crowded parts of India are bound to be thrown increasingly on purely vegetable food materials with fast diminishing quantities of animal food. It will follow that, apart from every other consideration, vegetarianism will be forced over a large part of India unless effective measures are taken to check the increase in population.

Taking the above facts into consideration, it would follow that the task of the nutrition expert will soon become one of providing adequate and easily assimilable diet out of purely vegetable food materials for a large section of the population of the country. As already mentioned, vegetable food materials, especially of the coarser type, are not easily digestible, so much so that if this defect is not removed, mal-nutrition and under-nutrition will prevail even in spite of the apparent adequacy of the diets.

Examination of the gastric secretion of a large number of persons, as also of children, suffering from mal-nutrition and related disorders have shown that they have very low powers of digestion. Continued eating of poor and coarse food materials has affected their power of secreting their digestive juices, and consequently they are unable to build up the essential reserves. In this manner, the deterioration will go on until a very low level of existence is reached. This vicious circle must be broken up at some point by suitably modifying the vegetarian diet so as to render it more easily digestible.

Processing of foodstuffs to improve their digestibility is well known and practised all over the world. The commonest method is cooking. Steeping and germination are also generally known, though not universally practised. Leavening is a method of processing for making bread and other similar preparations more digestible. The number of methods known and practised are fairly limited and excepting in a few cases, they are not sufficiently effective in achieving the desired end. The people concerned with the preparation of food, generally, the housewives, are usually very conservative, and they will not readily change from the methods handed to them from one generation to another. It is here that science has to come to the aid and help to educate the people to adopt new and improved methods of processing foods.

Not many years ago, there was a good deal of active propaganda for the use of the wonder bean, the 'Soya', as an article of household diet in India. Not many were first willing even to try it; even those who tried, had followed the usual traditional methods of cooking and found that, under such conditions, it was no better than the common Indian pulses. Some even found it to be highly indigestible. Nutrition experts who compared it in the conventional way with the other pulses found it to be in no way, superior to the ordinary pulses. The fact still remains that in other parts of the world, especially in China and Japan, it has really proved to be a very valuable article of diet and has helped people to maintain excellent health in spite of the necessity of having to give up meat and milk.

The reason for the above divergence of experience lies in the method of processing employed by the users. In China and Japan, the soya is never cooked and eaten whole. It is usually first processed to yield the milk which is subsequently utilized in different ways. The elimination of the roughage, the colouring principle and the bitter principle tend to improve the appearance, the taste and the digestibility of the pulse and hence its utility as an article of human food.

Similar and even more improved methods are possible in regard to the other articles of food. One of the best methods is to treat the food at the appropriate stage with small quantities of digestive enzymes of animal or vegetable origin so that the food material becomes soft and easily penetrable to the digestive juices of the body.

In cases of extreme deficiency of digestive juices and under conditions in which no form of processing is possible, use of predigested and concentrated foods will be of utmost importance in building up healthy reserves of body material and in facilitating resistance to infection of various types.

Over-processing of foodstuffs should of course be avoided, especially in the case of normal people, as that will tend to reduce the normal processes of secretion and even encourage easier and more sedentary habits of life. Adopted with discretion it should be of great value in bridging the apparently enormous difference between rich animal diets and coarse vegetarian food.

The time has now come when the increased application of science to the processing of foodstuffs, not only to improve their taste but also their digestibility and general food value, is badly needed. This should definitely be one of the post-war programmes of work in India.

Thanks to the exigencies of war, India has now an active department of food. This department has now a unique opportunity to initiate work in the above and related subjects. It is hoped that the opportunity will be made the fullest use of not only in standardizing and applying already known methods of processing, but also in sponsoring work that will lead to the development of new methods that can be used both for meeting the present requirements and for successful practical application during the post-war period. That will be the greatest service which the Indian Food Department will be rendering to the country and, to some extent, to the world in general.

CONSUMER SCIENCE IN INDIA

R. L. MOORE,
DEHRA DUN

CONSUMER science, or science applied to the problems of the consumer of goods, is a highly specialized study in America, but in India it does not seem to have made its appearance. In a perfect society consumer science would be the handmaid of producer science, the science of the manufacturer

but unfortunately the two sciences are often at cross-purposes.¹ Consumer science attempts to assess the real value of goods or services available to the consumer. Producer science on the other hand is attempting always to discover the easiest way to flood the market with profit-making goods. In our

present social system producer science is dominant and consumer science recessive. Backed by industrial wealth and brains, and with perfect understanding of the consumer's psychology, producer science in every way overshadows the ineffective attempts of the consumer to discover what goods or services are most profitable to him. Even the most gullible consumer sooner or later realizes that he has had a bad bargain, but the ease with which hair restorers or patent medicines are sold gives some indication of the feebleness of the consumers' mental processes. The fact is that the consumer seldom realizes that pure milk at Re. 1/- per seer is a better bargain than a 50 per cent milk and water mixture at nine annas; that a toothbrush with nylon bristles costing 30% more than an ordinary one is much better value for money. These are the sorts of questions the consumer needs to get answered if he is to keep his head above water in a world where his rupee can only buy six annas worth of goods. Some ways in which a scientific approach might be made to the problems of a consumer of moderate means in India are outlined below.

THE BUYING OF FRUIT

One interesting social effect of the war is that inflation has brought the middle classes into the bazaar to do their own shopping. One of the most difficult problems is the purchase of fruit. Why does one buy fruit at all? Many people buy it simply because they like it, but this reason, for the 'new poor', is not in itself a good enough answer. There is a reason beyond this; fruit, because it can be got fresh and eaten uncooked is the best source of vitamin C (ascorbic acid). Vitamin C,² we are told, is necessary in adequate dosage for buoyant health. There are other factors available in fruit which can equally well be obtained in vegetables, cereals or pulses. If fruit is an essential part of man's diet then the reason for it is that it is a sure way of getting an adequate supply of the anti-scorbutic vitamin.

The Director, Nutrition Research Laboratories,³ estimates that some 30-50 mgms. of vitamin C are required daily by both children and adults. Suppose 40 mgm. per day is taken as the amount we require from fruit, and let us hope that the rest of our diet is able to supply another 10 mgms. The consumer's problem is simply to find out how to get the 40 mgms. as cheaply as possible. He finds many kinds of fruits available, at different prices; some he likes, some he does not; and furthermore to complicate matters he discovers that they all have different vitamin C contents.⁴ The following table analyzes the problem progressively and needs little explanation. Prices are calculated from average control or market prices in Dehra Dun in 1944. In column 3

is given the cost of depending for one's 40 mgms. of vitamin C on a particular fruit. Column 4 gives the economy rank, No. 1 representing the most economical fruit. The last column labelled 'Economic factor' is to enable consumers in other price areas to find their most economical fruit. If the prices of the quantities mentioned (seers) are filled in for any place the lowest figure will correspond to the most economical fruit.

TABLE 1

Name of fruit	1 Rate per seer (Rs.)	2 Number of seers to give 40 mgm. vitamin C	3 Cost of 40 mgm. vitamin C	4 Economy rank	5 Popularity rank	6 Economic factor
Amla ..	0.62	0.0073	0.0045			1.0
Apple ..	1.5	2.2	3.3	10	3	300
Banana ..	0.66	4.4	2.9	9	4	600
Cape gooseberry ..	0.31	0.09	0.028	3.5	7	12
Grapes (blue) ..	3.0	1.5	4.5	11	2	200
Guava (country) ..	0.31	0.015	0.0047	1	5	2
Lemon juice ..	0.25	0.11	0.028	3.5	9	15
.. fruit ..	0.13					
Mango ..	0.75	0.34	0.26	6	1	46
Melon ..	0.25	4.4	1.1	8	8	60
Orange ..	0.62	0.065	0.04	5	6	8.9
Papaya ..	0.25	0.096	0.024	2	10.5	13
Tomato ..	0.5	0.14	0.70	7	10.5	19

From the table, it is concluded that the common fruits, amla, papaya, guava, lemons which are looked down upon by the well-to-do, can prove the poor man's salvation, for these fruits with their high vitamin C content are by far the most economical purchases. Referring to column 2 it will be seen that the consumer's capacity will be sorely tried should he attempt to get his daily dose of vitamin C from grapes, apples or bananas, and yet these seem to be very popular fruit.

There appears to be some obscure connection between the vitamin C content of fruit and its popularity, and in order to investigate this further a survey was taken of the likes and dislikes of two batches of school boys, each batch composed of 14 boys. Their ranking of various fruits in order of popularity is shown in column 5. From the table, the following correlations were obtained.

CORRELATION BETWEEN

1. Popularity and price per seer ... $\rho = 0.8$
 2. Popularity and vitamin C content ... $\rho = -0.3$
 3. Popularity and economy rank ... $\rho = -0.6$
- From the first correlation it is seen that there is a high correspondence between how much one likes a fruit and its cost. The more expensive a fruit is the more it is liked. Put otherwise it may

be that because everyone likes a certain fruit it becomes expensive, which is of course the conclusion which the ordinary laws of supply and demand would lead to. It also seems clear from correlation 2 that the more vitamin C there is in a fruit the less one likes it, and from 3 the more economical a fruit is the more it is despised. For the harrassed father this is bad news, and the probable explanation is that ascorbic acid is found most abundantly in fruits of an acid nature, and the resultant sourness diminishes its popularity.

Amla was not considered in the popularity survey or given an economy rank for the reason that few people seem to have tried it. As it is the richest natural source of vitamin C and also the most economical purchase, any consumer who finds his fruit bill giving him sleepless nights should consider laying in and preserving a stock between December and April.⁵ In conclusion it may be said that by purchasing the cheaper varieties of fruit only, as indicated in the economy rank, the consumer can cut down his normal fruit bill very considerably, as long as he is willing to face a certain amount of unpopularity by so doing.

THE BUYING OF FUEL

A large item in the family man's budget nowadays is fuel, both for heating as well as cooking. Most householders are guided in their purchasing by

utilized for heating a room. Each of the fuels mentioned contains a different amount of energy per pound and the prices are also different. The first consideration is the number of heat units available per rupee. This data is given in column 3, table 3.

This, however, represents the heat which would be available from perfectly dry fuel, burnt in an ideal grate from which no heat was wasted, both of which conditions are far removed from reality. All fuel contains some moisture and we can only make a guess as to its amount. In the case of steam coal and charcoal the moisture becomes easily noticeable if it exceeds about 20%. 10% has been taken as the average moisture content of charcoal and coal if purchased with care, but the seasonal phenomena of the influx of charcoal sellers after rain should be a warning to all consumers. It is also worth while noting that steam coal is in a process of slow combustion, and coal hoarders are likely to find the stock pile a good deal lighter each year.⁶

The probable moisture content of fuel wood is much more difficult to estimate. Freshly felled logs may contain 100% moisture, that is, a maund of wood after drying will weigh only 20 seers. The water content of wood depends upon the season in which the wood is felled and length of time it is stacked after felling. Experiments carried out by the Forest Research Institute show that it may take as long as six months for billets to dry out to a 10%

TABLE 2

Source of heat	1 Price per md. at Dehra Dun	2 B. Th. U per lb. of dry fuel	3 Apparent B. B. Th. U per rupee	4 B. Th. U per rupee allowing for moisture	5 Net B. Th. U	6 Economic factor
Charcoal ..	Rs. 3- 8-0	Approx. 12,000	270,000	250,000	50,000	3.7 lb.
Coal ..	Rs. 1-14-0	14,000	600,000	540,000	108,000	3.2 lb.
Wood ..	Rs. 1- 0-0	8,800	705,000	505,000	101,000	6.4 lb.
Electric Power ..	Rs. 0- 1-0 per K.W.H.	—	54,000	54,000	54,000	3.4 K.W.H.

principles of food economics learnt in pre-war days, but fuel costs have risen so unevenly that the careful consumer needs to re-examine the question of fuel economics. This is clearly the sort of problem which a consumer science might tackle and the two tables (table 2 and 3) represent the results of a preliminary investigation.

Fuel for heating the house.—For real economy of course the consumer can do without any fires and sit and shiver in the winter, but in many places in India people are accustomed to some sort of room heating in December and January. The fuels generally available are: coal, wood, charcoal or electric power, and a rather inefficient fireplace or an electric fire are the appliances in which energy can be

moisture content. Wood never becomes quite dry, in fact thoroughly air-seasoned timber averages between 7 and 15% moisture content depending on the place. Few consumers are able to purchase wood in this condition. The consumer rarely knows when the tree was felled or the length of time for which it has been stacked after felling, or possesses the time or equipment necessary to gauge the moisture content of the wood. The amount of water he is buying with his wood we know will lie somewhere between 10% and 100%. As a rough guess we may figure on a probable moisture content of 40%. This corresponds to sal billets from a tree felled at the end of November and stacked for about four months, or sal felled in early May and then stacked for 1½

months.⁷ Column 4, table 2 shows the heat value of wood fuel on this supposition.

It must not be imagined that even this figure represents the heat the consumer is going to circulate through his house, as so far consideration of the method by which the fuel is actually burnt has been neglected. Even a good grate only sends 20% of the available heat into the room.⁸ The rest goes

in diameter, the sawdust on a similar sized sawdust burner, and the electricity was used in the usual coiled nichrome wire set in an open porcelain matrix. In each case the heat was used to warm a large degchi and, after making a radiation correction for the degchi, the effective heat energy obtained was calculated. The results are given in table 3.

TABLE 3

Source of heat	1 Total B. Th. U. per lb. (gross)	2 Price per md. (D/Dn)	3 Efficiency* Actual heat Gross heat	4 Actual B. Th. U. per rupee	5 Rate of work- ing B. Th. U. per min.	6 Economic factor
Charcoal	12,000	Rs. 3-8-0	31%	86,000	37	9.2 lb.
Sawdust	8,800	Rs. 1-10-0	24%	102,000	24	16.3 lb.
Wood	8,800	Re. 1-0-0	22%	156,000	60	17.8 lb.
Electric Power		Re. 0-1-0 per K.W.H.	63%	34,500	29	16 K.W.H.

up the chimney and is lost for ever. Good grates are rarities but when this optimistic correction is applied the result is shown in column 5, table 2. It is seen that coal and wood are the most economical and charcoal should be ruled out entirely. When one remembers that electricity causes no smoke, gives off no fumes, and can be switched on and off as the occupant leaves the room, then it too is worthy of consideration as an economical way of room heating.

The troubles of the consumer as he searches for dry fuel should draw his attention to a solution. Why should wood or charcoal be bought by weight? If they could be bought by volume all would be well. There is in existence an old English measure for wood, the cord, which is a pile of wood 8 ft. long, by 4 ft., by 4 ft., and of course the charcoal sellers' kandi is a volume measure although there appear to be at least two sizes. Surprising though it may seem the average density of piles of irregular objects of reasonably similar size remain remarkably constant.⁹ The volume of a pile of wood therefore would be more likely to represent its heat value than its weight.

The economic factor in column 6, table 2 enables similar estimates to be made of fuel costs in other price areas.

Fuel for cooking.—In using fuel for cooking it is not difficult to measure experimentally the actual heat one is getting for one's rupee with various fuels. Here the fuel used should be thoroughly air-dried. People do not usually try to cook on damp sticks although they may try to warm a room with damp logs.

The following fuels were tested: wood, charcoal, sawdust, together with electric power. The wood and charcoal were burnt in an angiti of 7½"

Here again it is apparent that while charcoal is an uneconomical fuel in this price area, wood is the cheapest, followed by sawdust. Electricity again merits consideration for occasional heating as there is no loss in kindling or wastage after use.

THE CONSUMER'S HOUSE

In North India the average man* when not too busy, spends much of his time either trying to keep cool or to get warm. He may live in an old fashioned house with immensely thick walls which while cool in the summer months is chilly and dark in the winter, or else a modern house, ideal in winter but too bright and hot in the summer. The remedy for all this is a light airy house fitted with some kind of air-conditioning. Unfortunately to cool a whole bungalow is a very expensive proposition, a plant for a very small house costing in the neighbourhood of Rs. 2000/- and consuming one horsepower or more, night and day. This sort of outlay is beyond the means of many people, and even then the heating of the house in the winter would have to be done in some other way.

Professor Thoburn of Lahore has recently been investigating the possibilities of a cheap form of air-conditioning, utilizing the earth as a great heat reservoir, which well deserves consideration. Consider the annual temperature variations at Lahore as being typical of North India. The temperature averaged over the last 65 years has varied from 40° to 110° annually. If 5-day mean-maxima and minima are considered the all-year mean temperature is 76°F.¹⁰ Now 76° is distinctly chilly in the hot weather and yet beautifully warm in the winter.

* An average man—one whose income is between Rs. 100 and Rs. 1,500.

Cannot we avoid the extremes? We can of course if we go to the sea coast where the sea acts as a gigantic heat reservoir smoothing out the sun's variations and producing an equable climate all the year round. In North India there is no sea, but there is the earth. It also acts as a reservoir of heat energy but in a different way from the sea. When the sun's rays beat down upon the earth in summer the upper layers get warmed and this wave of warmth passes slowly into the earth. By early winter, when the upper earth is cool, this wave of warmth, now somewhat reduced in temperature extends between 6 and 15 feet below the earth's surface. Deeper still the annual temperature variations die away slowly and the earth eventually remains at the all-year mean temperature of 76°F. (There is an increase of temperature below the surface of about 1°F per 40 feet but this can be neglected).

One could, therefore, live at this ideal temperature of 76° if one built one's house underground. This is not news in India for one has only to visit the Emperor Akbar's Fort at Agra to find a well which has a series of five rows of rooms around it all below ground level.¹¹ The air-conditioning lessons of the Moghuls have been forgotten, but Thoburn's scheme is better than theirs. He wants the house built in the ordinary way, but with fewer doors and more windows and capable of being shut up. Underneath the house he would arrange, some 20' below ground level, a series of tubes in such a way that, by means of a fan, air from the house

whole scheme is illustrated in Figure 1. The fan can also draw a regulated supply of fresh air from outside. The direction of air flow is shown. Although the bungalow would be shut up it is not gas-tight and the vitiated air would gradually leave through the many cracks and spaces which exist in any building. It will be noticed that there would be a continuous movement of air from room to room which would mean that the use of fans would be unnecessary.

There are plenty of difficulties to be faced in designing such a house. How rapidly will the earth absorb or give out heat: how fast must the air move so as to be able to transfer its heat to the walls of the subterranean tubes: how much will the scheme cost? These problems have been tackled experimentally and mathematically, and Prof. Thoburn thinks he has the answer. To get a very rough idea to show that the quantities of heat involved are of the right order let us suppose that in the summer the underground pipes can get rid of their heat to a volume of earth 40' × 40' × 40'. Take the density of soil as 2.0 and the specific heat as 0.2 and assume that this volume of earth shows a mean increase in temperature at the end of the hot season of 10°F. The earth will then have absorbed 16,000,000 B. Th. Units. This is equivalent to 1 ton of refrigeration for 55.5 days or the heat required to melt 55.5 tons of ice at 32°F which is a very useful amount of cooling for the hot season. When winter comes there is now a well warmed heat reservoir underneath the house, and the heat which was absorbed in the summer will now be available in the winter. Suppose with the winter circulation the temperature of the volume of earth underneath the house now fell from 10° above the mean to 10° below. This would mean that 32,000,000 B. Th. Units of heat would be available. This is equivalent to over 80 maunds of best quality coal burnt in a grate with 20% efficiency. There is of course much more to it than this simple calculation shows. As far as my present information goes no one has the desire or time to try something which might make a tremendous difference to Indian living conditions. However civil engineers are so steeped in folk lore and old-fashioned ideas that it may take some time for this new-fangled idea to penetrate!

THE CONSUMER'S CAR

For many people, next to the house they live in, a motor car is their largest capital investment. One would have thought that in such a serious matter the consumer would be able to turn to some capable, disinterested party for advice on how to invest his money, but in very rare cases is it possible to obtain such advice. The first business of the consumer when facing the problem of car purchase

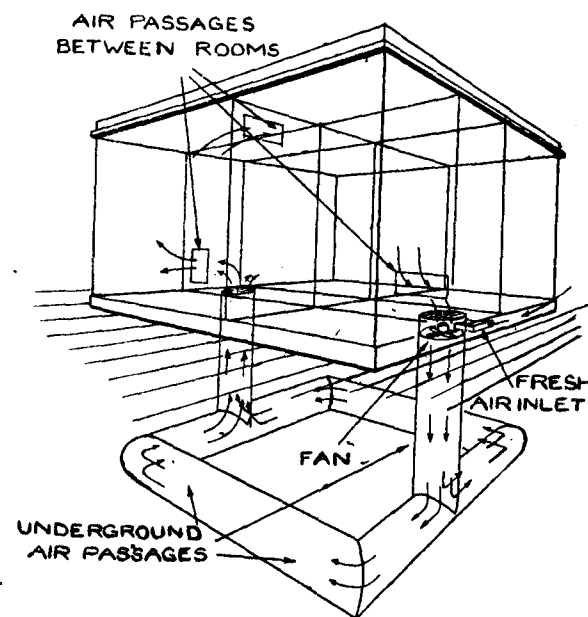


Fig. 1. Earth-heat Air-conditioning

could be sent 20 feet below ground level to return cooled in summer and warmed in winter. The

is to consider it in its personal aspect under the following headings.

Personal factors:—

- (1) How much cash is available?
- (2) How big is the consumer's family?
- (3) Have the wishes of the wife to be considered?
- (4) What is the car required for?

The amount of cash available determines whether the car is to be a new or a second hand one. As the purchase in many cases will be a post-war one the very steep slump in used car prices when new cars commence coming on to the market is a factor to be reckoned with. It may be better to wait for the new car.

If the car is to be used by a family the disadvantages of having a car just too small should be carefully considered.

The best wives always agree with a husband's choice in the matter of cars. The most difficult type seizes on irrelevances like the colour of the upholstery as reasons for their choice.

If the car is going to be used entirely for town work a small car might serve, but for anything in the nature of rough going a big car is essential for economical service.

Having considered personal factors the consumer should now try and understand what he pays for when he buys a car. In the case of the mass-produced car the cost is determined almost entirely by the weight. On the basis of 1940 prices British and American cars averaged about Rs. 2-4 a pound, about the price of butter. In the high powered range British cars tended to weigh more and were dearer than their American counterparts. If one has the money then a non-mass-produced car is a better car, but it is not an economical purchase in that giving three times the price does not mean that one gets a car with three times the life. For the

average man, however, the choice lies between British and American mass-produced vehicles. For real economy the British 8 or 10 h.p. cars take a lot of beating, but among the larger cars experience shows that the American car is the most economical in India. British car designers have always been hampered by a stupid taxation system,¹² which has meant that the designer has always been trying to circumvent the tax rather than produce the most efficient engine. British cars of higher power are thus heavy on petrol for their size, slow in acceleration, and are made in such a multiplicity of sizes and types that buying a spare part in India is a heart-breaking business. The belief of most Englishmen is that British cars wear longer. Certainly their coachwork is superior and rattles less but I doubt if there are any statistics to show that the mechanical part of the American car is in any way inferior. From press notices one gathers that British makers are concentrating on export models which it is hoped will compare favourably in both performance and price with post-war American cars.

There is something different about the possession of a car from the possession of other objects. A car in some way, like a house, reflects the personality of the owner. A flashy person has a flashy car; the wealthy business man travels in a car the size of a truck; the man who does not bother about appearances has a creaking, ramshackle vehicle. For this reason the modern American feels it his duty to have a fresh car every year: he lives in a go-ahead country and must always be experiencing the newest and the best. This wish to keep up appearances does not apply to other consumer goods. No one scraps his bicycle or her sewing machine because it is out-of-date. The reason is not far to seek: a bicycle does not express personality; no one can make a dignified entrance on a bicycle. Also bicycles and sewing machines have not changed in essential

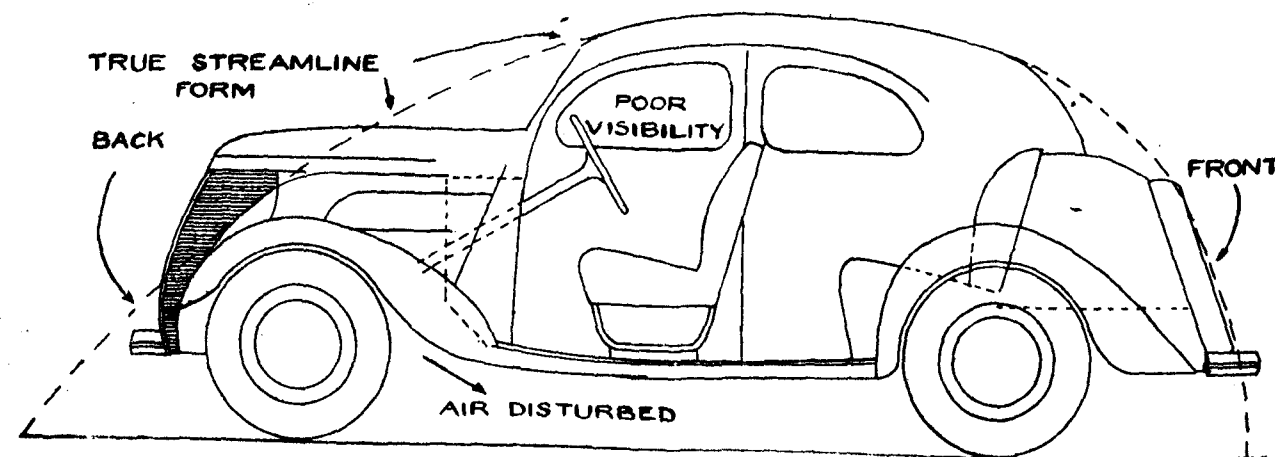


Fig. 2. The Car of Today

features or in external appearance for the last 30 years. Now all this is of considerable importance to the consumer who is about to purchase a car. Has he bought something which will last or has he merely entered a vicious cycle of car followed by new car. If only he were sure that the car he buys in 1946 would look pretty much the same as the car he could get in 1965 he would feel a good deal happier. I shall now endeavour to show that the general shape of the motor car will soon settle down

unfortunately difficulties would arise. The angle of vision of the driver forwards would be very seriously reduced and the engine would become more inaccessible than it is now. The only alternative solution is to move the driver right to the front of the car where he will have uninterrupted vision forward. This will mean that he must either sit on top of the engine (using a pancake type of engine) or else the engine must go somewhere else. Fig. 3 is a possible arrangement. One advantage of the

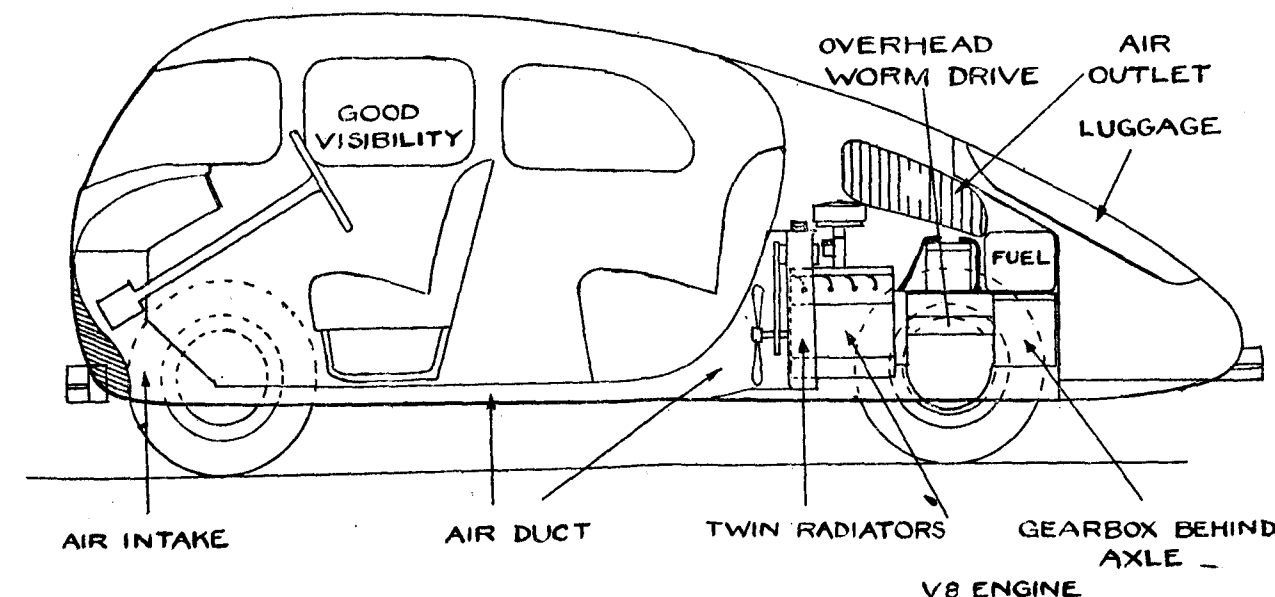


Fig. 3. The Car of Tomorrow

to one particular shape and then remain like this indefinitely.

Figure 2 shows a popular American car of 1939 vintage. An obvious disadvantage is that the driver has an extremely poor view of the road immediately in front of the car. In a large American car tested a six foot driver could not see the road nearer than 35 feet from the front of the car at the worst position (looking over the top of the radiator). The second feature which merits consideration is the streamlining. Streamlining, to reduce air resistance, is necessary in the interests of economy at speeds above 40 m.p.h. The dotted line drawn in Fig. 2 shows the typical streamline shape. The fit does not appear to be too bad until it is realised that a streamlined object should travel with its blunt end forward and the tapering end to the rear. To get the effect of the streamlining the present day car should be driven backwards! A streamlined object in reverse may have 100% greater air resistance than the same shape the right way on. An obvious suggestion which would help to convert the present day car to the correct shape would be simply to move the windscreen to the front of the car. Here

forward position of the engine is that it lends itself to a simple form of transmission to the rear wheels. The rear wheels must move up and down with every road inequality while the engine remains fixed. This with the forward engine is arranged for by having a long shaft whose small angular displacements are taken up by a universal joint or joints. In the suggested solution of this problem the engine and differential are bolted together and the movement of the rear wheels is taken up by independent springing of the axle tubes. When this change of design is carried out and the car has reached the shape shown in Fig. 3 its outward evolution will have been completed and only minor changes are then to be expected.

This evolutionary process has already taken place in the case of the aeroplane, where air resistance or drag is a much more important factor; it is taking place in the high speed railway locomotive and is talked of for ships. The car must complete its outward evolution but how long it will take is difficult to say. When the streamline shape has arrived the consumer will be in the happy position of being able to buy a car realizing that he

is no longer at the mercy of mere changes of fashion.

Hundreds of similar and even more important questions await an answer in India. One sometimes reads articles in India emphasizing the need for academic research into the problems of 'pure' physics and chemistry. Surely in India the emphasis should first of all be on the application of science to living. The problems of the citizen in India at the moment are too urgent to be put on one side in favour of academic research. The Indian consumer has to drink impure water and adulterated milk, eat adulterated *ata* and ghee; he has to try and cure his diseases with adulterated drugs; to wear clothes whose colours may or may not be fast, and watch them rapidly disintegrate by primitive laundrying. With millions of horsepower of water-power running to waste and eventually flooding his home he has to cook his food on a fire of dung cakes. When he moves he has to travel over unmetalled roads in a bullock cart whose design owes nothing to scientific principles. If in a city he travels in a tonga in continuous fear of falling out at the back simply because the vehicle is not on even keel. When he shops he finds there is no universal system of weights and measures and he faces the prospect of universal education for millions of children without that boon to the child, the metric system being in use. His

rupee is now only worth 6 annas and in despair he turns to our seats of learning and asks for help. Is it too much to ask for Indian scientific studies to be reoriented towards the problem of the Indian consumer instead of standing in academic remoteness?*

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* I am indebted to Mr Changappa and Dr Krishna of the Forest Research Institute, to Mr Hewitt of the Telephone Manufacturing Co. and to Prof. Thoburn for helpful discussions and to various Doon schoolboys whose opinions on fruit were made use of.

D. D. T. IN WAR AND PEACE

S. N. SEN

IN his general presidential address at the 32nd session of the Indian Science Congress, held at Nagpur this year, Sir S. S. Bhatnagar remarked, "The technique of operational research, the use of scientific methods of determining tactics and developing a national food policy, the discovery of penicillin and D. D. T., all these have contributed much to the realization by the common man and the Government that organized science is one of the most important factors in national development." It is with the last named discovery, namely D. D. T., the new synthetic organic insecticide, that the present discussion is concerned. D. D. T. is an abbreviation of the chemical compound dichloro-diphenyl-trichloroethane, more correctly described as α'' -bis-(parachlorophenyl)- $\beta\beta\beta$ -trichloroethane. It is curious that D. D. T. and penicillin, the two outstanding products of war-time research and development—one an insecticide and the other a bactericide, should have so much in common. Both concern the lower forms of life; while penicillin acts upon various bacteria which cause infectious diseases, D. D. T.

strikes at the very agents that serve as vehicle for a number of deadly scourges afflicting humanity. And yet, although credited largely as war-time developments, both were known several years before the outbreak of the present hostilities but remained undeveloped owing to lack of interest until fresh demands arose with war for alternative bactericides and insecticides. Furthermore, both of them, highly effective as they are against specific insects or bacteria, are remarkably non-toxic to man and animals and lend to easy and cheap manufacture.

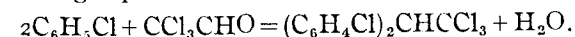
HISTORY OF D. D. T.

The compound was synthesized as early as 1874. In that year, Zeidler, a German chemist is reported to have written a paper describing the method of its synthesis from monochlorobenzene and chloral (anhydrous). Its insecticidal properties were also imperfectly known, but the intermediate nature of the compound did not for long attract the attention of the chemists and entomologists. The recrudescence of interest in D. D. T., as a possible insecticide,

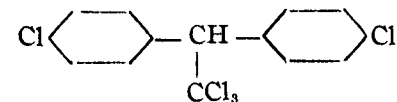
followed the investigations carried on by the research workers of the firm J. R. Geigy A. G., long interested in the problem of synthetic insecticides. In 1936-37, the research workers of the firm successfully demonstrated the insecticidal properties of D. D. T. which remained efficacious over a considerable period of time. In 1939, during an outbreak of Colorado Beetle, the potato crop pest, in Switzerland, Dr R. Wiesmann, the Swiss entomologist made field experiments with a preparation containing D. D. T. and succeeded in controlling the Colorado Beetle that season. The investigations of the Swiss workers on the insecticidal properties of D. D. T. did not at first receive much notice in Great Britain and the U. S. A. The new insecticide came to lime light only after the outbreak of the war, particularly after the entry of Japan in it, when the principal sources of supply (Japan and Malaya) of such insecticides as pyrethrum and rotenone were closed to the Allies. Since then a considerable amount of work on its chemical as well as its insecticidal properties has been done in both these countries, and D. D. T. has now been accepted as one of the most potent insecticides so far developed.

PREPARATION AND MODE OF ACTION

The synthesis of D. D. T., unlike its long chemical name, is a simple process. According to Zeidler, it is prepared by mixing chloral (anhydrous) with monochlorobenzene in the ratio 2:1 in 4-5 times its volume of concentrated sulphuric acid, and heating it in a warm water bath with occasional shaking. The reaction takes place according to the following equation:



At a temperature below 40°C, chloral has a tendency to polymerize into metachloral, a white amorphous substance insoluble in water and organic solvents, but soluble in dilute solution of sodium carbonate. Care should be taken to avoid this reaction. However, after D. D. T. has crystallized out, sulphuric acid is removed by decantation and excess of chloral is removed by treatment with water. The crystals are then dissolved in hot alcohol, to be recrystallized as a shiny cluster. Very pure D. D. T. can be prepared by subjecting it to recrystallization with alcohol for a second time. The compound thus prepared has the following structural formula:



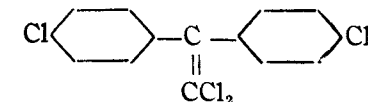
The pure compound is a white, waxy solid and has a melting point at about 105°C. It has a very faint fruity odour and is insoluble in water. It is sparingly soluble in cold ethyl alcohol, but readily

dissolves in it when hot. It is soluble in most organic solvents and also in some vegetable oils. We record below the approximate solubilities of D. D. T. in the more important solvents at ordinary temperatures.

TABLE I

Solvents	Solubilities (in gms. per 100 gms. of solvent)
Ether	45
Benzene	106
Toluene	48
Chloroform	96
Tetrachloroethane	56
Petrol ether: 40-60° b.p.	6
100-120° b.p.	10
Ethanol (99.5 per cent)	4
Cyclohexanol	8
n-butyl alcohol	8
tert-butyl alcohol	4
Ethyl acetate	68
Tetralin	52
Liquid paraffin	4
Orchard & spray oil	5
Kerosene (vaporizing)	11
Sextone	100

Some amount of work has recently been done with a view to correlating the insecticidal action of D. D. T. with its chemical structure. H. Martin and his co-workers, of the University of Bristol Agricultural and Horticultural Research Station, are inclined to believe, from their own investigations, that the $>\text{CH}-\text{CCl}_3$ group is probably associated with the insecticidal activity of D. D. T. When D. D. T. is treated with alcoholic alkali, it loses hydrochloric acid and passes into $\alpha\alpha$ -bis(parachlorophenyl)- $\beta\beta$ -dichloroethylene, but retains the other characteristics of D. D. T., as indicated in the following structural formula. Martin and his associates found that this compound was almost inactive both as contact and



stomach insecticide. They also studied the toxicity of a number of derivatives prepared by the same method as D. D. T., but none proved as effective as the original compound. These studies have led the authors to conclude that the action of D. D. T. is possibly due to its chemisorption at vital centres, interfering with essential enzyme systems. But inasmuch as D. D. T. is chemically unreactive, the alternative view of the intracellular decomposition of D. D. T. is also probable and perhaps more preferable. They are further of opinion that such decomposition results in the simultaneous production of hydrochloric acid to which the observed toxicity of D. D. T. appears to be related, as otherwise one

fails to account for the absence of toxicity of the ethylene derivative mentioned above.

INSECTICIDAL PROPERTIES

Preparations containing D. D. T. have been marketed under various trade names, e.g., Gesarol dusting powder and spray, Gesapon (an emulsion), Gesarex (a combined insecticide and fungicide), Neocid powder etc. All these preparations contain 5 per cent of D. D. T. When desired to be used as a powder for dusting purposes, it is mixed with some kind of inert carrier. An oily solution employing vegetable or mineral oil is, however, used for purposes of spraying.

A comparative study of the insecticidal properties of D. D. T. and other insecticides in use is the best way to assess the significance of D. D. T. At present, pyrethrum derived from the flowers of *Chrysanthemum cinerariifolium*, rotenone obtained from *Derris* and *Lonchocarpus* and synthetic products such as organic thiocyanates and *iso*-butyl-undecylenamide are the most important insecticides obtaining wide use. Pyrethrum differs from all insecticides in its quick knock-down action, but its action does not last long. Moreover, it proves irritant to some skins. The action of rotenone, when used as a dust, is more persistent than that of pyrethrum, and further it does not irritate the skin. But it has none of the quick knock-down action of pyrethrum. The thiocyanates and the like synthetic compounds resemble rotenone more closely than pyrethrum in their insecticidal action. The thiocyanates suffer from a persistent unpleasant odour, and these and other compounds, moreover, prove toxic to man and animals. The comparatively high cost of manufacture also militates against their wide application.

D. D. T. has all the good insecticidal properties of rotenone and other synthetic insecticides except, however, the quick knock-down action of pyrethrum, which is only characteristic of it. This lack of rapid action is more than compensated for by its remarkable persistence by virtue of which it remains toxic over an unusually long period unknown of any other insecticide so far developed. Thus the toxic effect of D. D. T. on bed-bugs was observed to persist over a period of 104 days. Flies alighting on walls sprayed with D. D. T. three weeks ago readily succumbed to it. What is more important, several launderings do not destroy the toxic action of D. D. T., and as such clothes sprayed with it remain free from body lice for a month or so and may be safely used. This keeping quality of D. D. T. has made it an invaluable addition to the list of insecticides, natural as well as synthetic.

The various insects yielding to D. D. T. include house fly, mosquito, mosquito larva, flea, bed-bug, louse, honey bee, ant, cockroaches, etc. Table II

records the results of two Chinese workers, Wei-Kuang Cheng and Cherng-how Lou, on the insecticidal properties of D. D. T. Sprays containing 1-3 per cent D. D. T. in kerosene and in kerosene-tung oil mixtures were prepared, as also 1-5 per cent D. D. T. dusts in kaolin, talcum, and others. The various preparations were sprayed or dusted on sheets of paper, on which the insects were separately placed and covered with a beaker. The results in the table refer to one set of tests carried out with 1 per cent D. D. T. in kaolin. It is important to note that, according to the authors, aphides (a common pest in vegetable gardening) which are readily vulnerable to rotenone and pyrethrum do not yield to D. D. T.

TABLE II

Name of insects	Partial paralysis (time in minutes)	Total paralysis (time in minutes)	Death (time in minutes)
House fly ...	6	20	150-160
Mosquito ...	20	60-70	170-190
Mosquito larva*	—	—	40-50
Flea ...	11	40-50	700-740
Bed-bug ...	—	340-380	940-980
Louse ...	—	160-200	820-860
Honey bee ...	—	19	110-130
Ant ...	8	80-90	110-130
Praying mantis ...	—	50-70	600-650
Cut Worm ...	Ineffective†	—	—
Grasshopper ...	—	—	—
Aphid ...	—	—	—
Caterpillar ...	—	—	—

* Treated by spreading 1 per cent D.D.T. in kerosene-tung oil mixture on the water surface.
† Ineffective even when fed.

D. D. T. acts against these insects both as contact and as stomach poison. Lice, mosquitoes and flies are responsible for the spread of typhus, malaria, dysentery, cholera, plague, enteric fever, etc. D. D. T. thus fights the menace of these diseases by striking at these insect agents. Here we shall briefly describe the effect of D. D. T. against body lice which transmit *Rickettsia prowazeki*, the cause of epidemic typhus. The best method of controlling typhus is, therefore, to attack the lice, for 'no lice, no typhus', as the old epidemiological, but still applicable, rule goes. Prior to the discovery of D. D. T., a number of insecticides effective against lice were available. Thus, an insecticide called AL 63, developed in Britain, protected persons from lice for 5-6 days. The U. S. Bureau of Entomology and Plant Quarantine recommended a dust, called MYL, produced in the U. S. A. Russian chemists were also not slow in this matter; they developed two synthetic compounds, diphenylamine and *bis*-ethyl-xanthogen, which were tried on Russian armed forces

as well as on civilians with varying degrees of success. After the discovery of D. D. T., it has been the insecticide of choice against lice. The work of P. N. Anand and his workers indicate that D. D. T. is more effective and persistent in its action than any delousing agent hitherto tried. It protects grossly infested persons against lice for two to three weeks and gives an effective control for a longer period. It may be mixed with kaolin or pyrophyllite to produce a powder that may be blown up the sleeves or down the necks of dressed persons. Another method of using D. D. T. consists in dipping undergarments in a solution of D. D. T. in volatile solvents and in an aqueous emulsion of the same. Delousing effect of such garments continues from 3 to 8 weeks or more, depending on the concentration of the solution, and even 9 weekly washings have not impaired the toxic effect of D. D. T. The way in which this insecticide has helped to arrest the spread of typhus and other diseases in this war will appear in what follows. As to its peace time uses which are likely to be varied and multiple, we shall have to wait till the return of peace.

The possibility of its use in industry has been indicated recently by the investigations of G. A. Campbell, of Geigy Colour Co. Ltd., and T. F. West, of Stafford Allen and Sons Ltd., on the persistence of D. D. T. in oil-bound water-paint. They have shown that oil-bound water-paint incorporated with D. D. T. is effective against house flies and that the paint does not lose its insecticidal properties even after two months. Small rooms painted with oil-bound water-paint containing D. D. T. readily become relieved of flies, and good results have already been obtained by employing such paint in factory canteen.

D. D. T. IN THIS WAR

At present the whole of D. D. T. is allocated for use in the armed forces. Small quantities are, however, available for purposes of laboratory investigations. The story of its entry in this war on the Allied side has it that in 1942 the J. R. Geigy Company drew the attention of the British Legation to the importance of D. D. T. on which they had already made satisfactory trials. The British Geigy Company in Manchester brought the compound to the notice of the authorities in Britain, and immediately the Government organized a team of workers from Government laboratories, the universities, and the industries to undertake the investigation and arrange for pilot-plant experiments. The results were highly satisfactory, and the product was recommended for use in the Army. In U. S. A., the

experience of the Geigy firm was communicated to the U. S. Department of Agriculture. The chemists of the Bureau of Entomology and Plant Quarantine soon analyzed the compound and confirmed the remarkable insecticidal properties claimed for D. D. T.

During January, 1944, D. D. T. made medical history by successfully bringing under control an outbreak of typhus in epidemic form in Italy. 1,300,000 civilians were dusted with D. D. T. powder, and further spread was arrested. 'This is the first occasion in medical science when a typhus outbreak has been arrested in mid-winter'. The significance of this success will clearly follow from the fact that typhus killed about 10,000 people in 6 months in Serbia during the World War I and some 3 million Russians after the Revolution. The typhus epidemic is a common aftermath of war, famine and the like national catastrophies and finds a fertile field among the starved and devitalized population.

The great demand for D. D. T. for armed forces will be realized from the fact that last year output of D. D. T. in the United States was 300,000 lb. per month. Her present production is reported to have exceeded a million.

CONCLUSION

The lay press have waxed eloquent on the startling insecticidal properties of D. D. T. as a reaction to the first impulse of a new discovery. In some quarters, it has even been suggested that it will soon replace all other insecticides. Remarkable indeed as the properties of D. D. T. are, it will be sober to describe it as 'one of the more promising synthetic organics', as one writer has stated. Under the stress of war, D. D. T. received far more organized and elaborate tests than did other insecticides whose sources are now controlled by Japan. It is improbable that the popularity of pyrethrum, for instance, as an effective controlling agent of flies and mosquitoes will suffer on the score of D. D. T. In an all-out drive against insect pests which at present constitute a standing menace to life and agriculture, the various insecticides will have their place in varying degrees of importance, and the success attending the investigation on D. D. T. should serve as a stimulant to further research in this important branch of applied entomology.

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INDIAN SCIENTISTS ON THEIR VISIT TO THE U. K. & THE U. S. A.

FIVE members of the Indian Scientific Mission, who have just returned to India from their tour in the United Kingdom, the United States and Canada, have issued a joint statement to the Press, the full text of which runs as follows:

"Five members of the Indian Scientific Mission, Sir S. S. Bhatnagar, Sir J. C. Ghosh, Prof. S. K. Mitra, Prof. J. N. Mukherjee and Prof. M. N. Saha returned to India on February 19th, after about five months stay in the United Kingdom and the United States of America and Canada. Two members of the Mission, Dr. Nazir Ahmad and Col. S. L. Bhatia will return later.

"The Mission were the guests of His Majesty's Government in the U. K. Excellent arrangements for their tour were made by the Royal Society of London and several other organizations. In the U. S. A. the party were the guests of the State Department for a short time after their arrival. An Officer of the State Department was deputed to help the Mission in their tour.

"The principal object of the party was to see for themselves how scientific and technical research has been applied in recent years to the development of natural resources and for economic betterment of the people of these progressive countries and to recommend suitable measures for India.

"In the U. K. the Mission visited the more important research institutions of all types *e.g.*, universities, research establishments maintained by industries, official and non-official research organizations, war production centres, agricultural research stations and also several special research stations brought into being to aid the war effort. They also contacted eminent men of science, technological experts, prominent industrialists and prominent public men.

"The Government and the public in these countries have, under the menace of Fascism, realized, as never before, the social and political implications of science. The Mission have been impressed by the total mobilization of scientific talent for the prosecution of war. The effort being made there has already effected vast changes in industrial efficiency and has been mainly responsible for the defeat of Fascism and has revealed that when the people and the Government are enthused with a common purpose, industrial and agricultural exploitation of resources offered by nature can effect wonders in peace as well during a war. The party is convinced that scientific exploitation of the natural resources of India can afford solution to her problems of poverty, malnutrition, disease and ignorance and restore her once more to

her rightful place in the comity of nations. India has the brain power and the population to achieve all this. But her progress in these directions must be by forced marches, and there must be a national purpose behind all her plans of development so that the people may be enthused and put their best effort and support the Government to the fullest extent in their effort for an all round industrial and agricultural development.

"We were rather surprised to learn that even though there was a desire in some quarters in the U. K. to have important operational research and research for development of war weapons carried out in India, as has been done in Canada, this policy was not adopted in India. Only some problems of supply and substitutes were assigned to the Council of Scientific and Industrial Research and the Supply Development Committee. If Indian scientific men had been given an opportunity to help in this matter, there is no doubt that very fine results would have accrued.

"For the success of any plan for the economic development of India, the first requisite is the creation of the necessary technical personnel. They are the key men and their training should be taken in hand well in advance. From the assurances we have received, and the contacts we have made we feel that there will be no difficulty in providing such training in these countries in sufficiently large numbers. Accordingly the Mission will recommend to the Government of India that immediate steps should be taken to open scientific offices in London and Washington for arranging the training, and to act as a clearing house for information. We hope that both Industry and Government in India will immediately formulate a comprehensive programme which will indicate their requirements of such technical personnel in the next five years.

"It will, however, be unwise to depend on foreign countries for long for the training of technologists. We feel that our own institutions should, in the course of the next five years, be able to offer to our young men the same facilities for training and research as are available in U. K. and U. S. A. The Mission, accordingly, will recommend to the Government that generous financial provision be made to raise the standards of, and widen the scope of, our existing institutions and also bring into existence fresh institutions as are necessary.

"The industrialists and businessmen of these countries are now convinced that no industry which had its root on scientific knowledge can prosper in a competitive world unless continually improved

upon by new inventions based on scientific research. They also recognize that the power that industry derives from new scientific knowledge comes from its early use and from contact with scientific men who created such knowledge. It is not surprising, therefore, that all the industrial establishments which we visited organized magnificently equipped research laboratories of their own, and their expenditure on research ran into millions of dollars. Hundreds of science graduates are working in each of these research laboratories. We found that such establishments generally pay very handsome dividends. We also found that not only such research laboratories were in charge of eminent scientific men, but often the key positions in the management of the large industrial concerns were held by men who started life as technical men.

"We could do but little justice in the way of acquainting ourselves with the numerous and unique industrial and scientific organizations in the U. S. A. in eight weeks. We were able to visit the Tennessee Valley which has won world-wide recognition as a model of successful regional planning. We also visited laboratories of the Gulf Research and Development Company of Pittsburgh, the Radio Corporation of America, the Bell Telephone Laboratories, the Mellon and Batelle Research Institutions, American Cyanamide and Chemical Corporation, and many others, which are models of private enterprise, each spending several million dollars per year in research alone. Researches in connection with the war effort are being carried out on a vast scale in the universities and other research institutions under the auspices of the O.S.R.D. (Office of the Scientific Research & Development)—a Government organization created during the war, and disbursing nearly 6000 million dollars for research and development. We understand that this organization will be retained under a different name even after the termination of the war, the object being to exploit as quickly as possible scientific discoveries.

"We have observed that discoveries of great industrial importance have been made in many fields *e.g.*, plastics, radio, etc. After the termination of hostilities, all these inventions will be exploited for peace time industries and the products let loose on the open market. They will have a revolutionary effect on chemical, electrical, mineral, mechanical and drug industries of which our Government and industries should take timely notice.

"America has been using, to a far greater extent than is generally known, geophysical methods of prospecting for finding out deposits of oil and valuable ores. Such methods have been responsible for the discovery of some of the biggest oilfields in Western Asia, and valuable ores under the snow covered fields of Canada.

"In Canada we acquainted ourselves with the work of the Canadian National Research Council and the Canadian Research Enterprises Limited. The former is a body created after the last war but functioning energetically only after 1939 and corresponds to our Council of Scientific and Industrial Research. It has rendered invaluable service to the cause of development of radiolocator (Radar) technique and other war research. The Canadian Research Enterprises was brought into existence in September 1939, with a view to mass scale production of optical glass, optical instruments, and instruments required for Radar and its annual outturn now amounts to 8 million dollars. All this has been achieved in an incredibly short time in a country which had neither the equipment nor the requisite technical knowledge. Canada has as it were jumped off 25 years in the course of 12 months which is the interval between which the first sod was turned and the first optical glass came out of the works. The history and performance of the National Enterprises Limited have convinced us that provided there is good will, understanding and the spirit of co-operation and long years of industrial apprenticeship, unpreparedness can be compressed into very much shorter period.

"The United States are very sympathetic towards the question of full industrial development of China. Large parties of Chinese are now receiving higher training in the U. S. A. at the expense of the Federal Government. In the Massachusetts Institute of Technology alone, we were informed, nearly a hundred Chinese students are being trained in all branches of technology. We came across a party of 33 Chinese engineers in the Niagara Falls, who informed us of a single hydro-electric project at Ichang on the Yangtse River which is expected to yield as much electrical energy as is now developed in the whole of U. S. A. from hydro-electric sources (nearly 1,00,000 million units). The industrialization of China on such a vast scale will have far reaching effect on the Indian economy, and this should engage the serious attention of the Indian public and the Government.

"In the matter of food production, the achievements in the United Kingdom and the U. S. A. have been most excellent. In the United Kingdom food production has been increased by about 60%. Agricultural researches and soil conservation measures are going on full speed ahead. The utilization of raw materials produced by agriculture is receiving organized attention by scientific workers. In the U. S. A. the four regional laboratories which are devoted to this purpose are splendidly equipped and on a scale which has been a matter of considerable surprise. A modern State has to deal with problems of land utilization in its various aspects such as location of industries, sites for town planning, pre-

servation of wild life and natural scenery and recreation centres and the rival demands on the land. Both in the United Kingdom and the United States, these problems are being dealt with by different Government departments, and the tendency seems to be to secure a balanced development of the land resources of the country.

"These countries have made great progress in surveying natural resources of mineral, vegetable and animal origin, and the lesson for us is that simultaneously with plans of development, wide scale surveys of various types should be taken in hand.

"It is our considered opinion that no much good will come out of the polemical discussions about the relative merits of private enterprise *versus* State management of industry and agriculture. We believe that every party should do its part. Scientists are

always willing to help anybody who is ready to shoulder this responsibility. For developing India we must use to the fullest extent her natural resources, and for this purpose there should be a National Government at the centre as well as in the provinces. This view was advocated by all of us in course of our lectures and conversations in the U. K., and we were happy to find that most of the scientists, administrators and industrialists fully endorsed this view. Mr Amery and other Cabinet members told us repeatedly that India now enjoys the fullest freedom regarding her economic development and if she fails to take any effective measures in this direction the responsibility rests solely with the members of the Government of India.

"Two of our colleagues are not with us at present, but we have reason to believe that they will endorse the above statement."

Notes and News

AN INTERNATIONAL SCIENCE CO-OPERATION SERVICE

In an able article in *Nature*, November 25, 1944, Dr Joseph Needham who is now in charge of the Scientific Co-operation Office of the British Council in China has made out a case for the creation of an international science co-operation service, which deserves the closest attention of those desiring to see free scientific intercourse established across national frontiers when peace comes. This war has brought into existence, as an emergency measure, a number of scientific co-operation offices such as the British Central Scientific Office in Washington, the American Scientific Office in London, the Anglo-Soviet Science Collaboration Committee, and the Scientific Co-operation Office of the British Council in China, which, by mobilizing important scientific information among the United Nations, have played, and are still playing, a significant role in the successful prosecution of the war. Similar scientific organizations were also created during the war of 1914-18 but were allowed to disappear with the conclusion of the war without giving much thought to them. It seems unlikely that this time too the science co-operation offices which are widely believed to exert an equally profound influence in solving the problems of peace will meet a similar fate. "We see every where", Dr Needham remarks, "a growing conviction that after the war a much higher degree of international

science co-operation must be attained. There are many who believe that the time has gone by when enough can be done by men of science working as individuals or even in groups organized in universities or societies, within individual countries, and contacting each other as individuals, across national boundaries. Science and technology are now playing, and will in the future increasingly play, so predominant a part in all human civilization, that some means whereby science can effectually transcend national boundaries is urgently necessary". In his opinion, an international science co-operation service having representatives to be drawn from both government and academic laboratories and entitled to the same diplomatic status as accorded formerly to League of Nations officials and to guaranteed Government facilities for communication and transport is best calculated to fulfil this purpose. Dr Needham defines the character and functions of such an organization in the following terms:

- (1) That an International Science Co-operation Service should be set up by the United Nations at the conclusion of the War under the aegis of whatever supreme international organization is devised, parallel with the International Labour Office, the International (Permanent) Commission on Food and Agriculture, and other similar bodies.
- (2) That the functions of the International Science Co-operation Service should be (a) the promotion of scientific co-operation in all its aspects, (b) the collection and dissemination of scientific information, (c) the furtherance of schemes of collaboration in research, (d) the facilitation of the movement of scientific men across national boundaries, (e) the provision of advice on scientific matters to

government and diplomatic personnel of individual States when desired, (f) the provision of scientific assistance to all other international organizations.

(3) That the International Science Co-operation Service be supported by funds, which relatively to those required for other purposes would, of course, be small, subscribed by the Governments of the United Nations on some agreed income-tax basis.

(4) That the International Science Co-operation Service should have permanent representatives in all countries or regions, with diplomatic or 'League official' status, and guaranteed Governmental facilities for communication and transportation.

(5) That the International Science Co-operation Service should have permanent headquarters in some centre to be later decided on; but that apart from a central and peripheral permanent secretariat, a considerable proportion of the total number of its officials should be working scientists of every nationality serving on a temporary leave-of-absence basis, that is, seconded from governmental, academic and possibly industrial, laboratories; in order to ensure that the organization shall always preserve the true atmosphere and understanding of research.

We cordially welcome Dr Needham's proposal for the establishment of an international science co-operation service in the post-war period. That there exists today a clear need of the promotion of all aspects of scientific co-operation, including collection and dissemination of scientific information, collaboration of research, the facilitation of the movement of scientific men across national frontiers and the like, is admitted on all hands. He has not, however, made clear how this organization will be evolved out of the existing scientific collaboration offices which are at present mainly concerned with the prosecution of the war. We hope that this and other questions relating to details, likely to be raised, will be clarified in the process of discussion which Dr Needham's memorandum is certain to stimulate.

A NATIONAL INSTITUTE OF ECONOMIC RESEARCH

In his inaugural address at the 27th session of the Indian Economic Conference held in Delhi on December 30, 1944, the Hon'ble Sir Ardeshir Dalal, Member for Planning and Development, revealed that the Government were contemplating to establish a National Institute of Economic Research. The Institute which will be located in Delhi will be an autonomous body mainly non-official in its composition and management. The Government will, however, provide the necessary fund to be utilized for carrying out systematic, scientific and impartial research surveys into various problems bearing on the task of planning and economic development of India.

An institute of economic research is a prerequisite for successful planning for the economic development of a country, and it is gratifying to see that the Government are aware of it and are thinking to take necessary steps in that direction. As Sir Ardeshir rightly said, a great deal of research work will have to be undertaken into the various

aspects of the country's economic life, not only for facilitating the formulation of proposals for planning, but also for watching the progress and for making readjustments from time to time to ensure the success of the plan. The facilities which such an institute will provide, coupled with the analytical judgment of the professional economists, will be of the greatest value now that the Government have embarked on a planned economic development.

In this connection Sir Ardeshir also referred to the poor statistical data, often of doubtful accuracy, in which again large gaps exist. This inadequacy in statistical information constitutes a real stumbling block in the way of planning, as we have often emphasized. We learn that a closer association with the Indian Statistical Institute is being considered by the Government.

FERTILIZER PLANT NEAR DHANBAD

THE news of the Government decision to establish a synthetic fertilizer factory at Sindri, near Dhanbad in Bihar, for manufacturing 3,50,000 tons of ammonium sulphate per annum has already appeared in the press. In an earlier issue, we reported the recommendations of the Technical Mission headed by Mr G. S. Gowing, which favoured the establishment of a single plant at Harduaganj near Aligarh. A heated controversy, both in official as well as in non-official quarters, followed the submission, by the Mission, of the report, and the press, the industry, and the experts were almost unanimous in their opposition to their recommendation in favour of Aligarh as the most suitable site for economic production in preference to the coal-producing areas of Bihar and Bengal. It is indeed gratifying that wiser counsels have at last prevailed with the Government who have now been convinced that Sindri in Bihar, by virtue of its proximity to the coal deposits, has greater potential advantages than the site recommended by the Mission. It further holds out the possibility of developing subsidiary industries from nitrogenous products. The Government are also investigating the prospects of erecting another unit having the capacity of 1,00,000 tons per annum on a site somewhere south of the Vindhyas.

The factory at Sindri should be State-owned and State-controlled, as the Government have suggested. The Central Government will undertake the management of the factory. The relation that should exist between the States and the provincial Governments in the scheme is now under consideration.

The rejection of the Mission's recommendation concerning the most vital question of location of the factory confirms the misgivings which we entertained from the very outset regarding the technical competence of the experts constituting the Mission. The

Mission toured throughout India for about two months visiting industrial and economically important areas, and all available facilities and information were placed at their disposal. They finally produced a report on whose recommendations even the Government, always encouraging foreign technical mission whenever any development is projected, failed to act. And this, after public money has been lavishly expended to bear the cost of the Mission! More such tragedies are in store for us until the Government learn to abandon the thoughtless practice of inviting foreign missions and rely on Indian experts who, if required, may be sent abroad for expert advice, experience and training—a practice which is universally followed in all free countries enjoying national governments.

THE RUBBER INDUSTRY IN INDIA

THIS is the title of a monograph by Prof. N. N. Godbole, recently issued by the All-India Manufacturers' Organization, Bombay. The monograph briefly traces the development of the rubber industry in India and also discusses its chemistry and technology. The introduction of the rubber plantation in this country has an interesting history. Sir Henry Wickham smuggled the precious seeds of *Hevea brasiliensis* out of Brazil, the natural habitat of this most important species of the rubber plant. The seeds arrived at Kew in 1876, where they were planted, and the seedlings were later distributed to India, Ceylon, Malay, Java and other parts of the East. In India, the cultivation of the *Hevea* plant started rather late compared to other parts of the East. Travancore State, with its multiple plantations in the Shencottah, Mundakayalam and Rani Valley districts in the Western Ghats, has now become the leading rubber producing centre in the whole of India and accounts for about 80 per cent of the Indian crop. The total area under rubber cultivation stood at 1,36,614 acres by the end of 1941, and in 1942, the total production was about 17,000 tons. According to an estimate carried out in 1943, there are 114 rubber factories in India, using both rubber latex and para rubber. Rubber trade of India, comprising both export and import, accounted for Rs. 382 crores in 1939-40 and Rs. 360 crores in 1940-41.

An intensification in the production of rubber in India followed the Japanese occupation of Malaya, the Netherland East Indies and other important rubber growing areas of South-East Asia, when a supply about nine-tenths of the world output was lost to the Allies. India could have increased her acreage under rubber and indicated a far greater annual output, but for the rubber cartel known as the International Rubber Regulation Committee con-

stituted in 1934. The rubber cartel controlled largely by the combined U. S., British and Dutch interests led to the imprægnable South-East Asian monopoly. This was one reason of the great development in the production of synthetic rubber in Germany and the Soviet Union before the war.

CULTURAL CO-OPERATION

THE U. S. Department of State has issued a report, by H. Hanson, containing the activities of the Division of Cultural Relations since its inception in 1938. The scope of the cultural co-operation programme, as envisaged by the General Advisory Committee of the Division of Cultural Relations, is intended to be a long term one and includes vigorous development of cultural relations between the people of the United States and other free peoples of the world on a basis of mutual understanding and appreciation and inter-changes in all fields of the arts, sciences, technology, letters, and education, and throughout the entire range of economic and social life. In fact, the programme is intended to be as broad as intellectual and cultural activities themselves.

When the Division was established in the Department of State in 1938, its activities were confined mainly within the Western Hemisphere. During the period 1938-41, its programme was guided by one aim, namely, the promotion of inter-American unity, necessitated largely by Axis expansion in Europe. The extension of its sphere of activities outside the Americans took place with the inclusion of China in 1941 within its cultural co-operation programme. The China programme began to operate from January, 1942, with an allocation from the Emergency Fund for the President and revolved around four principal activities: the sending of American technical experts requested by Chinese Governments, exchange of professors, the awarding of study grants to Chinese students in the United States, and the sending in microfilm of technical and scholarly journals requested by Chinese universities. Since 1943, the Division steadily extended its activities to the countries of the Near East and included Turkey, Syria, Liberia, Egypt, Iran, Ethiopia, Morocco, Spain, Sweden, Soviet Russia and others. The nature of this co-operation has been different in different countries.

Up to the close of 1943, the Congress had made appropriation to the Department of State only for the programme with the other American republics only. The programme in countries outside the Western Hemisphere was financed from the Emergency Fund for the President. The total funds available for this purpose during the period 1940-44 are as follows: 1940-41, Hemisphere only, \$1,09,000 ;

1941-42, Hemisphere and China, \$3,47,000 ; 1942-43, Hemisphere and China, \$1,234,000 ; 1943-44, Hemisphere, China and Near East, \$2,871,000.

A statement of policy on the participation of the United States in the educational and cultural rebuilding of Europe indicates the Department's concern in the educational rehabilitation work after the war. The programme which the Department now has in view may consist of (1) assistance in the restocking of essential educational facilities, especially with books and scientific and other teaching aids, (2) assistance in providing opportunities for the training of carefully selected foreign students in American institutions, (3) assistance in re-establishing essential library facilities, etc. The report further includes notes on professional and scientific relations, and on various activities under the programme.

PROF. R. A. FISHER IN INDIA

OUR readers will be interested to learn that Prof. R. A. Fisher, Balfour Professor of Genetics, Cambridge University, came out to India on January 24 as the visiting Professor of the Indian Statistical Institute, Calcutta. While at Calcutta, Prof. Fisher delivered six lectures on Genetics at the Institute and visited a large number of scientific institutions, including the Bose Institute, the All-India Institute of Hygiene and Public Health, and the Indian Association for the Cultivation of Science. Prof. Fisher's consultative services, it is understood, are being utilized by the Government of Bengal and the Central Government in the Departments of Agriculture, Civil Supplies, Irrigation, Commerce, Industries and Labour, and Finance. He will leave for England by air on March 10.

An eminent statistician of the present time, Prof. Fisher was Head of the Department of Statistics of the Rothamsted Agricultural Institute from 1918 to 1933. He succeeded Karl Pearson as Galton Professor in the London University and in 1943 accepted the Balfour Professorship of the Cambridge University.

SCIENTIFIC CONSULTATIVE COMMITTEE

THE Government of India have constituted a Scientific Consultative Committee consisting of official and non-official members, which will advise the Government on all general questions of policy relating to research throughout India and on any special matters concerning research that may be specially referred to it. The Hon'ble Member for Planning and Development is the Chairman of the Committee which include the following members:

Officials—The Master General of the Ordnance, the Vice-Chairman of the Imperial Council of Agricultural Research or the Agricultural Commissioner to the Government of India, the Director General, I.M.S., the Director, Geological Survey, the Director, Scientific and Industrial Research. *Non-officials*—Sir C. V. Raman, Sir J. C. Ghosh, Prof. M. N. Saha, Dr Nazir Ahmad, Col. Sir R. N. Chopra.

CHEMISTRY IN THE SERVICE OF MAN

IN an address on the above subject recently delivered before the Royal Society of Arts, Dr E. F. Armstrong, F.R.S., has discussed how chemistry not only tells all about natural substances but also enables us to make new products rivaling the natural products in utility. He describes how knowledge of chemistry is helping the cheap production of edible proteins, which is of great interest in view of the present world shortage of proteins. According to Dr Armstrong, each protein is made up of a large number of molecules of amino acids, of which there are twenty different kinds. The protein molecules are very large, containing a thousand or more amino acid molecules, and they differ in the percentage of amino acids present. The individual amino acids are joined end to end in a chain, the exact pattern of which has not yet been established for any protein.

The body breaks down the protein it eats into individual amino acids and uses them again to make its own protein ; hence the importance of each amino acid. Men and animals need most of them. Probably meat is so important a food because it contains those very amino acids which we require to make muscle tissue. Our main source of protein is meat from animals, which converts vegetable proteins in herbage into beef, mutton and pork ; the process is a slow one. Another source is the pulses, seeds of high protein content etc. which can be improved by selection and cultivation. Another source is fish. The wide-spread cultivation of the soya bean is a notable example of progress in protein production. Unfortunately, this vegetable protein only ranks as second class. Considerable interest, therefore, is attached to the production of protein in the form of yeast, which can be multiplied very rapidly in the course of a few hours. Whereas animals make their protein from the small amount of organic vegetable protein in the very large quantities of herbage they consume, the yeast can make its own protein with the help of carbohydrates of vegetable origin and of ammonium salts which are inorganic and manufactured from nitrogen in the air. The technical question becomes whether yeast can be made in large quantity from carbohydrate and inorganic nitrogen at a competitive price with meat. In-

organic nitrogen, a product of high pressure technique, is very cheap today and is available in unlimited quantity. It is claimed that the yield of protein per acre in the form of yeast made from molasses calculated from the area of land required for production of molasses is several times greater than that of protein grown as soya beans which have a high protein content. It is also much higher per acre than that obtained by feeding fodder crops to animals. Beef protein needs not only a large acreage on the other hand, but takes a much longer time, about year or more; yeast protein is a matter of twenty-four hours.

A specially suitable race of yeast (*Torula utilis*) for the purpose has recently been developed in London, and factories are understood to be under construction to make it in Jamaica and Mauritius, where its first use will be for the under nourished children in those colonies. In the tropics protein scarcity is often severe, but waste carbohydrates are plentiful. Certain races of yeast multiply so rapidly that alcoholic fermentation is practically negligible. The yield of dried yeast in practice is 60 per cent of the fermentable sugar. Another source of carbohydrate is the waste sulphite liquor of paper mills from which according to a calculation made in Germany 1,00,000 tons of dry yeast a year equivalent to 50,000 tons of protein can be made. A development which is not very far remote is the making of fermentable carbohydrates from wood. By what is known as the schollar process wood in the presence of dilute sulphuric acid at a pressure of 4 atmospheres, the temperatures being taken up to 190°C, is converted into easily fermentable glucose. At present in the United States it is calculated that about 1,00,000 tons of Baker's yeast has been produced in 1944, about half of which is protein. The vitamin content of this yeast is not high, but it will be possible to enhance it by changing the nutrient. Brewer's yeast is essentially a byproduct of the fermentation of beer, more than 12,000 tons are available as a sherry, of which one-third is recovered as cattle food, and about one-tenth used as food or sold in the pharmacy. The vitamin content is some three times as great as that of baker's yeast. This yeast is now grown as food, without using hops, so that the product need not be delittered. The dried yeast has a high vitamin content of vitamin B complex and retails at 3s. per pound and contains 46 per cent of protein. Beef with 10 per cent of protein sells at 2s. per pound. The lecturer remarked how within one generation Britain and the United States have passed from the stage in which most of this food supplies went directly from the farm to the consumer, to the present development in which the food industry processes distribute a large and growing part of the total food supply.

PHARMACOGNOSY IN INDIA AND ITS FUTURE

A SCHEME for post-war development of drug industry in India and the role of botanists in the study of pharmacognosy was put forward by Mr S. N. Bal, in his presidential address entitled "Scope of Pharmacognosy in India and its Future" at the 9th Annual General Meeting of the Botanical Society of Bengal, held at the Botanical Laboratory, Calcutta University, on February 18, 1945.

It is high time that the botanists should seriously take up the study of pharmacognosy in all its aspects, viz., proper identification, distribution, anatomy, pathology, etc., of plants, and it is only by the collaboration of the botanists, chemists and medical men that India can be independent of her drug requirements.

India is very rich in her drug resources comprising about 2,500 medicinal plants including 300 mentioned in the British Pharmacopoeia and British Pharmaceutical Codex. Fifty per cent of B. P. and B. P. C. plants are found in India, and as this country possesses all sorts of climate and soils, there is great potentiality of introducing new plants. When all the branches of pharmacognostic studies are pursued in India, it will lead to the production of standard products of requisite potency, which will be accepted throughout the world.

Potency of many vegetable drugs in India has already been well recognized, but we have not as yet any book on 'Indian Pharmacopoeia', with the consequence that we have to fall back on British Pharmacopoeia as our standard in spite of the fact that the standards prescribed for England may not be suitable in India. "We ought to have a national pharmacopoeia of our own which could fulfil all our requirements by solving the various pharmacognostic problems and by incorporating in it such indigenous drugs which have been scientifically and pharmacognostically investigated. The needs for such a work has been recently realized by the Government of India who have undertaken the preparation of an Indian supplement to the British Pharmacopoeia".

In tracing the history of development of pharmacognostic studies, Mr Bal went on to say that the cultivation of medicinal plants can be traced to 2000 B.C. when the Babylonian kings encouraged culture of medicinal plants. In India, earliest mention of the cultivation of drug plants is mentioned in the treatises of *Charaka* and *Susruta*.

During the middle ages, culture of medicinal plants was confined to monasteries, and later a number of *herb gardens* were started with the establishment of universities, earliest of these being the Padua Herb garden founded in 1533 A.D. Modern pharmacognosy really developed during the 19th and

20th centuries, that has led to the development of histological and chemical pharmacognosy.

Large scale cultivation of medicinal plants except cinchona and ipecac, however, is still unknown in India, and the authorities still appear unperturbed by the fact that thousands of people have died in recent years due to 'drug famine'.

While researches are being undertaken in India on the chemical aspects of the drug plants in the School of Tropical Medicine, Biochemical Standardization Laboratory and the University College of Science, Calcutta, such researches should go hand in hand with researches in pharmacognostic line.

The following were elected to the various offices of the Botanical Society of Bengal for the year 1945-46. *President*: Prof. S. R. Bose; *Vice-Presidents*: Prof. S. P. Agharkar, Mr S. N. Bal (*Ex-officio*), Mr I. Banerji Dr K. P. Biswas, Prof. G. P. Mazumdar; *Honorary Treasurer*: Mr J. C. Banerji; *Members*: Prof. K. G. Banerji, Mr E. A. R. Banerji, Mr A. K. Chakravorty, Prof. A. C. Datta, Mr A. K. Ghosh, Dr K. T. Jacob, Mr P. N. Nandi, Prof. J. C. Sen Gupta, Dr S. R. Sen Gupta; *Honorary Secretaries*: Dr P. N. Bhaduri, Dr J. K. Chowdhury.

ROYAL ASIATIC SOCIETY OF BENGAL

THE 161st Annual Meeting of the Royal Asiatic Society of Bengal was held in the Society's rooms on February 5, 1945. His Excellency Mr R. G. Casey, Patron of the Society presided.

Presenting the annual report, the General Secretary (Dr Kalidas Nag) referred to the task of reorganization of the Society. During the year under review the Society made a number of proposals in connection with the post-war scientific, industrial and cultural reconstruction of India. The latter deals with such problems as the establishment of (1) a traveller's department in India, (2) a central record office in Bengal, (3) a national museum at New Delhi, (4) a school of Indian architecture and planning, (5) a national cultural trust, (6) a national academy of arts and letters, (7) national parks, and also (8) the future of the archaeological department.

Referring to these proposals for the cultural reconstruction in India, that so vitally concern the country's future welfare and progress, Dr S. P. Mookerjee, the retiring President said, "Our proposals form the basis for fruitful discussion and will serve to stimulate public opinion. The ideals and aspirations of a nation are best represented by its culture. India, in spite its having a variety in languages, religions and physical types, has a basic national culture."

His Excellency Mr R. G. Casey, addressing the Society, emphasized the part that a learned body like the Royal Asiatic Society of Bengal can play

in the application of modern scientific research to the "old arts of agriculture and industry".

"I am encouraged to speak to you of these scientific matters by reason of the terms of encomium in which Prof. A. V. Hill has written of this Society in a recent report on scientific research in India."

His Excellency congratulated the retiring president on the successful activities of the Society during the year and welcomed the new president, Dr Meghnad Saha, whose election, he hoped, 'may be said to portend closer integration of science and culture, which is of very great importance to the future development of human civilization'.

The following awards of the Society's medals and prizes for 1944 were announced:

Jay Gobind Law medal to Rai Bahadur Dr S. L. Hora, D.Sc., F.N.I., Director of Fisheries, Bengal, in recognition of his conspicuously important contributions to our knowledge of ichthyology of Asia. Paul Johannes Brühl medal to Dr N. L. Bor, D.Sc., F.N.I., Chief Refugee Administrator, Burma Refugee (Formerly Forest Botanist, Imperial Forest Research Institute, Dehra Dun), for his important piece of original research in the graminaceae and the ecology of Indian plants.

Dr Bimala Charan Law medal to Dr D. R. Bhandarkar, Ph.D., formerly Professor of Ancient Indian History and Culture, Calcutta University, for his conspicuously important contributions to ancient Indian history and culture.

Sarat Chandra Roy medal to Dr Verrier Elwin, D.Sc., F.N.I., of the Bhumijan Sevamandal, Patnagarh, C. P., for his meritorious and many-sided contributions to the study of cultural anthropology of India.

Elliot Prize to Dr S. K. Chakrabarty, D.Sc. of the University College of Science and Technology, Calcutta for his contributions to mathematics.

Dr P. C. Bagchi, M.A., Dr es letters (Paris) was elected an Ordinary Fellow of the Society.

The following were duly elected as members of the Council for 1945:

President: Dr Meghnad Saha, D.Sc., F.N.I., F.R.S., F.R.A.S.B.; *Vice-Presidents*: the Hon'ble Mr Justice N. G. A. Edgeley, M.A., I.C.S., Barrister-at-Law, Dr R. C. Mazumdar, M.A., Ph.D., F.R.A.S.B., Dr M. Z. Siddiqui, M.A., B.L., Ph.D., Dr S. P. Agharkar, M.A., Ph.D., F.N.I.; *General Secretary*: Dr Kalidas Nag, M.A., D.Litt.; *Treasurer*: K. P. Khaitan, Esq., M.A., B.L., Barrister-at-Law; *Philological and Library Secretary*: Dr Nalinaksha Dutt, M.A., Ph.D., D.Litt.; *Joint Philological Secretary*: Dr Muhammad Ishaque, M.A., B.Sc., Ph.D., *Natural History Secretaries*: *Biology*, Dr S. L. Hora, D.Sc., F.Z.S., F.R.S.E., F.N.I.; *Physical Science*, Dr K. N. Bagchi, B.Sc., M.B., F.I.C. D.T.M.; *Anthropological Secretary*, Rev.

W. C. Griffiths, M.A., B.L., B.Sc., *Historical and Archaeological Secretary*, Dr B. C. Law, M.A., B.L., Ph.D., D.Litt., F.R.A.S.B.; *Medical Secretary*, Dr Indu Bhushan Bosu, M.D.; *Other members of Council*: C. W. Gurnar, Esq., C.S.I., I.C.S., L. R. Fawcus, Esq., C.I.E., I.C.S., Percy Brown, Esq., M.B.E., A.R.C.A., F.R.A.S.B., Dr W. D. West, M.A., D.Sc., F.N.I., Maharajahdiraj Bahadur U. C. Mahtab of Burdwan, A. P. Benthall, Esq.

Dr N. R. DHAR'S ENDOWMENT TO THE UNIVERSITY OF CALCUTTA

Dr N. R. Dhar has recently made the handsome endowment of approximately one lakh of rupees to the University of Calcutta for perpetuating the memory of late Acharya Prafulla Chandra Ray and for founding a professorship in agricultural chemistry in a University College of Agriculture to be established. He has further expressed the hope of making a second endowment of another one lakh of rupees for the same purpose in the near future. In his letter to the University, Dr Dhar stated that the said professorship would be created out of the interest accruing from the securities in which the amount might be invested as soon as funds would permit. For the present, however, teaching and research posts in agricultural chemistry of such rank, status and emoluments as might be possible within the available income should be created. These posts should always be filled by Indians.

Dr Dhar was an alumni of the Calcutta

University, and the gift bears testimony to his deep concern for the well-being of his *alma mater*. He thus joins the rank of Sir Tarak Nath Palit, Sir Rashbehary Ghose, Kumar Guruprasad Singh of Khaira and Sir P. C. Ray, whose princely endowments were so largely responsible for whatever progress science has made in this part of the country.

NATIONAL INSTITUTE OF SCIENCES OF INDIA

At the Annual General Meeting of the National Institute of Sciences of India, held on January 2, 1945, at the Science College, Nagpur, the following were duly elected office-bearers and members of Council of the National Institute of Sciences of India for the year 1945: *President*: Mr D. N. Wadia; *Vice-Presidents*: Prof. S. P. Agharkar, and Sir S. S. Bhatnagar; *Treasurer*: Rai Bahadur K. N. Bagchi; *Foreign Secretary*: Prof. D. S. Kothari; *Secretaries*: Rai Bahadur S. L. Hora and Dr W. D. West; *Editor of Publications*: Prof. J. N. Mukherjee; *Members of Council*: Prof. P. R. Awati, Dr K. Bagchee, Dr S. K. Banerji, Prof. H. J. Bhabha, Khan Bahadur M. Afzal Husain, Prof. M. O. P. Iyengar, Prof. P. C. Mahalanobis, Dr K. G. Naik, Dr B. N. Prasad, Dr H. S. Pruthi, Prof. M. Qureshi, Mr B. Rama Rao, Dr L. A. Ramdas, Prof. P. Ray, Rai Bahadur J. M. Sen, Dr. A. C. Ukil, and Dr K. Venkataraman.

ANNOUNCEMENT

Sir M. Visvesvaraya, K.C.I.E., I.L.D., has been re-elected unanimously as President of the All-India Manufacturers' Organization for the year 1945.

SCIENCE IN INDUSTRY

THE MILLION VOLT X-RAY TUBE

THE Machlett Laboratories, Inc., Springdale, and the General Electric Company, Schenectady, U. S. A., have recently perfected a 2,000,000 volt X-ray tube each. Prior to this development a million-volt tube developed for the testing of metal sections was known to be the most powerful X-ray tube. The 2,000,000 volt tubes have thus established a new record in the art of high-voltage tube-making.

The tube developed by the Machlett Laboratories is completely sealed off, thus obviating the necessity of maintaining high vacuum by pumping. The focussing arrangement is very fine; the electrons supplied from a greatly improved source are accelerated in several steps of 12,000 each before

finally striking the anticathode with an energy of 2 million electron volt.

In the G. E. C. tube which is also vacuum sealed, the electrons from the heated filament at the top are speeded up in 24 stages until they attain the maximum energy. Tungsten backed with copper serves as the anti-cathode. The G. E. C. made use of an alloy, called fernico, between sections of glass. This alloy expands like glass and enables the metal and glass to be fused directly.

The new high-volt X-ray tubes mark a real advancement and are expected to speed up industrial operations to a remarkable extent. It is stated that the new unit requires an exposure time of only 3½ minutes in taking pictures through 8 inch steel castings, whereas the old one million volt tube takes about 4½ hours to do the same job.

ARDIL—A NEW SYNTHETIC FIBRE

THE development of a new synthetic fibre, called Ardil, by the Imperial Chemical Industries is reported in *The Chemical Age* of December 2, 1944. The new synthetic fibre resembles wool in many of its properties, such as resiliency, softness and warmth, but, unlike wool, does not shrink and is not attacked by moth. It is prepared from ground-nut protein, one ton of nuts producing about 500 lb. of Ardil fibre. The possibility of utilizing vegetable protein for the production of synthetic fibres arose out of the researches of Astbury and Chibnall. The latter's success in preparing a wool-like fibre from humpseed protein led the I. C. I. to consider the commercial utilization of this development, and ground-nut was chosen for reason of economy, and also on account of its good protein content.

Ground-nut contains 48-50 per cent arachis oil, about 28 per cent protein, 11 per cent carbohydrate, and 8 per cent salt, water, etc. The oil is first extracted from decorticated nuts by a low temperature process and may be used for human food. Protein is next extracted from the oil-free meal containing 9 per cent nitrogen, leaving a residual meal, with 2 per cent nitrogen, which may be used as a cattle-feed. The protein is then dissolved in caustic soda solution to produce the spinning solution which is extruded through spinnerets to form the filaments. The company has evolved a special method for hardening the filaments, as the traditional method with a formaldehyde bath did not prove satisfactory owing to the hydrolysis of protein. Hydrolysis was avoided by lowering the pH of the bath.

Ardil fibre thus obtained dyes like wool in acid dye-baths; like wool it absorbs moisture and has a similar heat of wetting. Although fabrics may be made purely of Ardil, it is recommended that Ardil should be profitably used in mixture with wool, cotton or rayon. Yarns may be made on the worsted, woollen or cotton systems according to the type of fibre required.

The raw material for the manufacture of Ardil by the British firm will have to be supplied largely from the East, from India in particular. India ranks first in the acreage and production of ground-nuts, with China, Senegal, the U. S. A., and others following her in order of importance. India alone accounts for 34 per cent of the world production, according to an estimate covering the period 1933-37 (*SCIENCE AND CULTURE*, Vol. VIII, No. 2). The new process, if worked successfully on a commercial scale, is likely to lead to a great demand of Indian ground-nuts in British factories, to be processed and developed there into a far more costly fabric, for which this country will again in all probability be the principal customer. It is in this way that

a supplier country of raw materials, indifferent to technological development, is deprived of wealth which could have so rightly belonged to her.

A NEW UNDERWATER CAMERA

At a recent meeting of the Optical Society of America, (*Science*, October 27, 1944) Professor Maurice Ewing, of the Columbia University, described a new underwater camera that bids fair to be an invaluable aid to such investigations as concern the geology of the ocean's floor and the deep-sea life.

In one type, the camera is equipped with a ballast and a float. The complete unit is thrown over board, and the ballast carries it to the bottom. When it reaches the bottom, a trigger starts clock work and enables the camera to take a series of pictures at any time interval set beforehand. After the camera has been exposed for the last picture, the ballast is automatically released and the camera rises to the surface with the help of the float. In order to indicate the changes that occur in the direction of the current as the camera is active in taking pictures, it may be further provided with a compass and a drift indicator suspended in its field of view. The other camera is designed to take just one picture and is simply lowered on a wire.

The idea of obtaining photographic record of the ocean basin and of the marine life was conceived in the last century. In 1890, Boutan, a French man, first made such underwater photographs by lowering his camera into shallow water. The shutter was operated from the surface of the water by pulling on a cable attached to it. The new automatic and self-recording camera is, in fact, the latest culmination of an idea that originated fifty-four years ago.

Results of considerable geological interest have already been obtained with the new camera. A number of photographs have recently demonstrated sand ripples at 97 fathoms, proving the existence of enough current at this depth. The constancy of this movement appears from the fact that tides alter the direction of ripples.

In the study of the habits of deep-sea life, the camera has proved a valuable tool. It has made possible correct census of submarine animal population, as photographic records can include fragile and easily vulnerable fish, not possible by means of net.

MOBILE POWER PLANTS

THE war has given rise to many scientific achievements and veritable feats of engineering undreamt of even a decade ago. One such feat is the design and construction of mammoth mobile power plants for generating and supplying electricity wherever and whenever needed. The destruc-

tion of electric plants in the European, African and Asiatic theatres of war presented the problem of quickly restoring electric power for military operations as the liberation of the occupied territories proceeded on. Special trains containing full power generating equipments were designed and built for this purpose and are now serving the Allied forces with power as rapidly as they are advancing. The United States has taken the lead in developing such mammoth plants, and very recently the American Society of Mechanical Engineers, in collaboration with three of the largest engineering concerns, discussed at length the future potentialities of such equipments. As a result of these discussions, ten 5,000 kilowatt and forty-five 1,000 kilowatt mobile power plants are now being constructed by the Westinghouse Company, while the General Electric Company is constructing forty 3,000 kilowatt turbine electric power trains.

The 5,000 kilowatt train is made up of eight freight type rail road cars, each about 50 ft. in length, having double insulated walls. Of the eight cars, the first two are for the main steam generator, the third for the main turbine generator and switch-board, the fourth for air compressors and boiler feed water pump, the fifth for feed water, the sixth and seventh for main steam generating equipment and the last for workshop and living quarters for the operating personnel. The 1000 kilowatt trains, on the other hand, have only three cars, each car being mounted on two four wheel trucks. They comprise a boiler car, a turbine generator car, a cooling tower car and a coal handling equipment. The turbine car houses the 1000 kilowatt electric generator driven by a steam turbine, a steam condenser, electrical transformer, gasoline driven generator for starting and emergency auxiliary service, and circuit breakers for main generator and feeder circuits. Both these plants are designed to obtain the maximum power output per unit of material to operate efficiently in an atmospheric temperature range from

-40°F to +95°F on low grade lignite fuel with a limited quantity of water for make-up and cooling and are capable of being put into operation without power from any external source. The 3000 kilowatt electric power trains, one of which was delivered to U. S. S. R. Government last June, consist of 10 units, having locomotive boiler cars, tenders, a turbine and condenser car, a switchgear car, cooling tower cars, and a car for maintenance and operating crew.

Apart from these, smaller "Package" type floating plants of 500 watt capacity are also built by the Westinghouse. They are shipped in 24 packages made up of relatively large pre-assembled units necessary for power generation, all being mechanically and electrically interconnected. Together they comprise 8 functional units of a complete power station, each with its auxiliary equipment. They can be moved by rail, motor or water transport and assembled for power generation in 36 hours, their floor area on location being only 1870 sq. ft. The steam boiler required to produce the energy can burn coal, wood, or heat-oven green logs, fed by hand into the furnace. For handling these fuels, the plant is equipped with a tramway bucket type conveyor, a portable coal unloading conveyor, and a coal peat crusher.

The design and construction of these mobile power plants capable of readjusting the destroyed life and network of ruined cities in the shortest possible time represents an achievement of a very high order in the annals of engineering. After the needs of large cities devastated in this war have ended, these plants and probably many others that will be constructed later will have vast potentialities in general civic work, in restoring back power lost as a result of damage to the existing electric plants and machinery by fire, floods, earthquakes or explosion, while they will also find use as temporary power stations for salvage work or for hydro-electric purposes.

S. K. G.

STEEL-MIX IRON CASTINGS TO ENGINEERING SPECIFICATION

M. N. MUKERJI,

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A review of early documentary evidence shows that cast iron was also known in ancient India as "Munda". As a mater of fact, pure iron takes up carbon at about 1000°C to 1400°C and this temperature could hardly be attained in the old Indian furnaces on account of their inadequate blast pressure. Some European authors, therefore, maintain that cast iron might have been produced in ancient India only

by accident. A block of such iron was discovered near Rungpur, North Bengal, about fifty years ago. The chemical analysis of the sample revealed as follows:—

Iron	...	96.42%
Total Carbon	...	2.81%
Manganese	...	0.21%

On account of its inherent low strength, brittleness and openness of grains, ordinary cast iron is still

regarded with great disfavour as a material of unreliable engineering properties, on the other hand its low cost and easy casting properties still lead the market.

The addition of steel to pig iron in a cupola would produce a stronger material so called "semi-steel" and it raises the tensile strength of cast iron. The term "semi-steel" which is sometimes used in Indian Railway Standard Drawings, Specification, technical books and journals is a vague trade name for products intermediate between steel and cast iron. Its physical properties are intermediate between cast iron and cast steel. Moreover, the term might have been originated from the fact that a certain amount of steel scrap is used in the cupola charges, say, pig iron 50%, cast iron scrap 25% and steel scrap 25%.

The essential constituents of cast iron and their physical properties are given below:

Constituent	Sp. Gravity	Tensile strength in tons per sq.in.	Elongation %	Brinell
Ferrite (Fe) ..	7.86	23	40	95
Pearlite (Fe ₂ Fe ₃ C) ..	7.84	53	20	197
Sorbite (Fe ₂ Fe ₃ C) ..	7.86	71	15	255
Cementite (Fe ₃ C) ..	7.66	2.4	None	550
Phosphide (Fe ₃ P) ..	7.32	None	Brittle	400
Graphite (C) ..	2.55	None	None	None

The introduction of steel scrap in the cupola mixture does not, as a rule, involve any reduction in the total carbon content but effects a reduction in the quantity of silicon and phosphorus in the resultant iron according to the amount of steel scrap used. The melting point of steel is about 1500°C whereas the maximum temperature of the cupola seldom exceeds 1400°C. The melting of steel in the cupola is accompanied by an absorption of carbon up to 3% up to its eutectic requirements. Indian Railway Standard Specification No. M.14-42 for iron castings has laid down 12 tons and 10 tons as minimum ultimate tensile stress for Class I and Class II respectively on 0.564 inch gauge dia. test bar. Brinell hardness number in the case of locomotive cylinder castings under Class I should be not less than 200 in accordance with B.S.S. No. 240.

We have seen sleepers on the railway track, these are either of wood or metal. The average life of an wooden sleeper is reckoned as ten years whereas the metal sleepers may last over forty years. These last named type of sleepers are manufactured either from cast iron or from pressed steel plates. I.R.S. Specification No. T. 7-36 for cast iron plates or pots for sleepers lays down that the metal used for casting the plates or pots shall be pig iron and scrap which may be either cast iron or steel. The bars for transverse strength which are called for in the Specification

must be placed on knife edges 3 feet apart and these shall withstand a load of 30 cwts. applied at the centre and shall show before fracture a deflection of not less than 0.30 inch. Drop tests are conducted using a monkey weight of 420 lbs. dropping vertically on the head of the rail keyed to the plate or pot sleeper to be tested. One impact blow of the weight falling from 3 feet and three successive blows from 7 feet are specified for broad gauge sleepers. The plate or pot casting must withstand this prescribed test without showing any sign of fracture. It is customary

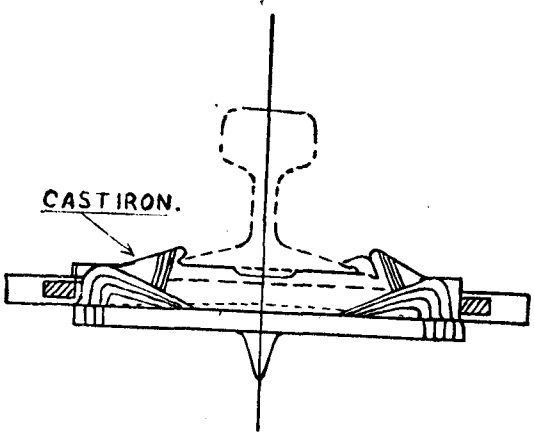


Fig. I.—Sleeper plate keyed in position for drop tests.

with the manufacturers of these sleeper plates or pots in this country to add on an average of 10% steel scrap in the cupola charges so that the resultant castings may conform to the above test requirements. The chemical composition of the sample casting as drawn approximates as follows:—

Combined Carbon	...	0.37%
Graphitic Carbon	...	2.7
Silicon	...	1.38%
Phosphorus	...	0.26%
Sulphur	...	0.08%
Manganese	...	0.65%

Salient features of poor strength of common cast iron as revealed by the microstructure are large graphite flakes constituting planes of weakness and hard brittle phosphide eutectic. Proper technical control of the cupola working is needed to control graphite, to reduce phosphorus and to obtain an all pearlitic structure in the final castings. The demand for improved grades of cast iron having a tensile strength greater than twelve tons per sq. in., B. S. S. No. 321 for grey iron castings was superseded by B. S. S. No. 786/38 for high duty castings which specifies 1270, 1420, 1620 and 1910 lbs. minimum breaking loads with 11, 12, 13 and 0.14 inch minimum deflection on 0.75 inch dia. test bar for transverse test; 16, 19, 23 and 26 tons per square inch minimum tensile strength for grades 1, 2, 3 and 4 respectively. It is imperative that the dia. of the test bar should conform to the main cross sectional thickness of the casting it represents.

In the manufacture of heavy sectioned castings where the running of the metal presents no difficulties in obtaining a perfect, clean and sound castings 30% to 40% steel scrap could be safely used. In the case of lighter sections it may be 10—15% of the charge. This charge, however, has to be melted hotter than the ordinary pig iron and cast iron scrap charges, usual coke consumption is generally higher in proportion to the amount of steel scrap used. The steel scrap should be on the top of the pig iron and cast iron charges. Volume of air is more important than pressure, say, 14 cubic feet per lb. of the charge melting. The metal may be tapped at 1400°C and cast around 1300°C. This steel-mix iron is superior to grey iron in tensile values, chemical composition, impact tests and Brinell hardness, etc. It wears better and resists shocks better than ordinary cast iron. Microstructure reveals a close grained structure consisting mainly of pearlite, some ferrite and cementite with some flakes of graphite uniformly distributed and a few patches of phosphorus eutectics.

Meehanite irons which are usually manufactured from high steel charges are now being produced by some firms in Calcutta with success. Normally we expect to get a white iron at the spout of the cupola with high steel charges but graphitization is effected by the addition of calcium silicide as an occulent.

Typical analysis of the Meehanite iron:

Total Carbon	...	2.4 —2.7%
Silicon	...	1.0 —1.5%
Phosphorus	...	0.1 —0.2%
Sulphur	...	0.05 —1.0%
Manganese	...	0.65 —1.0%

These special irons cost 10% to 20% more than ordinary high duty irons. Cast iron is usually

made up of graphite, pearlite, ferrite and iron phosphide; malleable iron is simply made up of graphite and ferrite; meehanite consists mainly of pearlite and controlled graphite in varying forms and quantities. Meehanite castings are sometimes called "bridging the gap" between cast iron and steel. In the manufacture of meehanite, millions of tiny particles of graphite act as a nucleus in the molten metal for the formation of equiaxed crystals instead of columnar crystals which sometimes cause structural weakness. The entire process of meehanite manufacture is scientific and the resultant castings are more dependable, uniform and conform closely to Engineering Specification. They are practically displacing steel casting and forgings from the market.

A few grades of meehanite for various service requirements may be summarised as follows:—

	Typical illustrations	Tensile Min. in lbs.	Brinell Min.	Modulus of elasticity in millions per sq.in.
(1) General Engg. Castings.	Crankshafts, Hydraulic Cylinders, Tool Shanks, Machine Tools, Units for Pumps, etc.	GA 50,000 GB 45,000 GC 40,000 GD 35,000 GE 30,000	223 212 207 193 174	21 19 17 15 12
(2) Wear-resisting	Gears & Pinions (Torch hardened) Brake Drums, Brake Blocks, Valves, Crank, Crane Wheels, Dies, Sand Blast Nozzles, Pug Mill Knives, Pulversing Hammers.	WA 50,000 WB 38,000 WBC 45,000	196-321 350-550 Up to 550	
(3) Heat-resisting	Diesel Castings, Steel Guides, Dies, Valves, Burner Parts, Stoker Parts, Gas Retort Parts, Blast Furnace Parts, Fire Grate Bars & Bricks, Annealing Furnace Rails, Tempering Tanks.	HA 50,000 HB 40,000 HC 38,000 HE 30,000	196-240 300-400 350-500 170-220	
(4) Corrosion resisting Castings.	Acid Pumps, Valves, Pans, Condensers, Retorts, Stills & Fittings.	CB 3 45,000 CB 45,000	197 187	

Present war conditions have given a great fillip to the use of steel-mix irons and it promises an ample field for the post-war development of this industry.

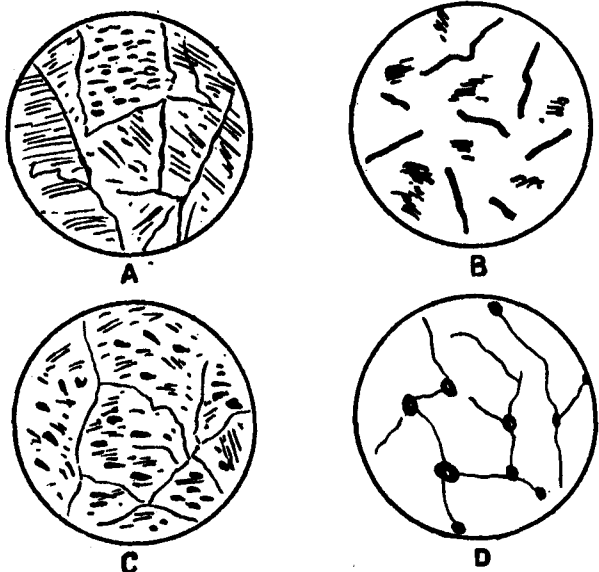


Fig. II.—(A) Carbon steel (B) Cast iron (C) Meehanite (D) Malleable iron

The writer has attempted many a time to advise small and big foundries of this country to improve on their technical control of the cupola working such as accurate regulation of quality and quantity of raw materials charged, control of chemical analysis and metallurgical structure in the final castings. In a word, the manufacturers have been impressed that they must know what they are putting in the cupola

so that they may be sure what they are getting out of the cupola. On account of the proximity of coal, pig iron and sands, this part of the province is eminently suited for the foundry trade. A little technical guidance in the way of setting up a provincial "Foundry Advisory Board" in Bengal would be of immense help not only for the foundrymen but also for the advancement of foundry research in Bengal.

MEDICINE AND PUBLIC HEALTH

MENTAL DISEASES IN INDIA

MENTAL diseases in India form the subject of a useful memorandum recently prepared by Lt.-Col. M. Taylor, I.M.S., Medical Superintendent of the European Mental Hospital, Ranchi, following the request of the Medical Relief Advisory Committee under the chairmanship of Sir Joseph Bhore. The problem of mental diseases in India, about which the general public still maintain a crude and primitive attitude, has so far received far too little attention of the medical profession. A lunatic case is not regarded as a 'patient', as it should have been, but is generally treated as an alien. There is no provision for the diagnosis and treatment of early and recoverable cases, and treatment is not undertaken until the patient has fully qualified for a *bonafide* case of mental disorder, i.e., has fully reached the stage of lunacy. It has now been ascertained that insanity begins before a person is insane, and if proper medical attention be taken early, the maladjustment can be cured. The accommodation in the few mental hospitals, the medical staff and other facilities are so inadequate that several voluntary boarders have to be refused admission, and the undesirable mixing of acute and recoverable cases with the chronic incurable has become inevitable.

The memorandum suggests that, as the old Indian Lunacy Act of 1912 is now out of date, better and more enlightened legal provision will have to be made. Clinics should be associated with general hospitals, whose help could be given to border line cases. Principal clinics should, however, be associated with medical schools, and provision should be made for both indoor and outdoor patients. In view of the importance attaching to the after-care of patients who have completed hospital treatment, the establishment of convalescent houses and after-care associations is recommended.

Special emphasis should be laid on the much neglected teaching of psychiatry which is now looked upon by the medical profession merely as a kind of pathological curiosity. Indian colleges should also provide for better psychological training to their students inasmuch as the trained social worker has an indispensable part to play in any scheme of mental hygiene.

The memorandum has also dealt with the case of mental defectives which also present no less difficult a problem. Although wholesale sterilization is outside the scope of practical politics, it suggests that adoption of sterilization as an alternative to life-long segregation and with the consent of the defectives or their nearest relatives will be the most human course. It recommends the creation of proper institutions and utilization of hostels and colonies to house the defective population finding home environment unsuitable.

SILICO-TUBERCULOSIS

The *Medical Newsletter*, No. 41, issued by the U. S. Office of War Information, has summarized the recent work of O. Auerbach and M. G. Stemmerman on silico-tuberculosis from a paper published in the *American Review of Tuberculosis*. In order to determine whether or not pneumo-noconiosis alters or it itself altered by pulmonary tuberculosis, the authors of this study reviewed 54 cases of silico-tuberculosis and compared them with 9 cases of pneumoconiosis without tuberculosis and 200 cases of tuberculosis without pneumoconiosis. They found that, although silicosis and tuberculosis exist concomitantly in the same lung, each maintains its individual integrity. The tuberculosis apparently alters the silicosis not at all. The pneumoconiosis alters the tuberculosis only in so far as the silicotic nodules prevent the full development of tuberculosis granulation tissue and, in the

walls of cavities, the pyogenic membrane. Both granulation tissue and pyogenic membrane, however, are present in those portions of the lung where the silicotic foci are small or absent. Except for this quantitative difference they found little variation in the tuberculous process, whether or not pneumoconiosis is present. The size, situation and number of cavities are approximately the same. There is a slightly greater incidence of perforation of cavities through the interlobar fissures in the silicotics and a greater incidence of death from fatal pulmonary haemorrhage. The latter factor is due to the greater productive reaction in the silicotic lung with greater opportunity to develop an aneurysm of a branch of the pulmonary artery. They found it difficult to

determine the exact time at which pulmonary tuberculosis was superimposed on pneumoconiosis, unless the patient was under observation during the transition period, since the symptoms of the two diseases are so similar. While fever and definite evidence of cavitation on roentgenography are useful diagnostic aids, the final conclusion must be based on the demonstration of the tubercle bacillus. Collapse therapy was of little value in cases of silico-tuberculosis. This is apparently due to the fact that the silicotic lung remains voluminous and shows no tendency to collapse. Most cases succumbed to progressive pulmonary insufficiency. When the tuberculous process invaded the remaining portions of resilient lung tissue sufficiently, death was inevitable.

MINIMUM REQUIREMENT OF FAT IN HUMAN NUTRITION

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HAFFKINE INSTITUTE, BOMBAY

IT is becoming more and more evident that those nations who can provide their people with adequate diet for proper health and growth are likely to survive most in the post-war period. Today nutrition and diet are not mere matters of personal choice or individual peculiarities, but must depend on planned dietetics according to physiological needs as determined on scientific lines.

The large variety of materials which are available as human food contain substances which can be allocated to one or more certain comprehensive chemical categories or groups, the chief of which are protein, carbohydrates and fats, commonly known as "proximate" principles of food. A diet to be complete must contain all the three staminal principles, and in addition, the necessary inorganic materials in correct proportion and liberal amount of vitamins.

It is, however, to be emphasized that the quantitative aspects of dietetics are as important from the point of view of the physiology of nutrition as the quality of food. The optimum protein consumption is a matter of supreme importance, inasmuch as most of the tissue constituents are nitrogenous compounds and of necessity have their origin in food protein. An adequate diet must provide enough energy for the maintenance of body temperature and for the performance of physical work. Fats and carbohydrates are mainly concerned with the supply of energy. A marked deficiency in the ingestion of certain dietary components, such as the essential amino acids and vitamins, leads to a failure of appetite, whereas, the consumption of diet deficient in calories but adequate in other respects creates a sensation of hunger. Under

the ordinary circumstances, this mechanism tends to prevent the ingestion of insufficient food fuel purpose.

In any planning of a national dietary standard, energy requirement is a matter of primary consideration. The actual amount of energy needed and, therefore, of food required, together with the proportion of the proximate principles in the diet, has been the subject of a large number of investigations. Amongst the basic researches may be mentioned those of Voit, Rubner and Atwater, and a host of modern workers have continued similar enquiries. Our fuel requirements of the body vary considerably according to the nature of the occupation and a variety of other factors such as size, age and climate. With the present knowledge of basal metabolism and the means now available of estimating the added heat requirement for a definite amount of muscular work, including an additional allowance of energy exchange of approximately 10% due to the specific dynamic action of food, it is now possible to place such data as caloric requirement on a much more secure foundation. It has now been realized that children's needs are out of proportion to their size. The figure, 3000 calories, is now generally accepted as a sound average figure for the average man. For working class men engaged in a greater expenditure of energy calories intake of 3,000—6,000 or more per day may be necessary. Many dietaries have been proposed for the average adult man from time to time by different authorities and by scientific bodies. Some of them are shown in Table I and Table II.

The first three in table I are now chiefly of historical interest. The Food (war) Committee of the

TABLE I
STANDARD DIETARIES

	Protein	Fat	Carbo-hydrate	Calories
Voit (Germany) ..	118 gr.	56 gm.	500 gr.	3,065
Rubner (Germany) ..	127 "	52 "	509 "	3,092
Atwater (United States) ..	125 "	125 "	450 "	3,520
War Society Food (war) Committee of the Royal Society ..	100 "	100 "	500 "	3,390

Royal Society which met at the close of the war (1918), however, pointed out that there is a distinct relation between work and fat ration and asserted that where vigorous muscular effort has to be undertaken it is essential that the diet should contain not less than 25% of its energy in the form of fat.

Daily requirement of protein, fat and carbohydrates and total calories of an adult male, according to the report of the British Medical Association, is indicated in the Table II.

TABLE II
DIETARY STANDARD LAID DOWN BY B.M.A.
Total calories required 3,400 in food as purchases

Derived from	Quantity	Per cent of total calories	Number of calories
First class protein ..	50 gr.	6	206
Second class protein ..	50 "	6	206
Fat ..	100 "	27	930
Carbohydrates ..	500 "	61	2,050
Total ..	700 "	100	3,392

Ordinarily, the protein of the diet supplies only about 300 calories per day. The protein intake need not be increased as a result of greater work, inasmuch as it is physiologically more economical to work at the expense of carbohydrates and fat. Most dietaries contain roughly four to five times as much carbohydrates as fat by weight.

Without making any alteration in the amount of protein in the diet, variation within wide limits in the relative proportion of carbohydrates and fat in isodynamic amounts are possible without injury to health. But it is not possible to replace the whole of the carbohydrates in a diet by fat or to rely upon carbohydrates to the exclusion of fat without certain disadvantage in the general metabolism of the body. Thus it is important to consider that this property of mutual replacement is not unlimited. This raises the question of the significance of fat in the diet and minimum requirement of fat in human nutrition.

DIETARY VALUE OF FAT

Fat is important as a source of energy. Its energy value is the highest of all the foodstuffs.

The inclusion of fat in the diet as a concentrated source of energy makes it possible to provide sufficient calories without increasing the bulk of the food to a degree which takes the capacity of the digestive tract. Starling who served as a chairman of the Royal Society of Food (war) Committee (1918) remarked, "That the question of bulk is probably one of the most important factors in determining the need of fat. The human alimentary canal has been so developed as to cope with a diet in which 20 to 25% of the energy is presented in the form of fat. In order to get the same energy from carbohydrates the alimentary canal would have to be larger." A meal lacking in fat is deficient in staying power. People who are restricted to diets very low in fat frequently complain that they become hungry soon after meal. Premature hunger was also a universal experience during the first five months of the year 1918. Starling recites the above experiences in 1918. He has further remarked, "The ordinary individual deprived of fat diminishes his total intake of food and exists on a lower metabolic rate." There are probably some reason for this craving for fat. In the first place, when the greater part of the carbohydrate food is absorbed three hours after the food has been taken the chief absorption of fat occurs between five and six hours after a meal. On this account, individual deprived of fat get hungry sooner than when he takes fatty food. Secondly, carbohydrates are more subject to fermentative changes in the intestine than the fats. Overloading the intestine with carbohydrates leads to many individuals to abnormal production of gases and general discomfort. Although certain individual can for a time dispense with fat, yet to develop their full efficiency as a working machine, fat is an essential ingredient of the diet.

Besides their high calorific value, fats are of extreme dietary importance as a vehicle of certain fat-soluble vitamins, namely A, D and E. Animal fats are generally the potent sources of vitamins A and D. Recent studies indicate that some of the unsaturated fatty acids attain a place similar to that of the vitamins in being necessary constituents of a complete diet. Thus a deficiency disease resulting from a fat-free diet has been observed in rats (1929). The animals are said to show regularly a scaly condition of the skin, necrosis of the tail, degeneration of the kidney and in some cases, sterility. This nutritional disease is curable by the inclusion of linoleic and possibly other higher unsaturated acids or fats containing a large proportion of them. Hansen (1933), Epstein and Glick (1937) have suggested that certain eczematous conditions in humans, particularly in infants, might be related to the deficiency of essential fatty acids. It has been shown by Hansen that the blood of eczematous infants tends to have less unsaturated fatty acids than normal. Administration of

fats containing a high proportion of unsaturated fatty acids raised the degree of unsaturation of blood and in a gratifying degree alleviated the eczema. It is, however, necessary that further investigation should be continued on similar lines to clarify the relation of dietary fat to eczematous condition.

A certain amount of fat seems necessary to ensure satisfactory absorption of some nutrients of the food. F. Maignon (1934) is a strong supporter of the view that fat plays a quantitative role in nutrition affecting like vitamins, and in the utilization of food constituents. He remarks, "They have a favourable effect in the utilization of proteins for synthetic purposes and on nitrogen metabolism." There are evidences on record to show that fat helps in a better absorption of the pigment carotene, the precursor of vitamin A in the body, from the intestinal tract. Probably by far the most important effect of fat of practical nutritional significance is concerned with the absorption of calcium and phosphorus of the food. The experimental evidence for the influence of fatty acids on calcium absorption has been pointed out by a number of investigators. Holt, Courtney and Falss (1921) found that utilization of calcium by infants was augmented by fat in the diet. Some of the very recent researches indicate that fat *per se* possesses antirachitic properties. Kon and Booth (1942) seem to have definitely established this finding. Our results (to be published shortly) also lend strong support to the view that fats free of vitamin D exert a definite beneficial influence on the calcification of the bone of rats and further indicate that fat probably acts as an anti-rachitic by influencing a better absorption and retention of phosphorus from a high calcium-low phosphorus rachitogenic diet where phosphorus forms a limiting factor. Probably of relatively less practical importance is the effect of fat in delaying or averting the symptoms of vitamin B₁ deficiency, known as "the sparing action of fat on vitamin B₁."

Thus considerable experimental evidence to support the hypothesis that fat possesses some intrinsic quality of value to the organism other than supplying energy has accumulated in recent years. It has nutritional importance and physiological significance.

FAT CONSUMPTION

The actual intake of fat amongst people in various parts of the world show wide variations. In an interesting discussion of the dietary value of fat, Howe (1935) comments as follows on the consumption of fat. "In the so called standard dietaries the weight of fat consumed has varied between 50 to 100 grams per day. The average daily consumption of fats and oils purchased as such in the United States is roughly 63 grams per capita. Some dietaries in the south have

shown a consumption of almost twice as much fat." The average American diet of today has been estimated to provide from 25 to 30% of its calories in the form of fat or approximately 80 to 130 grams of fat daily for the adults. In the countries of Western Europe, the feasible dietary limit has likewise been defined as approximately 80 to 125 grams per day from a varied diet of 3,000 calories. Orr (1937), by dividing the total food supply by the population, gave the average intake of fat and carbohydrates as 124 and 425 gm. respectively per "head" of population in 1934 in the United Kingdom.

Turning now to the food habits of the people of some tropical countries and in the Far East, it is found that the standard of fat intake is extremely low. Fat only accounts for 6% of the total energy value of the diet of some Japanese. Mc. Clendon (1936), while a visiting professor in Japan, writes that he "was much impressed by the low fat content of the Japanese diet and the great amount of fermentative dyspepsia among the Japanese. It seemed to me that men were incapacitated for long periods of time because of low fat content of the diet." The diet of the average rice eating population of India is also characterized by a very low intake of fat. The diet of poor rice eater who form the vast majority of the people of our country is much the same all over India. Their consumption of vegetable fat is low, that of animal fat is negligible. As to the actual intake of fat by an average Indian we have very little reliable data at hand. As reported in the *Health Bulletin* (Rice, 1940) by Dr Aykroyd, typical rice diet supplies less than 20 grams of fat daily. It is, however, correct that the influence of climate, locality, habits and work on the intake of fat is so great that it is not possible to utilize one particular standard for general application; nevertheless, the question as to what should be the adequate intake of fat with our usual high cereal diets should receive more importance than has hitherto been recognized.

The importance of the question of the minimum requirement of fat in human diet has now been realized, and it may be mentioned that this question was one of the subjects, which was taken up for discussion and consideration by the Technical Commission appointed by the League of Nations (1938).

CHARACTER OF FAT IN THE DIET

In determining the minimum requirement of fat, it is, however, to be considered that the character of fat is not a matter of indifference. The choice of fat in human diet is no doubt governed by such factors as availability, local production, season of the year, personal preference and economic status. In India alone, a great variety of fats and oils are consumed in its different parts. Mustard oil is used all through-

out Assam, Bengal and Orissa, gingily and coconut oil are favoured in the south. Sweet oil is common in Bombay Presidency. In certain parts of Northern India, where milk fat is reasonably abundant and cheap, it is consumed in greater amounts more in preference to common vegetable fats and oils. As a general rule, the diet of the well-to-do class contains relatively more of butter fat. In recent years the large scale production of processed hydrogenated vegetable fats has made them available as a cheap substitute for butter. In fact, the recent increase in their consumption for cooking and other dietetic purposes may truly be called enormous. As a cheap source of energy available to the poor, the use of these products cannot be objected to, as in terms of calories, all edible fats and oils in the market are the same. However, the question arises as to whether these processed hydrogenated vegetable fats exhibit any noteworthy inequalities in respect to the coefficient of digestibility and absorbability as compared to other natural fats and oils and consequent availability for nutritive foods. It is reported by American workers from the results on human experiments that hydrogenated fats are digested with virtually the same ease and completeness as other natural fats and oils. We have found (results will be shortly published) that in regard to the relative digestion by rats of butter and hydrogenated fat, the behaviour of the two fats was practically the same but the utilization of the fatty acids of hydrogenated fat was about 3% less than butter fat. This, no doubt, can be explained as due to the large proportion of saturated fatty acids present in the hydrogenated fat. Absorption of fat depends on the length of the chain of the fatty acids and also on their unsaturation. It has been further observed that hydrogenated fat interferes with the absorption of calcium. When hydrogenated fat constitutes the sole source of fat in the diet, calcium absorption was about 14% less as compared to that obtained by feeding butter fat. The diminished absorption of calcium as effected by hydrogenated fat is caused by a greater elimination of calcium in the faeces as calcium soap. The results point to the importance in the selection of suitable dietary fat specially for the feeding of infants.

Extremely interesting results are now being reported from the studies on the comparative nutritive value of butter fat and vegetable fats. The idea which remained cogent until very recently that except for the vitamins present there is no difference in the food value of different kinds of fats is now being challenged by the gradual recognition on the possible role of certain specific essential fatty acids in the animal organism. The results of the recent researches tend to show that as the different proteins differ in their nutritive value depending on the make up and

distribution of the essential amino acids in their molecular composition similarly the nutritive value of different fats and oils may be related to the presence or absence of certain specific essential fatty acids in their chemical structure. Butter fat is held superior to vegetable fat because it contains vitamin A which is lacking in the vegetable oils. Recently, however, Hart and his workers (1940, 1941) have conclusively proved that, in addition to its vitamin A content, butter fat is constitutionally superior to the vegetable oils. The superiority of butter fat is traced to a saturated acid (or acids) of high molecular weight which is not present, at least in quantity, in the vegetable oils investigated. The unsaturated portion of butter fat when reconverted into glycerides is less growth promoting than the whole. But it appears, as shown by them, that the unsaturated fraction of butter fat could be activated by hydrogenation. They further state that hydrogenation of the vegetable oils, such as corn oil, cottonseed oil, soya bean and coconut oil, did not improve their growth promoting properties. The necessity for growth and vitality of certain unsaturated acids or glycerides, notably linoleic acid, has been recognized for some time now. The suggestion that there are certain specific higher saturated acids, peculiar to butter and not present in vegetable fats, which also exert growth promoting properties, if applied in human nutrition, will have a value of far reaching character from the practical dietetic point of view. There appears to be further room for further study of this phenomenon. This will no doubt place butter fat as an indispensable item of food in the human diet and more particularly in the diet for feeding of infants and children during the whole course of their growth period.

It may be interesting to quote the words which Leaths (1925) remarked on the role of fat in vital phenomena, "Whichever way we may turn we find that what is known of proteins points to the impossibility of accounting for the properties of the cell substances by their aid alone. Whichever way we may turn there are indications that what is known and what is possible to learn of the properties of fat must be of service. The role of fat in vital phenomena is a subject in which it may be expected that much may turn out that is of importance to the physiologists and to physicians."

SUMMARY

It is necessary to understand that our newer knowledge of nutrition has afforded a new outlook on the question of nutritional importance of fats and fatty acids. Fats and oils are no longer to be looked upon as merely contributing in the energy they supply to the diet, but they play a role in the vital phenomena of life. Fat is essential and must be a constituent of normal human diet.

Food habits of the people of the different parts of the world show that the actual intake of fat varies from races to races. The diet of the average rice eating population of India is grossly deficient in the amount of fat. Typical rice diets supply only 20 grams of fat daily. Vegetable oils are the main source of fat in the diet of the majority of the people of India.

In the light of what is known today that, in addition to its vitamin content, butter fat is of value to the diet as supplying some essential saturated fatty acids, which may attain a place similar to that of certain vitamins, it is to be hoped that our people should be advised by the nutritional experts of our country to furnish a part of their calories requirement from animal fat such as butter. This, however, is only possible if the fat is reasonable in price.

What should be the minimum measure of fat and how much of it should be derived from butter fat and how much from vegetable sources in an ideal diet is, however, one of the many important problems, still awaiting a solution.

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BOOK REVIEWS

A Critical History of English Poetry.—by H. J. C. Grierson and J. C. Smith. Chatto and Windus, Pp. VIII+527. Price 21 shillings.

Sir Herbert Grierson and Dr Smith have collaborated in writing this history of poetry to excellent purpose. That they have done it in the midst of a cataclysmal war speaks volumes for that unperturbed spirit which enabled England to weather through the darkest days;—it would augur well for her future if her politicians could imitate the level-headed sanity of her scholars. Twenty years ago the late T. Earle Welby gave us his admirable version of the progress of English poetry. But of work such as this we cannot have too many; for whatever one may think of England in other spheres of life, we unhesitatingly endorse M. Arnold's reminder to his countrymen that, "by nothing is England so great as by her poetry". For the mere history of English poetry, we believe Courthope's monumental six volumes will continue to hold the field. Neither Welby nor Profs. Grierson and Smith have attempted Courthope's

admirable correlation between historical forces and literary expression. But Courthope's pages, we might say, almost reek with scholarship. It is not meant for the general reader,—the heavy atmosphere of the library is all round it. Welby wrote for the general reader; in his work emphasis is distributed with an eye to agreeability. The present authors steer a safe middle course. Scholarship is lightened with lively enthusiasm; appreciation is weighted with undeniable authority. Every page is alive with a freshness that challenges attention. From the opening page to the last, interest never flags, and the variety of information is not allowed to oppress. The Anglo-Saxon period is dismissed with a summary that is adequate, though space might have been found for a discussion of the influence of Christianity in modifying Nordic paganism. But we are not disposed to cavil at this since English poetry, as we know it, may be said to have been shaped by the civilizing agency of France as exerted under the Plantagenets. Welby devoted some of his most en-

tertaining pages to the influence of Provence both direct and indirect. Profs. Grierson and Smith have been more compendious, but nothing can improve their masterly resume of the evolution of romance;—we did not know that so much completeness could be achieved within such brief compass. We might have relished a fuller treatment of *The Pearl*, specially in view of its relation to the later poetry of the Renaissance and Spenser. But these are matters of individual preferences which do not affect the general excellence of treatment. A serious objection is the complete absence of all reference to the very considerable influence exerted on the literature of the romance countries, and therefore of England, by their contact with the Moors. Chivalry itself, which lies at the basis of romance, is traceable to the Saracens of Cordova, and much of the accessories of chivalry, and, we believe, almost all the oriental glow of colouring that reaches its acme in the poetry of Spenser, is directly traceable to this. Altogether satisfactory, however, is the treatment of the Italian influence generally, and that of Petrarch in particular in the fifteenth century; and the anti-Petrarchan reaction in Ben Jonson and Donne is glanced at with a happy felicity. Incidentally while the discussion of the Elizabethan sonneteers is more than sufficient, we note that the authors continue to regard Milton's use of the *enjambel* as a liberty with the Petrarchan model. We had thought that Dr Smart had conclusively shown it to be patterned on a recognised Italian model. Why Castiglione is ignored is not clear, since "The Courtier" looms large in the poetry of Spenser, Shakespeare and other Elizabethans; "the perfect gentleman" was much nearer to their heart than it was to the Victorians. The treatment of the Jacobean and the Carolines is, as was to be expected; admirable, and the same might be said of the discussion of the eighteenth century poets, particularly of the satirists. That Blake should have a chapter to himself is legitimate in an age that might be said to have rediscovered him; we would have liked to see a fuller treatment of Blake's relationship with Milton. Coming to the Romantic poets, we are unable to reconcile ourselves with the author's view of Wordsworthianism. In fact, our objection extends to almost all European critic who have undertaken this. For the Wordsworthian attitude is entirely foreign to the West;—the proper connection between Wordsworth's predilection for silence and solitude and his communication with nature can be appreciated only through an understanding of the nature and significance of the mystic vision as immanent in a process of spiritual discipline. It is easy to expound the mysticism of Vaughan or Traherne or Blake; but to understand mystic vision that emanates from a period of proba-

tion, one must be familiar with the esoteric heritage of the Hindus. Similarly familiarity with Vaishnavite mysticism might have improved the discussion on Patmore. Indeed we have a further quarrel with the authors;—the direct and indirect influence of Indian thoughts on latter-day English poetry is not so much as glanced at, though it is distinctly operative in much of recent poetry—including that of Hopkins, Yeats, A. E., and perhaps also of Eliot. Swinburne, in view of his influence on Kipling, Henley, and even Ezra Pound could have received more attention.

But the editor frowns and we must stop. We take leave of the book with nothing but admiration for the ease with which weighty matter is handled throughout, for the intellectual clarity displayed in ordering a many-patterned, multi-coloured tapestry. Only one suggestion we have to make. The book should include in its re-issue an account of the development of English versification—in which so much valuable work has been done in recent years. The publishers should be congratulated on the general excellence of the get-up which is pleasing to jaded eyes.

D. N. G.

Weatherwise.—By John H. Willis. George Allen and Unwin Ltd., 1944. Pp. 110, 30 plates. Price 7s. 6d.

This book contains a record of weather at Southwell Lodge, Norwich, England, during thirty years from 1913 to 1942 by an experienced meteorological observer. It is divided into three sections. To avoid the usual method of description followed in weather reports, which may sometimes appear dull and uninteresting to ordinary readers, the author has narrated in the first section each year's weather in a flowery style. But it is doubtful whether this method of narration, which is somewhat a lengthy one, leads to a clear grasp of the main features described; it often appears to be cumbersome.

In the second section, tables containing usual meteorological data for the thirty years are given. They give monthly and annual means and extremes of temperature and total values of rainfall and sunshine.

The most attractive feature of the book is its third section of photographs showing the effect of weather on the growth of plants and trees. These plates show the apparent condition of (a) the same snow-drop clump, (b) the same daffodil clump (c) the same chestnut branch and (d) the same branch on some fixed dates of a year, the dates being different for each of these objects. The author has not, perhaps rightly, given much space to discuss this

aspect, as further study is necessary to know the details.

Casual mention of historical events, such as Battle of Britain, has enlivened the interest of readers.

The narration gives mainly the weather of Norwich with occasional references to other parts of England; as such the sub-title of the book, "England's weather through the past thirty years" is not quite appropriate, though the chief points of interest to the public have been covered by the writer.

In spite of restrictions due to the war, the book has been printed on paper of good quality and the reproductions of photographs are excellent.

N. K. S.

Paranormal Cognition.—By Laurence J. Bepdit, M.A., M.D. (Cantab.), D.P.M., Late Assistant Physician, Tavistock Clinic, etc. Published by Faber and Faber Ltd., London. Pp. 79. Price 5 shillings.

The book forms the text of the thesis on the basis of which the author was awarded the degree of the Doctor of Medicine by the Department of Medicine of the University of Cambridge. It is a significant sign of the times that an essay on what is popularly called 'psychism', and that too written from the standpoint of a believer, should have been considered fit for acceptance by an academic body of the standing of the Cambridge University as a doctorate thesis. The author believes, and he has cited cases of histories in support of his belief, that animals including human beings are endowed with a sixth sense, which he, following Thouless, designates as 'Psi'. The Psi functions originally guided the instinctive behaviours of animals. In human beings it works on the protopathic or subconscious level. Mediums and certain neurotics show in an eminent degree the manifestations of Psi function. The author tries to explain irrational emotional disturbances in certain patients as a Psi experience conveying the mental agitation suffered by some other person. The reviewer would like to point out that the author, like J. W. Dunne, who wrote that fascinating book 'An Experiment with Time' on an allied theme, failed to consider the possibility of paramnesia as a factor affecting the validity of the records. The recent theory of the

secondary ego as developed by Bose will again do away with the necessity of any paranormal explanation for the phenomenon of experiencing other peoples' emotion in an unknown manner. Although the book may not fulfil the expectations of a rationalistic mind it will be read with great interest by all classes of readers.

S. C. M.

A Text Book of Plant Physiology (for undergraduates)—By Shri Ranjan, M.Sc. (Cantab.), Docteur ès Sciences, Professor of Botany and Dean of the Faculty of Sciences, Allahabad University. Published by Indian Press, Ltd., Allahabad, 1945. Pp. VI+228. Price Rs. 6/-.

The needs of our undergraduate (B.Sc.) students in Botany are really fulfilled by this text book and laboratory manual combined in a single volume by Shri Ranjan of Allahabad University. Since Reynolds Greens' Vegetable Physiology appeared last in 1911, no other suitable book on Plant Physiology has appeared to fulfil the requirements of our undergraduates.

The past 25 years have seen many advances made in experimental work, and in the suggestion of new theories. Prof. Ranjan has endeavoured to incorporate as much of this as seems to be sound and the material thus presented is interesting and attractive.

Each chapter has commenced with a brief historical resume of the subject and the author has even ransacked vedic literature (3000—5000 B.C.), to trace the history of the fermentation processes in plants.

The book has been kept within reasonable dimension but unfortunately certain parts *e.g.*, growth and movements have been unjustifiably compressed and some of the more important aspects of physiology of movements have not been dealt with at all. A bibliography of works referred to in the text, at the end of each chapter, would have considerably enhanced the value of the book.

The book is concluded with a chapter on the elementary principles of logarithms about which our students are often ignorant and a knowledge of which is so essential, for a correct interpretation of the physiological processes.

We have no doubt that the book will be found to be very useful to those for whom it is intended.

A. K. G.

LETTERS TO THE EDITOR

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

A NOTE ON LEAF MUTATIONS IN JUTE

In Jute the only recorded mutant, till now, was a trisome reported by Nandi¹ called V_1 hereafter. Two new mutants (V_2 and V_3) were found, early in the 1944 crop season, at Bashbari (a village near Dacca). Later in the season two plants of V_2 were located at Konda (Tipperah district), and two plants of mutant type V_1 were found, one at Narsingdi (Dacca district) and the other at Kishoreganj (Mymensingh district).

Ghose and Das Gupta² have dealt with the description of normal jute plants. In this note it will be shown how the mutants differ from the normal and from one another.

The V_2 mutant.—The plants are characterised by profuse branching, peculiarly cut up leaves and clusters of very small flowers. The conspicuous distinctive leaf forms, and the association of more or less complex clusters of the leaves, along with the numerous branches, gives the plant a dense bushy appearance. (Fig. 1)

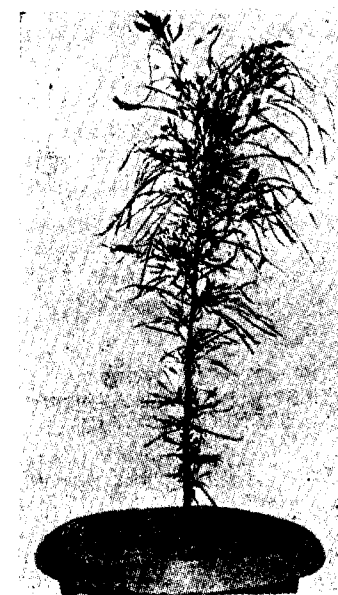


FIG. 1. V_2 mutant.

The leaves differ from the normal and from those of the other mutants in not possessing a complete lamina. Segments of the leaf blade are found missing, resulting in the exposure of the midrib. The extent and the number of points at which lamina portions are wanting, varies from leaf to leaf on the same plant; in extreme cases the entire

length of the midrib is exposed, except at the base where a lobe of the lamina is left. A considerable variability is present in the expression of the lamina, and a few examples of the range available are illustrated. (Fig. 2).

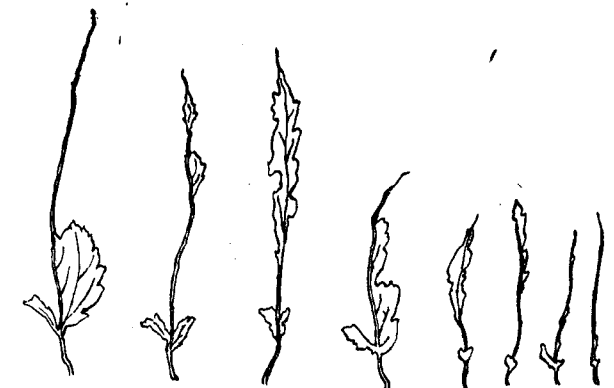


FIG. 2. Leaf forms of V_2 mutant.

The flowers of the mutant are tiny and much smaller than those of normal *C. capsularis*. The petals are fused with the sepals at the base up to a certain length, after which they are free and project out of the sepals forming a lip (Fig. 3).

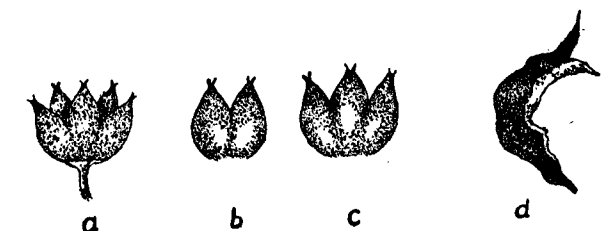


FIG. 3. a. apocarpous ovary, b. bicarpellary group, c. tri-carpellary group, d. fused sepal and petal.

The stamens are greatly reduced in number, which varies from 7 to 12. All the stamens are not normally formed, one of them is petaloid, some are staminodes, yet in others the anther lobes may be partially or entirely missing exposing a barren filament without even rudiments of another at the top. In some flowers filaments of two stamens cohere. In flowers found later in the season, the staminodes are replaced by normal stamens.

The ovary is more or less apocarpous, formed of five carpels present in two groups, one of three carpels and the other of two, the margin of the

carpels are fused at the base within the groups (Fig. 3), stigma single or bifid.

No capsules are produced, but peculiar cup-shaped and discoid structures are developed towards the end of the season, as a result of the fusion of the margins of the apocarpous ovary (Fig. 4). No seeds are produced. Leaf tip smears showed that the mutant had the normal complement of chromosomes $2n=14$.

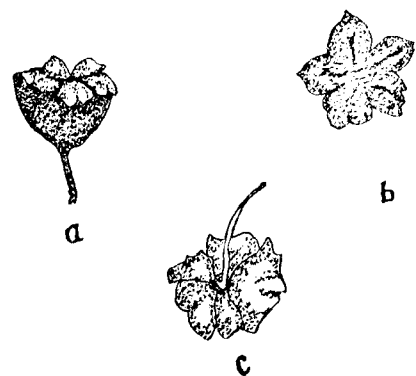


FIG. 4. a. cup shaped structure, b. discoid structure, c. discoid structure inverted in V_2 mutant.

The V_3 mutant.—This plant proved to be a normal variant chimera, all branches, except one, had normally formed leaves. On the variant branch the leaves differed from the normal in being narrower, more deeply serrated and the lamina irregularly spread on both sides of the midrib. The leaf of V_1 differs from V_3 in being narrower, more deeply serrated and the lamina spread equally on both sides of the midvein, i.e., the leaf of the mutant branch of V_3 is intermediate in breadth and serration of the lamina, between normal and V_1 leaves. Flowers small with 5-merous free sepals and petals and 10-16 stamens. Stigma trifid or fourfid.

Leaf tip smears of the V_3 mutant showed an extra chromosome in the aberrant branch giving $2n+1=15$ (Fig. 5), while rest of the branches were normal diploids with $2n=14$ chromosomes.

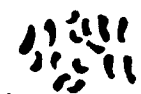


FIG. 5. $2n+1=15$ chromosomes in V_3 mutant $\times 3200$.

Even though the V_2 mutant flowered profusely, no seeds were produced. Early in the season the flowers shed completely, but towards the end of the season, after the shedding of the sepals and petals, the peculiar cup like the discoid structures, described above, developed and were devoid of seeds.

Early in the season and again towards the middle of October pollen grain viability of the flowers were studied. From each plant a large number of flowers were examined, all the anthers (7-12) of a flower were isolated on a slide and crushed in a drop of acetocarmine and count of fertile and sterile pollen grains made.

In the early flowers the pollen grains were found to be badly formed, shrunken and completely sterile. In the later flowers, while some anthers in a flower showed a large number of sterile grains, others in the same flower showed equally large number of fertile grain, and in the rest an equal number of sterile and fertile pollen grains. The percentage of fertile pollens in anthers ranged from 18 to 96 and the mean percentage of fertile grains in flowers was 56.7.

This influence of environment on pollen fertility has been demonstrated in other crops, in *Nicotiana*, by East and Park³ and in *Brassica Pekinensis* by Stout.⁴

In V_3 mutant some anthers have non-viable shrivelled up pollen grains. Pollen sterility count showed more than fifty per cent of non-viable grains.

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Dacca, 3-12-1944.

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INCIDENCE OF 'BLOOD WORMS' (LARVAE OF *CHIRONOMUS* SP.) DURING AEROBIC PURIFICATION OF SEWAGE

The larvae of *Chironomus* sp. (Chironomidae, Diptera) are commonly found in stagnant waters and occasionally in water purification systems. They may be readily recognised by their crimson colour, which has suggested the popular name of 'blood worms'. The larvae of some species of *Chironomus* are green.

The following observations mainly relate to the occurrence and development of blood worms in sewage and sewage sludges under aerobic conditions.

In the effluent channels from certain sewage farms in South India (e.g., Madura), where purification is proceeding satisfactorily and the effluents are comparable to those from the activated sludge tanks,

blood worms have been found to flourish throughout the year, along with a number of ciliate protozoa (such as the species of *Epistylis*, *Carchesium*, *Zoothamnium*, *Vorticella*, and *Paranesisium*), certain algal forms and some species of fish, all of which develop naturally and persist in all seasons of the year the different forms of life would appear to form links of the cycle of nature.

The blood worms are not normal inhabitants of activated sludge, but they occasionally make their appearance in the aeration tanks, as has been observed in most of the installations in India^{1,2}, as also in a few plants at other centres^{3,4}. Fowler's observations would suggest that inadequate air-supply favours the occurrence of larvae of *Chironomus* in activated sludge and that they appear in quantity in the slowly moving sludge and completely alter its physical characteristics. Swaminathan also reported that the rapid development of *chironomus* larvae is due to defective aeration and improper circulation of sludge in the aeration tanks; he found that the larvae lived even at very low oxygen level and collected all the sludge particles into small cylindrical masses which were buoyed up to the surface of the liquid. According to Anderson at Michigan, the production of blood worms in sewage is due primarily to stale sewage and warm temperature; when the temperature of the sewage in the flat sewers reaches about 70°F., the treatment plant usually becomes infested with blood worms which cause a great deal of difficulty with the operation of the aeration plant; the worms form 'cocoons of sludge', about one inch in length an one-eighth inch diameter, which adhere to the walls of the tanks and finally break loose and float on the surface of the final settling tanks, due to entrained air or the septic condition of the sludge particles. Barton at Ohio has also described the devastating effect of chironomid infestation. At the same time, it is not clear from these accounts of the invasion of blood worms, how exactly they interfere with the process of sewage purification and how they come into the aeration tanks.

Recent researches carried out in India and in other parts of the world have revealed and established that the start as well as the efficient functioning of the activated sludge plant is essentially dependent on the development of certain special forms of protozoa, especially the members of *Epistylidae* and *Vorticellidae*⁵⁻⁹. Continued observations at Bangalore for a period of about six and a half years have conclusively shown that the efficiency of activated sludge may be referred entirely to the active presence of the special forms of protozoa, more especially the genus *Epistylis* of which some nine different species have been isolated (*Epistylis articulata*, *Epistylis anastatica*, etc.). Normally, the sides

of the aeration tanks are densely covered with the slimy masses of *Epistylis* and activated sludge is largely made up of the protozoan colonies. These and other conditions obtaining in the activated sludge tanks are apparently favourable for the development of the blood worms, if they have a chance to come into the tanks. It has been observed that when the blood worms develop in large numbers in these tanks, they interfere with the normal development and activity of the useful protozoa. The worms attack the protozoan colonies on the sides of the tanks as also in the sludge and use them as material for making their characteristic tubes which at the same time become sources of their food supply as well. In addition to such protection and nutrition, there is adequate air supply in the aeration tanks which are therefore admirably suited for the development of the blood worms.

Observations on the incidence of *chironomus* in the aeration tanks have shown that they make their entry in two ways. If, as in the case of some installations, aeration is discontinued for some time, more especially during the nights, the adult flies come and lay their eggs directly on the supernatant liquid in the tanks, and the eggs proceed to develop into larvae. The eggs may also be taken along with the sewage and sullage into the aeration tanks, depending upon the conditions of the sewerage system.

Experiments with the blood worms in the laboratory as also those carried out on the tanks have shown that aeration is most important for their development in sewage. If the air supply is cut off, the larvae become inactive and die. They can also be killed out by using kerosine, pyrethrum powder and a few chemicals, such as copper sulphate.

Another interesting observation on the *Chironomus* larvae collected from about forty different sources (waters and sewage sludges) was that their body cavities showed the presence of certain parasitic nematodes which were identified as *Mermis* sp. Those from activated sludge were found very heavily infested, each larva showing sometimes seven or more *Mermis* at various stages of development. It may also be observed in this connection that there appears to be no record relating to the occurrence of such parasitic nematodes in the blood worms, at any rate from Indian waters and sludges.

The above observations are of very considerable scientific and practical importance introducing a new outlook in regard to the oxidation of sewage and other organic matters in nature and their re-absorption into the cycle of life.

The detailed paper will be published elsewhere.

The author's thanks are due to Prof. V. Subrahmanyam and Dr G. J. Fowler for their kind interest

in the work and various facilities placed at his disposal; and to Mr T. V. Subramaniam, Dr B. R. Seshachar, Dr G. D. Bhalerao and Dr Baini Prasad for their kind help in identification and valuable information bearing on the subject.

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LIFE HISTORIES OF SOME MAJOR CARPS OF BENGAL

ALTHOUGH it may sound strange to note that we are taking the major carps of Bengal as the second staple food for the time immemorial, it is certain that no complete description of their life-histories have been recorded as yet. We are running a scheme 'On the life-history, bionomics and development of the fresh water fishes of Bengal' under the Imperial Council of Agricultural Research for the last eight years and below we are giving the gist of our knowledge in this direction for the benefit of the other workers in this line. The details and discussions will be given elsewhere.

	<i>Catla catla</i>	<i>Labeo calbasu</i>	<i>Labeo gonius</i>	<i>Labeo rohita</i>
1. Breeding season ..	June to July.	May to July.	June to July.	June to July.
2. Spawning ground	(i) In shallow areas forming pockets adjacent to river after a heavy shower. (ii) In bundhs—a special type of pond where the old water is replaced by rain water from shower or from a collection of rain water at a higher level.	Same as in <i>C. catla</i> .	Same as in <i>C. catla</i> .	Same as in <i>C. catla</i> .
3. Structure of fertilised egg on extrusion.	Mostly spherical, light red but some are oval, 2 mm. to 2.2 mm. in diam.	Oval bluish, 1.5 in diam.	More or less spherical bluish, 1.5 mm. in diam.	Round reddish.
4. Nature of eggs ..	Demersal, non-adhesive without oil globules.	Same as in <i>C. catla</i> .	Same as in <i>C. catla</i> .	Same as in <i>C. catla</i> .
5. Size of the egg after swelling.	5.3 mm. to 6.5 mm. in diam.	3 mm. to 4 mm. in diam.	4.5 mm. in diam.	5 mm. in diam.
6. Segmentation ..	Regular; 35 min. since fertilization.	Regular; 45 min. since fertilization.	Regular; 30 min. since fertilization.	Regular; 35 min. since fertilization.
(a) 8 celled stage	1 hr. 29 min. since fertilization.	1 hr. 30 min. since fertilization.	55 min. since fertilization.	1 hr. 10 min. since fertilization.
(b) 16 celled stage	1 hr. 54 min. since fertilization.	1 hr. 50 min. since fertilization.	1 hr. 25 min. after fertilization.	1 hr. 35 min. since fertilization.
(c) 32 celled stage	2 hrs. 19 min. since fertilization.	2 hrs. 15 min. since fertilization.	1 hr. 55 min. after fertilization.	2 hrs. 10 min. since fertilization.
(d) Completion of yolk invasion and formation of blastopore.	6 hrs. 30 min. since fertilization.	6 hrs. 25 min. since fertilization.	5 hrs. 25 min. since fertilization.	5 hrs. 45 min. since fertilization.
7. Appearance of embryonic rudiment.	8 hrs. 50 min. after fertilization.	8 hrs. 30 min. after fertilization.	7 hrs. 45 min. after fertilization.	8 hrs. after fertilization.
8. Appearance of optic rudiment.	11 hrs. 5 min. after fertilization.	11 hrs. after fertilization.	10 hrs. 40 min. after fertilization.	10 hrs. 35 min. after fertilization.
9. Appearance of heart rudiment.	14 hrs. 30 min. after fertilization.	14 hrs. after fertilization.	15 hrs. after fertilization.	15 hrs. 5 min. after fertilization.
10. Appearance of gill rudiment.	16 hrs. after fertilization.	14 hrs. 40 min. after fertilization.	15 hrs. 45 min. after fertilization.	15 hrs. 50 min. since fertilization.

LIFE HISTORIES OF SOME MAJOR CARPS OF BENGAL—(Contd.).

	<i>Catla catla</i>	<i>Labeo calbasu</i>	<i>Labeo gonius</i>	<i>Labeo rohita</i>
11. Appearance of pectoral fin-buds.	16 hrs. 10 min. after fertilization.	14 hrs. 40 min. after fertilization.	17 hrs. 10 min. after fertilization.	14 hrs. 30 min. since fertilization.
12. Appearance of otocyst rudiments.	14 hrs. 30 min. since fertilization.	14 hrs. after fertilization.	13 hrs. 50 min. since fertilization.	13 hrs. 20 min. after fertilization.
13. Period of incubation.	16 hrs. 40 min. since fertilization.	15 hrs. after fertilization.	16 hrs. 45 min. since fertilization.	17 hrs. 15 min. since fertilization.
14. Length of newly hatched larva.	4.2 to 4.7 mm.	4.2 mm.	3.3 mm. to 4.8 mm.	3.5 to 4.5 mm.
15. Characteristics of newly hatched larva	Eyes, otocyst, gill-slits, rudiments of pectoral fins, embryonic fin folds are present. Body laterally compressed and transparent.	Same as in <i>C. catla</i> .	Same as in <i>C. catla</i> .	Same as in <i>C. catla</i> .
16. Appearance of the median fin fold.	12 hrs. 45 min. since fertilization.	14 hrs. since fertilization.	15 hrs. 50 min. since fertilization.	14 hrs. 20 min. since fertilization.
17. Beginning of pulsation of heart.	15 hrs. since fertilization.	14 hrs. 40 min. since fertilization.	Not known.	15 hrs. 20 min. since fertilization.
18. Appearance of dorsal fin rudiment.	7th day since hatching.	8th day since hatching.	7th day since hatching.	8th day since hatching.
19. Appearance of pelvic fin rudiment.	13th day since hatching.	19th day since hatching.	198 hrs. since hatching.	18th day since hatching.
20. Appearance of anal fin rudiment.	10th day since hatching.	11th day since hatching.	162 hrs. since hatching.	12th day since hatching.
21. Appearance of scales.	31st day since hatching.	35th day since hatching.	5th week since hatching.	38th day since hatching.
22. Appearance of barbels.	No barbels.	29th day after hatching.	3rd week since hatching.	3rd week since hatching.
23. Appearance of liver	3rd day since hatching.	3rd day since hatching.	126 hrs. since hatching.	4th week since hatching.
24. Appearance of air-bladder.	2nd day since hatching.	3rd day since hatching.	24 hrs. since hatching.	2½ days since hatching.
25. Fry ..	Head large, transparent opercular flaps; snout long, chin compressed, no barbels, mouth anterior, toothless, body with scales.	Mouth narrow, lips fringed, snout depressed and obtuse, colour greyish, a yellowish spot at the front part of base of dorsal fin, a yellowish band at the nape, barbels black.	Head compressed, thin barbels, mouth toothless, body with scales, lip fringed, both continuous at angle of mouth no symphyseal knob on lower jaw, body with longitudinal bands, fins dotted black.	Lips fringed; lower one deflected downwards and continuous, body with scales and the longitudinal bands, fins marked with vermilion red.
26. Developmental modifications of the facial structures.	10 mm. stage. Lower jaw bigger and upturned; gape of the mouth is 1.7 mm. eye 1 mm. nostrils not prominent. 14 mm. stage. Lower jaw bigger, mouth obliquely upwards, gape of the mouth 2.7 mm. eye 1.7 mm. 22 mm. stage. Lower jaw much bigger, mouth upturned, gape of the mouth is 5.2 mm. lips fleshy but non-continuous, no taste buds; nostrils completely formed, eye 1.9 mm.	9 mm. stage. Lower jaw bigger and upturned; gape of the mouth 1.6 mm. eye 0.9 mm. nostrils prominent. 12 mm. stage. Both jaws equal, the mouth at the top of the snout, gape of the mouth 1.7 mm. each nostril divided by septum, eye 1.1 mm. 12.5 mm. stage. Upper jaw bigger, mouth on the ventral side, lips thickened and continuous, taste buds present; eye 1.1 mm., gape of the mouth 1.4 mm.	7 mm. stage. Lower jaw bigger, narrow and upturned, no barbels, nostrils prominent, gape of the mouth 1.4 mm. eye 0.8 mm. 13 mm. stage. Upper jaw bigger, barbels developed, nostrils constricted, gape of the mouth 1.6 mm. eye 1.2 mm. 18 mm. stage. Upper jaw bigger, mouth ventralwards, barbels well developed, gape of mouth .6 mm. eye 1.4 mm.	10 mm. stage. Lower jaw bigger and upturned, gape of the mouth 1.7 mm. eye 1 mm. nostrils prominent. 12 mm. stage. Jaws and mouth same as in <i>L. calbasu</i> , gape of the mouth 1.7 mm. nostrils prominent, eye 1.1 mm. 15 mm. stage. Both jaws are equal, mouth at the tip of the snout, lips fleshy, continuous; no taste buds; division of nostrils is complete; eye 1.3 mm., gape of the mouth 2.2 mm.

LIFE HISTORIES OF SOME MAJOR CARPS OF BENGAL (Contd.).

	<i>Catla catla</i>	<i>Labeo calbasu</i>	<i>Labeo gonius</i>	<i>Labeo rohita</i>
	44 mm. stage. Jaws and mouth same as in previous stage, no taste buds, gape of the mouth 8 mm., lips not continuous, eye 2.5 mm.	16 mm. stage. Jaws and mouth as in previous stage, gape of mouth 1.6 mm., lips fringed and contain taste-buds, eye 2 mm.	23 mm. stage. Upper jaw much bigger, barbels and taste buds are well developed, gape of the mouth 1.8 mm., eye 1.7 mm. Each nostril is divided by a septum.	21 mm. stage. Both jaws equal, mouth shifts slightly ventralwards, taste buds present, gape of the mouth 2.5 mm., eye 1.8 mm.
		23 mm. stage. Jaws and mouth as in the previous stage, taste-buds well developed, gape of the mouth 1.8 mm.	30 mm. stage. Mouth and lips same as in previous stage, gape of the mouth 2 mm., eye 1.9 mm.	40 mm. stage. Mouth ventralwards, gape of the mouth 2.6 mm., eye 2 mm.
		40 mm. stage. Aperture of the mouth narrow, gape of the mouth 2.5 mm., eye 2 mm.	36 mm. stage. Mouth narrow and ventral, groove behind the lower lip very prominent, lips fleshy, fringed and adapted for sucking, eye 2 mm., gape of the mouth 2.2 mm.	47 mm. stage. Mouth ventralwards, gape of the mouth 3.1 mm., eye 2.2 mm.
		47 mm. stage. Mouth narrow and ventral, gape of the mouth 2.9 mm., lips adapted for sucking and continuous, eye 2.2 mm.		
27. Habitat of the adult	Generally surface-feeders.	Generally bottom feeders.	Generally bottom feeders.	Generally middle-water feeders.
28. Food.	After yolk absorption take minute unicellular algae.	Same as in <i>C. catla</i> .	Under investigation.	Same as in <i>C. catla</i> .
5 mm. to 10 mm.	Protozoa of various nature.	Same as in <i>C. catla</i> .	Under investigation.	Same as in <i>C. catla</i> .
1 cm. to 2 cm.	Unicellular algae 10% Protozoa } .. 6% Rotifer } Crustacea .. 80% Sand particles .. 1% Unidentified mass 3%	Filamentous algae 32% Unicellular algae Crustacea .. 38% Rotifer & protozoa 10% Sand particles .. 2% Unidentified mass 16% Mollusca .. 2%	Under investigation.	Unicellular algae 35% Protozoa } .. 15% Rotifer } Crustacea .. 40% Sand particles .. 2% Unidentified mass 8%
2 cm. to 10 cm.	Unicellular & filamentous algae 5% Rotten vegetable 10% Protozoa & Rotifer 3% Crustacea .. 65% Sand particles .. 2% Unidentified mass 15%	Unicellular & filamentous algae 12% Rotten vegetable 40% Protozoa & Rotifer 2% Crustacea .. 8% Sand particles .. 5% Unidentified mass 31% Mollusca .. 2%	Under investigation.	Unicellular & filamentous algae .. 15% Rotten vegetable 55% Rotifer & Protozoa 2% Crustacea .. 8% Sand particles .. 5% Unidentified mass 17%
10 cm. to 25 cm.				
More than 25 cm.	Unicellular & filamentous algae 5% Rotten vegetable 30% Protozoa & Rotifer 3% Crustacea .. 34% Sand particles .. 3% Unidentified mass 25%	Unicellular & filamentous algae 2% Rotten vegetable 50% Protozoa & Rotifer 2% Crustacea .. 3% Sand particles .. 10% Unidentified mass 29% Mollusca .. 4%	Under investigation.	Unicellular & filamentous algae .. 3% Rotten vegetable 57% Protozoa & Rotifer 2% Crustacea .. 8% Sand particles .. 5% Unidentified mass 25%

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ANOTHER SPECIES OF *PHERETIMA* FROM INDIA

The most recent revision of Indian forms of *Pheretima*¹ recognized thirteen species, each regarded as a recent importation or immigrant. In a collection from Dehra Dun there are several specimens of a fourteenth species, *Pheretima birmanica* (Rosa, 1888). This species has been known hitherto only from a restricted area in Burma, mainly on the Shan Plateau, peripheral points of which are Toungoo Karen Hills, Kengtung, Pang Long and Mang Lung States, Bana (Yunnan), Lashio, Kutkai, and Namkham. The species gets down into the plains at Toungoo, Bhamo, Myitkyina, and has been found across the Irrawaddy only at Naba and Katha. Presence at Dehra Dun of a species which is lacking in so much of central and western Burma must be due to importation, presumably by man.

Although the species has been able to maintain itself in Dehra Dun, it does seem to be having difficulties there. Eight of the eighteen specimens had lost a posterior portion at or behind 52/53. Eight others probably had lost a posterior portion perhaps followed by some slight reorganization of the last two or three segments or by regeneration of a tail of two or three segments. The two remaining specimens appear to have tail regenerated of three and four segments only at 66/67 and 87/88.

If these interpretations are correct *P. birmanica* has a rather restricted regenerative capacity, being able to replace only two to four of the segments of lost tail portions. This is not in agreement with a rather general assumption that an anterior portion of any earthworm species can regenerate all of a lost posterior portion. Nothing, however, is certainly known of regeneration in the genus *Pheretima*.

The number of segments is 112². Specimens 9 and 10 (Table 1) accordingly appear to be nearly complete. In these two worms the typhlosole ends in segments 81 and 85 which may represent about the normal termination of that structure. If so, we should expect the typhlosole to extend into the terminal segment when a posterior portion has been lost anterior to segment 80. This however is not so, the typhlosole ending 3-12 segments in front of terminal metamere in specimens 1-3. Does this indi-

cate that loss of a posterior portion is followed by regression of the typhlosole? Some evidence for an

TABLE 1

	Number of segments in worm	Typhlosole ends in segment	Number of post-typhlosolar segments	Posterior end
1	52	44	8	Lacking
2	65	62	3	Lacking
3	66	54	12	Regenerate of 3 segments?
4	87	63	24	Regenerate of 4 segments?
5	87	64	23	Lacking
6	90	71	19	Probably lacking
7	96	79	17	Probably lacking
8	103	76	27	Probably lacking
9	106	81	25	Probably lacking
10	109	85	24	Probably lacking

affirmative answer may be provided by specimens 4-7 in which the tail has been lost or probably has been lost, shortly behind the region of assumed normal typhlosolar termination, for in these worms the number of post-typhlosolar segments tends to approximate the number in specimens 9-10.

In the key of the 1937 revision, as well as in that of Bahl's memoir³, *P. birmanica* runs down to 8b, *P. hawayana* from which it is distinguished (externally) by absence of genital markings, invaginate spermathecal and male pores.

The author's thanks are extended to Miss Marion Beebe and Miss Jane Tracy for assistance in procuring the worms.

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³ Bahl, K. N., *Pheretima*, 3rd edition. *Indian Zoological Memoirs*, I. Lucknow, 1943.

Mathematics and Statistics

The Summability of A Fourier Series and its Conjugate Series

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HISTORICALLY the summation and use of infinite series is as old as Newton and Leibnitz, or even Archimedes; but the creation of a satisfactory theory is the achievement of only recent times. Although in connection with his researches on the hypergeometric series Gauss made an important and rigorous examination of infinite series and Belzani defined clearly what should constitute a convergent series this ever-growing edifice of infinite series remained without a stable foundation until it was supplied by the remarkable investigations of Cauchy and Abel. The convergence of infinite series having been disposed of, the question of *divergent* series, known as *Asymptotic series*, was taken up and developed chiefly by Poincaré and Stieltjes.

In order to utilize usefully a much wider class of divergent series other than asymptotic series, methods were devised towards the end of the last century so as to associate with them by processes closely associated with Cauchy's concept of convergence, certain values which may be called their 'sums' in a reasonable way. Such processes of the summation of series which were formerly tabooed being divergent, have recently multiplied, and the whole thing has grown into the modern rigorous theory of *summability*. Among others, mention may be made of the processes of summability commonly associated with the names of Hölder, Cesàro, Abel, Borel, Le Roy, Euler and Riesz.

The application of such processes of summation is found to be most suitable particularly in Fourier series, its conjugate series and other important allied development in Mathematical Physics. Regarding Cesàro summability of Fourier series, Fèjer obtained the fundamental result which was subsequently generalized by Lebesgue and extended further by Noaillon and W. H. Young. Recently B. N. Prasad has developed an elegant, general method by which all the previously known results and several new ones can be obtained in a simple manner.

In order to gain deeper insight and more information about the degree or mode of non-convergence or convergence of Fourier series and its conjugate series, summability of *fractional* and *negative* orders of these series has been investigated by Hardy,

Littlewood, Chapman, W. H. Young, Bosanquet, B. N. Prasad and others. Recently various other types of summability like *strong* summability, *absolute* summability (A) and (C), have been applied to Fourier series and its conjugate series, and numerous results of far-reaching character have been discovered by Hardy, Littlewood, Titchmarsh, Zygmund, Plessner, B. N. Prasad, Bosanquet, Chow and a host of other workers. A comprehensive investigation of the conjugate series has been made by B. N. Prasad who has developed a powerful method which continues to remain effective even where the classical theory fails.

In spite of the tremendous amount of work done during the last hundred and fifty years in developing the theory of Fourier series the basic problem of finding a *necessary and sufficient* condition for convergence at a given point remains so far unsolved. With the processes of summability the situation, though somewhat improved, remains essentially almost the same. Nevertheless, there is hardly any important aspect of the theory of these series which have not been affected directly or indirectly by this new concept of summability.

It may be remarked that the huge amount of work that has been done in recent years in investigating the summability of a Fourier series and its conjugate series bears ample evidence to the power and potentiality of these new processes of summation. In fact, for obtaining a deeper insight into the nature of infinite series, indeed infinite integrals, the various orders in Cesàro summation may be considered to form successive steps of a long observation ladder of which the ordinary convergence is only a particular step, but if instead of taking observations while remaining fixed on this step, we do so by moving upwards and downwards on the ladder as necessity arises, we may naturally be in a better position to secure the fullest sight of our object in view. Since most of the problems in physics and allied subjects are ultimately reduced to infinite series or infinite integrals, it is not surprising that a judicious application of this new and powerful tool of a suitable type of summability process, may produce results unheard of before.

Botany

Some Aspects of Plant Anatomy in Modern Research

G. P. MAJUMDAR

PROF. MAJUMDAR divides the subject matter of his address into two parts, viz., study of the cellular organization at the apices of the vegetative and flowering axes, and the importance of the study of anatomy to taxonomy. He stresses the indispensable nature of the first to the proper interpretation of the structure, development and phylogeny of plants and their functions, and tries to substantiate the contention of Prof. Bower "that it is here rather than in the mature parts that the key to causality should be sought". He then goes on to discuss the different theories propounded from time to time to interpret the cellular organization at the vegetative apex, and suggests that in the light of the present studies the Tunica-Corpus theory of the apical meristem should be revised.

With regard to the initiation of leaf primodium at the growing apex he supports from his own studies the *soubassement foliare* (foliar foundation) theory of Gregorie and Louis. He shows that at successive time intervals or plastochrones, the foliar foundation is laid at a particular sector of the growing apex on which the primodium is erected subsequently. The erection or emergence is caused by the differentiating vascular system running up from below into the foliar foundation and liberating special nutrition into the active meristem. Each foliar foundation with its vertically emergent primodium is thus really a *shoot unit*, or *phyton*, or as Schuepp, Priestley and Priestley and Scott would describe it a *growth unit*.

He then deals with the phenomena of 'Vacuolation behind the apex', and the formation of leaf gap. With regard to the formation of leaf-gap he challenges the old theory that it is caused by the basipetal influence travelling downwards from the leaf primodium, and explains that the leaf gap is caused by the basifugal impulse to more vigorous and earlier growth activity which has isolated the most vigorously growing sector of the prodesmogen cylinder in a new leaf primodium.

In describing the shoot apices of inflorescence buds he discusses the Classical theory of Floral Morphology, and also the theory that holds the carpel and stamen as reduced branch system. From his limited researches on this subject he shows that the Classical theory of Carpel Morphology cannot be supported on the grounds of developmental history. The two apices, vegetative and flowering, are

fundamentally distinct and are not reducible to a common plan. In this he agrees with the late Prof. Gregorie. But pending further researches he reserves his opinion on the conclusions of Gregorie that the stamens and carpels are "microsporangiophores" and "spermatophores" respectively. Thompson, however, supported Gregorie by calling the 'embryonic or meristematic muff' at the flowering apex as the 'sporogenous meristem'. He believes that Mrs Abber is right when she says that the term homology should be dropped when comparing floral parts with foliage leaves, but keeps an open mind when Wilson regards stamens and carpels as reduced and modified branches homologous with leaves of a similar origin.

In the second part Prof. Majumdar starts by defining anatomy and anatomical methods, and emphasizes that anatomy should be understood not in a narrow but in a comprehensive sense. This comprehensive view has given rise to the development of such studies as physiological anatomy, phylogenetic anatomy, experimental anatomy, protoplasmic anatomy, and similar other anatomical studies. He, however, confines himself to anatomy and taxonomy of flowering plants. He quotes profusely to prove the indispensable nature of anatomical evidence in establishing phylogenetic relationships in plants. In this respect invariable anatomical features are more reliable than the variable external characters. The Kew Herbarium enlists the collaboration of anatomists in determining the correct taxonomic position of plants of uncertain relationship, but he regrets to point out that the Royal Botanic Garden Herbarium at Sibpur is neglectful in this respect. He shows that allied species founded on the basis of single type specimens have been reduced on anatomical evidence in many cases to mere varieties of a single species.

But he warns against overrating of anatomical characters. He agrees with other anatomists that the endomorphic and exomorphic characters should be employed in conjunction with each other as an auxiliary to taxonomy, as a means of confirmation of results obtained on external features.

With regard to the selection of anatomical characters only the conservative and peculiar in nature should be taken. In this connection the phyletic and biological characters should be distinguished for the phyletic is superior to biological. To obviate the difficulties of selection these characters

have been standardised. In this respect the International Association of Wood Anatomists have taken and are taking leading parts. They employ four methods for this purpose, namely, the methods of Association, Correlation, Exception and Sequences.

Prof. Majumdar concludes his address by appeal-

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ing to all taxonomists of India to take anatomical features into consideration when publishing new genera and species, and to the Heads of Botany Departments at the Indian Universities to include anatomy as a major subject in the curriculum of honours and post-graduate courses.

Chemistry

Some Aspects of Synthetic Dyes

K. VENKATARAMAN

IT is only in recent years that the importance of the dyestuff industry to the economy of the country has been realised in India, although textiles constitute our premier industry and our annual import of dyes has been of the value of about four crores of rupees. This figure may be doubled if we provide for a rise in the standard of living and an increase in the per capita consumption of textiles to double the present figure. The history of the dyestuff industry in other parts of the world, particularly in Great Britain, its intimate relation to other chemical industries, and the experience of the two great wars are a clear demonstration of the need for organising the indigenous production of coal tar intermediates, dyes and synthetic organic chemicals.

A survey of the necessary raw materials for dye manufacture has shown that the position is on the whole favourable, and provided certain conditions are fulfilled, it is practicable to manufacture all the dyes in substantial demand in the country in 15–20 years. There are, however, many problems to be faced and solved. While the coal tar raw materials are available, or can be readily produced, our limited coal resources must be carefully conserved and utilised in a rational manner.

The inorganic heavy chemicals, consisting mainly of sulphuric, hydrochloric and nitric acids, caustic soda and soda ash, are over 90 per cent of the total raw material requirements. Although they are already being produced on a considerable scale, they are more or less fully allocated to existing industries, and it is unlikely that, with the possible exception of sulphuric acid, the dye industry will be able to draw on the present production. Further, the prices are too much high, and it may be necessary for the Indian dyestuff industry to include in its own programme the manufacture of such heavy chemicals

as nitric acid by ammonia oxidation and sodium nitrite as a by-product, oleum, and sodium sulphide.

The plant requirements represent a serious problem and it will be necessary to import a considerable part of the plant, after taking the fullest advantage of engineering facilities in the country. We will have to develop ultimately a full fledged chemical engineering industry capable of producing all the machinery and equipment for the chemical industries, including the special plant which can withstand the stringent conditions of corrosion, temperature and pressure involved in modern chemical processes; but the time factor is the primary consideration, and the early establishment of dye manufacture must be made possible by entering into working arrangements with foreign manufacturers of plant. In view of the difficult and complex nature of the processes of dye manufacture, co-operation with one of the large and well established dyestuff organisations in Europe or America will be desirable, so that their technical experience may be available to us. State aid would also be required in many forms and one may recall in this connection the steps taken by the British Government during the last war to safeguard the British dyestuff industry.

Research on synthetic dyes should have ample provision in the national programme of research. The leadership of Germany in the manufacture of dyes and medicinal chemicals was mainly due to her far sighted encouragement of research. Great Britain and America were not long in learning this lesson, and it has been computed that the American dye manufacturer spends over two million dollars per year on research, devoted not only to the discovery of new dyes, but also to continuous improvement in methods of production and plant design.

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SCIENTIFIC EDUCATION AND RESEARCH IN RELATION TO NATIONAL WELFARE—III.

AS a result of the discussions which have appeared in the two previous issues of this series of articles it was concluded that the application of scientific methods to national welfare involve the following steps:

(a) To ensure (i) that a scientific and technological bias is given in the pre-university stage of education of the school going population and (ii) that advanced teaching and training in methods of research in pure and applied sciences are given in universities and professional and technological institutions of university rank.

(b) To provide facilities to selected groups of able students to undertake advanced training in fundamental and applied researches.

(c) To provide suitable organization for co-ordination and direction of research, and also to provide machinery for the utilization of results of pure research.

(d) To ensure the application of the results obtained to practical problems of agriculture, industry and medicine by means of pilot plants in industries, field trials in agriculture, and in public health by operation in small health areas. This represents the development stage.

(e) To provide agencies for the broadcasting of results obtained in the development stations to the interested sections of the community.

In the present article we shall deal with certain aspects of these problems and shall in this connection consider the recommendations which have recently appeared in several reports dealing with the different aspects of the problem of reconstruction in India. These are: Post-War Educational Development in India (will be referred to as I), Abbot Report on Vocational Education in India (II), C. E. Preston's

'Education and Training of Engineering Personnel' (III), Memorandum on the Development of Agriculture and Animal Husbandry in India (IV), and A. V. Hill's 'Scientific Research in India' (V). We are still awaiting reports of the Health Survey and Development Committee and of the Industrial Research Planning Committee.

DELIMITATION OF AUTHORITY OVER EDUCATION, RESEARCH, ETC. BETWEEN CENTRAL AND PROVINCIAL AUTHORITIES

This question has been discussed in most of these reports and the underlying principle in all their recommendations appear to be (i) that for all purposes of planning India is to be considered as a single geographical and economic unity, (ii) but for convenience of administration, a large devolution of power should be entrusted to the provincial authorities, (iii) but where such devolution has taken place, it will be necessary for the Central Government to exercise a large degree of control, to ensure uniformity in standards of education and opportunity for technological training and research. This will be necessary in view of the fact that the different provinces are not equally well provided with economic, agricultural and industrial resources and also not equally advanced in education and technical training. Thus for all schemes of educational and other planning it will be necessary (a) to establish a much closer co-operation between the Central and the Provincial Governments, (b) to break down existing provincial barriers, and (c) to introduce financial arrangements weighted down in the interest of the poorer areas. Thus it is suggested in (I) that all national planning and co-ordination of effort on a national basis will involve some kind of subsidy from Central to Pro-

vincial revenues. At the same time there will be some effective liaison between these authorities in order that the former may not only advise and assist the latter, but may also ascertain that the central subsidies are being spent on approved developments.

Further the location of technological and research institutions must largely be determined by industrial and commercial considerations and not by provincial areas. It is also necessary at the same time that in a national system students, whatever their place of origin, should have access to those institutions which provide the special training. As a consequence it will be necessary to make a drastic change in the existing system of financing education, which may be given in the form of block grants for approved schemes. But whatever form it takes, unless the whole cost of education becomes a charge on Central Revenues, which is unlikely, it will be equitable to 'weight' the formula in the interest of those provinces whose revenue producing capacity is below average.

The view is also expressed in this report that while the Provinces should remain the main units for educational administration, the activities of the higher educational centres like universities and technological institutions should be co-ordinated on an All-India basis.

Similarly in all proposals made in I and IV for the planning of research and development of agriculture, while there is a large degree of devolution of authority to the provinces regarding education, research and development, the Central authorities will (at the same time) remain responsible for the co-ordination and for supplementing the activities of the provincial authorities, which will be exercised through a Federal Department of Agriculture and Animal Husbandry, with its associated Institutes for Research and Development. The starting of a large number of All-India Commodity Committees illustrates the same tendency for the integration of research and development activities of the provinces; each Committee will have a Central Research Station linked up with a number of regional research stations. These stations will be maintained by means of cess or duty levied on the particular commodities concerned. Advanced teaching in agriculture is, however, recognized as a provincial responsibility, and no proposal has yet been made to co-ordinate agricultural education from the centre by an All-India Committee.

On the other hand medical education imparted in the provincial medical colleges are co-ordinated by the all-India Medical Council. Medical Research is undertaken in several All-India institutions which are not in any way connected with the medical colleges and are maintained partly out of grants from the

Indian Research Fund Association. We are not aware how many experimental health areas, of the type maintained at Singur, Bengal, by the Red Cross, are in existence in the whole of India. Need has been felt for associating medical research more intimately with medical colleges and universities and for the establishment of a large number of field health centres.

In technology very little has been achieved in co-ordinating higher teaching in engineering and technology on an All-India basis. Attention is drawn in I to the lack of any unifying principle in the mode of control of technical education in the provinces. In most areas such education is under the control of Labour, Commerce or Industry Department. It is pointed out that in every industrial country general and technical education is administered by the same Department of the State *viz.*, that of Education. At the same time closest contact should be maintained with Industry and Commerce, and also the technical institutions must be localized as near to industrial areas as possible. The result will be that some provinces will contain many more institutions than others. For these and other reasons stated previously, it will be necessary to establish an All-India body vested with the power to initiate, co-ordinate and control the provision for technical education, *e.g.*, by means of a National Council for Technical Education. Already an Association of Principals of Technical Institutions in India has been started, whose object is the formulation of a national policy in technical education and to establish All-India standards for courses in the major branches of technical institutions. Support of industrial research by the Central Government commenced only in 1940 with the establishment of the Council of Scientific and Industrial Research. A research laboratory under a Director has been established in Delhi, and the Council also provides grant for pure and applied research undertaken in university laboratories and research institutions.

Schemes have been approved for the starting of National Research Laboratories in Physics, Chemistry, Metallurgy and Fuel Research. Proposals have also been accepted for the starting of a number of Industrial Research Associations, which are to be maintained out of funds to be provided by the industries concerned. The Industrial Research Planning Committee will, it is expected, make detailed recommendations as to how such industrial research will be undertaken.

In addition to the different Advisory Councils and Boards maintained by the Central Government for education, research and development in agriculture, industry and medicine, the latter also maintain certain scientific departments and surveys *viz.*, in Meteorology, Geology, Geodesy, Zoology and Botany.

There is very little contact between the activities of these departments with those of similar departments in the universities.

UNIVERSITY EDUCATION

As the universities are the source of supply of trained personnel, research workers and administrators required for industry and Government scientific departments, it will be necessary to consider in some detail the past history and present position of the Indian universities.

As is well-known the first universities were started in 1857 in the three presidency towns of Bombay, Calcutta and Madras. They were then only responsible for the conduct of examinations for the benefit of a number of affiliated but largely independent colleges. As a result of the recommendations of a number of Commissions and Committees like the Hunter Commission of 1882, the Universities Commission of 1902, the Sadler Commission of 1917, and the Hartog Committee of 1927, there has been a gradual development in the character of the universities. The purely affiliating and examining universities of the old type like that in Calcutta have developed successful departments of post-graduate teaching and research. On the other hand unitary universities have been started in Dacca, Lucknow, Allahabad, etc. It is recognized under the present conditions there is place for both types of universities in India. The principal academic difference between the two types of universities appear to be that (i) in the unitary universities the intermediate teaching is no longer the responsibility of the universities, but is under the control of special Boards, (ii) the post-intermediate course of four years is split into an honours graduate course of three years and a post-graduate M.Sc. course of one year; while in the older universities the respective under-graduate and post-graduate course extend each over two years. There has been a great deal of discussion on the respective advantages and drawbacks of the two schemes. Our personal experience of examining the work of the candidates from both types of universities, both in the graduate and post-graduate stages, leads us to the view that a two years honours graduate course plus two years M.Sc. course provide a better specialized training in science. Probably for the purpose of competitive examinations the three years course is better suited. It has to be stressed that, unlike conditions prevalent in the United Kingdom, university training in India is considered to be completed with the Master's degree.

Some of these defects and drawbacks in university education are discussed below:

(i) *Inadequacy of high school education.*—The education imparted in most of the high schools provides an inadequate preparation for a university

career both in content and in teaching. The high school education being a provincial responsibility varies from province to province. The conditions are specially deplorable in Bengal, where there are about 1,400 high schools almost all of which are maintained from very inadequate fee incomes. It has to be investigated whether the education imparted during the ten-years course of school education does not lead to a deterioration of both the physical and mental efficiency of the pupils. Better provision in staff and equipment as well as a radical change of the authorities controlling high school education will be necessary before any improvement in the products of school education can be expected. National efficiency depends so much on the type of basic and school education provided for the growing generation, that it is a matter of great concern that school education is becoming so much a subject for political and religious controversies.

(ii) *Inadequacy of funds.*—The total expenditure in 1940-41 on university education according to I amounted to Rs. 4,65,83,971, of which 47.7 per cent came from fees, 12.9 per cent from endowments and 39.4 per cent from public funds. The total number of students during the year was 1,21,484 which represents a per capita expenditure of Rs. 300/- a year; the actual amount for different types of education vary, being highest for medical education and lowest for education in arts subject. The number of students in 1941, who graduated in the arts subject was 32,972 and in science 10,700. This outturn of graduates is to be considered as very inadequate compared to the total population of the country, but even then previous to the present war, there was a large amount of graduate unemployment. According to the estimates given in I, only 30 per cent. of the university products can be said to have obtained employment in keeping with their attainments or commensurate with the time and money spent on their education. This indicates a failure to relate the activities of the universities sufficiently closely to the requirements of the community. Co-ordinated effort will be necessary from now to increase the avenues of employment by planned expansion of industry and agriculture and also to adjust our educational efforts to the requirements of the country. Such expansion and reorientation of university education will not be possible unless there is a considerable increase in benefactions from private sources and grants from public funds of sufficient amounts required to place the universities in a position of financial stability. So long as they remain largely dependent on students' and examination fees, the universities can hardly be expected to put such restrictions on admission as to allow high standards to be maintained, and minimize risks of graduate unemployment. It has to be recognized that adequate teaching in

science is not possible in institutions (like private affiliated colleges) whose income depends on the very moderate scale of fees which the average student can afford to pay. It is also extremely undesirable that post-graduate teaching and research should depend, as in some universities, on the allocation of a portion of the fee income received by a university for conduction of examinations. Larger grants are necessary for better provision of adequate teaching in universities, especially in science subjects. When increased funds are available, it will be desirable to establish some kind of target to the number who can be admitted to university courses in arts, science, and in professional subjects and also to establish some criteria on the relevance of different courses of study to the requirements of the community.

The present war has created a large demand for persons trained in science, technology and commerce. This has resulted in a rush for admission of students to these courses of study and in a consequent drop in admission to the arts departments of the colleges—subjects in which admissions have been lowest being Sanskrit and Philosophy, both of which are of humanistic importance. Probably when the contemplated expansion in agriculture, industry and medicine takes place, the requirements of trained personnel will parallel in many respects the demands created by the war. It will require a great deal of forethought on the part of the authorities responsible for education and development to devise plans for utilizing during the period of transition the large number of trained personnel who will be thrown out of employment with the cessation of the war industries, and also to modify during this transition period the whole system of education to meet future requirements. Otherwise a great deal of unemployment and social unrest may be engendered.

Organization of higher teaching in science and training in research.—The credit for recognizing that not only conservation and diffusion of scientific knowledge but also the advancement of science by research is the function of a university belongs to the Calcutta University and to the generous donors like Taraknath Palit and Rashbehary Ghose. These two donors during 1912-13 endowed a number of research professorships in Physics, Chemistry, Applied Mathematics and Botany, and a few years later further Chairs were founded in Applied Physics and Chemistry and in Agriculture. At the same time it was recognized that research scholars should be associated with the Professors both for the purpose of training in research and for the advancement of research. The emoluments of these scholars were fixed at Rs. 75/- per month and were awarded to M.Sc. graduates for periods up to a maximum of three years. Most of the scholars so trained in research had no further opportunity of utilizing their

training and had to content themselves by obtaining posts as lecturers in affiliated colleges. The standard of teaching in these colleges has improved as a result, but very few of these lecturers have either the inclination or the opportunity to continue their research. Some of the more fortunate scholars have been absorbed in industry or in Government scientific services. Need was felt for creating a limited number of junior research fellowships tenable for two years to enable the more gifted of the scholars to continue their research and qualify for Doctor's degree. A small number of post-doctoral senior research fellowships like the P. C. Ray Fellowship in Chemistry and J. C. Bose Fellowship in Biophysics have been created. In addition to these some of the industrial firms are giving grants and stipends for research in earmarked subjects.

It has been felt for some time that additional junior and senior research fellowships should be created to enable a larger number of gifted research workers to continue their post doctoral training till they can be absorbed in the universities, Government scientific services and industry. At present due to the unusual demand for trained scientific workers in war services and in industry, where the emoluments are on a much higher scale than those existing in universities and research institutions, many of the research posts cannot be filled up. Similarly a large number of sanctioned posts in Government scientific services especially in medicine and agriculture are vacant for want of suitable candidates. There is a great need for strengthening the biological departments by creating additional posts and by increasing accommodation and equipments. That biological subjects have been neglected in comparison with the physico-chemical subjects is apparent from the following example. In the Calcutta University there are four endowed chairs each, in Physics and Chemistry, pure and applied, while there are one each in Botany and in Zoology; there is also a corresponding discrepancy in the number of research scholarships awarded in these subjects. Not only should the number of posts in science subjects be increased to meet the increased demand for science teaching and research but also the emoluments attached to these posts and the value of research stipends should also be increased in order that a proportion of the ablest minds of each generation may be attracted to such careers.

We have dealt in some detail with the provision of research in the Calcutta University, as the latter has taken the lead in associating research with teaching. The provision for science teaching and research is not uniform in other universities. In several very satisfactory progress has been made in making provisions for teaching and research, in others the conditions are less satisfactory. We find for example

that emoluments for research scholarships and fellowships vary from Rs. 30/- upwards per month. Sir S. S. Bhatnagar, in his recent presidential address to the Indian Science Congress is responsible for the following statement "I have been told that in at least two universities in India, scientific research is positively discouraged and (in the name of economy) admission to research students, inspite of willingness of the professors concerned, is almost completely prohibited." There is definite need for the setting up of some minimum standard in teaching and research in scientific subjects, to which all Indian universities should be expected to conform to.

Co-ordination of University Education.—In response to a growing need which has been felt for some time for obtaining a large degree of co-ordination in matters of administration, and for securing some uniformity of academic standards, conditions of service, remuneration etc. amongst university teachers, the Inter University Board was started in 1925, on which the universities are usually represented by their Vice-Chancellors. The function of the Board is purely advisory and it does not possess the authority which would enable it to co-ordinate university development from the national rather than the provincial point of view. The drawbacks in the functioning of this Board according to I are that it is not able to restrain unhealthy and uneconomic rivalry between the universities in regard to new development, also to prevent the creation of new universities, the need for which has not been established, or to counteract provincial outlook which puts obstacle in the way of students seeking facilities for study which are not available in their own areas. Above all it is not invested with any power of the purse.

University Grants Committees.—Suggestions have been made in I that some authority like an Indian University Grants Committee should be established by Statute, whose main function will be to exercise a general supervision over the allocation of grants to universities from public funds, with the object of ensuring that the universities are in a position to meet such demands as may be made upon them. To enable them to plan ahead, financial assistance should be in the form of block grants for definite periods of years. It is not proposed that provincial Governments should cease to make grants direct to their local universities, unless they would prefer to do so through the Grants Committee. It is however suggested that when a provincial Government desires to make a grant to a university for any substantial new development, they would prefer to do so through the Committee. All grants from the Central Government for new university development should be through this Committee. Amongst other powers to be given to the University Grant Com-

mittee, the following have been suggested:—(i) to co-ordinate university activities with a view to avoid overlapping and to adjust as far as possible the output of the universities to the economic needs of the country, (ii) to prevent undesirable competition between the universities and to remove inter-provincial barriers, (iii) to visit universities periodically, to ascertain their needs at first hand.

At present two leading members of the British University Grants Committee are touring this country, and are explaining to the university authorities the role of their Committee in the United Kingdom. We have not been informed how this Indian Committee is proposed to be constituted; according to I it is suggested that the Committee should consist of a few eminent persons not directly connected with any Government, Central or Provincial, or with any particular university, though for obvious reasons they should have considerable experience of university administration. The relation between the proposed Grants Committee and the Inter-university Board has not been clarified. Discussing a recent proposal for the establishment of a University Advisory Council for the United Kingdom (see previous issue), the Vice-Chancellor of the London University, Dr Frank Horton has expressed the view "the University Grants Committee has recently been reconstituted and enlarged. It has always been able to command such additional expert advice as it has needed from any academic or Government source. It is in constant touch with the Committee of Vice-Chancellor and Principals (corresponding to the Indian Inter University Board), which already fulfils some of the functions set forth above (i.e., of a University Advisory Council)" Dr Horton evidently is not in favour of the establishment of the proposed Council, as in his opinion the same functions can be efficiently discharged by his Committee. We hope a similar view of the function of the Inter University Board *vis a vis* the Grants Committee will not be taken by the Central Government. The Vice-Chancellors are mostly men with non-science degrees (in 1942 out of the 19 university representatives only one had a science degree), and as such are ill equipped to speak with authority on the requirements of the science departments of their respective universities. To meet our Indian conditions it will be necessary to establish some University Advisory Council, in which the science departments should find adequate representation (see p. 361 previous article).

Recently too much stress has been laid on the desirability of vesting some authority like the University Grants Committee to co-ordinate university development with a view to avoid over-lapping and to prevent undue competition between the universities. Except in the United Provinces with its five

universities, no other province in India can be said to possess its required number of universities, and these provinces can with advantage start a few more and better equipped universities. As a measure of co-ordination, the Indian universities may be divided into four regional groups; between the universities belonging to each group, a considerable measure of co-operation and co-ordination may be encouraged especially for purpose of post-graduate teaching and research. Need has been felt for some time for the creation of such a Grant Committee for ensuring some desirable standard of teaching in science and training in research. Results of periodic inspection of existing universities instituted by the Grants Committee may be expected to focus public attention to inadequacies of teaching, of standards of examinations, and of facilities for research, from which any particular university may suffer, and this may ensure remedial measures being taken by both the Central and the Local Government in the shape of increased grant when such is indicated and by withholding of grants when considered necessary to induce the particular university to introduce necessary reforms. One of the important function of the Grants Committee will be to lay down the conditions, financial and otherwise which must be satisfied by the local authorities before permission is accorded by the Central Government for the starting of a new university. The Committee will take into consideration the financial ability of the local authorities and recommend in what proportion the local grant to the university will be supplemented by the Central Government. There will also be other sources from which funds may be expected by universities for equipment and for maintenance of research personnel *e.g.*, from the Research Grant Committee and Research Studentship Committee of the Central Organization for Scientific Research, if the suggestion of A. V. Hill materializes. Grants for applied researches may be obtained from Federal Councils for Agricultural, Industrial and Medical Research. We may expect some indications from the Industrial Research Planning Committee of the conditions under which research on behalf of industrial firms, whose results cannot be freely published, should be undertaken.

University in relation to professional and technological training.—Having considered in some detail the problem of science teaching and training in research in the universities, we shall discuss briefly the existing relation between universities and the institutions responsible for advanced teaching and research in applied subjects like medicine, technology and agriculture.

Medical Education.—It is unfortunate that the Health Survey and Development Committee presided over by Sir Joseph Bhore have not yet published their recommendations. This Committee have been asked

to make a broad survey of the present position in regard to health conditions and health organizations in British India and to make recommendations for future development. Advisory Committees have been appointed to consider questions relating to public health, medical relief, medical education, industrial health and research. We understand that the procedure followed by the Committee was to draw up tentative schemes based upon their observations and then to submit them to a group of foreign experts for their criticisms and suggestions; the final recommendations of the Committee will be based upon modifications of their tentative proposals in light of expert criticism. We should like to see similar procedure being followed when the Central Government find it desirable to import foreign experts for enquiry and recommendations. In the absence of any report from the Bhore Committee, we shall content ourselves with giving a summary of the observations and recommendations of A. V. Hill published in his recent report (V).

The standard of teaching in pre-clinical sciences, like Anatomy, Physiology (including biochemistry and biophysics), Pharmacology, normal Psychology, in medical colleges in India is according to Hill unduly low. Routine teaching is carried on to a moderate standard, limited by staff, space and equipment, and there is little significant research. Both teaching and research is very much neglected in Physiology and Anatomy, due to the habit of running these departments on the cheap, mainly with the help of busy medical practitioners who are employed on a part-time basis. No real improvement can take place until most of the members of the pre-clinical departments hold full time appointments, reasonably well paid, in which research as well as teaching are regarded as normal duty. The pre-clinical sciences are the basis of the scientific study of medicine, and if they are weak, it will inevitably follow—and it followed in India—that clinical research and the standard of higher medical thought and education will be in a bad way. One of the steps necessary for improvement of medical education is the improvement of salaries status and conditions of employment of the junior staff.

In Great Britain and the United States many of the most important contributions to physiology have come in from other subjects—physics, chemistry and zoology. In India little encouragement has been given to such peoples, chiefly due to lack of funds necessary to provide full time appointments for them. As a result, physiology has not developed as an independent science, but has remained purely an adjunct to medical education. Hill suggests that a necessary step in the development of scientific medicine in India will be to start one first class department of physiology, at which teachers and re-

search workers of a new standard and a new outlook will be reared and then sent out through the whole of India. The previous criticism applies equally to most other subjects like anatomy and pharmacology and there is little provision for psychology. Biochemistry is better off because it has developed a certain independence, and has connection with nutrition, agriculture and industry. Biochemistry should be in close touch with physiology, pathology and medicine.

Clinical Sciences.—Similar criticisms have been directed to the ill-equipped understaffed departments of Pathology and Bacteriology, most of whose members are mainly employed in earning their living in other ways than by teaching and research. An estimate is given, from the Goodenough Committee's report on Medical Education in Great Britain, of the staff required for the division of Pathology in a university medical centre, to illustrate how much the medical education in this country falls below the standard considered desirable in other countries. Even if funds were available for such increase of staff, sufficient number of people of the right calibre and experience are not available here. It will be necessary (a) to send able post-graduate students for training abroad, and (b) to establish centres of higher teaching and research in clinical sciences. There are plenty of keen able young people who given the training and the opportunity, and reasonable salary and status and prospects for the future, would be glad to devote their lives for the advancement of medicine by teaching and research. There are very few full time teachers and research workers in clinical subjects and there are no full time medical, surgical or gynaecological units. It is imperative that full time clinical units should be started in Indian Medical Colleges in all these subjects, as soon as teachers and research works of a high standard are available; and the full time professional heads of these units should control the use of these hospitals and laboratories for all purposes of education and research.

Hill suggests that a great All-India Medical Centre should be established, an Indian 'John Hopkins' staffed in all departments by the ablest people available any where, employed full time and adequately paid, with the intention of producing the future leaders of Indian medicine and public health teachers and research workers. 'In no other subject than in medicine is it so necessary that education should be given a research atmosphere. Each patient presents a problem, each diagnosis is a theory, each treatment an experiment, often an expensive and painful one; it seems almost a crime that the results of nearly all these costly experiments go unrecorded. In the right research atmosphere this would not be so, but in an ordinary general hospital, with

a large part time staff and no provision, *e.g.*, by an almoner's department, for 'follow up', it literally is. How can medical education produce a scientific attitude of mind in such circumstances? In fact it very seldom does.'

Medical Research.—In India by a long tradition medical research has been done in the main at special institutes, of which eight have been mentioned in Hill's report, usually quite unconnected with the medical colleges and the universities. The research department of the Indian Medical Service has been mainly responsible for this work, some of which have been very distinguished particularly in tropical medicine. There is an obvious advantage in placing talented research workers in a situation when they need not be unduly burdened by teaching and routine; conversely however there is a disadvantage in isolating medical education and the clinical work of teaching hospitals from all contact with research. Moreover it is a serious loss to many research workers to remove them from the stimulus of young enquiring mind, and from the general scientific contact of a university. The process of setting up separate institutes in India for medical research has probably gone far enough; some advantage would now result from bringing existing research institutes wherever practicable in closer contact with medical colleges and higher medical education. In setting up new institutes for medical research in India or in promoting new scheme of research units, the advantage of associating them with appropriate medical colleges and hospitals should be kept in mind. The criticisms and suggestions contained in Hill's report on medical education and research will, we hope, receive careful attention from the Bhore Committee. Improvement in them will require not only greatly increased grants from Central and Provincial Governments, but also a change in outlook of the medical profession and of their leaders, as well as of the politicians who control policy. There has been noticeable deterioration in the standard of medical treatment available in hospitals attached to medical colleges and of others in control of the Government in this province. In addition there is considerable room for improvement in the standards of teaching in medical colleges and of research in medical research institutions. Paraphrasing a remark of A. V. Hill we may stress that the best possible staff and students available should be attached to medical colleges regardless of other conditions—financial, religious, social, provincial and so on. If any reasons are accepted for recruitment of staff and student other than ability and character, all projected improvement in medical education and research is bound to fail.

Agricultural Education and Research.—In most provinces the agricultural colleges are affiliated to

their local universities. But so far there has been no uniformity of practice as to the qualification of the candidates considered necessary for admission to these colleges, and the period of training in them. At present, for admission to the Institute of Agriculture in Dacca, a B.Sc. degree with biological subjects is considered necessary, and the course extends over two years. In the other provinces four years post-Intermediate training is the rule. In order to meet the present acute shortage of staff required for agriculture it is suggested (IV) that courses should be recast to provide intensive technical training in a much shorter period than is considered desirable during normal times. It is also suggested that in certain cases a post B.Sc. course of two years may also be instituted. The provincial organization for head quarters research and experimental stations are usually attached to the local agricultural college. It has been suggested that the universities should be encouraged and helped to establish course for agricultural training. No suggestion is forthcoming as to the types of agricultural training which will be available in the universities and in the provincial colleges; whether they will be similar or different. It may be desirable to organize the university courses for purpose of imparting a research bias in agricultural subjects, while the colleges will train candidates for development and extension work.

There is no proposal for establishing an All-India College of Agriculture, but a great deal of attention has been directed to the provision of facilities for research and development. The Imperial Council for Research in Agriculture and Animal Husbandry with its associated Research Institutes have been established for furthering research and development.

We suggest that there should be an All-India Council for supervision of agricultural education, for ensuring uniformity in syllabuses of the provincial colleges and for periodic inspection of these colleges, to ensure that some minimum standard of staff qualification, equipment, etc., is observed. At the same time it is desirable to establish some central authority in agriculture, to ensure that the provincial agricultural departments conform to some minimum standard of administrative efficiency. Enquiries instituted after the recent disastrous famine in Bengal have revealed how inefficient and backward in the application of science to Agronomy the existing department of agriculture is. We would like to be informed of the contents of the report and of the recommendations of Mr L. K. Elmhirst, the well-known authority on agriculture and rural reconstruction, who was brought over as a special agricultural officer in Bengal, and what portion of it the Government of Bengal are prepared to accept.

Technological education and research.—Most of the Indian universities have engineering faculties to

which the local engineering college is attached; some of the universities have in addition faculties for technology and in others there are post-graduate courses in applied sciences. It is suggested in IV that in addition to the university courses in engineering and technology, a certain number of senior Technical Institutions of the Polytechnic type, should be started. These institutions should be started and maintained by the Central Government, and administered by an Advisory National Council for Technical Education, in which both the Central and Provincial Governments and other interested bodies will be represented. Corresponding to the university degree course there will be a full time three years National Diploma course and a further two years Advanced National Diploma course corresponding to two years university post-graduate course. The broad distinction between the respective fields and functions of the university engineering college and the engineering department of the technical colleges, is according to W. E. Fisher (as quoted in IV) one of the purpose and outlook, and is irrespective of differences of status or recognition. The task of the university is to train selected men in such a way that they may subsequently adapt themselves to the needs of whatever professional posts they may secure, while the role of the technical college is to train men in direct relation to the particular place in industry which they hope to fill. In all cases the technical college should offer its students courses appropriate to their needs, the highest courses being provided under schemes of regional co-operation if necessary. Recently a Committee under the chairmanship of Mr N. R. Sarker has been appointed who will report on the constitution, training and research to be undertaken in federal polytechnical institutes.

The present system of training for Indian university degree course in engineering suffer according to Mr Preston (IV) from certain drawbacks. The Indian courses have to a large extent been modelled on the lines of those in England. Even in regard to syllabus contents they, in many cases, represent the highest common factor of the equivalent syllabuses of English universities. But whereas in England there is a reasonably close co-ordination between universities and industry, whereby industry provides a systematic but by no means perfect practical training which is complementary to the theoretical instruction at the university, the same is not the case in India.

This author has also been struck by the dearth of engineering graduates of Indian universities who have obtained degrees of higher than ordinary "bachelor" rank. Rarely does one come across an engineering graduate who has obtained an 'honours bachelor', 'master' or 'doctor's' degree in engineering from an Indian university. Surely it is to the

universities that we must look for the best of our research workers, and the 'master' and 'doctor' degree in engineering are usually conferred for work in research field. Obviously engineering faculties are not playing their proper part in engineering research, either because facilities are not provided, or graduate students do not remain to undertake research work, or both.

Research in engineering subjects except in hydraulic appears to be lacking in this country. It is expected that opportunity for research in engineering subjects will be provided in the new technical institute and in the engineering sections of the proposed National Physical Laboratory.

The following extract from Hill's report (V) on engineering research will be found interesting. 'Among scientific and technical people in the United Kingdom the opinion is widely held that Britain has lagged behind in the provision of facilities for higher education and research in technical subjects. There is no institute as yet in the United Kingdom comparable in magnitude, in the quality of equipment, and in the excellence of teaching and research work, with the M.I.T., Cambridge, U.S.A., or indeed with several similar institutions in the U.S.A.... This being the view held in England, where after all the conditions are not so bad, how much more can we

recognize the importance of one or two such institutes or colleges of very high standard in India? The future of Indian industrial and agricultural development must depend on the supply of first class technical brains trained in an atmosphere both of original research and of practical experience'.

Besides these technical colleges and university courses in engineering and technology, certain universities offer a two years M.Sc. course in applied sciences. Some enquiry should be instituted to find out how these M.Sc. graduates are being absorbed in industry, the particular aptitude which is developed by such training, and what modification may be desirable for improving the usefulness of these graduates to industry and to applied research.

We have in this issue given an account of the facilities available in the country, in the universities and institutions of university standing for advanced teaching and training in methods of research in pure and applied sciences. Attention has been directed to criticisms of existing defects and to suggestions which have been made of effecting improvements. No scheme for the application of science to national welfare will be successful unless consideration is given to these fundamental problems and serious efforts are made to effect necessary improvement.

CONSERVATION OF METAL RESOURCES AND THE FUTURE OF GLASS INDUSTRY WITH SPECIAL REFERENCE TO POST-WAR PLANNING IN INDIA*

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THE economic depression from which the world at large suffered after the last Great War is still fresh in our memory. To prevent its recurrence after this war all the countries are now preoccupied in planning their industrial production on strictly scientific lines. It is now recognized that unless plans for the proper development and co-ordination of the industrial output are made well in advance, the entire world will have to face the vagaries of an economic depression far greater than the previous one.

* Paper read before the Society of Glass Technology, Great Britain (Overseas Section) on 2-2-45 at Calcutta.

India too has not lagged behind in these activities, and both the Government and the public are seriously considering future plans for the welfare of the country in different spheres, such as agriculture, industrial development, transport, housing, public health, education etc. The comprehensive Bombay Plan which has been drawn up by a group of progressive industrialists has attracted considerable attention both in this country and outside. Planning for the welfare of the population of a vast country can be successful only if all the aspects of the plan and their mutual relationship, both material and human, are carefully examined in relation to the resources of the country. In the case of industrial planning, one

has to consider the relationship and influence of one industry on another, and it is only when these are taken into consideration that a full plan of industrialization of the country can be evolved. The dyestuff industry may be taken as an illustration; it is the textile industry which is most dependent on the dyestuff industry which in turn is dependent on the textile industry for its market; its development is dependent on the coal tar, chemical engineering and heavy chemical industries. Equally important for industrial planning is the consideration of resources. In fact, *resource planning should take precedence over the former.*

RESOURCES

Broadly speaking material resources can be divided into two groups:

- (1) *Replaceable*, such as forest and agricultural products, live stock, etc., *i.e.* those which can be renewed.
- (2) *Irreplaceable*, such as minerals, coal, mineral oils, etc. which are limited, exhaustible and cannot be renewed.

The problem of conservation resolves itself into a consideration of the means by which they can be protected from wasteful exploitation. It is natural that the conservation of irreplaceable resources which are so fundamental to the development of industries should have engaged the attention of almost all the industrially advanced countries. In fact, if one goes deep many of the present day rivalries can be traced to the possession of irreplaceable resources. They can be compared to a limited capital in the sense that unchecked expenditure results in its depletion. The guiding principles in the conservation of irreplaceable resources like coal, oil, minerals etc. should be *efficient production and wise spending*. There can be only two reasonable methods of conserving these resources.

- (1) An efficient and sparing use of the materials so that they can last for the maximum period possible.
- (2) Substitution by other materials which can be produced from easily replaceable and replenishable resources.

In most of the countries, the above two measures are now being vigorously adopted as policies of national welfare. Even a country like the U. S. A. which possesses about half the total coal resources of the world is planning for the conservation of this key material. Other countries which have limited resources of certain essential materials are pursuing the policy of conserving them by employing substitutes. In this connection, the following general discussion

which took place at the Third World Power Conference,¹ Washington, is note-worthy.

"The principles of resource planning are:

- (1) to hold soil, water, forest and grass *at par*, and
- (2) economize in the use of the irreplaceable minerals by way of every possible means. Nature lays down terms; we must obey or suffer. We can come to terms with Nature in regard to the self renewing resources by using them as fast as they are replaced. In regard to non-replaceable minerals, we can come to terms only by finding new and abundant *substitutes* faster than we use up the older materials—Technology races with waste.

Modern technology has given to the civilized man the power to support a greatly increased population by drawing more rapidly upon the material resources of the earth. For a century man has expanded his activity with little thought of the outcome. We cannot expand our destruction of forests and soil, coal and petroleum without limit. Unless we mend our ways and stop living on our capital we shall merely press against the limits of subsistence. We are threatened with a crisis in which essential materials will be exhausted and the population will have to be drastically reduced by war or starvation. Nature sets the terms; we must obey or suffer."

METALLURGICAL RESOURCES AND THEIR CONSERVATION

The metal resources come under irreplaceable assets. Events of the present war with numerous weapons of enormous destructive power have involved the use of colossal amounts of metals. A major part of the metals has already been destroyed, and the assessment of these losses may well tax many a mathematician. When the hostilities cease, every country, rich or poor with regard to these resources, will find very discouraging estimates of the residual resources. The losses of key non-ferrous metals like copper, zinc, tin, lead, etc. have been proportionately large. After the war, one may not be surprised to find some of these nearing exhaustion. These metals are required in the production of numerous alloys, like brass, gun metal, white metal, etc. employed not only for the fabrication of utility articles for domestic consumption but also in the manufacture of special steels and of machinery and agricultural implements. After the cessation of hostilities every country will have to organize her industries, and it is natural that these resources will assume still greater importance. The Atlantic Charter whose application to every country in the world is being advocated should make provision for the conservation of irreplaceable and indispensable resources. In India, the resources of non-ferrous metals are estimated to be not very large. Even if they be considerable, the ambitious industrial developments contemplated in the Bombay Plan will entail large consumption of metals in the fabrication of machinery and implements. Moreover, for power generation and transport industries, India will require a very large amount of the

¹ Report, Third World Power Conference, 9, 383, 1936.

metals in the form of transmission wires, electrical machinery, special parts of machinery, etc. Therefore, it is necessary that in any scheme of industrial planning the question of conservation of these resources should be critically studied from all points of view.

Without curtailing the requirements of the population, effective conservation can be attained only when proper substitutes for the metals can be found, the irreplaceable resources being reserved for essential requirements. By a curious thinking a substitute has come to be regarded as something inferior to the material it replaces. It need not necessarily be so; it can be inferior, equal or superior. What are the possible alternatives to metals where the special property of the metal is not necessary? The possible substitutes that strike one's imagination and whose resources may be considered almost inexhaustible are glass, porcelain, plastics and hardened wood.

The bulk raw materials for the production of glass and porcelain are sands, sandstones, quartz, feldspars, limestones, clays and soda ash. With the possible exception of soda ash, the other materials existing on the earth's crust are recognized to be inexhaustible. Soda ash, an important constituent of glass batch, is prepared from common salt which is also abundant. With regard to plastics, the raw materials employed so far are derived both from the mineral and plant products, such as from coal and coal-tar industries, the petroleum refining and cracking industries, cellulose and other plant exudations and constituents. The rapid development of the plastics industry followed the discovery of synthetic resins by Bacheland. Recently plant resins such as shellac and bhillawan resin, cellulose materials like bagasse, etc. are finding increasing application in the plastics industry, but the recent trends are that for some time to come, the plastics industry will utilize synthetic materials to an even greater extent. These synthetic plastics, it should be remembered, depend on irreplaceable raw materials. There is yet no plastic industry worth considering in India. The development of the synthetic plastic industry is very intimately connected with the development of coal-tar, petroleum and heavy chemicals industries which have not so far been developed in this country. In view of the variety of resins obtainable from indigenous plants, there is a great scope for developing the plastics industry from plant resins. In some of the industrially advanced countries, possibility of competition between the plastics industry on the one hand and the glass and porcelain industries on the other is being seriously examined. It is probable that, whereas plastics may substitute the use of glass to some extent, they are not likely to be serious competitors to glass; in fact, they may serve as complementary materials. In view of its non-inflamma-

bility, non-corrosive character and possibly low cost of production, glass will continue to dominate the field, especially after the invention of toughened glass which has considerably reduced its fragility. In fact, glass and plastics have become so inter-related that synthetic plastics, specially those of the transparent variety, are called organic glasses and glasses are sometime referred to as inorganic plastics. It would be unwise to minimize the importance of plastics; we are living in an age of plastics. But this does not preclude consideration of the potentialities of the glass industry and the rôle it is destined to play in post-war developments.

GLASS AND PORCELAIN—KEY INDUSTRIES

One of the greatest events in the entire history of glass brought about by the events of the last Great War was its transformation from an article of artistic taste to that of wide and strategic use. During this period, having been the principal material for the construction of indispensable instruments of warfare, such as field binoculars, army and navy telescopes, periscopes, range finders etc., glass assumed the importance of a strategic material. The Great War made clear the importance of the glass industry to the well-being of a nation, and in the post Great War period, the industry witnessed unparalleled developments in the U. S. A. and the U. K. Few materials have found such an extensive use, and even a bare description of its uses will cover many papers.

To the scientist, whether a botanist, a geologist, a physicist, a chemist, a pathologist, an engineer, or a surgeon, glass is indispensable for the supply of a wide range of instruments and apparatus. Without glass modern science which has contributed so much to human welfare and has placed enormous resources at man's disposal, would have made little progress, for indeed glass is one of the triumvirate—the other two being steel and rubber—largely responsible for the progress of science and technology. There is hardly any instrument which does not require glass in some form or the other. It may be stated without any fear of contradiction that there is hardly any other single substance which has contributed so much to man's knowledge of the universe. It has extended human vision from the macroscopic to the microscopic. But for glass which has provided the wonderful instrument microscope, many of the present day sciences and industries would have made little progress.

FRAGILITY OF GLASS PARTIALLY OVERCOME

In the almost unlimited field of its utility four characteristic properties of glass have come into play—optical characteristics, resistance to action of corro-

sive materials, non-combustibility and insulating properties. It is unaffected by food materials and this had led to its wide use in the household. Its extreme fragility had, however, stood in the way of its more extensive use. The recent invention of toughened glass, a material possessing high tensile strength* (still not approaching the metals), has changed the position and has extended its field of utility. Glass now bids fair to be a useful adjunct of metals in providing a really tough substitute in every field where the use of metal was necessitated not because of any specific property of the metal but because of its toughness and rigidity. In fact, this invention ranks as one of the most remarkable inventions in the history of glass technology and has led to its use in hitherto unconceived fields. Thus, it has been successfully employed in fabricating articles of furniture, high-duty machinery, e.g., centrifugal pumps, flange pipes, valves, etc. In the U. S. A. all glass chemical plants and glass-lined plants have been installed for processes involving the use of corrosive materials. While the events of the last Great War demonstrated the value of glass as a material of strategic importance, the present war has established its utility as an important substitute of metals for a variety of articles. After the declaration of hostilities, there was a great drive in the U. S. A. to conserve the essential war metals. Glass came to the rescue in several ways. For instance, for articles used for domestic purposes such as dinnerware, packing containers etc. and although toughened glass articles may not have reached a state of perfection to match with the strength of metal articles, they have become sufficiently strong to withstand rough use. The Army on the field where these articles are put to rough use has found in it a material of great promise. The Quarter Master General, U. S. A. Army, has found toughened glass dinnerware very serviceable under field conditions and a substantial amount of metals required for these articles has been saved.

SOME POST-WAR TRENDS

In view of the several advantages which glass possesses over metals, such as immunity to attack by foodstuffs, cleanliness, transparency and attractive appearance, glass will be preferred to metal for domestic requirements, such as cooking utensils, dinnerware, containers etc. After the war, food preservation industries which will be called upon to bear the brunt of feeding a large population are expected to undergo a wide expansion, and glass containers being now comparatively less fragile will find a large demand, incidentally helping the conservation of metals.

* Imagine a sheet of glass 24" x 6" x 1/4", supported at its two ends, supporting the weight of Bessie, the famous (weighing 400 lbs.) American actress without breaking.

Another important field in which the use of glass has been surprisingly successful is in making gauges for the use of factory inspectors. This is, in fact, an unpredicted development. They were being made from tough tool steel. The substitution became possible by the organized efforts of the Ordnance Department of the U. S. Army. The glass gauges are considered by the Ordnance Officers equal to, if not better than, the steel gauges. The following remarks of Col. H. B. Hambleton, Chief, Gauge Division, Chief of Ordnance, U. S. A. are of interest.²

"While still more or less in the experimental stage, six months use at the Frankford Arsenal and elsewhere has proved glass gauges to be the equal of, if not superior to, steel gauges. In fact, so efficient are glass gauges that they are fully expected to become a permanent fixture in the industrial world after the war.

"First, glass gauges, with their fragility characteristics, would seem to be an anomaly which dissolves when one reviews some of the characteristics inherent in glass".

In post-war developments, in view of the rapidly depleted coal and oil resources, the world will have to look more and more to electric power. In fact, even during the war, there is already a movement to prepared harness hydro-electric resources. If the transmission of electricity at high voltage and over thousands of miles has been possible through efficient metallic conductors, the part played by the insulators in this transmission and supply is no less fundamental. Insulators are mostly made from glass, porcelain and plastics. Due to their excellent heat resisting and heat shock absorbing qualities, glass and porcelain will dominate the field, and between these two glass has many unique advantages. With the expansion in the generation, long-range transmission and use of electricity, glass which has already established its supremacy will be called upon to play a very important rôle not only as insulator for transmission but as complement parts of many electrical instruments and appliances. Moreover, the recent invention of fibre glass which is an insulant *par excellence* for electric wires and for making insulation tape has further added to its field of utility. The enormous demand for glass articles needed in connection with the future development of electrical power in India, as envisaged in the Bombay Plan, may be easily visualized.

With the increasing emphasis on better housing and sanitary conditions, the demand for glass and porcelain articles which have proved to be of immense value in town planning, is likely to be increased several-fold. The expected expansion in the chemical, pharmaceutical, fermentation and other industries is likely to create a very large demand for glasslined vessels and an almost unlimited range of containers from the smallest phial and ampoule to the largest carboy. It may be emphasized here that glass, as a

² Glass Industry, 24, 69, 1943.

transparent and comparatively inactive material to chemicals and food stuffs, will always be preferred to metal containers if it can withstand rough handling. Toughened glass has at least shown the way. The invention of foam glass with its remarkable heat insulating properties and low density has provided another field for glass in refrigeration engineering, transport, housing etc. It has a decided superiority over cork in being non-combustible and more durable.

The recent discovery of plastics supported glass as a very tough material suitable for use in making aeroplane parts, and its likelihood to be of great utility for making high-duty articles has yet provided another field of application.

From the foregoing account three conclusions can easily be drawn:

- (1) That in view of their limited character, their rapid depletion and their key position in the welfare of the nation, there is a strong case for the conservation of metal resources for more urgent needs.
- (2) That without curtailing the requirements of the people, glass is one of the potential materials which can be of immense assistance in achieving this conservation by way of providing an excellent substitute whose resources are regarded as inexhaustible.
- (3) That as a result of great technological advancement during the post-war period and its utility during the present emergency, glass in view of its fundamental properties has established itself as a material of first rank utility covering almost an unlimited field of application and has vast potentiality in future.

This discussion on the potential applications of glass as substitute for metals in the conservation programme does not imply that the activities of the metallurgical industries are to be curtailed. Far from it—in post-war development the metallurgical indus-

tries are likely to be far more occupied with urgent fields of activity. For instance, in the programme of electrification, the copper industry which provides the key materials for transmission and electrical machinery may be unable to meet the requirements of the brass manufactures supplying the domestic needs of the population; glass and porcelain can be of immediate help. One may argue that this is an alarmist view; in the post-war period metal articles will be freely available and that glass will lose its significance as a substitute for metals. Let it be remembered that *technology runs forward*. When once the potentiality of a thing was established, technology invariably succeeded in making it a reality. The metal resources are undergoing rapid depletion, they will have to be conserved to save us from the dangers of a ruin. Human adaptability is slow, and when even during emergency we grumble to change things we are used to for new ones, in peace time the change over will take a pretty long time.

From these considerations, the versatility of glass as a key material of wide application is easily established. If, therefore, the definition of a *key industry* be one whose products are indispensable for the welfare of the country, glass by common consent will be regarded as one. It is, therefore, gratifying to note that the authors of the Bombay Plan have included glass under the *Major Industries*.

The author has written these lines by no presumption of prophecy, but with the genuine hope that these may focus the attention of those concerned with these affairs to circumstances in which we may soon find ourselves. It is now pertinent to ask the question how far the glass industry in this country is prepared to play its important rôle in post-war developments, true to the lines from George J. Overmayer.

'And so in modesty I proclaim—I am man's invaluable and versatile servant—I am Glass.'

(To be concluded)

DR N. R. DHAR AND HIS ENDOWMENT

THE princely endowment of approximately one lakh of rupees which Dr N. R. Dhar had recently made to the University of Calcutta for 'perpetuating the memory of Acharya Sir Prafulla Chandra Ray and in furtherance of establishing a University College of Agriculture' was reported in our previous issue. Dr Dhar was one of the most distinguished pupils of late Acharya P. C. Ray and has been the pioneer worker in the field of physical and agricultural chemistry and allied sciences in India. Nothing could have been more fitting than the

way in, and the purpose for, which he has placed such a munificent gift at the disposal of the University. The spirit in which he has made the endowment will be fully conveyed by the text of the letter addressed to the Vice-Chancellor, which we have the privilege to publish in full as follows:

Beli Road,
Allahabad,
13-11-1944.

Dear Mr Vice-Chancellor,

I desire to offer at the disposal of the University of Calcutta approximately one lakh of rupees for perpetuating

the memory of Acharya Sir Prafulla Chandra Ray and in furtherance of establishing a University College of Agriculture. The amount may kindly be used in the following way:

1. (a) To invest in securities the interest of which shall be utilized in creating a Professorship in Agricultural Chemistry as soon as funds permit,
(b) for the present from the interest, teaching and research posts in agricultural chemistry will be created of such rank, status and emoluments as may be possible within the available income.
2. The posts mentioned above be always filled by Indians.
3. That the appointments for the posts be made by the Senate upon the recommendation of a Board formed hereafter, and the power of removal of the members of the staff by Senate, if occasion should ever arise, be exercised only after the matter has been considered fully by the said board.
4. That both postgraduate teaching and original researches should be carried on in furtherance of agricultural knowledge.
5. The Board should consist of:—
(a) Vice-Chancellor of the University President, *ex-officio*,
(b) Dr. Shyama Prasad Mookerjee,
(c) Dr. Bidhan Chandra Roy,
(d) President, Post-graduate Council of Science,
(e) Khaira Professor of Agriculture,
(f) Two members of the Syndicate,
(g) Donor, and
(h) One member nominated by him both being entitled to nominate their successors, the same power to be enjoyed by the derivative members also.

I hope to make a second endowment of approximately one lakh of rupees for the same purpose at a subsequent date.

As soon as I am informed that the University is willing to accept these endowments on the terms mentioned above, I shall arrange to make the necessary payment to the University.

Yours sincerely,
N. R. DHAR

Hon'ble Mr Justice R. B. Pal, LL.D.,
Vice-Chancellor,
Calcutta University, Calcutta.

The University College of Agriculture, we fervently believe, will go a long way in providing the much needed opportunity for the development of agricultural and allied sciences which have received far too little attention in this country compared to their magnitude and possibilities. It is of significance to note that the inspiration and lead come from one who has not only substantially advanced this science by his life-long researches, but who now stands true to his science by expressing a rare willingness to bequeath to his countrymen a large share of his life's savings so that the posterity may continue the work so well begun by him. A perusal of his eventful career as a scientific worker will alone enable our readers to appreciate his supreme urge for research and development that has found so magnificent an expression in his endowment.

Dr Nilratan Dhar was born on January 2, 1892. He had his school education at Jessore Zilla School. At Calcutta, he was educated in the Ripon and the Presidency Colleges and obtained his M.Sc. degree of the University of Calcutta on submission of a thesis in physical chemistry in 1913. He was awarded

a State Scholarship which enabled him to proceed to Europe and continue his research at the Imperial College of Science and Technology, London, and at the University of Paris, Sorbonne. He received the Doctorate degree of both London (1917) and the Paris (1919) Universities.

Dr Dhar has served as University Professor of Chemistry, Allahabad University, for nearly 20 years and also as Dean of the Faculty of Science for a considerable period. Since 1928, he has been carrying on very important research work in agricultural chemistry and soil science, which form the basis of agriculture, and has published numerous papers on these subjects. His discoveries in the enrichment of



DR N. R. DHAR

soil and land reclamation have been taken up in different parts of the world and have received wide recognition, as is evident from his correspondence with eminent workers in America, England and other places. He has been invited by several universities and experiment stations in Europe and America to lecture on his researches. He is a recognized authority in colloid chemistry. His three books, (1) Chemical Action on Light, (2) New Conceptions in Biochemistry, (3) Influence of Light on Biochemical Processes, are important treatises in his subject.

In his presidential address to the United Provinces Academy of Sciences, India, on December 19, 1935, Prof. N. R. Dhar gave a general account of the work carried out by himself and his collaborators on

nitrogen transformations in soil. We publish below a short review of his address which appeared in *Nature*, April 11, 1936.

"Prof. Dhar leads the school of thought which believes that nitrification in soils and nitrogen fixation from the atmosphere are, especially in the tropics, photochemical at least as much as bacterial actions. Prof. Dhar has produced strong evidence in support of his theories, and the question appears now to have reached the stage at which the protagonists of bacterial and photochemical nitrification respectively are unwilling to admit any evidence which might shatter their beliefs.

Meanwhile, other soil workers will be wise to keep an open mind on the matter, for the philosophical implications of recognising that light plays a part in soils analogous to photo-synthesis in the vegetable kingdom are at least as important as the practical possibilities of utilizing that knowledge for the enrichment of the soil. Given sufficient facts, their practical application does not necessarily depend on their correct interpretation. The practical facts of Prof. Dhar's researches are that Indian soils are generally deficient in nitrogen, that more than half a million tons of molasses from the sugar industry are annually wasted in India, and that the application of molasses to the soil can double and may treble the soil nitrogen content, with a consequent large increase in crop yield.

Molasses contains about 70 per cent. of carbohydrates and small quantities of nitrogen, phosphorus, potash, etc., these quantities, however, being much too small to account for the observed manurial effect. According to Prof. Dhar, the energy set free in the oxidation of the sugars in molasses is utilized, either bacterially or photochemically, in promoting nitrogen fixation and nitrification. Whatever the nature of the process, Dhar has produced indisputable evidence of increases in available soil nitrogen and crop yield following the application of molasses. Under temperate conditions, the converse result would be expected, as it is well known that the addition of carbohydrate-rich material to soil tends to reduce the amount of nitrogen available to plants, the nitrogen becoming fixed as microbial protoplasm or as humus. An essential difference, however, between temperate and tropical soil requirements is that, whereas in temperate regions the limiting factor to crop growth is often the slowness, in the tropics it is the rapidity with which soil nitrogen is made available to plants, soluble nitrates being formed and leached from the soil before they can be absorbed by the crop. The general effect of molasses on the soil should be the same everywhere, but only in the tropics will its 'braking' effect on the mobilization of soil nitrogen be a positive advantage to the cultivator, and only in

the tropics will its stimulation of atmospheric nitrogen fixation, whether bacterial or photochemical, be appreciable, since temperate regions lack the heat necessary for bacterial and the light for photochemical stimulation.

For these reasons, the potentialities of carbohydrate manuring—of which molasses manuring is an example—have perhaps been overlooked by agriculturists. If Prof. Dhar can substantiate his claims, he may effect a revolution in agriculture in India, where the supply of the ordinary organic manures is far below the demand. Prof. Dhar suggested that a most valuable use can be made of molasses in reclaiming alkaline land. The acids produced in the decomposition of molasses neutralize the alkalis, and at the same time and contrary to experience when land is reclaimed with gypsum or sulphur, soil nitrogen is increased. A period of about four years is usually necessary to reclaim alkali land with gypsum, whereas with molasses applied at a rate of 30-40 tons per acre, good crops can be grown within six months. It is not stated whether such reclamations have been found permanent—in view of the oxidisability of the neutralising acids, this is open to doubt—but the method obviously merits further study. There are four million acres of infertile alkali land in India, and irrigation practices are increasing the area. The economic reclamation of these lands is one of the country's greatest agricultural problems, to the solution of which Prof. Dhar's work is pointing the way."

Dr Dhar has created a big school of scientific research in agricultural chemistry and allied subjects. Several of his pupils who have carried on research work in agricultural chemistry and allied subjects under Dr Dhar are holding important posts in different parts of India, e.g., Dr K. C. Sen, Director, Imperial Dairy Research Institute, Bangalore, Dr N. G. Chatterji, Officer-in-Charge, Power Alcohol, U. P., Dr P. B. Ganguly, Professor of Chemistry and Principal, Science College, Patna, Dr A. C. Chatterji, Reader, Lucknow University, Dr S. Ghosh, Reader, Allahabad University, Dr V. Gore, Professor, Science College, Nagpur, Dr D. N. Chakravarti, Professor, Science College, Nagpur, Dr H. L. Dube, Lecturer, Allahabad University, Dr B. K. Mukerji, Agricultural Chemist, U. P. Government, now Deputy Director of Agriculture, U. P. Government, Dr Gopala Rao, Reader, Andhra University, Dr S. K. Mukerji, Soil Chemist, U. P. Government, Dr N. N. Pant, Professor, Meerut College, now on active service, Dr S. P. Srivastava, Agricultural Chemist, Bharwari Farm, Jhansi, Dr Sant Prasad Tandon, Lecturer, Allahabad University, Dr E. V. Seshacharyulu, Bio-Chemist, Imperial Dairy Research Institute, Bangalore.

For over 10 years Dr Dhar has been maintaining a big research laboratory known as the Indian Institute of Soil Science in Allahabad and he has been designated as Officer-in-Charge of this laboratory by the U.P. Government. In this institution very important researches on nitrogen fixation and alkali land reclamation have been carried on. The Imperial Council of Agricultural Research sanctioned Rs. 10,000/- for meeting the expenses of these researches. The U. P. Government also contributed to this institution Rs. 10,000/- for research work in agricultural chemistry. Dr Dhar has delivered lectures on soil science and visited the Agricultural Institutes in the Universities of Cambridge, London, Paris, Uppsala, Groningen (Holland) and Wageningen

(Holland). He was invited by the International Fertilisers Congress to write and present a report on the fertilisation of dry soils to the Congress held in Rome in 1938. Dr Dhar was invited and attended the International Agricultural Conference in Holland in 1937. He served on the International Nobel Prize Committee in Chemistry in 1939. He was president of the Indian Chemical Society 1933-35 and the Chemical section of the Indian Science Congress in 1922. He has been serving as an examiner in agricultural chemistry in the universities of Allahabad, Agra, Lucknow and other places and served on the Soil Science Committee of the Imperial Council of Agricultural Research.

LIFE-HISTORY AND BIONOMICS OF THE CAULIFLOWER PEST, *PRODENIA LITURA*, Fb., IN BENGAL

A. C. BASU,

ADDITIONAL ENTOMOLOGICAL ASSISTANT, GOVERNMENT AGRICULTURAL LABORATORY, TEJGAON, Dacca

IN Bengal, the larva of the moth, *Prodenia litura*, Fb., (Noctuidae, Lepidoptera), is a major pest of the cauliflower. It is damaging not only to this particular crop, but also to many other economic plants and fruits in India as well as in other parts of the world. In Egypt, the larva is a great enemy to the cotton plants and is known there as the cotton-worm; in Nyssaland, the larva injures the tobacco plants, and is popularly called the tobacco-caterpillar; in Rhodesia it is called the tomato-caterpillar; in Mauritius, it is known as the bean-army worm. In the Tamil areas of the Madras Presidency the larva is known as 'arakkan', and in Bengal where the devastation of the cauliflower by this larva is alarming to the peasantry, it is popularly described as the 'kafipoka', the cauliflower worm.

Since the larva causes damage to economic crops of the globe, it has been a subject of investigation by entomologist. Wilcock (1905) furnished some information on this moth, and made a list of host plants devastated by its larva. Fletcher (1914) gave some accounts on the general habits of the moth and the larva with notes on plants which might be injured by *P. litura*. Janish (1930) carried on observations on this moth under different grades of temperatures. Bishara (1934) added an elaborate account on the bionomics and prepared a list of plants, fruits and flowers injured by the larva of *P. litura*. Raichoudhury and Basu (1941) noted its pupa formation in relation to its pupating media. Basu (1943) recorded observations

on the effect of the different food-stuffs on the variations of the larval growth, pupal size, period and the size of the moth of *P. litura*. In view of the importance of this pest its life history together with brief notes on the morphological peculiarities is given below.

DESCRIPTION OF VARIOUS STAGES IN THE LIFE-HISTORY

The Egg (Fig. 1).—The eggs are laid in small patches. Sometimes a second and a third batch are deposited over the first patch. The egg is round, when just oviposited it is iridescent in colour. Just prior to hatching the egg assumes a black tint. The larva emerges on cutting a hole in the chorion by its mandible. The eggs are always laid on the under-surface of the leaf of the cauliflower and are covered with a fine woolly mass.

The Larva.—The freshly emerged larva moves over the leaf, gnawing small pits in it. It spins silk enabling it to maintain its position on the foliage. Later, the larva marches towards the cauliflower to settle down there. It constructs tunnels inside it devouring the entire flower. "Frass" is noticed scattered on the cauliflower, and this helps spotting of the pest in the field.

The larva undergoes six instars.

First stage.—The larva on emergence measures 1.06 mm. Its general body colour is white, the shape is cylindrical but tapering at the posterior end. The

larva later assumes a greenish colour on eating the foliages. The head is shiny black, it is big when compared to the body. The mouth-parts are pale brown in colour and maxillae somewhat paler.

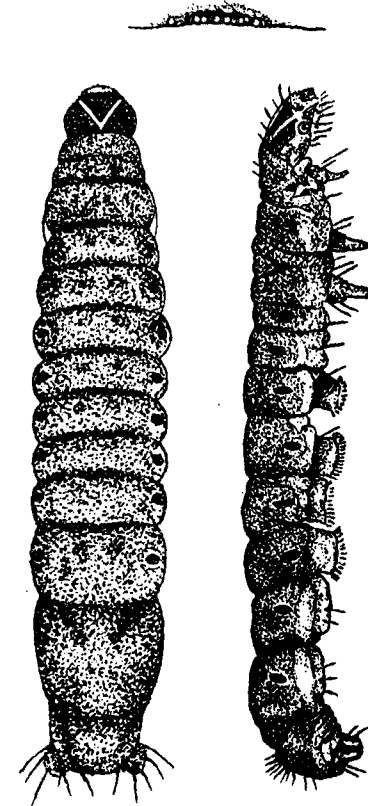


FIG. 1. Upper—Egg (side view). Lower Left—Larva (Dorsal view). Lower Right—Larva (side view).

Circular black tubercles occur on each segment and each tubercle is capped with long black hairs.

Second stage.—After the first moult the larva measures 7.30 mm. in length. The general body colour is olive green or pale green with a somewhat yellowish line on the dorsal side of the body. The head is pale or dark brown and presents a prominent triangular mark. The tubercles become more distinct. The thoracic shield is smoky. The distinctive feature is the presence of a prominent black spot on each side of the first abdominal segment.

Third stage.—After the second moult it measures 18.60 mm. in length. The general body colour is deeper than in the previous instar; but the colour is variable, being dark brown, dark grey or almost black mottled with irregular spots. There are two black spots with yellow edges on the dorsum of meso-thorax and two similar ones on the meta-thorax, and two big black areas on the first and eight segments of the abdomen. Distinct light bands occur; one across the first abdominal segment, and other bands run longitudinally.

Fourth stage.—After the third moult the length increases to 25.00 mm. No important changes in colour are observable.

Fifth stage.—After the fourth moult the length measures 37.60 mm. The transverse black band on the first abdominal segment and the longitudinal band on the larval body become faint.

Sixth stage (Fig. 1).—After the final moult the larva measures 43.30 mm. in length. The

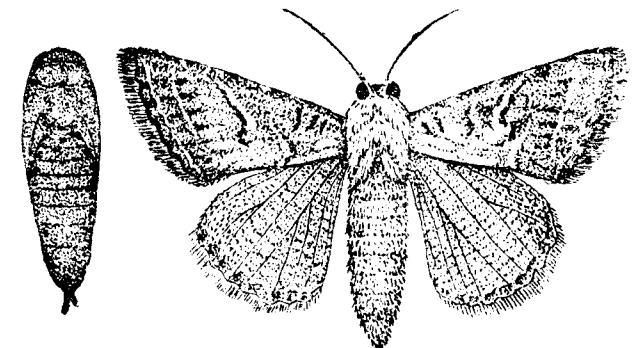


FIG. 2. Left—Pupa (Dorsal view). Right—Adult (Dorsal view).

transverse and the longitudinal bands on the larval body fade away. Afterwhile the larva stops feeding. It now travels towards the soil for pupation under earth. Hereafter the larva shrinks in size, and the body is annulated. It now passes into the pupal stage. Prior to the transformation, the ripe larva emits a resinous substance which helps in building up a cell for pupation.

The Pupa (Fig. 2).—The pupa measures 19 to 22 mm. in length including the hooks. It is 7 to 8 mm. in width across the fourth abdominal segment. The colour of a justly transformed pupa is green but as the age of the pupa advances the general body colour turns to reddish brown; the abdomen is a shade lighter than the rest of the body. It tapers gradually towards the posterior end and terminates in two straight hooks. Of these one is more blunt and shorter than the other. The spiracles are prominent and darken in colour than the abdomen. They are round and raised above the surface. The antennae are comparatively long, reaching nearly the edge of the wing pad.

At the time of emergence, the pupal case splits open liberating the moth.

The Adult (Fig. 2).—The moth fly at dusk; during the day time they hide in crevices or in dark recesses of the neighbouring trees. On account of its peculiar colouration, it is difficult to detect the moths especially when they rest on the bark of trees. If disturbed they fly to a long distance. They are attracted to light. The moth measures 38 to 40 mm. in wing expanse; the body length is 19 to 22 mm.; abdominal width 6 to 7 mm. The general body

colour is greyish brown. The fore-wing is full of ochreous lines and bars, running for longer or shorter distances along the veins and also runs obliquely. In the male moth the ochreous lines are more prominent than in the females. The male differs from the female in having a ochreous band on the lower edge of the fore-wing. The hind-wings are white, iridescent and the wing edges are dark brown with brown veins. The wing expanse is 30 to 32 mm. The thorax and abdomen are ochreous to light brown with tuft of hairs. The head is covered with brown tuft of scales.

OVIPOSITION

Paring takes place one or two days after the emergence of the adult. It lasts for one to two hours. Generally coition takes place at night but sometimes during day time the adults are found in the conjugating stage. The oviposition usually occurs either early in the morning or just after the sun-set or in the night. As the time for oviposition approaches, the female becomes quiet. She then slowly lifts the tip of her abdomen and starts laying eggs. This process is repeated again and again until the eggs being laid in batches. The maximum number of eggs deposited by a single female is 578. The pre-oviposition period varies from 2 to 4 days.

The incubation period of the egg is 4 days. After hatching the active larva starts damaging the

cauliflower attacking the leaves first. The entire larval period lasts from 18 to 20 days and the amount of damage thus can be conceived. The pupal stage lasts from 9 to 10 days. The adult can live from 10 to 24 days.

The life-history may be summarized as follows :—

TABLE I
SUMMARY OF THE LIFE-HISTORY OF *Prodenia litura* ON
CAULIFLOWER

Stages in life-history	Maximum (days)	Minimum (days)	Average (days)
Pre-oviposition period ...	4	2	3
Incubation period ...	4	4	4
Larval period ...	20	18	19.5
Pupal period ...	10	9	9.5
Life of adult moth ...	24	10	17
Number of eggs deposited per female ...	578	292	435

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PROFESSOR P. C. MAHALANOBIS, F.R.S.

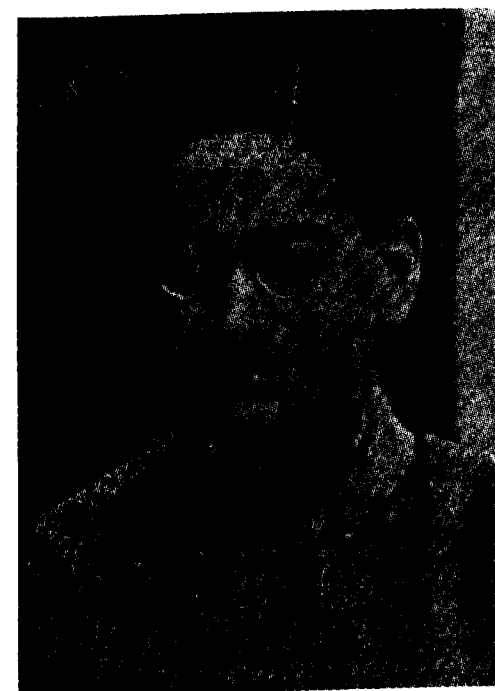
THE recent election of Prof. Prasanta Chandra Mahalanobis to the Fellowship of the Royal Society of London is a fitting recognition of what he has been doing during the last 25 years for the science of statistics in general and its application to the study of Indian problems in particular.

Born in 1893, Prof. Mahalanobis graduated from the Presidency College, Calcutta, in 1912 and had a very distinguished career at Cambridge. He obtained Mathematical Tripos in 1914 and a first class in natural science, Part II, in 1915. During 1915-17, he was a senior research scholar of the King's College, Cambridge, and in 1918 received the Master's Degree of the Cambridge University. On his return to India, he joined the staff of the Presidency College as a professor of physics in the Indian Education Service, and also became lecturer of the Calcutta University. In 1941, he became the Head of the Department of Statistics, Calcutta University.

Although he had his early training in physics and began his career as a professor of that science,

statistics has been his first love for nearly 30 years now. Descriptive statistics, as is well known, is a very old science, but analytic statistics as a separate branch of knowledge is of comparatively recent origin and came into being during the last quarter of the 19th century. The new branch of science, like most of the positive sciences, was born out of, and grew in response to, social and economic urge and finally developed into an abstract system of knowledge to be studied for its own sake by a few of the many men of science. The foundations of the new science were laid and the main outlines of the methodology developed, among others, by the late Prof. Karl Pearson and Prof. R. A. Fisher, both doyens of analytic statistics in England. Among the numerous other workers in this comparatively young science within the last twenty-five years which include Prof. Neyman of Poland, Prof. Hotelling of U. S. A., and Prof. Yates of Great Britain, Prof. P. C. Mahalanobis holds a distinguished position. On the purely theoretical side, the science owes him

significant developments in two important directions. Once different species of the same genus have been distinguished as such (by methods to which also he has made important additions), there still remains the problem of classifying them by ordering against some sort of scale. This he has tried to tackle with a fair measure of success, opening out in fact a vast field of work for statisticians and mathematicians for years to come. The second line of development, one with perhaps much greater socio-economic significance, is



PROF. P. C. MAHALANOBIS

concerned with the formulation of correct principles on which large scale sample surveys should be designed and the results interpreted so as to secure at minimum cost and with maximum precision any item or items of information about areas and populations as big as those that cover an entire province or even a country of the size of India. Here, as elsewhere, the methodology evolved out of his attempts to tackle the problems arising out of actual surveys he had undertaken at the request of the Central Government, the various provincial Governments and other non-official bodies and organizations.

Great as his contributions to the theoretical and practical aspects of analytic statistics are, the services

he rendered in the direction of creating an Indian school of statistical study and research have been greater still. The Indian Statistical Institute which is the only organization of its type in India and of which he has been the Founder Secretary since 1931 owes its inception to him and expresses most eloquently his interest in, and concern for, the development of statistical science, both pure and applied, in India.

Professor Mahalanobis combines in a rather unusual manner passion for abstract science with interest in its applications, the academic detachment of a scientific worker with the social sense of a responsible citizen, the leanings and temperament of a recluse and savant with the actual habits of a big routine administrator. This rather unusual combination of slightly incompatible traits has not made life smooth for him personally, but it has brought his country a very rich harvest of varied activities. He has great interest in literature, philosophy, anthropology and various other social sciences.

Prof. Mahalanobis was associated with many progressive and cultural activities. He was the Honorary General Secretary of the Visva-bharati during 1921-31 and Honorary Editor of the *Visva-bharati Quarterly* during 1927-29. *Sankhya*, the Indian Journal of Statistics, of which he has been the editor since 1933, is a recognized periodical of high standard in the subject. He is a fellow of the National Institute of Sciences since its inception in 1934 and was president of the Anthropological Section in 1925 and of the Mathematics and Statistics Section in 1942, of the Indian Science Congress. He was awarded Weldon Memorial Prize in 1944, a singular and rare distinction shared by an Indian for the first time (See SCIENCE AND CULTURE, Vol. X, No. 3). He is the chairman of the Statistics, Standards and Quality Central Committee of the Council of Scientific and Industrial Research and Statistical Adviser, Statistical Bureau, Government of Bengal. Besides, he has served on several Government Committee set up from time to time to advise the Government on statistical issues. The session of the Indian Science Congress held early this year at Nagpur elected him as its General Secretary.

We wish him many more years of fruitful activity.*

* Based on materials kindly supplied by an ex-student of Prof. P. C. Mahalanobis.

Notes and News

BOMBAY PLAN II

THE second part of the plan of economic development for India, popularly known as the Bombay Plan and prepared by a number of leading industrialists of India, discusses the various problems connected with distribution and also the allied question of the part to be assigned to the State in a planned economy. Sir Ardeshir Dalal, one of the eight authors of the Plan, was unable to sign part II, owing to his appointment as Member for Planning and Development in the Government of India. The authors have drawn pointed attention to the gross inequality and disparity of income, which act as a serious hindrance in the development of a country's economic resources. In 1931-32, the authors state, one half of the total urban income was in the hands of less than 10 per cent of urban workers and 'even among the comparatively well-to-do class, whose annual incomes exceed Rs. 2,000 a year, 38 per cent of their number could claim only 17 per cent of their total income, while a little more than 1 per cent were in possession of as much as 10 per cent of their total income.' The authors believe that in any economic planning it is desirable in the best interest of the country to have enough scope for variations in income according to ability and productivity, but there should be adequate safeguard against gross inequality. The suggestions they have produced with a view to securing an equitable distribution of income include the imposition of death duties and other similar levies, the reform of the system of land tenures, decentralization of the ownership of means of production through widespread distribution of shares in joint stock companies, regional distribution of industries, and through the development of co-operative enterprises. They further advocate that a steeply graduated income tax would be the most direct and important method of keeping personal incomes within limits and preventing gross inequalities.

The creation of a minimum standard of living required for civilized existence is the main purpose of economic planning. To secure this, the authors propose two classes of measures: (1) those that would raise the general level of income and (2) those that would reduce the cost of living. The former involves (a) provision of full employment, (b) increase in efficiency, (c) improvement in urban and rural wages, (d) security of agricultural prices and development of multipurpose co-operative societies, and (e) reform of the land system, each of which is discussed in the memorandum. To reduce the cost of

living, they suggest provision for free social services such as primary and middle school education, adult education and medical treatment, and essential utility services at low costs, such as electricity and transport. In addition to these services, there will be need for creating a national relief fund on the lines of the present famine relief fund, but larger in resources and in scope, to meet emergencies arising out of a failure of the monsoon, and hence, of crop, or any other national calamity. There should also be some provision for social security against such contingencies as sickness, old age, technological unemployment etc., and a comprehensive scheme of social insurance should be implemented for this purpose. This scheme cannot, however, be introduced at the outset, as it requires, for its success, the condition of full, or at least stable, employment for a greater part of the population, and also a reasonable level of average individual income.

The authors, while proposing taxation on such a large scale are, however, conscious of the possible abuse by the foreign imperial government of large powers derived from such taxation. In fact, the possibility of this abuse with its dangerous implications constitutes a powerful argument against heavy taxation under a government neither responsible to the people, nor wedded to a stated policy of full scale national development. The authors have, therefore, emphasized the creation of a responsible national government as the *prima facie* condition of the successful working of the Plan.

In elaborating the part to be played by the State in the economic organization contemplated in the Plan, the authors accept the democratic form of government and assume that planning is not inconsistent with a democratic organization. They have worked out their Plan on the supposition that Democracy permits of State intervention implicit in planned development but leaves enough scope and freedom to the individual to exercise his personality and initiative to the fullest extent. Co-ordination of general economic activity, management of currency and public finance, collection of statistical and other information, and adoption of legislation to safeguard the interests of the economically weak classes are usually recognized as the primary concern of the State. In addition to these, State intervention is now increasingly being sought in the direction of ownership, control and management of economic enterprises, and the authors have briefly indicated the nature of the State's functions in these directions.

In placing their views about the relation of State with the economic organization of a country, they have developed no new thesis, but have followed typical British economists, such as Professor Pigou, from whose writings they have quoted freely.

WANTED A WELL-DEFINED POLICY

THE speech delivered by Mr G. L. Mehta at the 18th Annual Session of the Federation of Indian Chambers of Commerce and Industry on March 4, 1945, in moving the resolution on Government's policy regarding post-war industrial development, has been significant from more considerations than one. His speech, we are afraid, may rudely shake the rosy optimism engendered to certain extent by the Government's big reconstruction talks. The various issues he raised concerning the future industrial development of India merit close attention. At the outset he drew pointed attention to the absence of a positive declaration by the Government of their policy with regard to industrial development after the war. The Government came forward with no categorical and unequivocal declaration that they would safeguard the position of industry and would stand by it and encourage its development for a specified period of time. Vague assurances regarding the liberalization of the tariff and protection policy have been given by high officials from time to time; but these have encouraged no hope since the Government 'speak sometimes with as many as eight voices and we do not know which voice to give credence to at that time and in what respect.'

Mr Mehta strongly criticized the Hon'ble the Finance Member's remark in his budget speech that 'post-war development must mean and must continue to mean post-war development and by no magic or optimism can it be made to mean war-time development'. He cited the instances of Canada and Australia, the governments of which already evinced their attitude to lay the foundations of post-war development during war-time by and through the development of war industries. "In the very carrying of the burdens", said the then Australian Premier, "we are laying industrial foundations, opening up new resources, acquiring new skill and experience; paradoxically enough, our war needs are likely enough in many ways to provide our peace opportunity." This spirit of working has enabled Canada to become today the second country in the world in the building of cargo ships, fourth among the world's air powers and the third trading nation in the world. Australia developed her steel and aircraft industry almost from a scratch. But not only India has not been able to build up one single key or heavy industry, her industrial development has been handicapped in many respects owing to difficul-

ties of obtaining supplies of some essential raw materials, plant and machinery from abroad.

With regard to India's participation in any international agreements, Mr Mehta sounded a note of warning. The series of international conferences which are being held as the prospect of peace is drawing near may witness arrangements, understandings and agreements, commercial and otherwise, in regard to many matters, in which India will, whether with or without her wishes, be made a party. Mr Mehta said, "Our experience in regard to international agreements in the past has been very unfortunate. We have had to accept obligations, burdens and responsibilities under such international agreements while being denied the rights, privileges and benefits they confer." For instance, the proposed formula of the equal access of raw materials of the world contains the disquieting suggestion that the more industrialized countries will have abundant and cheap raw materials to the permanent disadvantage of the less industrialized. There is as yet no sign that the imperial powers are prepared to give up Imperial Preference. Furthermore, the fears of international cartels and combines are now as great as ever, and it is essential that the operations of such cartels, in so far as they affect Indian industry, should be carefully studied. Mr Mehta also discussed the role of State in industry in future, the problem of foreign capital working in India and various other topics. With regard to the dangers of foreign capital, he quoted a passage from a historical speech by President Wilson, which runs as follows: "A country is dominated by the capital invested in it. It is a fundamental idea that in proportion as foreign capital comes in and takes hold, foreign influence comes in and takes hold. Therefore, processes of capital are in a sense processes of conquest".

TUNGABHADRA PROJECT

THE Tungabhadra Project which was inaugurated on February 28, 1945 by H. E. Sir Arthur Hope represents the joint endeavour of the Governments of Hyderabad and Madras to eradicate famine from the Ceded Districts. The project estimated to cost Rs. 20 crores provides for the construction of a dam across the river Tungabhadra at Mallapuram, from which each Government will at present draw about 65,000 million cubic feet of water. The dam will be 150 ft. high and 8,200 ft. long, with ample provision for sluices and high and low level canals. The lake formed by the dam will cover an area of about 140 square miles and will have a capacity of 112,000 million cubic feet. The cost of the dam would lie in the neighbourhood of Rs. 7 crores, while the total canal system of 440 miles would involve an expenditure of about Rs. 6 crores. Power will also be developed out of the supplies from the reservoir. The

execution of the project, it is reported, will take about eight years.

The project would primarily benefit the dry and arid northern portions of the Bellary and Kurnool districts which frequently suffer from failure of crop and hence from famine. The net revenue from irrigation is estimated at about Rs. 12 lakhs and power revenue at Rs. 8.08 lakhs. The annual value of crops, both dry irrigated and wet, has been estimated at Rs. 5 crores. The project will be primarily a dry irrigated one and has been conceived with a view to extending its benefits over as large an area as possible.

The possibility of harnessing the waters of the Tungabhadra, which run to waste to the sea, was always before the Government since the time of Sir Arthur Cotton. The Famine Code Revision Committee of Madras, in their report issued in 1938, demanded the early execution of the Tungabhadra project as the solution of recurrent famine in these districts. The present initiation of the project is largely due to the co-operation of the Governments of Hyderabad and Madras in their common effort to utilize the waters of the Tungabhadra for the benefit of their people. Rao Bahadur N. Govindaraja Ayengar, chief engineer for Irrigation, pointed out in his statement that this was the first time in the history of India when two autonomous units, a province and a State, co-operated in a joint endeavour of this magnitude for the common good of their two peoples. Narrow provincialism has often stood in the way of initiating hydraulic and irrigation schemes of inestimable value. Let us hope that the example of the Nizam and Madras Governments should be followed in future by other provincial Governments whenever need for such joint action in the interest of the people would arise.

DIVISION OF HIGH-POLYMER PHYSICS

THE Council of the American Physical Society, according to a report of the *Journal of Applied Physics*, has recently authorized a new Division of High Polymer Physics under the Society. The object of the Division, as stated in the by-laws, is to secure 'the advancement and diffusion of the knowledge of the physics of high-polymeric materials of any kind. Illustrative examples include rubber, textiles, plastics, pulp and paper, paints and varnish, and leather.' The scope of the Division is declared to be sufficiently broad to include fundamental as well as technical problems of high-polymer research physicists working in academic, industrial and Government laboratories.

The institution of this Division is a clear indication of the rapid development of high-polymer physics which concerns the study, by physical prin-

ciples and techniques, of such substances as rubber, textiles, and plastics. Work in this specialized field has proceeded so fast under the stress of war that text and reference books have failed to keep pace with the development, leaving the research workers to fall back on personal discussion, technical literature and such other means for exchange of information. Research directors and scientific workers of this field increasingly regarded the available opportunities for exchange of information as insufficient and pressed for the creation of a division in the American Physical Society to fulfil their needs. At a meeting held towards the end of 1943, the Council of the Society fully considered the case presented by the physicists engaged in high-polymer research for the establishment of a division and approved of its creation. The President of the Society subsequently appointed an organizing Committee consisting of Council representatives headed by Dr K. K. Darrow as chairman and members of the Society sponsoring the new division. The Division which had already started work since its authorization in 1943 was formally established at an inaugural meeting held on June 23 and 24, 1944. Any Fellow or Member of the American Physical Society may enrol in the Division, while for other interested scientists and research workers, the Division provides an association with all facilities except the rights to vote and to hold office.

QUININE IN INDIA

At a recent meeting of the House of Commons, according to a report of *The Chemical Age*, Mr L. S. Amery, in reply to a question by Mr R. Sorensen, stated that 49½ million tablets of synthetic anti-malarial drugs were shipped to India in 1943. The total shipment of the same drug in 1944 amounted to 632½ million tablets, in addition to 1,000 lb. of totaquina. Quinine stocks in India in April, 1944 stood at 244,000 lb. He further stated that India was producing more quinine than she had been doing in the pre-war period, which was about 90,000 lb. a year. He also gave out that pre-war consumption of quinine was about 200,000 lb. a year, while that of synthetic anti-malarial drugs was negligible.

It appears that Mr Amery tried to present a very bright picture of the supply of quinine in India. It is curious that despite such improved supply of quinine, the mortality rate due to malaria has assumed alarming proportions during recent years and has surpassed previous records. Competent authorities have ascribed the high incidence of malaria with its heavy toll of life to serious shortage of quinine. The figures which Mr Amery produced in course of the parliamentary debate are utterly without any significance, as these do not tell us the

amount available for civilian consumption. Moreover, the figures are misleading. This is how the Secretary of State keeps the people of his country informed about affairs in India.

MAHARAJA ANUPSINGHJI AS AN ASTRONOMER

IN the February 1945 issue of the *Bikaner Bulletin*, K. Madhava Krishna Sarma, curator, Anup Sanskrit Library, describes the astronomical work of Maharaja Anup Singhji of Bikaner, who flourished in the seventeenth century A.D. The great scholar Maharaja who patronized all branches of learning, including Kavya, Jyotisha, Ayurveda, Dharma-shastra, Kamashastra, Mantrashastra and Astronomy, was himself a learned astronomer and made important contributions to this science. His monumental work 'Anupasimha-Karana' which ranks in importance with the astronomical work 'Rajamiganka' of the famous Bhoja of Dhara deals with the calculation of planets. His famous work and the astronomical instruments belonging to him are now available in the Anup Sanskrit Library. The Maharaja gathered round him a number of eminent astronomers of his time, such as Manirama Dikshita, Virasimha Ganaka, Hoshinga Rama Bhatta and Kashiraja. It may be noted that the 'Arya-Siddhanta-Tulya-Karana' (written at the age of sixteen) and 'Anup-Mahodadhi' of Virasimha, the 'Anup-Vyavahara-Sugara' of Manirama and the 'Anup-Megha-Mala' of Hoshinga Rama bear testimony to the excellence attained by Hindu astronomy.

STUDY OF THE UPPER AIR

Two types of radio-sonde have recently been developed by the Indian Meteorological Department for the study of upper air, one at the Upper Air Office at Delhi and the other at Upper Air Section of the Meteorological Office at Poona. The radio-sonde is designed to send radio signals of the pressure, temperature, and humidity, which can be automatically recorded by receiving apparatus on the ground. The instrument is light, weighing only a few ounces, and is tied to a balloon filled with hydrogen which carries it to upper air, usually to a height of 8 to 10 miles. The observations are telegraphed to the various forecasting offices and enable them to get an accurate picture of the physical processes affecting weather and to estimate the course of its evolution. This knowledge is of great importance in the issue of weather warnings to aviators, irrigation engineers, agriculturists and the general public. It is reported that all the parts of the instrument excepting the wireless valves are now being made in the departmental workshops on a mass scale. A few selected stations have made arrangement for the daily sending of balloons equipped with radio-sonde to sound the upper air.

ECONOMIC MINERALS BUREAU

THE Council of the Geological, Mining and Metallurgical Society of India has recently circulated a letter, proposing the establishment of an Economic Minerals Bureau on the lines of the present Imperial Institute in London, with which the Imperial Mineral Resources Bureau is incorporated. The Bureau will maintain (a) an office to supply accurate mineral and metal facts relating to the Indian mineral and metallurgical industries, including cement, pottery and glass-making, (b) a bureau for the collection of information and data relating to the geological, mining and metallurgical industries throughout the world for Indian enquirers, (c) an office for registering and recommending staff for geological surveys, mineral prospecting and opening ore deposits or starting metallurgical works, (d) a laboratory for making assays, chemical analyses and physical tests quickly, cheaply and reliably in regard to mineral substances for industrial purposes, and (e) an advisory staff or committee or council to control the above offices, bureau and laboratory and advise on the mineral development on safe and sound lines.

The total cost of establishing such an Economic Minerals Bureau has been estimated at about Rs. 3.5 lakhs, of which capital expenses will account for Rs. 2,75,000, rent and salaries, Rs. 50,000/- and running expenses, Rs. 25,000/-.

Many individuals and firms have often felt the need for such an organization, which is now further reinforced by the prospect of a planned development of India in the post-war period. It gives us much satisfaction to think that the Society has applied its mind to the problem of establishing an organization that should act as a clearing house for geological, mining and metallurgical information and at the same time provide scientific assistance in the form of making assays, chemical analyses and physical tests.

METAL INDUSTRIES

At the first ordinary annual general meeting of the Jaipur Metal Industries Ltd., held on 28th February last, Mr R. H. Kamani pleaded for the development in this country of our mineral resources of non-ferrous metals like copper, zinc, lead, tin, etc. India will have to depend on outside sources for her supplies of these metals either in the form of virgin metals or as scrap metals. It should be one of the primary objects of our national policy to develop the mining of non-ferrous metals in the country itself as far as possible.

The establishment of a large non-ferrous refining and manufacturing industry in the country will provide the necessary market when the production of virgin metals has been developed. The non-ferrous manufacturing concerns should be given every facility

and preference for the import of non-ferrous virgin metals and scrap from abroad, which can be used by the indigenous manufacturing concerns, and the import of finished or semi-finished goods which would compete with these industries should be discouraged.

Before the war, India was exporting most of the non-ferrous scrap to Germany and Japan. This policy will have to be changed if India is to develop her own non-ferrous industry, and the export of such scrap should be either prohibited or restricted by the imposition of a heavy export duty. It is to be hoped that the Government will soon see their way to altogether abolish, or reduce considerably, the import duty on non-ferrous scrap, and also levy a much lower duty on import of virgin metals like copper, zinc, etc.

Rajputana is rich in non-ferrous mines, of which the copper deposits of Jaipur and zinc deposits of Udaipur State are well known. The development of these deposits deserves an early attention. The Jaipur Metal Industries Ltd. is the first in India to be successfully manufacturing arsenical copper rods which are required by the railways for locomotive boilers.

MICROFOSSILS AND PROBLEMS OF SALT RANGE GEOLOGY

PROF. BIRBAL SAHNI, F.R.S., since he delivered his Presidential Address to the National Academy of Sciences, India, at Hyderabad, in December 1943 (See SCIENCE AND CULTURE, November, 1944, p. 199), has further evidences to put forward in support of tertiary age for the Punjab Salt. In his Presidential Address to the National Academy of Sciences at Poona in December last (*Proc. Nat. Acad. Sc. Ind.*, 14, 1944), Prof. Sahni discussed the results of recent investigations. Problem of the age of Punjab Salt has now received the serious attention of scientists, of geologists in particular. The presence of microfossils in the rock salt and kallar in the salt mines of Khewra and Warchha, which has been amplified and corroborated by repeated discovery of similar microfossils in dolomite and in the oil shales at both these places, is doubtless a simple and direct proof of a post-cambrian age for this series. Although a great majority of these microfossils (coniferous wood fossils) could not be referred to their genus and species, their repeated occurrence at widely different localities and in different members of the series is a strong evidence against a cambrian or a pre-cambrian age.

In view of the great practical as well as scientific importance of the problem, a field party deputed last November by the Geological Survey of India and by the Burmah, Attock and Anglo-Iranian Oil Companies paid a special visit to critical sections near Khewra, Warchha and Sakesar to re-examine the

field evidence in the light of the fossil data. Their unanimous verdict is that an eocene or later age for the Saline Series is irreconcilable with the field evidence and that the Series is cambrian or older in age. In a letter to *Nature* (in the press), they (Coates, Crookshank, Gee, Ghosh, Lehner and Pinfold) have further stated that they have at present no clear explanation to offer on the occurrence of minute plant remains of post-cambrian age in dolomites and oil shales, as discovered by Prof. Sahni.

Sahni's researches point very strongly to a tertiary age of the Series, supporting the idea of Koken and Noetling that the junction of the Saline Series with the overlying paleozoic beds is a tectonic one, involving an immense overthrust fault.

Prof. Sahni's suggestion for research into problems of stratigraphical work in controversial and disturbed areas in general by microfossil technique, radio-active determinations, magnetic orientation of rocks etc. deserves careful attention.

AGRICULTURE AND ANIMAL HUSBANDRY IN INDIA

A PLAN for the development of agriculture and animal husbandry in India, prepared by a special Committee of the Imperial Council of Agricultural Research (with Sir Pheroze Kharegat as its Chairman) and approved by its advisory board, has the immediate object of increasing production by 50 per cent in the next 10 years and ultimately by 100 per cent in 15 years. This is not a post-war plan but one which has been taken in hand in connection with the "Grow more Food" campaign and will merge in course of time in post-war plans for general betterment.

A capital expenditure of Rs. 1,000 crores, according to pre-war costs, (on the basis of present costs, it is likely to increase to about Rs. 2,000 crores) and a recurring annual expenditure of Rs. 25 crores are provided. This amounts to an average total expenditure of nine annas per acre per annum, when all the cultivable area has been brought under cultivation.* Out of over 6,00,000,000 acres of such area, nearly 25,000,000 are uncultivated or fallow. The suggested production targets include 10 per cent increase in cereals, 20 per cent in pulses, 250 per cent in fats and oils, 100 per cent in vegetables, 50 per cent in fruit, 300 per cent in milk, and 300 per cent in fish and eggs.

The aim of the plan is to provide enough food of the right kind for every individual and effect a higher standard of living. The plan thus put forward is not a complete scheme but only a skeleton as to the lines along which work should be undertaken and is

* The Bombay Plan provides for an expenditure of Rs. 1,245 crores to achieve an increase of 130% in agricultural productions in 15 years.

meant for those who have to do the actual planning. Much of the work will devolve on Provincial Governments, and the Centre can only help by co-ordinating and finding out part of the money. Thus, of the recurring expenditure of Rs. 25 crores, the Central Government would bear Rs. 2½ crores. This represents an average of less than one rupee per acre on the present total area under cultivation or of less than twelve annas per acre, if the whole of the acre now recorded as cultivable waste can be brought under cultivation.

The most important requirement from the point of view of the agricultural department is trained staff. A scheme of intensive short-term training of agricultural staff has been suggested to the provincial Governments, and arrangements are in hand to start training courses at the various agricultural colleges according to the needs of the provinces. Other important points include both long and short-term possibilities e.g., the provision of irrigation facilities, bunding and drainage, manure, improved cattle, improved seeds, and spread of better methods of cultivation.

Under manure, the plan estimates that 2½ million tons of nitrogen are required annually. Production can be raised by 10 to 15 per cent by the use of better seed, the best rotation crops and the raising of two crops instead of one. A seed farm should be set up in every district to produce pedigree seed and to arrange for their multiplication, storage and distribution.

There is scope for tractor cultivation, and some of the prejudices against it are unwarranted. But the use of tractors and other costly mechanical equipment implies large farms to be established through either co-operative farming or consolidation of holdings, a reform long overdue.

For marketing, villages should be organized to be co-operative, maintain quality and sell the surplus produce jointly. The Government could help by guaranteeing to cultivators assured markets promising a reasonable price.

In cattle improvement, there is a need for improved methods of feeding, breeding, management and disease control. Surveys should be taken in hand for schemes for reclamation of waste lands and the maximum utilization of water resources.

There now exists a big gap between scientific knowledge and its dissemination. It is suggested that every *tehsil* and district should have an agricultural association, and every village a guide who will act as a link between the technical experts and the cultivators and will be the departmental correspondent for his village. The village guide will have to be in knowledge, status and equipment something more than a village chowkidar.

It is further suggested that the Imperial Institutes of Agriculture and Veterinary Research should

specialize in work of a fundamental nature and their programmes should be co-ordinated with those of provincial research institutions and universities.

Regional or provincial research stations for each commodity and experimental farms in each division are also recommended. That should help in spreading out scientific work and therefore knowledge.

Central commodity research stations should be established, apart from cotton, jute, tobacco, sugarcane, tea, coffee and rice (now about to be established), other foodgrains, vegetables, potatoes, fruits, medicinal plants, plantation products, oilseeds and grasses. Of these rice, oilseeds, potatoes and vegetables seem to be the most important at present. Each such station should be linked up with an Indian central committee for that commodity and each central research station should be supported by the necessary regional research station and sub-station. The Federal Council of Agriculture and Animal Husbandry should co-ordinate the work of the commodity research station. The plan is now under examination by provincial Governments.

INDIAN CENTRAL RICE COMMITTEE

A BILL providing for the creation of a fund to be expended by a committee specially constituted for the improvement and development of the cultivation and marketing of paddy and of the production and marketing of rice and rice products and all matters incidental thereto is now pending the approval of the Central Assembly.

Introducing the bill, Mr Tyson said that the funds for the committee should be provided by the levy of a cess not exceeding a rate of six annas per ton on all paddy which is hulled in power mills in British India. Only 27 per cent of rice produced in India was brought to mills, and the cess worked out at less than one pice per maund or one anna per annum to each member of a rice-eating family. It was expected to raise Rs. 24 lakhs a year in this way and this sum was twice the income of the Imperial Council of Agricultural Research.

The bill had been circulated to provincial Governments, and all except Bihar had approved them. Bihar stated that rice was not a valuable commercial crop and the cost of research for its improvement should be supported by ordinary revenues. That was the opinion expressed also by several members of the assembly who raised serious objections, and the bill was thus circulated for eliciting public opinion. The re-drafted bill will shortly be introduced in the Assembly.

The main object of the bill is to put rice research, development and technology on a more permanent basis than it stands at present. The deficit production of rice in India, coupled with the increase in

population in the rice-consuming areas, can be balanced by increasing the acre outturn of rice, and this is only possible by intensive research in all aspects and making the results of such research available to the rice-growers. As a result of the investigations of the Imperial Council of Agricultural Research and by the provincial agricultural departments only 6 per cent of the rice area has so far been covered by improved varieties.

The committee when constituted would utilize the fund to defray expenditure involved in (a) undertaking, assisting or encouraging agricultural, industrial, technological and economic research, (b) supplying technical advice to growers and owners of mills, (c) encouraging the adoption of improved methods of cultivation and storage, (d) promoting testing, and distributing improved varieties of seeds, (e) aiding the control and destruction of insect and other pests and diseases of paddy and rice both in the field and in storage, (f) promoting the improvement of the marketing of paddy, rice and rice products, including the adoption of standard grades for paddy and rice, (g) collecting statistics from growers, dealers and millers on all relevant matters and improving forecasting of crops, (h) maintaining institutes, farms and stations as necessary, and (i) doing of such other things as may be necessary for carrying out the purpose of the act.

The committee is proposed to be formed on lines similar to those of the Indian Tea Cess Committee (1903), Indian Central Cotton Committee (1923), Indian Lac Cess Committee (1930), Indian Coffee Cess Committee (1935) etc. The committee will include representatives upto a maximum of 51 members, of which 14 will represent rice growers, 14 the rice industry and trade, 5 persons nominated by the Central Government and the rest forming the techni-

cal officers of the provincial and central departments of agriculture with the Vice-chairman, Imperial Council of Agricultural Research as its President. The committee would start functioning before another rice season begins this year.

In our opinion, while supporting the immediate formation of a committee to carry out the provisions of the bill, we would point out that the committee as proposed to be constituted has no representatives either of the consumers or of universities or similar non-official organizations. Further, rice being the staple food (and not a commercial crop), Government should at least provide half of the proposed funds for the committee thereby reducing the rate of the proposed cess.

JAYKISSEN MUKHERJEE GOLD MEDAL TO MR D. N. WADIA

THE Indian Association for the cultivation of Science has recently conferred its highest award, the Jaykissen Gold Medal, to Mr D. N. Wadia, late of the Geological Survey of India and now mineral adviser to the Department of Planning and Development, Government of India. On the occasion of the award, Mr Wadia delivered a lecture on 'India's Petroleum Resources' in the Association's lecture hall before a distinguished gathering. A short summary of his interesting lecture will appear in our next issue.

ANNOUNCEMENT

We are glad to inform that Mr. P. K. Dutt of the well known firm of Messrs. Adair, Dutt & Co., Ltd. has placed a further sum of Rs. 5,000/- at the disposal of the Adair, Dutt Research Fund Committee. The total sum up to date amounts to Rs. 17,000/- only.

SCIENCE IN INDUSTRY

WEALTH FROM THE SEA

THE difficulty of access to raw materials in land has driven the scientists to seek them in the vast expanse of the air and the sea. This is particularly the case in times of global wars such as the present one. The German chemists tapped the resources of the air to prepare nitric acid needed for the manufacture of explosives in World War I; the Allied chemists are now extracting magnesium from the sea for air-craft construction to win World War II. In fact the economic importance of air and sea as potential sources of indispensable materials is a new know-

ledge brought on by the impact of war. In a note in *The Scientific Monthly*, January 1945, Dr A. M. Low, British Consulting Engineer, has given an account of a number of important chemicals that have been successfully and economically extracted from the saline waters of the sea, and of others whose economic extraction, although not immediately possible, is likely to materialize in the near future. These substances include magnesium, bromine, potassium, phosphorus, copper, iodine, arsenic and gold.

The success attending the extraction of magne-

sium from the sea has, however, been the most spectacular. Magnesium chloride is present in sea water to the extent of 1 part in 800. Dr Low who concentrates mainly on the progress made in Britain reports that two plants were built in Britain, handling 11,000,000 gallons or more of sea water every day. The water is pumped into the plant through large pipes, filtered and then passed to a tank where the finest particles of insoluble matter are removed. It then passes to precipitation tanks for treatment with finely powdered lime. In practice, a mixture of lime and magnesium oxide obtained by calcining dolomite is used in place of pure lime. One plant in the U. S. A., it is reported, makes use of crushed oyster shells taken from the adjacent sea-bed and previously calcined into lime as a precipitating agent. Lime reacts with magnesium chloride dissolved in the sea water and produces magnesium oxide in suspension, which is filtered off and subjected to well-known reduction processes to obtain magnesium metal. The extent of the progress in the extraction of magnesium during recent years may be realized from the fact that it now incurs a cost of less than 20 cents a pound against \$4 a pound 30 years before.

Bromine is another element of which the sea happens to be an important source. It is present to the extent of 1 pound in every 4,000 gallons. Bromine finds an important use in the manufacture of "anti-knock" fuel for which a lead compound dissolved in ethylene bromide is the key-substance. Its extraction from the sea water calls for exact chemical measurements, and methods have been so perfected in the U. S. A. that a single plant can now easily handle 60,000,000 gallons of sea water daily.

Dead sea, with its estimated potash reserve of 2,000 million tons and with the prospect of this amount being maintained more or less constant by the rivers flowing into it, offers a potential source of this substance. Methods of extracting potash from the sea are now available, but these require further improvement before manufacture on a commercial scale proves economic.

Gold is yet another element recoverable from the sea where it is present to the extent of one part in 1,000 millions. But even this amount far exceeds the quantity mined from the earth within the historic times. Search is going on for a practicable method of extracting gold from the sea as none exists up till now. But the difficulty with gold is that as soon as it begins to be available in plenty gold is no longer gold but lapses into an element with certain special physical and chemical properties.

CHARCOAL FROM INDIGENOUS KILNS

INDIAN Forest Leaflet No. 56, issued by the Forest Research Institute, Dehra Dun, contains re-

sults of investigation on the quality of 37 species of charcoal obtained from different types of indigenous kilns. It is well-known that the factors which determine the quality of charcoal are moisture, ash, volatile matter, fixed carbon and density. In determining these factors, sample from a particular lot was taken, crushed to a coarse powder and thoroughly mixed. A portion of this crushed charcoal was further powdered to enable it to pass through 60 mesh sieve and finally cleaned, washed and dried at the oven temperature of 105-100°C. The ash content, the amount of volatile matter, fixed carbon content etc. were then determined in the usual way, of which the results are indicated in a chart. It is found that the type of kiln and the selection of locality certainly influence, though to a limited extent, the quality of the charcoal as far as it depends on these factors. The temperature at which the charge is carbonized is by far the most important factor in deciding the quality, and the general conclusion is that almost any type of kiln can produce charcoal of good quality provided care is taken to carbonize the charge at regulated temperatures.

POLYTHENE—THE NEW PLASTIC

IN a recent issue of *Endeavour*, Dr J. C. Swallow, of the Imperial Chemical Industries, gives an interesting account of polythene, the simplest synthetic thermo-plastic. Polythene is obtained by the polymerization of ethylene under high pressure and is largely the outcome of recent researches on high-pressure chemistry. Although plastics containing the vinyl group were developed previously, ethylene—the simplest of the series—could not hitherto be made to yield anything except short-chain oils. The study of the effect of high pressures on chemical reactions by Conant, Cohen and other workers opened a new field of investigation, which rendered possible the examination of gas reactions at pressures of several thousand atmospheres. The application of the new high-pressure technique has led to the polymerization of ethylene into a plastic composed of long methylene chains ($\text{CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-}$) of 1,000 units or more, which is polythene.

The new plastic has a very low solubility in most organic solvents, which, however, increases fairly rapidly between 50—70°C. At ordinary temperatures hydrochloric and nitric acids and 50 per cent. caustic soda have no effect on it, but chlorosulphonic acid strongly attacks it. Above 100°C, it is attacked by nitric and sulphuric acids. Ozone affects it, but only to a limited extent. At higher temperatures, polythene is oxidized in air, but oxidation can be altogether prevented by introducing anti-oxidants.

On the physical side, polythene possesses crystalline structure having orthorhombic symmetry. Its mechanical properties bear close resemblance with

those of other polymers such as nylon, the vinylidene chloride polymers, and the natural products gutta-percha and balata. On the application of tension, polythene separates into two regions, drawn and undrawn, marked by definite shoulders. This behaviour under tension is of considerable scientific and technical interest. The changes which occur when polythene is subjected to tension have been studied under polarizing microscope and by X-ray diffraction method and have revealed several interesting features.

Industrial applications of polythene include its growing use as a dielectric in the field of electrical engineering and as a suitable material for various purposes in which chemical resistance is important. The low power factor and low water absorption and permeability have particularly recommended it for telecommunication cables. Its use as a possible insulant for high voltage cables has also been suggested. A number of British firms have already undertaken to manufacture various types of high frequency cables with polythene insulation and submarine cable core insulated with polythene plasticized with polyisobutylene.

Large flawless mouldings and tubings have been made out of polythene by applying the technique of extrusion moulding. Extrusion moulding which consists in injecting the plastic by means of an extrusion machine has been possible with polythene, since above its melting point it is a liquid which can be conveniently pumped at comparatively low pressures. Polythene powders and films have also been prepared for specific uses.

NON-DRYING IMMERSION OIL

The Review of Scientific Instruments, August, 1944, reports the development, by the Fisher Scientific Company, Pittsburgh, of a non-drying microscope immersion oil which may be used in place of cedarwood oil for high magnification work. The new oil has the same refractive index (1.5150 ± 0.0002) as cedarwood oil, but has a number of distinct advantages over the latter. It is much less corrosive inasmuch as it has an acid number of 0.2 as against 60 for the cedarwood oil. It does not attack glass or metal parts of objectives or Canada balsam, for does it affect the polished surfaces. Further, the new oil remains 'wet' for a much longer time and can be readily removed with a piece of cotton or cloth

when the objective or slides require to be cleaned. Long standing and exposure to air do not change its refractive index.

There are two grades of the new oil, one with high viscosity and the other with low viscosity; their other properties are, however, identical. The heavy oil which has nearly the same viscosity as cedarwood oil is suitable for use at higher temperatures or for instruments used in tilted or horizontal position. For ordinary uses, however, the light oil may be preferred and, if necessary, the two grades may be blended to obtain a grade of any desired viscosity.

LATEX-BEARING PLANTS OF INDIA

K. BUDHIRAJA, Rubber Chemist and R. Beri of the Forest Research Institute, Dehra Dun, have summarized the results of their investigations on the indigenous sources of rubber, in Indian Forest Leaflet No. 70 (1944). They have examined 150 latex samples, covering six families, and 46 species with a view to discovering the possible, rubber yielding woody plants in India. With the exception of *Cryptostegia grandiflora* (see SCIENCE AND CULTURE, Vol. X, Pp. 200) none of the species have been found to contain high proportion of caoutchouc with proportionately low resin, but a few species, e.g., *Palaquium* (*Dichopsis*) *ellipticum*, *Madhuca* (*Bassia*) *latifolia*, *Ficus glomerata*, *Wrightia tinctoria*, *Tabernaemontana heyneana*, *Wrightia tomentosa* and *Poinsettia pulcherrima*, though they have high resin content, have also 15% or more of rubber and might therefore, find some use where rubber content of more than 10-30% is not required as for example, in code wire insulations, jar rings, floor coverings, ground sheets, coating to rope soled shoes, adhesives, etc. especially on dilution with pure rubber.

The pamphlet in addition not only gives an account of the history of *Ficus elastica*, and *Hevea brasiliensis*, but also remarks on the important sources of natural (commercial) rubber from *Parthenium argentatum* (U. S. A.), *Taraxacum Kok-saghyz* (U. S. S. R.) and *Landolphia Kirkii* (S. Africa) at the present time. The latter are neither indigenous to India nor they grow in countries from where the rubber could be made available to India.

Following the standard method of analysis the rubber and resin content in the latex of the 150 samples investigated are given in a tabulated form.

RUBBER YIELDING PLANTS

GEORGE T. VERGHESE and G. T. KALE

RUBBER is defined as tough, elastic substance, so named because of its ability to rub out pencil marks. It is not known precisely who named it, or when it was named. The diversity of sources, clime or country, and the development of manufacturing processes made little difference to this basic name. It was called "India Rubber" because it was first obtained from a country which Columbus thought to be India. It was called "Fine Para" (pronounced as 'Pah-rah') and "Para Rubber" after the city in Brazil, 'Pah-rah' from where rubber has been obtained in large quantities. Such trade names with different prefixes sometimes indicate the source of the product. Thus, African-, Madagascar, Lagos-, Ire-, or Silk-, from *Funtumia* (*Kickxia*, Blume) or *Funtumia elastica*, Stapf, or Landolphia, Beaur; Bolivian-, Columbian-, and Virgen-, from *Sapium* P. Br.; Borneo-, from *Willughbeia*, Roxb; Ceara-, from *Manihot glaziovii*, Muell.-Arg. and Manicoba-, from other species of the same; Chilte-, from *Cnidioscolus* spp.; Central American-, Panama-, Mexican-, or West Indian-, from *Castilloa*, Cerv.; Ekanda-, from *Raphionacme utilis*; Mangabeira-, or Pernambuco-, from *Hancornia speciosa*, Games-, Indian-, from *Ficus elastica*, Roxb; Mgoa- from *Mascarenhasia elastica*, K. Schi.; Potato- from *Euphorbia rhipsaloides*; Thina-, from *Loranthaceae*, spp.; and so on. These rubbers are generally classified as "Wild Rubber". Rubber is also called Caoutchouc (French), supposed to be derived from the original South American word "Cahuchu", meaning weeping tree. Other languages have similar sounding names, for example, Kautschuk (German), Cauccio (Italian) Caucho or Cauchuc (Spanish), Kauchuk (Russian).

The early history of *Hevea* rubber is well-known. Rubber was known and used in the New World and Southern Asia long before it was re-discovered by Europeans. In this connection the names of Columbus (1493-1507, Second Voyage), Petro Martyre d'Anghiera (1521), Salahan (1529), Oriedo Y Valdez (1535), Tordesilla (1601-15), Jaun de Torquemada (1615), and finally Marie de la Condamine who led the first expedition of the Academy of Paris (1735-1751), are often cited. During the 125 years after the date mentioned last no work of any significance was done on the subject, and it required the initiative, sagacity and foresight of the scientists of a Colonial Power to send an expedition in 1875-76 conducted by Henry A. Wickham (later Sir Henry Wickham) and financed by the Government of India. The growth of rubber plantation industry in Ceylon, India, and the Far East can be traced to the gener-

sity of the India Government assisted by the Kew Gardens. The names of the Marquis of Salisbury, then Secretary of State for India, Sir Clements Markham, Sir Joseph Hooker and Mr Cross are worthy of mention in this connection. Wickham proved a very lucky and successful collector of seeds, and out of the 70,000 seeds he sent from a table land in the upper Amazon Valley to Kew, 2,700 germinated; as the foundations of the tropical and subtropical agriculture were being laid at that time, 2019 seedlings were sent to Ceylon, and thence to Singapore and elsewhere in Malaya a year later, and then to Coonoor Estates in S. Malabar, and to Periyar Estate in Travancore. Some of the original trees are said to be still existing at Peradeniya in Ceylon. "Aux grands hommes la patrie reconnaissante", and it was an exceedingly fortunate accident that Sir Henry Wickham lived long enough to see the enormous expansion of the fruits of the early experiment of collection and trans-plantation. He died in 1930.

Though natural rubber is generally obtained from the latex of plants, not all the latex-bearing plants are rubber-yielders. Plants containing rubber occur in a number of very diverse natural orders: Euphorbiaceae, Moraceae, Compositae, Asclepiadaceae, Araceae, Sapotaceae, Apocyanaceae, Alismaceae, etc., (Appendix I). The latex, either white or coloured, is present in special tubes or cells of the tissues in several or all the organs of the plant. Many latices do not contain rubber or allied substances, and it was believed till recently that the latices obtained from plants in cold and temperate zones were especially lacking in rubber. According to the various reviews and articles appeared on the subject the number of plants from which rubber has been obtained exceeds 400. In the present article it is intended to deal with, besides *Hevea brasiliensis* Mull.-Arg., the world's chief source of plantation rubber for the past several years, a few rubber plants which have attained prominence in recent years.

Hevea brasiliensis Mull.-Arg., as a rubber yielder has displaced not only all other species belonging to the great family of Euphorbiaceae, but on account of the excellence of its rubber and its easy response to scientific methods of cultivation and manufacture, has come to establish itself as the king of rubber plants. *Hevea* (pronounced as Heev'ea), as its specific name indicates, is a native of Brazil and is the source of the best caoutchouc ("Pah-rah" rubber). Its habitat falls within 10 degrees of the equator, and it thrives best in hot and humid climate up to

an elevation of about 1500 ft. above sea level. The average temperature that favours its growth is about 80°F., and the average rainfall about 80 inches per annum. Attempts were made with some success to grow it in rather dry climate, and also at elevations of about 2500 ft. above sea level. But growth under these conditions was slow, and yields were poor. In favourable environment the trees grow to about 50-100 ft. in height, and about 8-10 ft. in girth. They have smooth petiolate, and deciduous leaves in clusters of three. The deciduous nature of the leaves is mainly controlled by the precipitations, and the trees "winter" losing their dense foliage. Both male and female flowers are found in the same inflorescence, the axes of the latter being terminated by female flowers which are less numerous than the male ones on the same panicle. The androecium has two whorls of five sessile anthers each. The gynoecium consists of a tri-locular ovary with three style-less stigmas. In the East the fertilization has been found to be poor and defective. The fruit has a fleshy tissue on its outside, and when this gets dried up, dehiscence violently with a loud report, shooting out its three seeds. The seeds are rich in an oil which does not appear to have been fully exploited. The presence of oil in the seeds is taken to be harmful to their germination after exposure for two months. The seeds are therefore planted either directly in the field or in nurseries as soon as possible after the harvest. The land is cleared and drained or banded if necessary, and marked into square or rectangular plots and the seedlings are planted at a distance of about 10-30 ft., which depends on the fertility gradient of the soil. Cover crops to serve as shade, and to prevent erosion have also been used. In the first few years, inter-crops of coffee, cocoa, tobacco, sesame etc. are sometimes planted. Another practice is to plant 180-300 trees per acre, and after tapping for the first few years to thin these to half the number. *Hevea* seems to respond well to manures, especially to nitrogenous and phosphatic fertilizers, and to certain cases to lime. So far, no major insect, fungus or virus disease has been found that could not be combated successfully, but it is the constant fear of the *Hevea* plantations whether a disease may not some day appear in an epidemic form which might ruin the plantation industry. This was actually the case of the Dutch Guiana plantations which were finally given up on account of a virulent fungoid disease of the leaf.

When the girth of the tree is about 24" at a distance of about three ft. from the ground, which usually takes place about 5-7 years after planting, the tree is tapped either in the herringbone fashion or in V or U style by means of gourd or cutting knife, as for instance the *Michie Gollegde*. Care is taken to see that the incision reaches the inner

cortex containing the laticiferous tissue, without damaging the cambium. The tapping as a rule is done in the mornings either according to half-spiral-alternate day system, or double-half-cut-in-3-days system, or on every week-day (Saturdays and Sundays excluded) in alternate months or fortnights, or giving the trees any other proper recouping periods. On the other hand, during periods of emergency great strain may be put on the tapping process, and slaughter tapping, increasing the breadth of the incision and the number of tapplings may be practised. There is considerable variation in the yield of rubber from individual trees not only on account of their varying capacity of producing latex but of the rubber content of the latter which is found to change with the soil, and the topographical situation and the season as well as the age, and the hereditary make-up of the tree. Better yields are obtained by suitable selection of seeds ultimately aiming at the production of "Super" trees, and by vegetable propagation especially bud-grafting, aided by special care of the wounded parts. The world's acreage under *Hevea* cultivation is about 2,000,000 acres. In India the acreage is about 140,000 acres. The pre-war production of *Hevea* rubber was in the neighbourhood of 1,000,000 tons. Of this, India's quota was about 16,000 tons.

The *Hevea* latex is a milky white fluid having a dry rubber content of about 30 per cent. Of this 2.5-3 per cent is resinous matter. The rubber is marketed either as preserved latex or as solid rubber. The latter is available in two different grades, smoked sheet and crepe rubber. The preservative most commonly used for latex is ammonia. Apart from normal latex (with a dry rubber content of about 30 per cent) concentrated latices upto a D.R.C. of 80 per cent are available. Latex is slightly costlier than solid rubber because of the charges involved in the transport of large bulk of fluid.

Hevea rubber possesses very good processing properties as also a wide range of applications. Thus, in plasticity, adhesion and cohesion, vulcanizability, and general workability, it is found to excel all other types of rubber. Also in elasticity, tensile strength, corrosion and abrasion resistance, it compares favourably with other grades of natural and synthetic rubbers. In this connection it is interesting to note that in spite of the great advances made by synthetic rubber in recent years, *Hevea* rubber has still retained its supremacy in the fields of processing and utility.

Castilloa (or *Castilla*) *elastica* Cerv., has along with *Hevea*, established itself for the past several years as an important source of plantation rubber. Its history can be traced back to Jaun de Torquemada who described in his book "Monarquia Indiana" (Madrid, 1615) a substance called "Ulei" prepared

by Red Indians from a tree known as "Ulaquahnil" or "Ulequahnil" or "Ule" and which was used by them in medicine, and in water-proofing textiles. This tree has not attained much importance from the point of view of plantation industry, but the rubber obtained from it has successfully compared with other rubbers. Due to the extensive natural adaptation of the tree new tracts containing "Ule" have been found and exploited in central America, Brazil, Amazon region and the territory bordering on the north, as well as in the Andes.

Castilloa, which belongs to Artocarpoideae of the Moraceae family, attains the same size as *Hevea*, but its branching habit is characteristic. The branches bearing short-stalked, simple, distichous leaves measuring sometimes upto a foot in length grow almost horizontally with a slight droop towards the ends. The older branches fall off, and the newer ones develop obliquely upwards leading ultimately to the formation of a crown. The monoecious flowers are found on separate fleshy receptacles surrounded by imbricated bracts forming involucre. The receptacles do not, however, close completely as in many other plants belonging to the family. The male inflorescence has flower consisting of straight stamens, but having no perianth. The female inflorescence bears flowers having calyx and a uni-locular ovary surrounded by a thin style divided into two staminiferous convoluted branches. The fruit is a drupe with a pulpy hull which dries up almost completely at maturity, and contains a small seed rich in oil which, as in the case of *Hevea*, does not appear to have been exploited.

For obtaining rubber the trees are completely felled and slaughtered. As a result of this many districts which abounded in *Castilloa* are now devoid of it; but as mentioned above the adaptation of the tree to central American climate is so great that the species is in existence. In central America the trees are not felled, but tapped by means of horizontal or inclined cuts. The rubber obtained from this tree is inferior to that of *Hevea*. The climatic conditions suited for the growth of *Castilloa* trees are the same as those of the *Hevea* tree; and as the *Hevea* trees yield a rubber of better quality, the cultivation of the former is found to be unprofitable. Further disadvantages of *Castilloa* are that the yield of rubber is low and the wounds made in the trees by tapping heal only with great difficulty.

Another important source of rubber is *Manihot Glaziovii* Mull., discovered by the French botanist Glaziovii near Rio de Janeiro, and later described and named after him by Mueller in Martin's *Flora Brasiliensis*. The tree is found widely distributed round Ceara (hence the name "Ceara rubber"), Rio Grande del Norte and Parahyba. Some seventy species of

Manihot are said to be found in Brazil, though systematic chemical and botanical investigations on these are rather scant. It would appear that a species other than *M. Glaziovii* was cultivated in South America, and was well known in San Paulo and S. Brazil, but it was not botanically identified, nor was the quality of the rubber examined for a long time. Other *Manihot* rubbers are "Jequie" obtained from *M. dichotoma*, "Manicoba de Sao Francisco" from *M. heptaphylla*, and "Manicoba de Pianhy" from *M. Pianhyensis*, but *M. Glaziovii* is generally considered to be the only one of economic importance.

The *Manihot* is an isolated representative of Adrianeae (Crotonoideae) of the natural order Euphorbiaceae. *M. Glaziovii*, is a tall tree, having a girth of 1-3 ft., and starts branching even from a height of 3 ft. from the ground level. The leaves are simple petiolate, and have the characteristic of being "hand-shaped" with 3-7 "fingers". Male and female flowers are found on the same inflorescence which is a simple terminal spike or raceme. The male flower is smaller than female, decandrous with stamens usually erect and has a star-shaped nectary at the base. The tri-locular ovary of the female flower carries three recurved fringed stigmas. The fruit is a capsule and splits on drying, its walls crumbling to pieces in the process. The seeds are small, dark and slightly flattened.

M. Glaziovii, although raced out by *Hevea*, possesses certain points of vantage which cannot be overlooked. It is a tree of granitic land, high and low, requiring much less moisture than *Hevea*, and as such it can be profitably used to extend to some extent the rubber-producing zone. Moreover, it does not deplete the soil as rapidly as does *Hevea* and it has the added advantage of yielding rubber even after 2 years' growth. Experience in Tanganyika seems to indicate that the tapping life of the tree can be prolonged over a number of years by the judicious use of the tapping technique. Altogether, if the same care of cultivation, selection, breeding and tapping are bestowed upon this tree as on the *Hevea* for improving the yield and quality of rubber, it does not seem unreasonable to believe that it will give profitable returns in certain parts of India (South) and in other places where labour is cheap and conditions are unfavourable to the growth of *Hevea*.

The tapping of *Manihot* is done much in the same usual way. In E. Africa a special method is employed. The bark is first coated with a coagulant for latex, and the upper portion is then tapped. The latex that flows out gets coagulated in the form of strips. The coagulated strips are then rolled into balls.

The quality of the rubber is inferior to that of para rubber. The resin content is rather high, and

the cost of production is also a bit high. The latex may be coagulated as in the case of *Hevea* by means of dilute acids and salts.

Ficus elastica, Roxb.; although this rubber is now classed under "Wild" rubber it was with this tree that the world's first rubber plantation was started in 1860 in Assam and in 1861 in Java. The tree and its rubber-yielding property were rediscovered accidentally by Roxburgh in Assam, and hence the names "Assam Rubber" or "India Rubber" have been assigned to it.

It is a stout handsome tree (Urticaceae, sub-order Artocarpeae) which usually commences growth epiphytically and often reaches an enormous size. It is found in the damp forests of the base of Sikkim Himalaya, Assam, Burma, Perak, and, according to Weight, now cultivated in most parts of South India. It is met with in Europe as a puny ornamental plant. In Germany it is grown as a home tree, under the name of "Gummi baum". In its native climate, however, buttress roots which spread out in all directions over long distances are found to develop. The trunk is massive, often several feet in circumference, and has a comparatively smooth bark. As with many other *Ficus*es, the branches give off adventitious roots which grow downwards and strike root on reaching the soil. The leaves are entire, oval or oblong, leathery and glossy. The species is characterised by its rosy coloured, enormous stipules that protect the bud and by unisexual flowers contained in a fleshy globular common receptacle open by a narrow mouth at the top. When the male and female flowers are not in separate receptacles, the former are at the mouth, and the latter occupy the rest of the cavity. The male florets are mono-adelphous and the female ones have oblong ovaries, each with its curved style and large stigma.

Although all parts of the plant contain latex which is said to yield about 30 per cent by weight of rubber it is not surprising to see that such a tree failed to be a successful plantation crop. The main reasons for this failure are the comparatively small number of trees which could be planted per acre and the slow growth of the tree.

The trees are usually tapped by horizontal or slanting hatchet cuts generally about 10-20 cms. long. The yield of rubber is found to be high during the first tappings, but it dwindles rapidly as the tapping is continued. The slow vigour of the tree reflects also in the long periods of rest required. These factors hastened the overthrow of *Ficus* by the *Hevea* and the *Manihot* varieties. In India there were about 9,500 acres under *Ficus* plantation in 1934, but this area has considerably decreased during the last few years.

Ficus rubber contains more resins than the

Hevea rubber, and is in no way equal to the latter in quality. The latex is not coagulated by acids, and is stable to mechanical treatment. The latex will coagulate spontaneously on exposure, the particles uniting to give a soft, resinous rubber.

Among other "Wild" rubbers are included those obtained from *Kickxia* (also called *Funtumia*), various species of *Euphorbia*, *Landolphia*, and *Clitandra*, *Mascarenhasia*, *Hancornia*, *Urceola*, etc.

Parthenium argentatum has of late assumed importance as a source of natural rubber in America. It is the Guayule (pronounced as "gwa-ee-oo'-lay" or "wee-oo'-lay") of the drier parts of northern Mexico and Southern States, and is said to be one of the few non-tropical sources of rubber. It belongs to the Compositae family which is generally regarded as occupying the highest position in the vegetable kingdom. Guayule is a lowly, woody, stubby shrub, seldom more than two feet and a half in height, growing wild on the limestone slopes covering an area of about 20,000 sq. miles in Northern Mexico, Southern Texas, Arizona, and New Mexico, where the annual rainfall is about 9-15 inches, and the summers are long, hot and dry. Its silvery leaves give it a desertic, dusty appearance. The plant does not possess any special system of laticiferous tubes, but rubber is secreted in the form of small granules in special cells in roots and stems. The root contains as high a percentage of rubber as the stem, and represents 45 per cent of the total rubber.

On account of the individualized and isolated latex cells, the guayule does not yield latex on tapping. The whole plant is pulled out, roots included, chopped up, and ground in water, and the floating rubber is skimmed off by mechanical means. The wild plant of which the yield averaged about 8 per cent of the dry weight remained for some time refractory to modern methods of cultivation and breeding. Experimental work on the cultivation of Guayule was carried out at Salinas and California some twenty years ago, and thanks to McCallum of the University of Arizona, the efforts at acclimatization and improvement of the plant by selection led to fruitful results. Among other things it was found that the soil for Guayule should contain a good percentage of the trace element: boron. The yield of rubber from the improved strains is 22 per cent of the dry weight, and the bearing age of the plant has been brought down from 10-20 years to 2-4 years. If the plant is not harvested after 2-4 years, its life-cycle may extend up to 40-50 years.

It is rather strange that although some 20,000 acres are devoted to guayule plantations in various parts of the U. S. A., Argentina and Chile no regular plantation industry seems to exist in Mexico. This is probably due to the abundant wild supply.

Factories for guayule rubber were started in Mexico about 40 years ago, the first one being at Torreon, with a capacity of a million pounds of wet rubber per month. When it was found that the wild supply was in danger of being exhausted in about 17 years, the Government introduced special legislation, and issued permits for harvesting only the mature plants in order to ensure a constant annual production of 10,000 short tons of guayule rubber.

Guayule rubber contains about 16-20 per cent resin, and when de-resinated compares favourably with the best *Hevea* rubber. As an emergency source of natural rubber the guayule rubber is said to be unrivalled. Also the cost of production has been reported to be very small, because the planting and harvesting operations are mainly carried out by machinery.

Gutta-percha and Balata.—These names are applied to the gums obtained from the latex cells of certain plants belonging to Sapotaceae family, particularly to the *Palaquium* species. Gutta-percha is obtained from the islands in the Malayan and Philippine Archipelagoes. This is also cultivated in Java. The natives of Malaya call it "Percha", and "Gutta" is the Malayan word for gum.

Gutta-percha was first introduced into Europe by Tradescant in the middle of the 17th Century. It was then known as "Plyable Mazer Wood". Nothing further was known about this plant till 1843 when it was re-introduced into Europe. In 1845, according to the suggestion of William Siemens, it was used for insulation of cables. Later on, it was used for water-proofing, and for making surgical goods. A large number of trees are commercially exploited for the production of gutta-percha. The particular species from which the original gutta-percha was obtained was the *Isonandra gutta*.

Balata is obtained from certain species of *Mimusops*, generally found in the Guianas, Venezuela, Trinidad, and surrounding regions. Balata is in many respects similar to gutta-percha.

The rubber is generally extracted from the mature leaves. The leaves are ground mechanically, the ground material is heated to about 70°C. for a suitable period in hot water with constant stirring, and the hot mass is then transferred into a large volume of cold water when the gutta that floats on the surface can be skimmed off. The yield is about 2-3 per cent, calculated on fresh leaves.

For obtaining balata the early practice was to fell the trees, and then collect the latex by making incisions at several points on the stem. But in certain places like British and Dutch Guianas, the trees are generally tapped, and the coagulation of the latex is brought about by allowing it to ferment for 2-3 days.

Extraction methods for obtaining rubber have not so far been found successful.

Until recently the gutta-percha market was controlled by Chinese merchants, and they used the gum for the purpose of adulterating better qualities of rubber. But at present the genuine material is obtained from two plantations, one in Java, and the other in Malaya. Commercial guttapercha contains about 10-60 per cent of resins, mainly albane and flauvile present in the ratio of about 2:1. Balata also contains the same resins as gutta, but the ratio of albane to flauvile is 2:3.

Cryptostegia grandiflora, R. Br. (formerly known as *Nerium grandiflorum* Roxb.) and *C. madagascariensis* were known as rubber-yielding plants for the last hundred years or so, and a crude rubber was prepared from them and exported on a small scale under the name of Palay rubber from Africa and Madagascar which are supposed to be their real home. These are showy, flowering twiners which were introduced into various countries during the latter half of the last century. They are now commonly seen as ornamental creepers on hedges, verandahs, trellises and in gardens in the U. S. A., in Central America and in India. These plants are found even in a wild state in certain localities in this country where it has well adapted itself to the climate. The frantic search for rubber created by exigencies of war in recent years resulted in a re-discovery of these plants, and they are now regarded as the quickest growing plant producing high-grade rubber.

The *Cryptostegia* or *Crypto-vine* belongs to Asclepiadaceae but in vegetative habit is like Apocynaceae with which it was formerly confused. It has simple, opposite, deep green, glossy, coriaceous deciduous leaves. Its large pale pinkish purple flowers are either solitary or in di- or tri-chasial cymes. The essential organs are complex. The stamens and style are usually united to form a gymnostegium, the anthers and the stigma being concrescent. Pollination takes place by the translator mechanism. The fruit is a pair of conical, triangular follicles, and the seeds are numerous and crowned with tufts of silky hair for wind dispersal.

Vigorous attempts are being made at large-scale cultivation of the vine in suitable localities in this country as well as in Florida, the Bahama Islands and especially in Haiti where some 65,000—75,000 acres were already planted to the crop up to last year and the plantings were expected to reach a total of 100,000 acres in the course of 1944. The carefully selected and treated seeds are germinated in nurseries and then transplanted in the open at the rate of about 4,000 plants per acre. The vines are grown in hedge-like rows and after a year's growth when a sturdy root-system is developed latex can be collected in

bamboo tubes or troughs from the shoots of which the tips have been clipped off so as to let the latex drip in. Latex may also be collected by tapping older trunks which may attain a diameter of 5-6 inches. Tapping done every two days does not seem to affect the vitality of the plant. Rubber is obtained also from the clogged ends of clipped shoots. Latex is present in leaves and stems and severe pruning will yield both these without injury to the adult plant. Claims have been made that mature plants may yield about 250 lb. of rubber per acre and that one man per acre can easily harvest the crop.

The latex obtained from the most promising of the plants of *C. grandiflora* contains about 11.8 to 21 per cent of dry rubber depending upon locality. Unlike *Hevea* latex, the *Cryptostegia* latex when treated with acetic or other acids in any dilution fails to produce a good coagulum and a clear serum. The acidity of *Cryptostegia* latex is also higher than that of the *Hevea* latex. As the result of elaborate experiments conducted on the coagulation of the latex obtained from *C. grandiflora*, it has been found that addition of sufficient quantity of water to the latex causes coagulation, about 10 to 12 volumes of water being required for this purpose. In quality *Cryptostegia* rubber compares very favourably with the *Hevea* rubber. In fact it has been reported that *Cryptostegia* rubber can be used even for high grade mechanical rubber if all the processes from coagulation to smoking are carefully controlled.

The U.S.S.R. have recently become much interested in rubber-yielding plants and organized some thirty botanical expeditions to ransack her vast territories and find native sources of this important raw material most of which she used to import till recently. In these expeditions flora of the Pacific shores at Vladivostok and Sakhalin, south-west to the Crimea and north to the Arctic Circle was studied covering some 100,000 species. About 5,000 plants were carefully analysed and tested, of which many were found to contain small quantities of rubber. In one expedition led by Rodin, unidentified species of *Taraxacum* was found in the valleys of the Tian-Shan mountains in the Republic of Kazakstan in Russian Central Asia, of which the roots contained rubber. This was the famous *Taraxacum kok-saghyz*, (*Kok* meaning root and *saghyz* "to chew"), so named because of its being used as a sort of chewing gum by the Kirghiz and Kazak tribes in Turkestan. Other Compositae of interest were *Scorzonera tau-saghyz* and the *krym-saghyz*, *Taraxacum hybernum*, Ster.

Like other Dandelions, the kok-saghyz is a low shrubby plant with a thick perennial primary root crowned by a very short sympodial stem. The root-system keeps on growing in the frozen ground long after the leaves and stem have been killed by the frost. The rubber is contained in the laticiferous tissue of the plant, especially of the roots which even when they are dry show elastic threads on breaking. The floral mechanism is of the usual type of the family and shows the final autogamy clearly.

In 1942 Russia is reported to have planted some 2,000,000 acres of its dry land with this rubber plant. The seed is very small and requires pre-treatment for a high percentage of uniform germination. The crop is harvested by digging the roots in 6-12 months. One year old roots yield up to 7.50 per cent of dry rubber and this percentage is being raised by systematic selection and breeding, and the use of fertilizers. The plant is being tried also on the experimental farms in the U. S. A., Canada, Alaska, Chile and Argentina and more than 18,000 lb. of the roots have been harvested from the first experimental plantings in the U. S. A. In Montana the yield was estimated at 4500-5000 lb. of roots or 45-55 lb. of rubber per acre. The yields obtained in America seem to be higher than the average ones obtained in the dry regions of the U. S. S. R., but the areas where the kok-saghyz thrives seem to fall within the sugar-beet zone. In Canada the yields obtained varied enormously, from 1600 to 8100 pounds of roots per acre.

Thus we see how the early rubber plants helped to develop the plantation industry in the tropical regions and how the co-operative efforts of botanists and chemists are revealing unsuspected sources of this strategic raw material. A number of plants in different countries were found to produce rubber-containing latex, but owing to want of application of the modern technique of the improvement of plants, have fallen in the background. The American and Russian examples have shaken the old belief that plants of the temperate belt were incapable of producing rubber and that rubber plantations could be established only in the tropics. They have pushed the rubber-growing zone northwards to such a point that countries habitually dependant on foreign supply may well pick up an incentive to seek self-sufficiency in rubber. It is clear enough that the era of exploration should continue in the post-war world, the age of hopes and promises; and then, botanists, plant-breeders, plant physiologists—scientists whose worth to a nation is so often unappreciated until a major crisis occurs will be none too many for the task.

APPENDIX I

Name	Natural Order	Trade Name	Habitat
1. <i>Achras Sapota</i> L. ...	Sapotaceae	Chicle gum	Central America
2. <i>Alstonia Dürckheimiana</i> ...	Apocynaceae	—	New Caledonia
3. <i>Amarjot</i> ...	—	—	—
4. <i>Argemone mexicana</i> ...	Papaveraceae	—	Tropical America
5. <i>Bleekrodia tonkenensis</i> ...	Moraceae	—	French Indo-China
6. <i>Calotropis procera</i> ...	Asclepiadaceae	—	—
7. <i>C. acia</i> ...	—	—	—
8. <i>Carica papaya</i> L. ...	Caricaceae	—	—
9. <i>Carpodinus landolphiodes</i> ...	Apocynaceae	—	Cameroons
10. <i>C. uniflora</i> ...	—	—	—
11. <i>Castilleja costaricana</i> ...	Moraceae	—	Costa Rica
12. <i>C. elastica</i> Cerv. ...	—	Panama rubber	Central America
13. <i>C. lactiflua</i> ...	—	—	Mexico
14. <i>C. micoyensis</i> ...	—	—	Costa Rica
15. <i>C. panamensis</i> ...	—	—	Panama
16. <i>C. Ulei</i> ...	—	Caucho	Amazon
17. <i>Chrysanthamnus</i> ...	Compositae	Crysil rubber	Western U. S. A.
18. <i>Clitandra elastica</i> ...	Apocynaceae	—	Ivory Coast
19. <i>C. laurifolia</i> ...	—	—	—
20. <i>C. nznude</i> ...	—	Black Congo	Tropical Africa
21. <i>C. orientalis</i> ...	—	—	—
22. <i>C. Simoni</i> ...	—	—	Cameroons
23. <i>Cnidioscolus</i> ...	Euphorbiaceae	Chilte rubber	North & Central Am.
24. <i>Cryptostegia grandiflora</i> R. Br. ...	Asclepiadaceae	—	Tropical Africa.
25. <i>C. madagascarensis</i> ...	—	Lonbiro	Madagascar
26. <i>Daemia</i> R. Br. ...	—	—	—
27. <i>Dyera</i> spp. ...	Apocynaceae	Jelutong or Dead Bor-neo or Pontianak	Borneo
28. <i>D. Costulaca</i> ...	—	—	—
29. <i>D. Lowii</i> ...	—	—	—
30. <i>Ecdysanthera cambodiensis</i> ...	—	—	French Indo-China
31. <i>E. Godefroyana</i> ...	—	—	—
32. <i>E. linearicarpa</i> ...	—	—	Burma
33. <i>E. micrantha</i> ...	—	—	—
34. <i>E. Quintareti</i> ...	—	—	French Indo-China
35. <i>E. Tournieri</i> ...	—	—	—
36. <i>Euphorbia antiquorum</i> ...	Euphorbiaceae	—	—
37. <i>E. dracunculoides</i> ...	—	—	—
38. <i>E. fulva</i> ...	—	Palao amarillo	Mexico
39. <i>E. geniculata</i> ...	—	—	—
40. <i>E. grandidens</i> ...	—	—	S. Africa
41. <i>E. hirta</i> ...	—	—	—
42. <i>E. intisy</i> ...	—	Intisy or Herotra	—
43. <i>E. ligularia</i> ...	—	—	—
44. <i>E. nerifolia</i> L. ...	—	—	Madagascar
45. <i>E. nivulia</i> ...	—	—	Madagascar
46. <i>E. pirahazo</i> ...	—	—	Madagascar
47. <i>E. pulcherrima</i> ...	—	—	—
48. <i>E. rhipsaloides</i> ...	—	Almeidino or Potato rubber	Angola
49. <i>E. Royleana</i> ...	—	—	—
50. <i>E. tetragona</i> ...	—	—	S. Africa
51. <i>E. Tirucalli</i> L. ...	—	—	Natal
52. <i>E. triangularis</i> ...	—	—	S. Africa
53. <i>Ficus babu</i> ...	Moraceae	—	Belgian Congo
54. <i>F. elastica</i> Roxb. ...	—	Karet or Rambourg	Assam
55. <i>F. hispida</i> ...	—	—	—
56. <i>F. hypophaea</i> ...	—	—	Dutch N. Guinea
57. <i>F. infectoria</i> ...	—	—	—
58. <i>F. nekbedu</i> ...	—	—	Belgian Congo
59. <i>F. palmata</i> ...	—	—	—
60. <i>F. Pr eusti</i> ...	—	—	Cameroons
61. <i>F. rigo</i> ...	—	—	British Guinea
62. <i>F. Schlechteri</i> ...	—	—	New Caledonia
63. <i>F. Supfina</i> ...	—	—	Dutch N. Guinea
64. <i>F. Vogelli</i> ...	—	—	W. Africa
65. <i>Forsteronia floribunda</i> ...	Apocynaceae	—	Tropical America
66. <i>Funtumia elastica</i> Stepl., or <i>Kickxia elastica</i> Blume p.p. ...	—	Silk Rubber or Lagos or Iré rubber	Africa
67. <i>Gonogrypta Grevei</i> ...	—	Komnitro*	Madagascar

APPENDIX 1 (Contd.)

Name	Natural Order	Trade Name	Habitat
68. <i>Heplopappus</i> spp. ...	Euphorbiaceae	—	West U. S. A.
69. <i>Hevea Benthamiana</i> ...	"	—	N. Amazon
70. <i>H. brasiliensis</i> ...	"	Para Rubber	Amazon
71. <i>H. guyanensis</i> ...	Apocynaceae	—	"
72. <i>Holarrhena microteranthera</i> ...	"	Piri piri	German E. Africa
73. <i>H. antidysenterica</i> ...	"	—	—
74. <i>Hancornia speciosa</i> Gomez ...	"	Santos or Rio Sheets or Magnabeira Rubber	S. and C. America
75. <i>Ichnocarpus frutescens</i> ...	"	—	—
76. <i>I. xanthogolax</i> ...	Euphorbiaceae	—	Dutch New Guiana
77. <i>Jatropha curcus</i> ...	(See <i>Euntunia elastica</i>)	—	—
78. <i>J. gossypifolia</i> ...	"	—	—
79. <i>Kickxia elastica</i> ...	Apocynaceae	—	—
80. <i>Landolphia braciata</i> A. Dew ...	"	—	West Africa
81. <i>L. camorensis</i> Benth. et Hook ...	"	African rubber	"
82. <i>L. capensis</i> Oliv. ...	"	—	"
83. <i>L. crassipes</i> ...	"	Fingotra	Madagascar
84. <i>L. Dawei</i> ...	"	—	East Africa
85. <i>L. Droogmansiana</i> ...	"	—	—
86. <i>L. fingimena</i> ...	"	—	Belgian Congo
87. <i>L. florida</i> Benth. ...	"	—	Madagascar
88. <i>L. Gentilii</i> ...	"	Red Kassai	West Africa
89. <i>L. Hendelotti</i> ...	"	—	Belgian Congo
90. <i>L. hispidula</i> ...	"	—	West Africa
91. <i>L. kilimandjarica</i> ...	"	—	Madagascar
92. <i>L. Kirkii</i> ...	"	—	East Africa
93. <i>L. Klainei</i> ...	"	—	East Africa
94. <i>L. Lecomtei</i> A. Dew ...	"	—	Belgian Congo
95. <i>L. lucida</i> K. Schum. ...	"	—	West Africa
96. <i>L. madagascariensis</i> ...	"	—	"
97. <i>L. Manii</i> Dyer ...	"	—	"
98. <i>L. Michelinii</i> Benth. ...	"	—	"
99. <i>L. owariensis</i> ...	"	—	"
100. <i>L. parvifolia</i> ...	"	Muteke	Rhodesia
101. <i>L. Perrieri</i> ...	"	Piralahy or Majunga noir	Madagascar
102. <i>L. Petersiana</i> ...	"	—	East Africa
103. <i>L. senegalensis</i> D.C. ...	"	—	West Africa
104. <i>L. sphaerocarpa</i> ...	"	Reiabo	Madagascar
105. <i>L. Stolzii</i> ...	"	—	East Africa
106. <i>L. subturbinata</i> Stapf. ...	"	—	West Africa
107. <i>L. Thollonii</i> ...	"	—	Africa
108. <i>L. tomentosa</i> A. Dew ...	"	—	West Africa
109. <i>L. Traunii</i> Sadeb ...	Euphorbiaceae	—	"
110. <i>Landolphia ugadensis</i> ...	"	—	Uganda
111. <i>L. Watsoniana</i> ...	"	—	East Africa
112. <i>Lenconotis</i> ...	"	—	Indo-Malay
113. <i>Loranthaceae</i> (spp. ?) ...	Apocynaceae	Thina rubber	Bahia
114. <i>Manihot dichotoma</i> ...	"	Jecquie	Ceara, Rio del Norte & Parahyba
115. <i>M. Glaziovii</i> Müll.-Arg. ...	"	Ceara	Bahia
116. <i>M. heptaphylla</i> ...	"	Manicoba de San Francisco	"
117. <i>M. piauihyensis</i> ...	"	Manicoba de Guidroa	Madagascar
118. <i>Mascarenhasia arborens</i> ...	"	—	East Africa
119. <i>M. elastica</i> K. Sch. ...	"	—	Madagascar
120. <i>M. laceolata</i> ...	"	Mgoa rubber	"
121. <i>M. lisianthiiflora</i> ...	"	—	"
122. <i>M. mangorensis</i> ...	"	—	"
123. <i>Microchites Bailloni</i> ...	"	—	Indo-China
124. <i>M. napeensis</i> ...	Cactaceae	—	"
125. <i>Nerium odorum</i> ...	Apocynaceae	—	"
126. <i>Oncinotis hirta</i> ...	"	—	Belgian Congo
127. <i>Opuntia</i> ...	Compositae	—	America
128. <i>Parameria barbata</i> ...	Euphorbiaceae	Rubber-like sub.	Burma
129. <i>P. philippinensis</i> ...	Asclepiadaceae	—	Philippines
130. <i>Parthenium argentatum</i> ...	Apocynaceae	—	Mexico
131. <i>Pedilanthus tithymaloides</i> ...	Asclepiadaceae	—	—
132. <i>Periploca canariensis</i> ...	Apocynaceae	—	Belgian Congo
133. <i>Pirabarium diudo</i> ...	"	—	French Indo-China
134. <i>Plumeria alba</i> ...	Euphorbiaceae	—	—
135. <i>Raphionacme utilis</i> ...	"	—	Angola

APPENDIX 1—(Continued)

Name	Natural Order	Trade Name	Habitat
136. <i>Rhynchosia Wallichii</i> ...	Euphorbiaceae	Ekanda rubber	Burma
137. <i>Sapium</i> spp. ...	"	—	S. America
138. <i>S. biglandulosum</i> ...	"	Caucho blancq	Colombia
139. <i>S. insigne</i> ...	"	—	Indo-Malay
140. <i>S. Jenmani</i> ...	"	—	Br. Guiana
141. <i>S. tapuru</i> ...	"	—	Amazon
142. <i>S. Thompsoni</i> ...	Compositae	—	Colombia
143. <i>S. verum</i> ...	"	Colombian or Virgen rubber	Amazon
144. <i>Scorzonera krim-saghyz</i> ...	Asclepiadaceae	—	U. S. S. R.
145. <i>S. tau-saghyz</i> ...	Leguminosae	—	"
146. <i>Secamonopsis madagascariensis</i> ...	"	—	Madagascar
147. <i>Soja</i> Max. ...	"	Vahimainty	—
148. <i>Synedenum grantii</i> ...	"	Norepol-rubber-like substances	—
149. <i>Tabernaemontana coronica</i> ...	Apocynaceae	—	—
150. <i>Thevetia nerifolia</i> ...	"	—	—
151. <i>Urceola actuoacuminata</i> ...	"	Separat	Indo-Malay
152. <i>U. brachysepala</i> ...	"	—	"
153. <i>U. elastica</i> ...	"	—	"
154. <i>U. esculenta</i> ...	"	—	Rangoon
155. <i>U. malaccensis</i> ...	"	—	Malacca
156. <i>U. Mangay i</i> ...	"	—	Indo-Malay
157. <i>U. pilosa</i> ...	"	—	Borneo
158. <i>Vallaris Heynei</i> ...	"	—	Indo-Malay
159. <i>Willughbeia firma</i> Bl. ...	"	—	—
160. <i>Wrightia tinctoria</i> ...	"	—	Java, Sunda
161. <i>Xylinabaria Reynodi</i> ...	"	—	Indo-China
162. <i>Zea Mays</i> L. ...	Gramineae	Rubber-like substances	U. S. A.

MEDICINE AND PUBLIC HEALTH

FOOD CONSUMPTION LEVELS IN THE UNITED STATES, CANADA AND THE UNITED KINGDOM

This report issued by the United States War Food Administration was prepared by a special Joint Committee set up by the Combined (Anglo-American) Food Board in May, 1943, as a guide for the Board and other governmental agencies in the allocation of foods in short supply. The Board instructed the Committee to consider and compare the pre-war, present, and prospective food consumption levels of the United States and United Kingdom. Canada was also invited to participate in the inquiry and subsequently accepted.

The work of the Committee fell under two main heads: Supplies and Distribution, which involved the collection of such material as the total disappearance figures for food in each country, ration allowances, extent of employment and intensity of labour, distribution among consumer groups in different areas and different income groups, waste and losses occurring

in the process of distribution, etc.; and Nutrition and Health, which dealt with the comparative analyses of nutritional needs of populations, determination of the nutritive content of the per capita food supplies available in the different countries, and an evaluation of the effects of dietary changes that have taken place or which might be required.

This report gives information on food supplies for civilian consumption in the three countries in 1943 and in the pre-war period for each (1934 to 1938 for the United Kingdom, 1935 to 1939 for the United States and Canada). Part I deals with the general problems involved in such a study and the methods adopted, the actual comparisons of consumption levels being presented in Part II in three sections: Comparison of Nutrient Supplies and their Relation to Requirements; Commodity Supplies in Relation to General Dietary Needs (by food groups and by individual commodities); and, finally, Trends of Supplies (1940-'43 and forecasts for the period July, 1943 to

June, 1944). Supporting data are presented in a number of charts, tables and appendices.

TUBERCULOSIS IN THE ANIMAL WORLD

Sydney Gordon Tippet, (*The Veterinary Journal*, June, 1944) basing his thesis on wide experience and investigation as medical superintendent of an important sanatorium in Great Britain, recommends that steps be taken to get animal tuberculosis under control, it being clear that human tuberculosis can never be controlled unless the disease is first controlled in the animals with which man comes in contact, and upon which he depends for a part of his food. The disease must be attacked among cattle, swine, and fowl. Both veterinary surgeons and doctors have contrary ideas as to dangers of the bovine tubercle bacillus, notwithstanding that the infection among children runs high as a consequence thereof. While bone and joint tuberculosis is more frequently of human origin, yet it is apparently not realized that the drinking of raw cow's milk fre-

quently sets up fatal and crippling forms of the disease in children. Nineteen percent of urino-genital and 16.6 per cent of tuberculosis meningitis have been found to be of bovine origin, and the largest percentage of cervical and abdominal tuberculosis in children under five years of age is traceable to cow's milk. One cannot expect the general public to understand the dangers of tuberculous milk until the medical profession itself becomes unanimous on the question of eliminating the tubercle bacillus from the milk supply. There is no ground for the belief that ingesting small numbers of tubercle bacilli has significant or lasting immunizing effect. The only method of making raw milk safe is by complete eradication of bovine tuberculosis, as was done in the Channel Islands and the United States through the systematic resort of the tuberculin test. Quoting: "For a real effort to control tuberculosis in human beings, the medical profession can thus learn from the veterinary work in the place of waiting until the X-ray shows distinctive disease of the lungs. . . ."

PROCESSED SOYA BEAN IN BALANCING INDIAN DIETS

D. K. CHATTERJEE,
CALCUTTA

BEFORE actually proceeding with the scientific considerations of the nutritional value of soya bean, it will not be out of place to outlay the history of our food requirements and their subsequent developments. This may help us to appreciate the importance of balancing our ordinary diets.

Food has always played a very prominent part in the mental and physical progress of mankind. In the Dark Ages, when mysteries of growth, development and sustenance were not scientifically revealed to the cave man, his choice of foodstuff was mainly guided by animal instincts. That is why in course of the struggle for survival during his wild existence, the primitive man's food requirement was similar to that of wild animals. When this instinct was superseded by discrimination for taste, the choice became varied. This variation in the old and uniform food habit was perhaps mainly responsible for the growth of different inclinations and faculties in our ancestors and thus the effects of food on the formation of body and mind came to be known. All these led the more scientific minds to formulate theories on food value and confirm them in practice.

The entire process of dietic evolution and the corresponding human progress may be summed up as follows:

Tired of their monotonous diets of raw flesh and scorched meat, the hunters of Stone Age were

moved by instinct to taste the vegetable and other diets of changed nutritional constituents (which might have acted on the series of slumbering cells of the brain). This change in dietary seems to be, to a considerable extent, responsible for driving them from progress to progress, promoting in them the urge for construction and preservation, as well as developing in them an anesthetic sense—the key rules of an organized social life.

To-day, scientific inquisitiveness has ably established that from an epoch of high protein diet in carnivorous age, the world has drifted to this period of scientifically calculated feeding, which demands of us that our food requirements should be balanced in accordance with the demands of body and mind.

Recent advances in chemical and biological science make analysis and synthesis of our requirements possible. Accordingly, nutritional requirements in terms of chemical constituents have been formulated by science, but social habits, taste craze and environmental factors influence national diet menu.

Thus with reference to the consumption of protein, the German schools advocate a liberal protein allowance. But Chittenden and Hindenhede in Denmark cried for limitation. Fischer, Cassel, Osborn, Mendel, Hopkins emphasize the quality.

To settle this difference in opinion, various scientific centres undertook study of high concentration of protein on organism. The data obtained favour the view that high protein level does not exert any unfavourable influence on the kidney.

In case of fat, there also exists a great difference in opinion. According to many 45 to 60 grams of fat is quite sufficient, whereas others favour 50 per cent more.

Thus the difference of opinion is always there as to the quantitative and qualitative nature of the dietary constituents, but there is no difference of opinion as to the low nutritive value of an entirely carbohydrate food, made more injurious by the presence of cellulose and fibres, which are assimilated only with the greatest difficulty.

It is in this that we face nutritional disaster, as the average daily diet in India consists mainly of carbohydrates in one form or other. This practice is responsible not only for a low level of our physical efficiency but has also at the same time disturbed the rhythmic equilibrium of organic secretions which play such an important part in the harmonious building up of proportionate bodies and balanced minds. Only a regular supply of balanced diet preserves the secretive equilibrium and helps the normal growth.

Unbalanced dieting, either due to inefficient knowledge of nutrition or due to perpetual economic difficulty, leads to the disturbance of the rhythmic phase of organic function with the result that pathological conditions set in.

The following is a comparative study of the constituents of the ill and well balanced diets published in the Health Bulletin No. 23 of the Government of India:—

	I Ill Balanced Diet	II Well Balanced Diet.
Protein	38 gms.	73 gms.
Fat	19 "	74 "
Carbohydrate	365 "	408 "
Calories	1750	2590
Calcium	0.16 "	1.02 "
Phosphorus	0.60 "	1.47 "
Iron	9.00 mgms.	44 mgms.
Vitamins		
A (I. U.)	500	7000
B ₁ (I. U.)	160	400
C	15 mgms.	170 mgms.

The Bulletin finds, the standard of diet under Group I to be of a very low nutritional value. We have ourselves constantly seen that the poor in India lives on a diet, whose Protein, Fat and Vitamin constituents are even less than half of what has been tabulated in Group I. While it is not difficult to understand what the condition should be of a community sustained by such a poor diet, the plight of the average Indian is beyond all description. It may be suggested that much of the physical and mental backwardness of a section of the Indian people is

due to a poor food selection. While introducing soya bean as an ideal balanced diet for Indians, we shall try to deal with the traditional as well as the scientific nature of the nutritional constituents in soya bean.

The traditional inclination of the Indian people is directed towards vegetarian diets. But recent scientific observations of experts show that an entirely vegetable diet can hardly meet the requirements of our body and mind. The great sages prescribed vegetarianism for people of India. This is of course against the present scientific trend. As a solution to these contradictory theories of past and present sages, we feel inclined to introduce soya bean as the missing link. It is of vegetable origin but possessing most of the favourable properties of an animal diet.

While dealing with the scientific nature and the subsequent laboratory treatments to render soya bean more suitable as a nutritive factor, we shall include experimental data, both chemical and biological, in confirmation of our line of work.

The food value of soya beans centres principally round its contents of high percentage of quality protein and unsaturated fat, besides vitamins and minerals in a high degree. These have secured for soya bean a very exalted position in the list of natural foodstuffs scientifically recommended for human use.

Publications which are already extensive often mention the role of soya bean in making *blitz krieg* possible for Germany and Japan. More than once it has been mentioned that Chinese labourers are harder than their colleagues in any part of the world though their cost of living is much lower than that of their friends elsewhere.

On the other hand, there have been several publications, both scientific and popular, regarding the difficulty in digestion of the protein of soya bean, and this takes away much of its value.

This led us to serious thinking, and a series of experiments on the digestibility of soya bean protein were conducted. In course of these experiments we found out some structural peculiarities in the linkage of the amino-acids of the soya protein. This unusual linkage system might be considered as the main agent of difficulty in digestion. Once these linkage systems are eliminated, the digestion immensely improves.

Before coming to the more complicated portion of soya bean protein structure and its influence on digestibility, we shall state our analytical results.

Analysis was done on soya beans collected from different sources and varieties. This need not be dealt with separately in this paper. On analysis it was found that the quantity of protein, fat and carbohydrate varied according to the variety of seeds, but

not much difference was observed in seeds of the same variety collected from different sources.

From our analysis, we came to the conclusion that "mammoth yellow large" seeded variety of seeds grown in Assam and Tista Valley, Darjeeling, were found most suited for nutritional purposes.

Here, as we are dealing with soya bean in its dietary value, we have entirely confined ourselves during experimentation to the mammoth yellow large seeded variety. The following are the findings of our laboratory investigations:—

Soya bean protein: 38–40 per cent. The total protein content ranges from 38–40 per cent. The bulk of this protein consists of globulins. One fraction constitutes more than 90 per cent of the total globulin, separated out of a 10 per cent sodium chloride solution by ammonium sulphate at 55 per cent saturation. The rest of the globulins did not separate out till the saturation of the ammonium sulphate was pushed to 66 per cent. The first portion of the total globulin responded to the physical and chemical tests of glycinin, which has often been mentioned as the principal protein of soya bean. The portion that separated out at 66 per cent saturation of ammonium sulphate, did not provide us with any definite nomenclature though most of its characteristics were similar to those of phaseolin.

The mammoth yellow large seeded varieties always contained traces of albumin. In one particular variety obtained from Darjeeling, we found about 3.75 per cent albumin present. But this particular variety being no more available to us, we had no opportunity to confirm this result. In course of our general analysis, we observed that the percentage of albumin in deep colour varieties is higher than in paler varieties. Along with these, proteose which is soluble in water could also be detected. It is assumed that soya protein, specially glycinin, is present in the seed in the form of glycinate of alkaline earths, as well as with alkaline earth phosphates.

The soya protein is completely dissolved in alkali, this base combining capacity of soya bean protein is perhaps due to the excess of dicarboxylic amino-acids not help in amide linkage.

On analysis the following amino-acids and their quantity were obtained:—

(1) Glycine—1.1%, (2) Alanine—0.30%, (3) Valine—0.53%, (4) Leucine—7%, (5) Proline—4%, (6) Phenylamine—5%, (7) Aspartic Acid—3%, (8) Glutamic Acid—18%, (9) Serine—1.25%, (10) Tyrosine—2%, (11) Arginine—5%, (12) Histidine—1.25%, (13) Lysine—3%, (14) Tryptophane—1.72%, (15) Cystine—2.25%, (16) Ammonia—2%, (17) Methionine (possibly)—Traces.

In course of isolating these amino-acids, we had to adopt different processes of hydrolysis. Tryptophane was our greatest trouble, as it broke up com-

pletely during acid hydrolysis. Hydrolysis with a varied strength of acids and alkalies gave us the above results. We observed that most of the amino-acids of soya protein had a tendency to permeate into one another and was liable to produce inconsistent results. The above results were confirmed by more than one tests.

Results of analysis already published in other places are not in entire agreement with our results, but we have worked with the Indian seeds and this may account for the differences.

Denaturation and coagulation.—Unlike animal proteins, the soya protein coagulates and denatures at a temperature above 100° and in presence of moisture. Prolonged boiling in water results in dehydration of the protein. The denatured protein contains less total nitrogen and more hydrogen and oxygen than the original protein. The iso-electric range also becomes less wide. Denatured soya protein has higher viscosity.

The nature of digestive activity also changes in denatured protein. During denaturation, a structural alteration takes place which leads to a rearrangement of the linkage of the sulphur atoms of the molecules. Raw soya bean protein gives no colour with sodium nitroprusside in presence of ammonia. But denatured protein gives a strong magenta pink colour, showing that the sulphhydryl groups have been released during the change. This change in colour served us as an indication in detecting the denaturation of the soya bean protein.

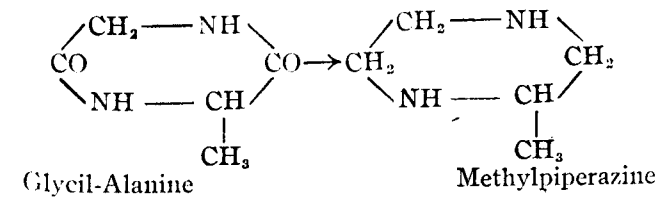
Digestibility.—As the question of the digestibility of soya protein forms the nucleus of our discussion, we shall try to deal with it somewhat in detail.

In course of our experiments on analysis by enzymic hydrolysis, we were struck by the consistency with which almost an equal amount of residue appeared every time, and we observed that this residue was not being acted upon by any of the proteolytic enzymes even under favourable conditions.

We altered conditions of hydrolysis by changing concentrations of acid and alkali, by changing concentration of the enzymes, by changing the nature of enzymes and also by changing the sources of origin of the enzymes. We observed that these altered conditions brought about a change in the velocity of hydrolysis as well as in the rate of liberation of amino-acids but the proportion of unattacked residue remained the same. Further we observed that (a) this particular portion of soya bean protein which could not be acted upon by enzymes remained optically stable, while the rest of the protein underwent racemization under alkaline conditions, (b) this portion of soya bean protein again exhibited a very strong affinity to an azonium base of the type of safranin, and (c) from this portion as well, a few piperazines were isolated by reduction.

This led us to postulate a theory on the complex nature of amino-acid linkage of soya bean protein.

Marston accepts the safranin reaction as indicative of the presence of diketopiperazine rings. Further on reduction of the two carboxyl groups of diketopiperazine ring with sodium and alcohol, a few piperazines were obtained. We believe that methylpiperazine isolated was produced by the reduction of glycyl-alanine anhydrides, originally present in the hydrolysate.



Positive colour reactions for diketopiperazines were also obtained with picric acid, alkali and *m*-dinitrobenzene.

Oxamides were readily isolated after oxidation of the protein hydrolysate, and this was obtained in excess of the amount, that could be accounted for by the quantity of glycine present (the only peptide that yields oxamide under conditions employed in glycyl-glycine).

All these reactions and indications convinced us of the presence of diketopiperazine rings in the unacted portions of soya bean protein. We suspected formation of diketopiperazine rings in the protein hydrolysate by secondary condensations from the previously liberated amino-acids. Accordingly, further experiments were continued by avoiding all the favourable conditions of pH and temperature which helped Emil Fischer and Abderhaldane to synthesize diketopiperazine rings. We even went further, and in some of our experiments, we did not allow the hydrolysis to advance sufficiently in order not to encourage the usual liberation of amino-acids (of course the control was not very rigorous) so that the chance of any secondary condensation was minimized; but even then the colour reaction of diketopiperazine rings was positive as before.

This experiment certainly favoured our assumption that diketopiperazine rings were present in the protein of soya bean and that they were not the outcome of a secondary reaction.

By applying Forbe's method, we achieved a separation of the proteins according to their linkage and structure. The entire lot of purified protein was combined with dye stuff safranin but the dye stuff remained in stable condition with only about one third of the total quantity of protein. Separation of coloured and uncoloured portions of the protein was done as far as practicable and afterwards the coloration was removed with butyl alcohol. Chemical tests

of these two protein portions gave the following results:

1. When attacked with nitrous acids, the portion that did not combine with dye stuff evolved nitrogen, while no nitrogen evolved in dye-stuff-combined portion of the soya bean protein.

2. The portion of protein that was purified from the dye-stuff combination remained optically stable, while the portion that did not combine with the dye-stuff racemized.

3. Most of the colour reactions for diketopiperazine rings were positive with the fractions that combined with the dye-stuff but not so in the case of uncombined portion.

From the results obtained we propose to say that though the principal linkage of amino-acids in the total soya bean protein is of polypeptide character (as per definition of Hofmeister and Fischer), there exists as well another important type of linkage corresponding to Abderhalden's diketopiperazine ring type. We also presume from the data obtained that these diketopiperazine rings were originally present in the seeds and not formed from secondary condensation during hydrolysis.

The presence of diketopiperazine rings in the protein of soya beans clearly explains the cause of the difficulties in its digestion so often communicated through publications.

Attempts were made to hydrolyze these diketopiperazine rings by different proteolytic enzymes but results have been almost negative. A very slow hydrolysis was observed in the case of activated trypsin and this we think falls under the classification of Matsui and Ishayama, who claim that diketopiperazines with free carboxyl groups were very slowly split up by activated trypsin. The hydrolysis was so slow that the progress was almost imperceptible. We neglected the issue in our final conclusion.

A second factor which is more mechanical than chemical in character was also found to interfere in a considerable manner with the digestibility of soya bean protein.

We have found that most of the vegetable proteins are mechanically enveloped in strong coatings of cellulose. In course of protein digestions, the cellulose is not very quickly acted upon by enzymes and this leads to the passage of a certain percentage of cellulose-covered protein in roughage.

From subsequent experiments that we carried on in the line, we had reason to disagree with authorities like Lucias Nichols, who declared that vegetable proteins in general were inferior to animal proteins in biological value. In some cases the vegetable proteins are undoubtedly of lower nutritional order because of the absence of a few essential amino-acids but in most of the vegetable proteins, under our

observations, we found the presence of sufficient quantities of essential amino-acids and when these proteins were purified and freed from cellulose embeddings, we found no cause of any complaint about its efficiency in promoting growth or in building tissue. This leads us to conclude that the defect is not in the protein itself but in its strong cellulose cover which protects it against the action of digestive enzymes.

In the case of raw soya bean protein, the same conclusion may be drawn. During analysis, we detected the presence of six essential amino-acids, but publications have appeared about the low biological value of soya bean proteins. Our biological feeding experiments have brought before us that an important fraction of soya protein passes out without being acted upon in the digestive tract.

A series of feeding tests were done on rats with raw soya bean powder. In some cases, the raw soya bean powder was coloured with indigestible fast colour, and we found the soya bean powder containing indigestible soya protein (with both peptide and diketopiperazine linkage) at the end of the digestive canal.

Further, the analysis of excretion of rats living on raw soya protein indicated qualitative and structural similarity to the intake protein.

All these show that the indigestible nature of soya protein is due principally to two factors, namely, (1) presence of diketopiperazine rings of linkage, and (2) presence of a strong cellulose envelope which does not allow the embedded protein to be acted upon by the digestive fluid.

(To be concluded)

BOOK REVIEWS

China and Britain—By Sir John Pratt. Published by Collins. Pp. 128, with 12 plates in colour and 68 illustrations in black and white. Price 8s. 6d.

This is an admirable monograph written with sympathy and understanding. People seldom realize how great is China's contribution to civilization as we know it; and Sir John's book is a timely reminder that we should respect China not only for her signal services towards the exorcism of the fascist ghost, but also for what she has done in furthering the cause of civilization in the light of her own singular spiritual endowments. Where all the chapters are equally interesting, one is yet constrained to single out the chapters on China's gift to the West, Ancient China, China's Civilization, Philosophy, Religion and Art for special notice. Sir John's analysis of the spirit that underlay China's social organization brings out the ethical bias that was as much characteristic of her genius as the civic was of Greece or the philosophic of India. The connection that he has shown between English Naturalism of the 18th century and the interest in Chinese art displayed by the younger painters of the era (Pp. 106-109) is worthy of further study; and the two illustrations on Pp. 108 and 109 are conclusive. The illustrations indeed have been chosen with discrimination and form a suggestive collection. The author has assigned much less significance to Buddhist influence than is customary or Dr Bagchi will allow. He also does not refer to the influence

of Chinese poetry on some modern English poets;—the preciousness to which so much value was attached in China being much in evidence in these latter-day English poets. We will pay the author the compliment of wishing that a similar book could be written by someone exhibiting China's relations with India and their reciprocal influence on each other. If such a book were to even approach the readability of Sir John's, we will not complain.

D. G.

New Road 1944,—Edited by Alex Comfort and John Bayliss. Published by the Grey Walls Press, London. Pp. 278. Price 10s. 6d.

As the editors explain in their explanatory title, the volume is intended to exhibit new directions in Art and Letters. It is an anthology and makes excellent reading. We appreciate the endeavours at revaluation in the selected essays, and Mr Comfort's pugnacious perspicacity challenges our deepest prejudices; his concluding statement—that "if God created the world, He did it as a protest against His own limitations" is something more than a defiant paradox. We are glad that the editors had the good fortune of coming across the writings of Prem Chand, though in what they found him symptomatic of 'new directions' is far from being clear. Prem Chand touches our deepest feelings, but he continues old traditions within strictly conservative limits. Perhaps the editors were attracted by the revolt of the under-dog which motivates also that poignant

essay 'No such House'. We confess we cannot be equally enthusiastic about the selected poems. They have the vice of an undefined esotericism which secludes so much of modern poetry from popular understanding. We wish that poets would begin to condescend to come down from their stilted heights and speak to us in a language we understand as it is the muscular phrases seem to be reaching out to some big purpose only to be frustrated by a nervous breakdown at the psychological moment. There is too much effort and too little effect. The anthology is significant in that it shows the spirit of the modern world in the throes of travail.

D. G.

Principles of Physical Geology.—By Arthur Holmes, D.Sc., F.R.S., Regius Professor of Geology and Mineralogy, University of Edinburgh. Published by Thomas Nelson and Sons Ltd., London. Pp. 509. Price 30 Shillings.

Sir Thomas Holland once said that a text-book should be ten years behind the times, meaning that it was only after that period that new theories could be regarded as having been thoroughly tested, and retained or discarded as experience dictated. This book is rather more up-to-date than that; but the newer theories, especially those relating to the internal structure of the earth, and the mechanism of mountain building and vulcanism, give rise to so much stimulating thought, that the author may be excused their treatment in an elementary text book.

The book is divided into three parts. The first part presents what the author terms a preliminary survey, in which the principles of physical geology are summarised, and the materials of the earth's crust described. This part serves as an introduction to the more detailed treatment that follows. The second part deals with external processes and their effects; while the third part discusses the internal processes of the earth and their surface expression. The latter part includes such subjects as earthquakes, earth movements and the resultant mountains, plateaus and rift valleys, volcanic activity, and continental drift, and the student will probably find it the most interesting part. Though much of this part is of a speculative nature, and necessarily so, since it deals with processes originating deep within the earth's body and on a scale so vast that it is doubtful as to how far the results of laboratory experiment can be held to apply, modern methods of investigation have made such progress during recent years that the depths of the earth are less inscrutable than before, though still the subject of much controversy.

Many students of Indian geology must have found it difficult to understand how it was that at approximately one and the same time a state of tension existed in one part of India, permitting the

extravasation of immense quantities of molten lava, while in a contiguous part conditions of compression existed resulting in the intense folding of the earth's crust, and the piling up of the great Himalayan range. Holmes is an advocate of the hypothesis of sub-crustal convection currents to explain such facts. He writes: "Where currents are flowing horizontally along the surface of the crust, they exert a powerful drag on the latter, throwing it into tension where they diverge and into compression where they converge." The difficulty, however, is to explain how convection currents start in the first place, and when started how they can lead to such a similar repetition of events on so many occasions. One gets the impression that speculative hypotheses are being invented to match the requirements, against which indeed Holmes utters a word of warning. Much of this third part of the book is of this nature; but because it is so controversial it is also interesting, and should stimulate the student to think for himself.

Perhaps the outstanding feature of the book is its fine collection of plates and text figures, which are refreshingly new and reflect the author's method of teaching. These illustrations are taken from all over the world (except India), though the largest number come from the British Isles. This may be justified by the fact that there is no country in the world of so small a size which displays so complete a record of geological history, or in which the relation between the geology and the physical geography is so clearly demonstrated. Nevertheless, let us hope that the time will soon come when it will be possible to provide such a book with illustration largely taken from Indian sources.

At the end of each chapter there are given suggestions for further reading. If only half of the books suggested were in the library of every geology and geography department in India, they would make a valuable collection suitable for the students' use.

Perhaps the main criticism that can be made of the book is that some subjects might have received more detailed treatment. However, the price of the book is already thirty shillings, and that is quite enough to expect any student to pay.

As a text book for students of geology and geography up to the B.Sc. standard the book is strongly recommended. If the student purchases this book, and one of the well known books on Indian geology, he will be well provided with reading matter concerning the broader aspects of his science, to supplement his lectures; while the book should also prove of interest to students of other sciences who wish to have a general idea of modern theories regarding the structure of our earth, and regarding the origin of the surface features displayed upon it.

W. D. W.

LETTERS TO THE EDITOR

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

USE OF MAHAJAN'S OPTICAL HYGROMETER

IN the previous papers, the author has dealt with the construction,¹ working,² time lag,³ humid fatigue,⁴ and humid hysteresis⁵ of Mahajan's Optical Hygrometer. Now, in order to have accurate results with the use of the same, the author has found that the following precautions which are platitudinous and commonplace, should be duly considered, while using this instrument.

1. In order to get rid of the errors due to time lag and hysteresis, a considerable time should be given to a hygrometer to reach its steady state so that the light spot is dead stop on the vertical scale.
2. If the instrument is subjected to much heat, such as, direct sunlight, or steam, and that if it is wet by exposure to rain or direct water-contact it requires readjustment. Therefore it should neither be kept near water nor any source of heat.
3. When the rod supporting the two pans turns upside down or dips too much it indicates either super-saturation or absolute dryness. In the former case there are minute particles of water in the air and in the latter case there is no trace of humidity in it. When this instrument is exposed to such an air, the adjustment of the apparatus is affected and hence it requires readjustment after that.
4. This instrument has a casing for protecting it from strong breeze of air which may upset its adjustment. But this casing also obstructs the free passage of the air. Therefore considerable time should be given to it to indicate a steady and correct reading by letting the light spot to come to rest.
5. The instrument should be placed in such a way that a current of air from a fan or otherwise enters the casing and comes out through the perforations at its base for the humidity is much more local than is generally supposed. By this process the period of time lag can easily be reduced from 20 minutes to even less than ten minutes.
6. To obtain the mean humidity of a room, the instrument should not be placed near the walls of a room for they are good absorbers of moisture from the air. The air at one inch from a cold wall is about 10 per cent more humid than what it is about one foot away.
7. The hygrometer should not be placed near

books, lumber furniture and the like as they generally affect the air near them, being good absorbent material.

8. Sometimes when the temperature is falling rapidly, practically all solid substances radiate heat rapidly and in extreme cases, the dew is deposited if the surface is non-absorbent, because the air at the surface is contracted by the cold, the saturation point is reached, and the water is precipitated. Thus the adjacent cold surfaces, even the casing of the hygrometer tends to moisten the air and the humidity percentage goes up with the cooling of air. Therefore some allowance should be made for this fact.

9. A rapid circulation of air can easily disperse the local humidity of the apparatus and will also equalise the humidity of the air in the room. Thus the instrument should be placed in a current of air from a fan and then more accurate reading will be obtained.

The author is indebted to His Highness' Government, Patiala for providing facilities to conduct this work in the Physics Research Laboratory, Mahendra College, Patiala.

L. D. MAHAJAN.

Physics Research Laboratory,
Mahendra College, Patiala,
19-12-1944.

¹ L. D. Mahajan, "The Optical Hygrometer", *Current Science*, 9, 100, 1941.

² "The Optical Hygrometer and its working", *Indian Journal of Physics*, 15, 425-432, 1941.

³ "Time lag and Humid Fatigue of Hygrometers", *Indian Journal of Physics*, Calcutta (in press).

⁴ "Humid Fatigue of Hygrometers", *Current Science*, 13, 73-74, 1944.

⁵ "Humid Hysteresis of Mahajan's Optical Hygrometer and Others", *Indian Journal of Physics*, Calcutta (in press).

PHARMACOGNOSTIC STUDIES ON "IPECACUANHA"

THE well known and highly important drug 'Ipecacuanha' is obtained from the roots of the plant *Cephaelis Ipecacuanha* (Brot.) A. Rich. (*Psychotria Ipecacuanha* Stokes.). This plant is a small shrub, indigenous to Brazil and is cultivated there.¹ It is

also cultivated in Selangor, in Federated Malaya States.² In India it is cultivated to a small extent in Bengal at Mungpoo in Darjeeling District. The root of this plant is the chief source of the alkaloid emetine and the drug is emetic, diaphoretic, one of the best expectorants and an excellent remedy for treatment of amoebic dysentry.

The present pharmacognostic study was undertaken to determine the particular age of the plant when the alkaloid content reaches its maximum limit, in order to ascertain the proper time of collection. The materials were obtained from Mungpoo in Darjeeling district where it is cultivated under Government supervision along with cinchona and 1-4 years old plant materials were collected.

The roots from plants collected at the end of 1st and 2nd year appeared to be thinner than those obtained from 3 and 4 years old plants. In 1 and 2 years old plants, most of the roots, though annulated showed that the ridges were not fully round and did not completely encircle the root. The average diameter of the roots varies from 0.4 to 0.6 mm. according to age of collection. Besides the external appearance the roots of 1 and 2 years old plants are found to be infested with a number of very thin thread like rootlets whose number gradually decreases as the plants grow old. In the 3rd year of collection the roots are found to be well developed with the ridges distinctly rounded and completely encircling the root. The roots of 4 year old plants are alike to those of the previous year except that the bark in several places is more separated from the root. The less annulated structure of the root and the presence of a number of fibrous non-annulated rootlets are special features of samples of earlier collection.³

The diagnostic microscopical characters⁴ as found in the roots are thin brown elongated cork cells filled with brown granular material. Below this the secondary cortex is found to be exceptionally wide and composed of thin walled parenchyma mostly filled with starch grains. In it there are also some scattered cells containing needle shaped crystals of Calcium Oxalate 30-80μ long. The starch grains are usually compound with from 2-8 components. Sclerenchymatous cells or fibres are absent in the bast ring. The xylem is characterised by the presence of perforated tracheids, small tracheal vessels and wood fibres. The structure of secondary or tertiary roots in plants of different ages are more or less alike but the difference in structure of primary root in plants of different ages is quite well marked as the number of rings of wood in the xylem varies from 1-4 according to the age of collection. Microchemical tests with hydrochloric acid and potassium chlorate as well as other reagents showed the presence of emetine in the bark and its absence in the xylem and these reactions were

more marked in three and four years old roots as compared with those of 1st and 2nd year old plants.

A comparison of the dry weights of the amount of roots per plant is stated below:—

	Total amount of roots per plant.	Average weight of roots per plant.
1st Year ..	2.021 to 4.952 gms.	3.5 gms.
2nd " ..	9.15 to 17.425 "	13.28 "
3rd " ..	20.145 to 24.785 "	22.46 "
4th " ..	18.85 to 25.43 "	22.20 "

The roots of the plants of these different age groups (i.e., 1-4 years of collection) were subjected to chemical analysis at 3 different places and the results are tabulated below:—

	1st Analysis		2nd Analysis		3rd Analysis
	Total Alkaloid	Non-phenolic Alkaloid	Total Alkaloid	Non-phenolic Alkaloid	Total Alkaloid
1st Yr.	1.45%	1.18%	2.30%	1.20%	1.95%
2nd "	1.70%	1.21%	2.33%	1.24%	2.00%
3rd "	2.33%	1.40%	2.50%	1.35%	2.15%
4th "	2.14%	1.21%	2.60%	1.35%	2.25%

B.P. (1932) Addendum VI prescribes that ipecacuanha root should contain not less than 2% of the total alkaloids and not less than 55% of these should consist of non-phenolic alkaloids calculated as emetine.⁵ From the above results it is found that the roots of 3 and 4 years old plant give an amount of alkaloid conforming to the B.P. standard. According to results of analysis No. 1, the highest yield of emetine is in the 3rd year of collection and according to analysis No. 2 highest yield is obtained in both 3rd and 4th year of collection. It is therefore feasible that even when the non-phenolic alkaloid content is the same in the 3rd and 4th year the crop should be harvested from 3 years old plants with better advantage.

It is also to be noticed that the percentage of total alkaloids is less than that obtained from roots of 2½ years old plants grown at Serdang in the Selangor State in the Federated Malaya States where as much as 3.1% of total alkaloids and 1.6% of emetine have been obtained. It is therefore worth-while to carry on further experiments to improve the cultivation of this very important medicinal plant with a view to get a better yield of alkaloids.

We are indebted to Messrs. Bengal Immunity Co. Ltd., for providing the necessary fund to carry on the work, to Mr S. C. Sen, B.A. (Cant.), B.Sc. (Cal.), A.M.I.Chem.E., Principal Quinine Officer, Government of India for his kindness in sending the samples of roots, to Dr B. Mukerji, D.Sc., M.D.,

F.N.I., Director, Biochemical Standardisation Laboratory, to Mr S. Mukherjee, M.Sc., of Bengal Immunity Co. Ltd., and to Professor (Miss) A. Mukherjee, M.Sc., of Lady Brabourne College, for their kind help in analysing the samples.

The details of the paper will be published elsewhere.

S. N. BAL
S. C. DATTA

Pharmacognosy Research Laboratory,
Industrial Section, Indian Museum,
Calcutta, 24-1-1945.

¹ Bal, An outline of pharmacopoeial drugs of vegetable origin.

² Bal, *Ipecacuanha*, *Ind. Jour. of Phar.*, 2, No. 1, 1940.

³ Trease, A Textbook of Pharmacognosy.

⁴ British Pharmaceutical Codex, 1934.

⁵ British Pharmacopoeia, 1932, Addendum VI, 1943.

RUPTURE OF WATER DROPS OVER LIQUID SURFACES

It has been reported elsewhere¹ that when drops of water of a given size are allowed to fall upon oil surfaces from gradually increasing heights, upto a certain critical value of the height, they sink into the oil as a whole but for heights greater than this critical value, they rupture into two or more droplets. This critical height depends upon the size of the drop and other physical properties² (such as viscosity, interfacial surface tension etc.) of water and oil. Further careful investigations of this phenomena have however revealed that in case of certain suitable size of water drops falling upon comparatively less viscous oils (or their mixtures) there are very often several critical heights for the rupture of water drops, and in between the consecutive critical values within a range of height, the drops are found to enter as whole (without rupture) into the oil.

In the actual experiment water drops of different sizes ranging in diameter from .2 to .5 cms. were allowed to fall on mixtures of Turpentine oil and Castor oil in different proportions by volume, ranging from 50 per cent to 0 per cent of Castor oil. The observations may be summed up in the following words:—

(1) The small size drops of the order of .2 cms. diameter do not exhibit more than one critical height. In some cases the second critical height was located but its distance from the first critical height was fairly large—of the order of four times the value of the first critical height itself.

(2) The bigger size drops of the order of .4 cms. diameter exhibit a number of critical heights spaced at intervals of 1 cm. approximately from the first critical height.

(3) There seems to be an optimum size of the drop for the maximum number of critical heights and as the size of the drop becomes more than the optimum value, the number of critical heights begin to decrease.

(4) The highly viscous liquids, as for example, 50 per cent Turpentine oil and 50 per cent Castor oil by volume, do not exhibit more than one critical height even with the optimum size of the drop. In some cases they exhibit a second critical height which is fairly apart from the first critical height.

(5) The less viscous liquids exhibit sometimes ten or more critical heights when experimented with the optimum size of the water drop.

Without entering into the detailed mechanism of the rupture of the water drop, it may be suggested that the rupture takes place when the drop has collided with the oil surface and when the distortion produced in it, exceeds beyond a certain limit. It is also clear that for a given size of drop falling from a given height, the amount of distortion and its speed will be more in the case of less viscous oils. This fact is supported by the experimental observation that for a given size of drop, the critical height is greater for more viscous oils, on which it is allowed to fall. The drops of water even after they have come into contact with the oil surface, will have a tendency to oscillate in the way first suggested by Lord Rayleigh.³ These oscillations will have a certain time period which will depend according to Rayleigh only upon the size of the drop and the interfacial surface tension between the oil and the water. It is however, not unlikely that in this case the viscosity of the oil may also affect the time period. In any case, it appears that the presence of a number of critical heights for rupture is due to the tendency of the oscillation of the drop to prevent its rupture. When the drop assumes a spherical form during its course of oscillation, it is much more stable and hence rupture may not be possible. The first critical height for the small size drops is greater than for the large size drops. There are several critical heights for the rupture of water drops and in between these consecutive critical values, the drops do not rupture but sink as a whole. The drop in its course of oscillation may assume a spherical form (from the elliptical form say) and here its potential energy is a minimum and is in a more stable form. Hence the distortion produced after collision with the oil surface is not sufficient to rupture a spherical drop (while it may be sufficient for an already distorted elliptical drop). So it is the tendency of the oscillation of the drop to assume either the spherical or elliptical form which prevents or produces the rupture. It has been observed experimentally that the first critical height for the small size drops is greater than that for the large size drops. As the

former fall through a greater height, the kinetic energy generated at the expense of the potential energy is also greater—sufficient enough to produce rupture even in the most stable (spherical) form and hence they will not exhibit more than one critical height. Their kinetic energy in relation to its surface energy is great enough to produce rupture even in the most stable (spherical) form and hence they will not exhibit more than one critical height. In case of more viscous oils, the tendency of their oscillation will be damped and hence the chances of more critical heights will become less.

B. N. SINGH
B. K. SAHAY

St. Xavier's College,
Ranchi, 12-1-1945.

¹ Singh and Sinha, *Sc. Coll. Phil. Soc. Mag.*, 1944.

² Singh and Sinha, *Curr. Sci.*, 13, 157, 1944.

³ Rayleigh, *Proc. Roy. Soc.*, 29, 71, 1879.

AMMONIUM SULPHATE VS. AMMONIUM NITRATE

THERE has been a big stir amongst the Indian scientists, industrialists and agriculturists, recently, on the decision of the India Government to erect plants for the manufacture of 350,000 tons of ammonium sulphate per year, to be used as a fertiliser. For the manufacture of the ammonium sulphate India will have to be dependent mainly on the foreign imported sulphur, which under unfavourable circumstances, as at the present time, may jeopardise the whole industry with a consequent heavy blow on the agricultural products of the country.

Is it not possible to use ammonium nitrate in place of ammonium sulphate, if not wholly, at least partly? Will any scientist enlighten as to what are the objections in using ammonium nitrate as a fertiliser? Ammonia can be prepared from the nitrogen of the air and hydrogen from water; this ammonia can be oxidised to nitric acid with consequent production of ammonium nitrate. So by substituting ammonium nitrate in place of ammonium sulphate India can become independent of foreign resources.

Large amounts of ammonium nitrate are being used as fertiliser, both directly and as an ingredient in mixed fertilisers in the United States of America. Since ammonium nitrate like sodium nitrate is a supporter of combustion, there are certain hazards in handling it, and storing of the material. The Agricultural Department of the U. S. Government are instructing the people, as to the possible hazards, and how to avoid them. A 50/50 per cent ammonium nitrate and sulphate mixture has found a favourable

market since there is practically no hazard in handling it. Other mixtures of ammonium nitrate impregnated with inert fertilisers or materials have also been marketed.

Though ammonium nitrate is used as a high explosive, it requires a high velocity detonator in sufficient quantity to energize the mass. Under favourable conditions of pressure, rapid heating and retention of heat, it may be exploded partially from heat alone at 207°C. to 350°C. or completely above 350°C., but these circumstances are unusual in practice. As a supporter of combustion it demands only that it should not be stored near wooden structure or other combustible materials. It should not be stacked near copper which reacts appreciably with molten ammonium nitrate producing nitrite, less stable than nitrate, and which has increasing tendency to violent conflagration or explosion.

So with above precautions it seems that at least 50 per cent of the ammonium sulphate can be replaced by ammonium nitrate thus making us 50 per cent independent of foreign resources, and under unusual circumstances the whole of the other 50 per cent ammonium sulphate can be dispensed with by replacing with other inert fertilisers or inert materials.

N. K. SEN GUPTA

Chemical Corporation of India,
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Cossipore, Calcutta.
12-1-1945.

ON THE DESCRIPTION OF THE INFLORESCENCE OF *RICINUS COMMUNIS* LINN.

WHILE examining the morphological details of the inflorescence of *Ricinus Communis* Linn., the present writer found certain discrepancies in the descriptions as recorded by Hooker¹ and Prain.²

Hooker records:—"Flowers large, in terminal subpanicked racemes, monoecious, apetalous, *upper male crowded, lower female.*"

Prain also follows thus:—"Flowers monoecious, large in terminal, subpaniculate racemes, perianth simple; *males higher up, crowded, females below.*" (Italics ours).

From the numerous observations made both from the specimens occurring in nature and from the herbarium sheets, it is evident that the female flowers are borne above and the male flowers below on the rachis, i.e., just the reverse as described by Hooker and Prain. Other descriptions stand correct. The

writer, therefore, wishes to record his correct observations for whatever they are worth.

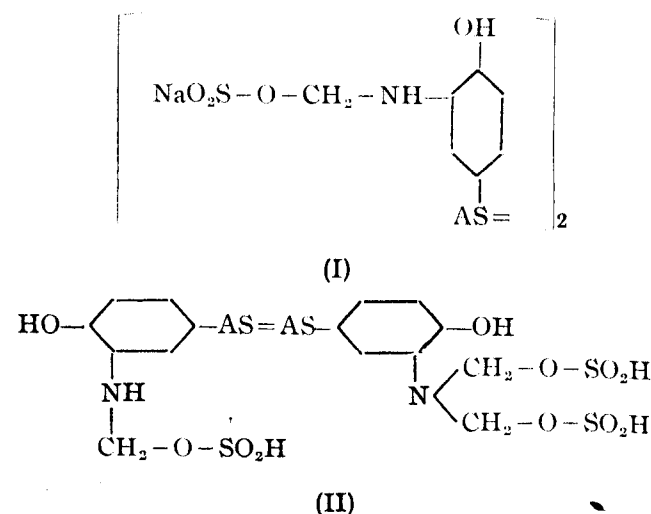
Botany Department, R. M. DATTA
J. I. College, Dacca.
1-2-1945.

¹ Hooker, Sir J. D.—*The flora of the British India*, 5, 457, 1890.

² Prain, D.—*Bengal Plants*, 2, 951-952, 1903.

ON THE CONSTITUTION OF SULPHARSPHENAMINE

SULPHARSPHENAMINE, a drug of choice for the treatment of syphilis, is described in the B.P. (1932) as consisting mainly of disodium 3:3'-diamino-4:4'-dihydroxy-arsenobenzene - N:N'-dimethylene - bisulphite (I). Dyke and King¹ suggested that the commercial product corresponds to a sodium salt of the N:N':N'-trimethylene sulphurous acid (II).



The fundamental difference between the two formulae lies in the fact that in the former the parent compound (3:3'-diamino-4:4'-dihydroxy-arsenobenzene) is reacting with 2 mols of formaldehyde, whereas in the latter it has reacted with three. As such, the above parent compound was prepared,² washed with sodium bicarbonate solution to remove any sulphonic acid derivative,³ subsequently dissolved in minimum amount of caustic soda, and the resulting solution was filtered from any insoluble impurities. All these operations were carried out in an atmosphere of nitrogen. The filtrate, containing the sodium derivative of the above parent compound was treated with the requisite amount of pure hydrochloric acid for conversion to salvarsan dihydrochloride. The resulting solution was reacted with formaldehyde, in one case with 2 moles and another with three. Both the reaction

mixtures were subsequently reacted⁴ with the requisite quantities of sodium bisulphite solution freshly prepared. In the latter case a product was isolated, containing 18.6% arsenic, which, on biological assay, did not pass the test for local irritant effect, as laid down in B.P. But products isolated from the mixture where the salvarsan dihydrochloride solution has been reacted with 2 mols of formaldehyde are being found to comply rigidly with the tests for toxicity, therapeutic potency and other specifications as laid down in B.P. The drug prepared in this way contains 20-20.5% arsenic, 2.5-2.75% sodium chloride and a trace of free sodium bisulphite (or sulphite).

Further, in order to verify the chemical nature of the product, a concentrated aqueous solution of the drug as obtained above was slowly treated with glacial acetic acid in the cold and the precipitated free sulphurous acid was filtered and washed with acetic acid and with small quantity of cold water. It was finally dried in *vacuo* over sodalime at 120° (Found: As, 26.58; N (Dumas), 4.96; S (Carius), 11.16. C₁₄H₁₆O₈N₂S₂As₂ requires AS, 27.04; N, 5.05; S, 11.55 per cent). These analytical figures conform rigidly to the formula (I; H for Na). Several other samples of this acid were similarly prepared and analysed, and in each case the analytical figures point to the formula (I). It is, therefore, evident that the drug sulpharsphenamine has the constitution (I), and because of the presence of traces of free sodium bisulphite (or sulphite) and sodium chloride, its arsenic content has been lowered from 25% (as required by formula I) to approximately 20% (as found above and as also specified by B.P.). It should be noted that these impurities crop in course of preparation of the drug. A sample of sulpharsphenamine (international standard powder) has also been found in our hands to contain traces of sodium chloride and of free sulphite.

Our thanks are due to Dr U. P. Basu, for his kind interest in this investigation and to Dr A. N. Bose for carrying out the pharmacological examination of various samples of the drug prepared in this laboratory.

T. N. GHOSH
S. N. MITRA

Bengal Immunity Laboratory,
Calcutta, 7-2-1945.

¹ Dyke and King, *J. Chem. Soc.*, 805, 1935.

² Kober, *J. Amer. Chem. Soc.*, 41, 442, 1919.

³ King, *Trans. Chem. Soc.*, 119, 1107, 1921.

⁴ Voegtlin and Johnson, *J. Amer. Chem. Soc.*, 44, 2573, 1922.

⁵ Gray's method (*J. Chem. Soc.*, 128, 3181, 1926) for the estimation of antimony in organic compounds has been utilised for the estimation of arsenic and has been found to be suitable.

EFFECT OF WATER VAPOUR IN THE ATMOSPHERE ON THE PROPAGATION OF ULTRA-SHORT RADIO WAVES

THE applications of ultra-short radio waves have become remarkably wide particularly in connection with television, aviation and radio sounding balloons. Usually it is assumed that if these waves are allowed to radiate up, they will travel straight through the lower atmosphere or troposphere and on further progress will penetrate the upper atmosphere or ionosphere, and may ultimately be lost for useful reception. Further it is often presumed that such waves may not reach a long distance beyond the optical horizon. Receptions of such short waves at fairly long distances with associated fadings have however been reported by various investigators¹⁻⁷ and incidentally it has been suggested that in addition to diffraction of the waves as calculated by Epstein,⁸ the lower atmosphere may be responsible for fading of the signals and also for their long distance travel by bending them along the curvature of the globe. The meteorological elements such as, temperature, pressure and water vapour in the atmosphere have been considered for possible agencies for bending such waves. It may be pointed out, however, that any sudden change in the above elements within a small region of the atmosphere may have a considerable effect on the mode of propagation of these ultra-short waves, as the dimensions of the region may be comparable to the wavelength.

Hulburt⁹ has shown that if the air be dry in the atmosphere, there must be an upward increase of temperature of 2.9°C per 10 metres for bending such waves along the curvature of the earth. Such large temperature inversions are however rather rare phenomena. The effect of pressure change also appears to be insignificant unless it is of very high magnitude.

The purpose of the present communication is to show that the presence of water vapour in adequate quantity to saturate the air in the lower layers of the atmosphere can cause considerable bending of the ultra-short waves, necessary for propagation along the curvature of the earth and even more. It may be mentioned that such amounts of water vapour may be found in many places in India in the pre-monsoon and monsoon seasons.

For simplicity, we may assume that the wave while travelling gradually from a comparatively drier region of the atmosphere to such a humid layer, bends in a circle and the radius of curvature can be calculated by Fermat's principle, from the equation,

$$\frac{K}{r} = \pm \frac{1}{2} \frac{\Delta K}{\Delta X}$$

where K=dielectric constant of the atmospheric layer,

$\frac{\Delta K}{\Delta X}$ =change in dielectric constant due to water vapour within a height ΔX , and
r=radius of curvature of the path of wave.

The signs of the right hand expression in the above equation indicate whether the signal will bend towards or away from the earth.

Two possible cases have been considered for calculation. Firstly, when the air is saturated up to a certain level and contains water in the form of vapour only and above the layer, there is perfectly dry air; and secondly, when the lower moist layer is raised by one kilometer and water is partly in the form of vapour and partly in the form of condensed water drops. Assuming the change in the dielectric constant of air ΔK due to added water (liquid or vapour) is proportional to the amount of material in one c.c. of the medium, it can be shown that $\Delta K = 12.7 m_1$ when water is in vapour form and $\Delta K = 80.0 m_2$ when it is in liquid form, where m_1 =amount of water vapour in gm/cc. and m_2 =amount of liquid water in gm/cc.

The calculated values of radii of curvature for bending of the waves in the above two cases are shown in the last column of Tables I and II respectively.

TABLE I

Ht. in km. above ground	Temp. °C	Amount of water vapour in saturated air (m ₁) in gm/cc.	Change in dielectric constant $\Delta K = 12.7 m_1$	Radius of curvature of the path of wave (r) × 10 ³ km.
1	28.0	27.234 × 10 ⁻⁶	345.8 × 10 ⁻⁶	1.44
2	20.0	17.300 × "	219.8 × "	2.27
3	12.5	11.006 × "	139.8 × "	3.58
4	4.5	6.579 × "	83.6 × "	5.98
5	-1.5	4.313 × "	54.8 × "	9.12

TABLE II

Ht. in km. above ground	Amount of water in vapour form in gm/cc. m ₁	Amount of water in droplet form in gm/cc. m ₂	Change in dielectric constant $\Delta K = 12.7 m_1 + 80.0 m_2$	Radius of curvature of the path of wave (r) × 10 ³ km.
2	17.300 × 10 ⁻⁶	9.934 × 10 ⁻⁶	1014.5 × 10 ⁻⁶	0.48
3	11.006 × "	6.294 × "	643.3 × "	0.78
4	6.579 × "	4.427 × "	437.8 × "	1.14
5	4.313 × "	2.266 × "	236.1 × "	2.12

tively. Representative temperatures in different layers for above calculations have been taken from normal temperatures in the month of May over Poona. For calculating $\Delta K/\Delta X$, the thickness of the layer of discontinuity has been assumed to be 250 metres. The change in dielectric constant when water is solely in the form of vapour is shown in the fourth column of Table I and the same for water in vapour and droplet form together is shown in the same column of Table II.

It will be noticed from the last column of Table I, that in the normal atmosphere over Poona in the month of May, saturation at a level of 3 to 5 km. will be capable of bending ultra-short waves along the curvature of the earth, assuming the radius of the earth to be about 6.36×10^3 km. The same column in Table II shows that such bending may occur even much higher above 5 km. due to the upward rush of humid layer. Further, it may be pointed out that in the second case pronounced bending will occur at lower levels which may be considerable enough to cause fading of signals and also give rise to measurable errors in actual bearings while locating an aircraft or a radio-sounding balloon.

The author's sincere thanks are due to Diwan Bahadur Dr K. R. Ramanathan, Superintending Meteorologist, for his helpful interest in the present investigation.

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India Meteorological Department,
Poona,
7-2-1945.

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WHY THE EARLY FRY OF CARPS DO NOT THRIVE IN PERENNIAL PONDS OR IN FRESH-WATER BHERIS NEAR SEWAGE CANAL, CALCUTTA

THE tiny little fry of carps when transferred to a big perennial pond soon after their hatching do not thrive well and in most cases leave no trace of their existence. This is due to (1) the existence of predacious adult fish which may devour them, (2) the

fry that we generally get as carp fry are not exclusively as such but contains many predacious fish fry as these fry are collected in lots, (3) the food of these early fry which is carnivorous is comprised of protozoon, tiny little crustacea, and small insect larvae, etc., which do not thrive in such perennial waters, (4) most of these perennial waters contain many weeds, grasses, dense higher aquatic plants which really become a hindrance to tiny little fry hunting their animal food as these are generally very fast in locomotion, or the carp fry fall an easy prey for the overgrowth of vegetation.

In the fresh-water *bheries* (former salt-water) in the vicinity of Calcutta sewage water canal the general complaint is that tiny little fry of carps do not thrive when put in these *bheries* fed by sewage water. So in all these *bheries* instead of tiny little fry they put *chala* fish which are really either stunted adolescent stage of the previous year or fingerling stage of the year concerned. We all know that it is the tiny little fry that is more economical than either fingerling or adolescent stages.

As regards the first two points of reasons for not thriving the tiny carp fry there is no dispute. Regarding the third point I performed an experiment with two ponds, one seasonal and another perennial. In both these ponds manuring were performed. In the seasonal, ploughing, administration of dried cowdung, mustard oil cakes and eventually after the accumulation of rain, bundles of straw and dried water hyacinth were put. The culture of unicellular algae, protozoon and crustacea were copious. In the perennial pond dried cowdung, bundles of straw and dried water hyacinth were put but the culture were not like the other one. Regarding the fourth point I asked a few owners of the fisheries to eradicate the grass of their fishery specially their dormant roots in summer when most of them become dry. Over and above they were advised to put fire to these grass roots. This prevents excessive growth of vegetation which feeds on sewage. In the *Hanakhali* Fishery in the Rajnagar area they acted according to the above suggestion and got good result. In former years they lost almost the whole of their tiny fry which they put in their fishery area without eradication of their grass or other weeds and when these fry were fed with sewage water. The result was vigorous growth of vegetation which hinder the access to their animal food and also their self-protection. But this time there were no such hindrance and they got a very high percentage of the fry with their desired growth.

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Calcutta University,
7-3-1945.

H. K. MOOKERJEE

Physics

Quantum Theory of Radiation Damping

R. C. MAJUMDAR

IT is well known that a moving electron experiences a sort of resistance due to its own electromagnetic field, similar to that of a body vibrating in the air and producing sound waves. This resistance is called the radiation damping. The classical theory of radiation damping has been worked out by Lorentz and Dirac. The quantum mechanical calculations of the radiation damping and its correspondence with the classical theory sets a limit of radiative processes involving energies not exceeding 100 million volts. It is, however, found that in almost all problems the radiation damping is in general quite small and does not lead to any divergent difficulties even if neglected.

But a different situation is met with in the theory of mesons, the new type of particles recently discovered in cosmic rays. It has been noticed that the quantum mechanical results involving mesons interacting with the electromagnetic as well as with the neutron and proton (which we shall call nucleon) are in general highly divergent. The cross section increase with increasing energy of the incident particle. This behaviour seemed so peculiar that even

the correctness of the fundamental equations of the meson field was questioned. But it was for the first time realised by Bhabha that this increase is essentially due to the neglect of the effect of radiation damping. In meson theory we are not only concerned with the usual radiation damping pertaining to the scattering of light by meson but also the radiation damping when the meson is scattered by the neutron and proton nucleon. The radiation damping in the latter case represents the reaction of the meson field emitted by the nucleon on the motion of nucleon itself. The quantum theory of radiation damping which has been described in the present address confirms to Bhabha's classical calculations in showing that the anomalous results for the process involving mesons disappear. It is also discussed that the correct theory of radiation loss of meson, including the effect of radiation damping, will give valuable information regarding its spin. It is believed that the theory of radiation damping when fully developed will be of profound significance in our understanding of the nature of fundamental particles and the phenomena in the field of nuclear and cosmic ray physics.

Zoology & Entomology

Protozoa Affecting the Health of Domesticated Animals in India

H. N. RAY

PROTOZOAN parasites infect all domesticated animals and factors to be borne in mind while devising methods of control or therapeutic treatment of such protozoal infections are: (1) *Geographical distribution*: When an intermediate host is involved in transmission, the disease is confined to the area which favours survival of the vector; but when the infection spreads by contact, introduction of a single affected host is sufficient to establish the infection into a clean area, (2) *Reaction of the host to infection*: recovery from a protozoan infection does

not mean complete disappearance of the parasite from the system of the host which exhibits a tolerance to the parasite for a long period. Such animals are called 'carriers', which are potential sources of danger to other animals, (3) *Treatment*: serum or vaccine treatment are of little or no value in protozoan infections. Control measures based upon natural history of the disease have played a very important role in stopping the further spread of infection.

Spontaneous amoebic dysentery amongst hounds

of Ootacamund was for the first time noted in India by Ware. The organism concerned is *Entamoeba histolytica* and the potential source of infection is man. *Leishmania* causes cutaneous leishmaniasis in dogs and bullock, and a few cases are reported from India. *Trichomonas* are known to produce sterility, abortion, and pyometra in cattle and enterohepatitis in fowl. Cases of giardiasis caused by *Giardia* in dogs of foreign breed were encountered at Mukteswar and one case was successfully treated with quina-crime.

Amongst the domesticated animals in this country flagellates of the genus *Trypanosoma* are recorded. *T. theileri* is non-pathogenic, while *T. evansi* is the causative agent of a most virulent type of trypanosomiasis amongst horses, mules, donkeys, camels, elephants, cattle, buffaloes, dogs, cats etc. *T. equiperdum* is the cause of dourine in horses and was known to occur in India but has been stamped out completely by the Livestock importation act IX of 1898 (Glander's & Farcy act) being imposed on this disease.

Indian equivalent of the disease caused by *T. evansi* is 'surra' meaning rotten or putrid. It has been taking a very heavy toll of our livestock for a long time. Salihotra appears to have recognised this condition in Indian horses perhaps as early as 700 B.C. and the credit of discovering *Trypanosoma* of surra goes to Evans who in 1880 reported that mules and camels at Dera Ismail Khan, were affected with this disease under natural conditions.

Transmission of surra from animal to animal is purely mechanical by means of species of biting flies (Fam. Tabanidae), and probably also mosquitoes in some cases. Under the act the affected animals have to be seized and destroyed. Drugs such as Naganol, Antrypol, and Moranyl have been found very effective in cases of surra. But recent observations have shown that neither slaughter nor treatment of clinically affected animals alone can be expected to check the disease as these measures cannot deal with the latently infected animals which spread the disease. It has been found by Dr Ray that when 0.1 c.c. of surra antigen is injected intradermally into ex-

perimentally infected hill bulls a local reaction characterised by a swelling which is hot, tender and oedematous is produced in 6-9 hours while in healthy animals the swelling is less marked, nodular, hard and circumscribed. The biological test subsequently performed have corroborated the above findings. Thus, for eradication of the disease from this country a three-pronged attack is necessary, viz., (1) detection of latent cases of the disease both during the surra season and when surra is absent, (2) adequate treatment of such cases and of clinically affected ones, (3) control of biting flies.

Eimeria, several species of which are pathogenic, produce diarrhoea or dysentery, emaciation and anaemia, which in acute cases causes death of the host.

'Red water' fever in dogs, cattle, sheep, horses etc. is produced by members of the genus *Babesia*. The disease is characterised by high fever, great destruction of red blood corpuscles with haemoglobinuria, jaundice, profound anaemia and finally paralysis and death.

In the members of the genus *Theileria*, schizogony takes place within the endothelial cells of capillaries of the internal organs. Such schizonts are known as *Koch's blue bodies*. Pathogenic species in this country is *T. annulata* which have two strains, one the Mukteswar strain, affecting young and adult cattle and the other 'J' strain producing fatal mortality in calves. The disease is transmitted by ticks and chemotherapeutic measures having proved of doubtful value, the disease is brought under control by tick control measures.

Concluding Dr Ray said that there remains yet wide gaps in our knowledge of life history of some of these protozoa affecting our livestock and it is important that these gaps be filled soon, as it is only from a knowledge of the life history of a parasite that we can plan an effective mode of attack. Protozoan infections, directly or indirectly are responsible for considerable economic losses among our livestock and the importance and urgency of intensive research work on such infection is emphasised if the health of our livestock is to be adequately safeguarded.

Medical and Veterinary Sciences

III Health With Special Reference to Ascites

S. W. HARDIKAR

IT is seen fairly frequently in Hyderabad and adjoining area in as much as about 1 in 65 of the patients seeking admission into the hospital show the presence of Ascites. It is not possible to state with accuracy how frequently it occurs in other parts of India; it would appear to be not less frequent at least, in parts where rice forms the chief article of diet, which is poorer in quality than a more varied diet. It is not a disease by itself. It is seen most commonly in diseases of the liver but occurs also in disease of the heart, kidneys, in tuberculosis and in tumours in the abdomen and chest. But when all these causes have been excluded there remain about 15% of the cases which show no evidence of organic disease, on the basis of their response to treatment and observation after discharge these cases appear to be due to malnutrition, i.e., underfeeding and defective quality of diet. It has now been proved that a diet lacking in proteins i.e., flesh forming foods and vitamins will in time produce poverty of blood and diseases such as beri-beri, and in experimental animals, ascites. Famine Oedema i.e. accumulation of water in the skin and swelling of limbs has been fairly widely recognized as the result of insufficiency and low quality of food under conditions of war and famine. But ascites with or without swelling apart from organic disease occurring in the poorer part of the population in times considered normal in India has not as yet so clearly been recognized as due to malnutrition. The treat-

ment in these cases consists in giving a well-balanced diet and a sufficiency of it rather than this or that particular drug though drugs are useful where special indications exist.

Evidence is accumulating to show that Cirrhosis of the liver, the disease in which ascites is most frequently seen, may itself be caused by malnutrition particularly insufficiency of proteins; in fact it has been shown that certain fractions of the protein molecule such as the amino-acid methionine are of particular importance in this respect. Milk protein is rich in methionine. To put into very simple language, proper food and enough of it particularly the inclusion of a certain amount of milk in the diet would go a long way towards preventing the occurrence of this condition and perhaps also of more serious liver disease.

In the not very distant past as a result of brilliant discoveries in Bacteriology the tendency among investigators was to look for external causative agents of disease. Recent studies have however, shown that a large group of widespread diseases (e.g., night blindness, beri-beri, pellagra, scurvy, rickets etc.) is due to a lack of something required by the body rather than an outside harmful agent attacking it. When the views put forward here about ascites are confirmed one more condition would be added to this group.

The problem is deserving of more attention and study than it has received.

Anthropology & Archaeology

The Megalithic Culture of Southern India

A. AIYAPPAN

DR A. AIYAPPAN, in his address to the above section, pointed out that in post-war sociology local or even national problems will tend increasingly to be parts of world problems. In dealing with post-war society, the men of affairs will have to base their actions on exacter estimates of public feelings, social stresses and strains etc., than in the past. Sociologists in India will have to prepare themselves for

new tasks and refine their technique on the lines of the Mass Observation and other kinds of social surveys. Referring to the problem of the aboriginal tribes of India, it is absurd, said Dr Aiyappan, to suggest that anthropologists desire to keep them "primitive". For scientific purposes a changing tribe is as full of interest as a static one. What the anthropologist wants is that reform or development

of the tribes should not mean break up as so often it has been in the past. Whatever is of value in tribal cultures should be conserved. The standard of archaeological and anthropological research and teaching in India is steadily improving. The school of archaeology, now functioning in full vigour at Taxila is a praiseworthy venture. Madras among the older universities of India is now giving considerable encouragement to anthropological studies and the arrangements made by this University to publish Canarese, Malayalam, Tamil and Telugu adaptations of the well-known textbooks of anthropology, Lowie's *Cultural Anthropology* will be specially appreciated by lovers of the subject all over the world. It is also pleasing to note that both in Bombay and Calcutta anthropological studies are being pursued with great enthusiasm. Though the Markham Report on Indian Museums made adverse comments on the very short-sighted neglect of ethnology in India, the projected National Ethnographic Museum for New Delhi, remains still a forgotten plan. If timely action is not taken now, posterity will lose the most valuable cultural material. Referring to the very important discovery made recently by Dr Wheeler, Director-General of Archaeology in India, of Mediterranean (Aretine)

pottery at the Arikamedu town site near Pondicherry it was pointed out that this discovery provides a basis for dating South Indian sites on the evidence of ceramic remains. The Arikamedu site is expected to throw considerable light on the nature of early Roman contacts with India.

Reviewing the existing knowledge of rude stone monuments of South India, such as funeral mounds, underground stone chambers, large earthenware jars and cists, which though not imposing in size as the pyramids yet are so numerous and varied in type that a good deal of information of past cultures from the prehistoric and the Vedic ages to comparatively recent times can be garnered from them by a diligent search. Even in the existing incomplete data there are pointers of cultural contacts between India and the far-flung regions of the Middle East and the Far East during prehistoric epochs.

The help that anthropology and archaeology gives in broadening and liberalising our outlook on the world has been appreciated in all well-conceived educational schemes (e.g. the Wardha Scheme). Anthropology can do a great deal in India to remove communal friction arising from mutual ignorance of the other man's cultural background.

Psychology

Language and Education

B. KUPPUSWAMY

THOUGH while some students are taught in Kannada and some in English at the High School stage, the medium of instruction at the college level is only English at Mysore. An attempt was made to study the relative differences between the two sets of students on the basis of their performance in the several subjects taught in the college.

Among the students in the Senior Intermediate class in the years 1942 and 1943 it was found that 335 has studied their subjects in the High school through English and 252 through Kannada. Their marks in the promotional examination in English, Kannada, and all the science and arts subjects were compared. The averages were computed and the significance of the difference between the averages was studied. In English and in Economics the

English group was superior to the Kannada group. But in the other nine subjects: Kannada, Mathematics, Chemistry, Physics, History, Logic, Zoology, Botany and Geology, the difference is negligible.

Barring the two subjects, English and Economics, we find that the continuation of English medium has not been a source of advantage to the English medium group nor the change from Kannada to English a source of handicap for the Kannada medium students. The performance of the two groups in the college examinations is about the same though the medium of instruction was changed with respect to some.

This investigation clearly brings out the fact that there is a confusion in the minds of people concerning the 'knowledge of a language' and 'the language as a medium of instruction'. Our results con-

clusively show that though some students learned all their subjects in their mother tongue in High schools, yet their knowledge in English language was enough to follow the lectures in the college classes in English and answer their papers in the English language just as well as those who were taught their subjects in English in the High school. In other words, the knowledge of English is not lowered when the medium of instruction was the mother tongue, so long as English is taught as a language subject.

As Ryburn remarks no child can grow up to be a good and useful citizen unless he has been properly educated in the use of his mother tongue. Clear thinking, clear expression, sincerity of thought and feeling, fullness of emotional and creative life can be cultivated best through the mother tongue.

The aim of the language teacher in the basic school should be to secure for the pupil a mastery over the ordinary language in daily use.

Recent work in Europe and America has shown that the text-books in the first few years of schooling should be very carefully planned.

There is a vast gap between the literary side and the spoken side of the modern Indian languages. The textbooks attempt to introduce the child to the literary language. But to the vast majority of our children the literary language is almost a 'foreign' language and hence the slow progress of elementary education. This problem can be solved only by preparing 'basic word lists' in each language and helping the child to master this limited vocabulary before he goes on to the literature proper. Another important aspect is a planned way of introducing new

words. Books must be prepared by applying all the known principles of language learning.

Should every Indian know his mother tongue, the national language, Hindustani, and the international language, English? Further what is the meaning of learning a language? Does it mean learning to read and write in that language? Should the medium of instruction be the 'provincial language' or the mother tongue?

If the provincial language is different from the mother tongue the child automatically picks up both the languages. In the interests of economy to the child's energies as well as to the provincial educational budget it is better that the child learns in the basic school in the provincial language.

When the provincial language is not Hindustani there is no need for the child necessarily to pick up a second language. After all the bulk of the people don't move out of their province. For inter-provincial contact learning how to speak and understand the national language is quite enough.

The international language, English, is only for the few who are destined to become leaders of the community. The microscopic minority who proceed to the University should know it. The rest do not need it.

But this should not mean that any individual is prevented from learning additional languages if he wants to. Language institutes should be started in each district or even *taluk* where courses are so designed that a man may pick up in a very short time mere speaking or reading and writing as well, of the language of the neighbouring province, or the national language or the international language.

Geology and Geography

India's Position with Regard to Coal Resources

N. N. CHATTERJEE

IN his Presidential Address before the above section Prof. N. N. Chatterjee reviewing India's position with regard to her coal resources suggested a more detailed survey and prospecting work to be undertaken by the Geological Survey of India, the provincial survey departments and the Indian States and that provision for adequate staff should be made accordingly.

Referring to the high sulphur in the tertiary coals of India, Prof. Chatterjee, elaborated schemes for the desulphurisation processes, thereby making available to us these low grade coals and utilising them in an efficient manner.

The problems of coal conservation included maximum extraction and proper utilisation of coal. Regarding maximum extraction he pressed for the

introduction of vertical rotation of working and compulsory and complete stowing process in the coalfields whenever such measures would be found necessary.

The partial grading of a seam as allowed at present by the Indian Coal Grading Board should be totally and immediately stopped as such partial grading led often to extensive fires and collapses with permanent loss of valuable coal properties. Assistance should be given to those who wanted to mine coal by stowing process. It has been suggested that in order to meet the demand cess should be levied on the Coal Industry as well as on the whole population of the country on account of the fact that coal is of enormous national importance and that the industrial expansion is intimately connected with the major interests of the *(whole)* people.

Prof. Chatterjee laid great stress on the subject of proper utilisation of the different grades of coal for specific purposes. This step according to him would go to complete the process of conservation of India's coal for the likely expanding needs of the future. Of the many instances of misuse of coal in India he mentioned about the Railway Board and suggested that the Railway Board should introduce pulverised coal firing in their locomotive boilers and in this way they could profitably utilise the inferior grade non-caking coals and release a great amount of high grade caking and non-caking coals for other more important uses. He also suggested that instead of mine sampling car-sampling during despatch should be universally adopted and that sale of coal should be made by contracts on specification of analysis with an arrangement of penalty and premium. Referring

to the schemes of Nationalisation and Rationalisation he strongly recommended that there should be more State control and intervention for the maximum conservation of India's limited resources of coal by process of widespread stowing and proper utilisation and suggested that the mal-practices should be stopped by strict legislation so that the coal industry might be placed on sound footing for its successful development and expansion.

The available coal resources is estimated as 10,000 million tons and calculating the probable life of the reserves Prof. Chatterjee showed that the high grade caking coals have only very short lease of life (less than 50 years) if the present wasteful methods of extraction and use is continued and thus emphasised the necessity for conservation and the urgency in the matter.

For the successful functioning of the schemes of improvement in the Coal Industry India should have a *National Mineral Policy* and that there should be a central organisation like the *National Research Council* for advice and guidance. For such economic planning and for all practical purposes India should be considered as a single unit devoid of provincial barriers. Mineral deposits and their development should therefore remain the subject of the Central Government and not of the different provincial Governments.

Prof. Chatterjee concluded his Address by mentioning about the serious lack of encouragement on the part of the authorities in the matter of teaching of geology.

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SOME CONSTITUTIONAL HINDRANCES TO DEVELOPMENT OF INDIA'S NATURAL RESOURCES

THE regime of President Roosevelt who passed away suddenly is a memorable land-mark not only in the history of the U. S. A., but also of the whole world. Posterity will remember him not only for his able leadership during the present world conflagration, but also for his peacetime activities, for the drive and initiative which he brought to bear on the otherwise dry routine of administration. When he took charge of the Federal Government in 1933, the U. S. A. had been for years in the throes of a terrible economic depression the memory of which has not yet completely faded. The historian Beards describe the depression in the following graphic words:

"In the autumn of 1929, just as the country seemed safe and sound on the 'high plateau of permanent prosperity', except for farmers, the business boom attributed to Republican statecraft burst with a resounding crash. The prime stocks of the leading corporations fell nearly forty points on the average in a single day, October 29, when more than 16,000,000 shares were dumped on the market at the New York Stock Exchange. This panic was followed by the explosion of banks, railway companies, and private concerns, by increasing woes among farmers already in straits, by the closing of factories, shops, and offices, and by a steep decline in the opportunities of employment for artists, writers, musicians, architects, engineers, playwrights, and teachers—indeed the whole white-collar class—from New York to California. In the opening months of 1933, it was estimated, 12,000,000 men and women were out of work. Ruin and hunger, if not starvation, haunted not only the shacks of tenants and sharecroppers on the land, not only the back streets inhabited by industrial and professional classes, but also the grand avenues of great cities."

President Hoover, a republican who was then occupying the White House, wrestled in vain with the situation in his own way, and in the Presidential Election of 1932, he had to make way for the democratic candidate, Franklin D. Roosevelt who at once took energetic measures now known as the 'New

Deal' to cope with the situation. This measure substituted Federal interference and initiative in place of *laissez faire* almost in every walk of life and had been the target of continuous attacks by the Republicans. But whatever opinions might be held about the measure, it is admitted that it dealt effectively with "Unemployment".

One of New Deal measures was the undertaking by the Federal State of huge developmental schemes for providing employment; these works were generally put in charge of relevant Federal Departments e.g. the Bureau of Reclamation which planned huge projects—building of dams, excavation of canals, and construction of hydro-electric stations. In 1938, work was in progress in 32 projects in 12 different States. It was during Roosevelt's regime that the Boulder Dam, the Grand Coulee Dam and many others too numerous to mention were constructed, and as a direct consequence of these measures America's productive capacity was enormously increased. It was during this period (1934) that President Roosevelt tried a new experiment in administration by creating the Tennessee Valley Authority to deal with the Tennessee River. It may be mentioned here that though the TVA Act was actually piloted through the Congress by Senator Norris during the regime of Roosevelt's predecessor, the measure was vetoed by the latter as being antagonistic to the American tradition of interference with private enterprise.

It is well-known that it was only President Roosevelt's forceful backing which was responsible for the quick execution of these constructive measures. In the U. S. A., there is a good deal of ambiguity in the constitutional position regarding the prerogatives of the States and the Federal Government, and legally many measures could not have been under-

taken without the concurrence of the States concerned. To take one example, in the Boulder Dam project, the river to be harnessed *viz.*, the Colorado River or its tributaries pass through the States of Utah, Wyoming, Arizona, New Mexico, Colorado, Nevada and California. Six of the States ratified the project drawn up by the Bureau of Reclamation, but the State of Arizona where the dam site is situated took a hostile attitude and never formally ratified the scheme.* Probably under a less resolute President than Roosevelt many of the projects of his State departments would have remained dead letters in the face of such strong opposition.

We have already indicated how in the case of the TVA Roosevelt circumvented the constitutional difficulty by enjoining the Authority to take such measures as will make the river "navigable with 9 feet of draft". It is now known that 'Navigation' was only the thin end of the wedge, and the Authority carried out the fullest measures of multipurpose development, *viz.*, flood prevention, soil conservation, navigation, and power generation, some of which undoubtedly, according to the constitution, were prerogatives of the States. The TVA projects have been frequently challenged in the Supreme Court by interested parties, mostly capitalists owning private electrical undertakings. We quote in this connection an interesting passage from Barrows' 'Water Power Engineering' (1943). The case is not connected with TVA projects, but nevertheless, it deals with a pertinent legal question:

"The decision of the U. S. Supreme Court in the New River case (85 L. Ed. 201) was of importance in this respect, for this case involved the scope of the Federal Commerce power in relation to the requirements of a Federal license upon New River, in the States of Virginia and West Virginia. The district and circuit courts had both held that New River was not navigable and that the United States could not enjoin the respondent from constructing and putting into operation a hydro-electric dam on the river just above Radford, Va. The U. S. Supreme Court, under date of December 16, 1940, found that New River was navigable, and further more affirmed that the constitutional power of the United States over its water is not limited to control for navigation. In this respect the Court stated:—In truth the authority of the United States is the regulation of commerce on its waters. Navigability, in the sense just stated, is but a part of this whole. Flood protection, watershed development, recovery of the cost of improvements through utilization of power are likewise parts of commerce control . . . the respondent cannot, by seeking to use a navigable waterway for power generation alone, avoid the authority of the government over the stream. That authority is as broad as the needs of commerce. Water power development from dams in navigable streams is from the public's standpoint a by-product of the general use of the rivers for commerce. To this general power, the respondent must submit its single purpose of electrical production. . . . The point is that navigable waters are subject to national planning and control in the broad regulation of commerce granted by the Federal Government. The license conditions to which objection is made have an obvious relationship to the exercise of the commerce power."

* It is said that Arizona actually mobilized its army to stop the Boulder Dam project being carried out.

Since the success of the American experiment, the idea of total development of river valleys has caught the imagination of the people and government of all countries. In the article by Mr K. Ray, published elsewhere in this issue, a description has been given of an attempt to develop the Murray River Valley in the Australian Commonwealth. One point will at once strike the reader; the rate of progress in Australia has been tantalizingly slow owing to the fact that four parties, *viz.* the States of Victoria, New South Wales, South Australia and the Federal Government had to agree before any measure could be undertaken. For example, though schemes for water power development have been prepared since 1924, no active measures appear to have been taken for twenty years. Australia has not produced a Roosevelt courageous enough to cut through the smothering red tapes of Constitution!

The importance of undertaking full scale development of river valleys has now been recognized in this country. Dr B. R. Ambedkar, the Hon'ble Member for Labour, presiding over the conference of representatives of the Central, Bengal and Bihar Governments, held in January, 1945 (*vide* SCIENCE AND CULTURE, February, 1945, p. 333), revealed the Government's intention to create the Damodar Valley Authority. In that connection he remarked:

"The Government of India have very much in their mind the Tennessee Valley scheme operating in the United States of America. They are studying the scheme and feel that something along that line can be done in India if the Provinces offer their co-operation and agree to override the provincial barrier which has held up so much of their progress and their prosperity. . . .

"The Damodar river is the first project along this line. The authority which will be in charge of this project after it is completed, will be more or less modelled, as far as it may be possible, on the *Tennessee Valley Authority*. It will be a co-operative undertaking in which the Centre and the Provinces of Bihar and Bengal will be partners. The Government of India are anxious to give shape, form and life to the project, and are keen that no time should be lost in doing so.

"The Government of India feel that they cannot proceed further in the matter unless certain preliminaries are explored. The first such preliminary is the site of the dam. Obviously it cannot be decided in accordance with the wishes of Bengal. Equally, it cannot be decided in accordance with the wishes of Bihar alone. And even if the two Provinces agree upon a site, it could not be finalized without the advice of experts. There are other aspects which have also to be gone into."

We learn from a recent press report that the Government have decided to set up a Central Waterways, Irrigation and Navigation Commission. The Commission will advise the Central, Provincial and State Governments on waterways, irrigation and navigation problems, on principles governing water rights, inter-provincial disputes, and on appropriate basis of agreement between the parties in dispute. But the Commission is no substitute for the Authority. Besides, past experience of the working of such commissions does not encourage us to entertain any optimistic view. We think that it would have been

a better policy to create a new department like the Bureau of Reclamation in the U. S. A.

We have not heard anything further about the appointment of the D.V.A., and according to a reliable source of information, the Central Government finds that probably they have not got the constitutional power to appoint such a new type of administrative machinery as the D.V.A.

According to List II of the Government of India Act of 1935 (*vide* C. L. Anand, p. 559), the provincial legislative list (defining the functions of provincial governments) includes (9) water, that is to say water supplies, irrigation and canals, drainage and embankments, water storage and water power, (20) inland waterways and traffic thereon, while List III, containing the entries under the concurrent legislative list, includes (31) electricity, (32) shipping and navigation on inland waterways as regards mechanically propelled vessels.

We are not lawyers, but it is obvious from these passages that the D.V.A. referred to by the Hon'ble Member for Labour cannot be created unless the Central Government and the two Governments of Bengal and Bihar agree to do so. For the two Provincial Governments it means surrender of some

power with which they have been invested under the Government of India Act of 1935, and one would be too optimistic to think that the two Provincial Governments would willingly surrender such power.

On the otherhand, we have not the slightest doubt that the course suggested by the Hon'ble Member for Labour is the right one, for the existing departments of the Provincial Governments have neither the personnel, equipment, nor the organization to frame comprehensive schemes and to tackle the multipurpose development of river valleys, and even if they create such an organization, it is doubtful whether two Governments can agree, quickly enough for the ensurance of the success of the scheme, upon a common line of action. This is true not only of the Damodar Valley, but for almost every river-valley which needs a similar treatment, for there is scarcely a single river valley which is confined within the limits of one single province or one single Indian State. By making '*Inland Waterways*' a provincial subject, the Government of India Act of 1935 has created a constitutional hindrance to development of India's natural resources, and we can scarcely expect any Rooseveltian lead from the Government of India as at present constituted.

SCIENTIFIC EDUCATION AND RESEARCH IN RELATION TO NATIONAL WELFARE—IV.

THIS article is the last of a series written with a view to clearing our ideas as to how scientific education and research can be utilized for purposes of national welfare. With this object in view we have in the first two articles given an account of how such problems are being considered in other countries like Great Britain and the U. S. A. In the last article we have made a survey of the facilities for advanced teaching and research in science available in this country, and of the suggestions which have been made for improving them. We started with the dictum that academic and industrial research are interdependent and complementary, from which we concluded that applied research *i.e.* application of science to problems of human welfare will flourish best under conditions under which fundamental research are found to be promoted. We have now, in conclusion, to consider the conditions favourable to the promotion of fundamental research in this country.

PLANNING OF FUNDAMENTAL RESEARCH

If we accept the view that application of science is essential in all schemes of planning for national welfare we have also to accept the corollary that fun-

damental research is a public need and a public responsibility.

The industries of our country are based upon fundamental discoveries of past generations; that some of them are successful depends upon a combination of favourable circumstances *viz.*, availability of raw materials, and of a large though poor consumer population. These industries have not been able to raise appreciably the standard of living of our people. For this purpose a much greater application of science to industry is necessary and for it two conditions are essential, namely (a) to establish conditions favourable for growth of fundamental research and (b) to diminish the time lag between the making of significant discoveries and their practical application to industry, agriculture, and medicine. The first is research and the second is development; both are essential and in both we have not so far achieved any large measure of success. When speaking of the needs of one, we do not desire to depreciate the other. Both Government and industry must recognize the essential importance of the former and also provide facilities for the latter. It will not be right to blame the scientist if he cannot at one and the same time make new discoveries and also develop

them to such a stage that the 'practical' industrialist and the financier can at once realize their applicability. Both the scientist and the industrialist must broaden their outlooks so that by mutual co-operation it may be possible to develop the technique of the pilot stage of production. A. R. Olpin states in a recent discussion in the U. S. A. that 'during the war many physicists are learning for the first time that there is as much thrill and satisfaction in applying physical truths as in discovering them.' Some of us in this country who have obtained their initiation in applied research during the present war have had similar experiences. We shall welcome similar expressions of change of outlook from some of our industrialists on the place of pure research in industry.

We have now to consider how fundamental research in this country should be financed and who should undertake such research. We have seen that in the U. S. A. training and research are supported (i) from funds of foundations and endowments, (ii) by industry, and (iii) by Government. In our country we obtain very little support from industry; a part of the examination fees received by some universities are utilized for this purpose, a not very desirable expedient. (i) represents usually the accumulated savings of the country. Some institutions for the advancement of science were founded in this way, e.g. the Indian Association for the Advancement of Science by Mahendralal Sircar, the Indian Institute of Science, Bangalore by Jamshedjee Tata, and the Bose Research Institute by Jagadish Chandra Bose. Besides two Bengali lawyers Taraknath Palit and Rashbehary Ghose gave away their life's savings to the Calcutta University for the endowment of a number research professorships in pure and applied sciences. Since then, as the intimate relation of applied research to industry began to be realized, the tendency has been to endow applied science. The industrial magnates have not yet discovered that 'applied science cannot live on the fundamental discoveries of past generation, and that unless fresh discoveries are made it dies of inanition.' There has been during the past few years a great accumulation of profits from war industries; but as yet no part of it is being set apart for the endowment of pure research. It remains to be seen whether the recommendations of the Industrial Planning Research Committee will include provisions for the support of pure research.

In the past the Central Government have provided funds for support of applied researches in medicine and agriculture. Besides a number of surveys are maintained by the Government in botany, geology, geodesy, meteorology, and zoology. Though these surveys are directed towards primarily practical ends, many first rate scientific publications have come out from these surveys. The several retrench-

ments to which these surveys have been subjected, on the recommendations of Committees presided over by such eminent business men like Lord Inchape and Sir R. N. Mookherji, have resulted in a considerable curtailment of their present usefulness. There is a great deal to be said in favour of A. V. Hill's suggestion (V) that the research organizations of the Central Government at present attached to different departments, like Education, Health and Lands, Industry, Labour, Post and Telegraphs should be put under a Central Organization for Scientific Research and placed in charge of the Member for Planning and Development. 'One great objection to the organization of research under a number of separate authorities, quite apart from lack of co-operation and a common policy resulting from it, is that financial and other support of research is often patchy and inadequate. The present sorry positions of the Botanical and Zoological Surveys and of Fishery Research is a good example how important scientific activities can be starved under a Department in which at some moment there was a failure of interest in them. The decision not to complete the 1941 census of India could never have been taken if the consequences had been properly thought out. . . . Under a central organization for research the different subjects could hope to be treated with the same degree of uniform encouragement according to their needs'.

In many reports we find the suggestion that fundamental researches should mainly be undertaken in the universities. It may be true that in the past century many fundamental discoveries have been made in university laboratories; even then the Royal Institution during the time of Davy and Faraday has been responsible for many of them. In recent years the Kaiser Wilhelm Institutes in Germany, the Research Laboratories maintained by Rockefeller, Carnegie and other well known foundations, and other laboratories maintained by big industries in America like the G. E. C., R. C. A., Bell Telephone Laboratories are responsible for many such discoveries. Under modern conditions even in this country it will not be wise to tie up fundamental research with the universities. They are primarily places for advanced training in science and in methods of scientific research; besides they undertake also researches in pure and applied sciences. It is desirable that universities should receive adequate grants for equipment, maintenance of laboratories, for the establishment of new schools of research, and also for the maintenance of a number of research scholars and fellows. There are, however, certain drawbacks attached to university research, when co-operation of specialists from several sciences are required for the purpose of forming research units. Departmentalism of science arising from the requirements of teaching

does not encourage such interdepartmental co-operation.

Some thing can be said in favour of starting independent research institutes in which research is directed towards the realization of a not too closely defined aim; in which provision is made for research in pure and applied sciences. In such an institute specialists from several sciences can be recruited, who, while free to devote themselves to investigations pertaining to their particular sciences, can also co-operate in investigations where team work is necessary. Such institutions can be maintained from endowments or Government grants or from both, supplemented by grants from organizations supporting research. Possession of endowments enable such institutions to undertake some fundamental research, whose utility may not be immediately discernible, while a certain amount of ballast is provided by the acceptance of grants for specific applied research problems. Such institutions should be in touch with their local universities and should also undertake the training in research of successive generations of young workers.

Fundamental research can, therefore, be undertaken in different institutions, e.g. (i) in universities and other teaching institutions of university status, (ii) in Research Stations maintained by grants from Imperial Research Councils for Agriculture and Animal Husbandry and under similar Councils for Medical, Scientific and Industrial Research, (iii) in industrial research laboratories, when industry has become sufficiently scientific minded to value and encourage pure research, and (iv) in research institutions. At present in many Government scientific departments some confusion exists between the relative importance of research, development and extension, and it happens sometimes that research minded young officers are discouraged by their official heads from undertaking any research work. Probably the suggestion of A. V. Hill of bringing 'research into a single organization, and leaving the departments to make their own arrangements for applying the results to practical problems they have to face' may obviate these difficulties.

All such proposals for extension of research will involve grants from public funds on scales much larger than has yet been contemplated in this country. Such grants should preferably be given in the form of block grants extending over a number of years, and distributed through some committee in which non-official scientists are strongly represented.

ORGANIZATION OF RESEARCH

We have seen in a previous article how State supported research is organized in the United Kingdom. Such research is controlled through the agency of three Research Councils for Agriculture,

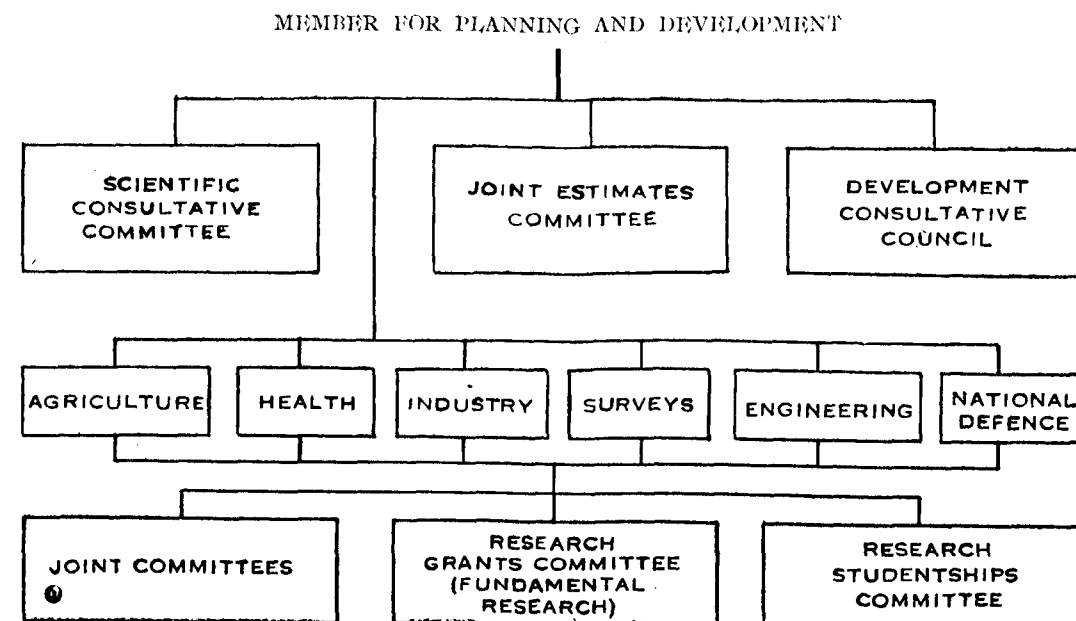
Industry and Medicine, all in charge of a single Minister, the Lord President of the Council. The executive heads of these Councils are the secretaries who have all been very distinguished scientists. The Councils are also the governing bodies and are composed mainly of distinguished scientists, professional men and industrialists with scientific interests and are presided over by non-official Chairmen. The appointments to these Research Councils are made by the Lord President, and the concurrence of the President of the Royal Society has to be obtained in each case.

In the U. S. A., the National Research Council is described "as a co-operative organization of scientific men of America; its members include not only scientists and technical men but also business men interested in engineering and industry. Membership of the Council is composed largely of representatives nominated by 85 scientific societies and include representatives of some research organizations, of Government Scientific Bureaus and a limited number of members at large. The total number is 220 in all. About one third of its members are appointed by the President of the United States after being recommended by the National Academy and from the various departments of the Government, such as War, Navy and others. All the rest receive their formal appointments by the President of the National Academy of Sciences." The constitution of the N. R. C. is entirely democratic; on the other hand, its function is only advisory and for ensuring co-ordination. It has no executive authority for the disbursement of public funds for support of research. A new body called the Office of Scientific Research and Development has been created by executive order for this purpose.

Turning to the question of organization of research in this country, two schemes are before us, (i) one formulated by A. V. Hill in his report (V) and (ii) the other sponsored by the National Institute of Sciences for India (see SCIENCE AND CULTURE, February, 1944). Hill's recommendations are extensions and modifications of the British plan to suit what Hill considers to be the present Indian conditions. The proposals are for the creation of a Central Organization for Scientific Research under the Member for Planning and Development, under which six Research Boards will be constituted. The members of each Board will be mainly eminent and experienced scientists with a certain number of professional men in the respective fields, whose number will not exceed those of the scientists. There is a half hearted suggestion that perhaps the National Institute of Sciences may be allowed to nominate some of the members of the Board. Each Board will have a certain number of ex-officio members representing the Development Departments. Each Board

will have as Chairman a non-official, either a distinguished scientist or a professional man in the field concerned. There will be a Director of Research associated with each Board, who will be its secretary and principal administrative officer. The Directors of these Boards will be responsible, under advice from their respective Boards and under the Member for Planning, for directing, organizing, initiating and co-ordinating research on a national scale in their respective subjects. Each Board will have the power to allocate grants for specific researches in its own fields, to be carried out by agreement in any institution in India. There will be a Joint Research Committee of all the Boards to award grants to university and other research laboratories throughout India for the encouragement of fundamental scientific research in general. When a University Grants Committee is set up, these general grants will be given in consultation with it. Also a Research Studentship Committee will be set up jointly by different Boards, to consider applications for Research Studentships. There is provision for preparation of joint estimates for presentation, through the Member in charge, to the Finance Department for approval and sanction, after which the Boards will be free to spend. These six Boards will replace the existing three Councils of Research. There will be also a Scientific Consultative Committee consisting of six Directors and six

authority for the members of the several Boards will be the Member in Charge who, unlike his British colleague, is not under the control of the Legislature, and therefore, not removable by adverse vote; his appointment and removal will be with the Governor General. Our past experiences do not justify the expectation that all decisions of the Governor General will be taken purely with the view of safeguarding Indian national interests. Further the Member in charge, when considering names for appointment to the different Boards, will not have the benefit of advice from any non-official scientific body as provided in the British case. He will have to depend primarily on the advice tendered by the Directors of the different Boards, and there may be a tendency on the part of some of the Directors to recommend 'yes men' for such nominations. Also the Boards so constituted will not be responsible to any representative scientific council for their activities. The scheme sponsored by the National Institute of Sciences contemplate the formation of a National Research Council, consisting of scientific and technical experts, not exceeding sixty in number, the majority of whom shall be elected by non-official scientific organizations including universities and other institutions of university status, the remainder being nominated by the Central Government from amongst their scientific and technical experts. This



A plan for the organization of scientific research and development in India.

distinguished scientists to advise the Member in charge on general policy in relation to research.

Hill's scheme is a well thought out one and, as said before, it is based upon British precedents, but with certain essential differences. The appointing

Council will formulate plans and watch over the main lines of research and technical development, advise Government on a common policy, distribute grants allocated to them by the Central Government for promoting approved researches, for the mainten-

ance of selected research scholars, for scientific publications and for other purposes. This Council will, in consultation with certain non-official scientific organizations, constitute Research Boards, four in number for the present. The functions of these Research Boards will be generally similar to those proposed in Hill's report, except that no provision has been made on matters of appointing Directors of Research associated with such Board and of the powers to be exercised by those Directors. The present scheme require to be further elucidated, both as regards the composition of the Research Boards and the nature of the control to be exercised by them over the Research Stations under the Central Government.

The scheme has the primary merit of interposing between the source of funds for the support of research, viz., the Government together with the Legislature, and the recipients of such support an independent body of scientists, with a necessary amount of representation from other interested bodies. The authority which such a Council will exercise depend on the attainments of the scientists elected or nominated to it. As Dr F. B. Jewett, President of the National Academy of Sciences, U. S. A., truly remarks, "If you want to get a thing done, don't give people police authority to do it—make them so distinguished that nobody dares run counter to their advice."

RIVER MURRAY COMMISSION IN AUSTRALIA

KAMALESH RAY

THE proposal of harnessing the Damodar River as a planned unit has presented certain difficulties on the question of provincial rights and responsibilities, since the river flows through two provinces of Bihar and Bengal. The river and other natural resources of a country, however, do not obey the political boundaries, and if we have to develop fully all that the river is capable of giving us, the governments concerned must have to invent the necessary administrative machinery to deal adequately with the problem, and, if necessary, circumvent the restrictions imposed by a defective Act of the Government (1935 Act). Such has been the story of all the rivers and river basins of the world, e.g. the Danube in Central Europe which flows through a number of sovereign countries, the Tennessee in the U. S. A. which flows through seven States of the Union, (for detail, see SCIENCE AND CULTURE, April, 1944), and the River Murray in Australia. The last river forms the subject of our present study and criticism.

THE RIVER AND THE PROBLEMS

The River Murray has a total length of 1,700 miles, with drainage basin 2,50,000 sq. miles. It forms the boundary between New South Wales and Victoria States for about 1,200 miles and then flows through South Australia for another 500 miles before it enters the Lake Alexandrina and communicates with the sea. The river rises at the Australian Alps at an elevation above 7,000 feet and drops to the plain in course of its first two hundred miles and then traverses a great length over flat country with an average slope of 3 inches to a mile. It has a large number of tributaries, the most notable of which are the Darling and the Murrumbidgee rivers.

The problems associated with the Murray River

in Australia have nothing striking in particular and present the usual story of the people taking trouble to move the Government in devising ways and means

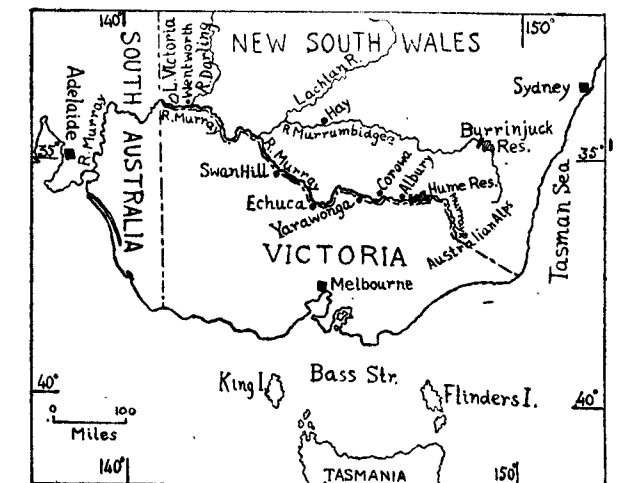


FIG. 1. Course of the Murray River.

to develop the river system for the benefit of the country.

The early problems were restricted to navigation and irrigation, and the attention to these problems was drawn as early as the middle of the nineteenth century. But as the river flows through the three States, viz., New South Wales, Victoria and South Australia, the difficulty of reaching agreement on the question of utilizing the river to the advantage of all raised problems of the rights of the three States to the river. The differences of outlook of the various authorities concerned undoubtedly prejudiced for many years any serious attempts to arrive at a satisfactory agreement.

EARLY INVESTIGATIONS

Primary investigations, however, were made by Royal Commissions to enquire into the utilization of the waters of River Murray by the Government of New South Wales in 1844, by Government of Victoria in 1886 and by the Government of South Australia in 1887.

In 1902, the Murray River Main Canal League held a conference at Corowa in April 2, 3, and 4 and invited the Prime Minister of the Australian Commonwealth, the Premiers of the three States, and many other representatives of various districts and associations. The Murray River League passed the following resolutions:

(1) The Governments of the Commonwealth and States concerned be urged to co-operate in preparing and carrying out a comprehensive scheme for the utilization of the waters of the River Murray which while improving the navigability of the river would also provide for the imperative needs for the residents on both banks in the conservation and distribution of its waters.

(2) That the States of New South Wales, Victoria and South Australia empower the Federal Government to provide definite storage reservoirs on the Upper Murray and a weir at Bungwannah, such works to be national.

(3) That public bodies interested be approached by their respective Governments and requested to complete their distributing works concurrently with the head works.

(4) That all natural waters not already appropriated under legal sanction shall be declared public waters and made subject to a suitable system of law applicable to the whole continent—Commonwealth and States to consider legislation to provide for regulation and disposal to secure fullest possible use for the whole people.

In his reply to the conference of the River League the Prime Minister, Mr Edmund Barton made it clear that the Commonwealth has sympathy and support for the movement, but would not like to arrogate to itself any power or to interference with respective State rights; and that enquiry among the States should be made about the recommendations of the League. He further suggested that to remove any political difficulties standing in the way of consummation of the scheme, the proper procedure would be to place the whole question in the hands of an authority which would be of an impartial character.

A Royal Commission was again instituted on 13th May, 1902 "to make a diligent and full enquiry concerning the conservation and distribution of the waters of the River Murray and its tributaries for the purpose of irrigation, navigation and water

supply". The Commission gave the following recommendations:—

(1) The division of waters of the Murray basin between the three States.

(2) The construction of storages in the Upper Murray, at Lake Victoria, and weirs at the Murray mouth.

(3) Appointment of a permanent River Murray Commission.

(4) First instalment of a scheme of locks.

(5) Legislation to vest the ownership of all natural waters in the Crown.

(6) Diversion scheme to proceed concurrently with the construction of the dam or the storage reservoir.

The Royal Commission remarked on the creation of a permanent River Commission as follows: "The control of Navigation being in the Commonwealth, and of Irrigation and Conservation in the States, it is necessary that their administration should be kept apart. Whilst, however, Commonwealth authority and control of State rights should be distinct, it is important that there should be proper concert between them. This object would be secured by the appointment of a Permanent Commission, representative of New South Wales, Victoria, and South Australia, to administer and control diversions, and to construct and control those works of irrigation and conservation in which more States than one are concerned, with power to consult with the Federal Government, and to conclude agreements with it, on all such matters affecting rivers as are subject to Commonwealth jurisdiction. The realization of this proposal would demand concurrent legislation on the part of the States, with confirmatory action by the parliament of the Commonwealth.

RIVER MURRAY WATERS ACT OF 1915 AND CREATION OF RIVER MURRAY COMMISSION

By a resolution at a conference of the Premiers of the three States held in Melbourne on 23rd January 1911, three engineers were instructed to present a report and recommendations which would be essential or conducive to a settlement by agreement between the three States on the question of River Murray and its tributaries.

The engineers sent their report and recommendations on 24th July 1913. Their recommendations chiefly concentrated upon Upper Murray storage of nearly a million acre feet to start with, and contained suggestions for building more storage dams on the tributaries as the main work progressed. The building of navigation locks and planning of diversion work for water distribution were also suggested. On the administrative direction, the Conference of Engineers suggested agreements between the three States.

The agreement was eventually entered into on 9th September 1914 to carry into effect the resolutions concerning to the economical use of the waters of the River Murray and its tributaries for irrigation and navigation and the reconciliation of the interests of the Commonwealth and the riparian States.

The agreements were ratified by the Act of Parliament—the River Murray Waters Act, 1915. Similar legislation was passed in the three States simultaneously, and it came into force on 31st January 1917.

The River Murray Commission was also appointed at this stage to give effect to the agreements and Act. The Commission consisted of four Commissioners, one from Commonwealth (he is the President) and one from each of the three States.

The River Commission, however, is not a body corporate and has no power to contract and carry out works or to acquire land. The Commission, however, may employ under its sole control officers and servants and may remove or dismiss them. It may also arrange with a contracting government for the performance of work or services by officers of that government, and the services of any such employees may be used partly by the Commission and partly by the contracting governments. Besides, the Commission (a) carries on an affective and uniform system of stream gauging on main river, tributaries and diversion branches natural or artificial, (b) deals with matters of finance, collecting from the three States and the Commonwealth their shares of the estimated expenditure for each year and remitting to the States the funds required for the works to be carried out, (c) approves of the general schemes of works submitted by the States, (d) orders, directs and supervises the work and watches the progress, (e) collects tolls and apportions same to the States, (f) may declare quantities and times for deliveries of water and the means of varification of all deliveries of water provided for in the Agreement, (g) submits annual report and balance-sheet to contracting governments.

The State governments are responsible to maintain the works constructed by them including snagging and dredging in the vicinity of the works.

FUNDS AND PROGRESS OF WORK

The original cost of construction was apportioned thus:

Commonwealth	£1,000,000
New South Wales	£1,221,000
Victoria	£1,221,000
South Australia	£1,221,000
Total	£4,663,000

Under a later agreement the amount was increased to a sum not exceeding 12 million pounds, to be borne in equal shares by the contracting governments.

By the close of 1944, the following works have been completed (excepting certain minor details):

(a) Upper Murray storage of capacity 1,250,000 acre ft. at Hume Dam, with a provision to increase the capacity to 2 million acre ft.

(b) Provision of storage at Lake Victoria.

(c) Construction of 5 barrages.

(d) Construction of 14 weirs with locks.

(e) Construction of 2 weirs on River Murrumbidgee.

The total expenses incurred so far have been estimated at £11,896,091, or nearly 16 crores of rupees.

It has now also been proposed that after the war, when labour and materials would be easily available, the Hume Reservoir should be increased in storage capacity from 1¼ million acre ft. to 2 million acre ft. by raising the dam height.

Among other post-war policies, one is that the water supply authorities would be made responsible to educate farms in scientific agricultural practices. Incidentally, this reminds us of the demonstration farms of the Tennessee Valley Authority in the U. S. A.

QUESTION OF HYDRO-ELECTRIC POWER DEVELOPMENT

The question of developing hydro-electric power from the Murray waters, particularly at the Hume Dam, has been in consideration since 1924, following upon a conference. The question was again discussed in 1930, but no conclusive action was taken. At the minister's conference in January 1944, it was again raised by the Victorian representatives when the following resolution was passed.

"That the question of the utilization of the Hume waters for purposes of generation of electricity be referred to a conference of representatives of the appropriate departments of the Commonwealth, New South Wales, Victoria and South Australia, as a continuation of discussions entered into in 1930 to determine the manner of utilization of the waters so far as generation of electricity is concerned."

Recently another conference was held of representatives of the Commonwealth and the State Electricity Undertakings to further consider the question. A report of this conference is awaited.

REGIONAL PLANNING ON MURRAY VALLEY AS A POST-WAR RECONSTRUCTION PROJECT

As the ideas are developing and progress is made, the problem of the regional development of the River Murray Valley has been raised by the Ministry of Post-War Reconstruction and also by municipalities and other bodies interested in this matter, who have formed themselves into a Murray

Valley Development League. The League held a conference on 15th and 16th August, 1944, and made the following recommendations to the Commonwealth Government:

"That this conference ask the Commonwealth Government to set up a Board of Enquiry consisting of representatives of the Commonwealth and the three States of South Australia, Victoria, and New South Wales, to report on all matters in connection with the development of the Murray Valley, in all its economic, cultural and social aspects, having regard in particular to the following subjects:

(a) The condition of settlement throughout the Valley.

(b) Any alteration in existing condition of settlement that may be desirable in order better to induce increased settlement, development and production.

(c) Methods for the better utilization of the lands of the Valley and the development of their potentialities by (i) the further development of the irrigation schemes; (ii) ensuring the use of the land for the purpose for which various areas are best-suited; (iii) encouraging the investment of capital therein; (iv) securing the permanent improvement of the lands by correction of soil erosion, reforestation and pastures; (v) encouraging increased profitable production; (vi) providing for organized marketing of products; (vii) the establishment of appropriate industries.

(d) The transport facilities of the Valley and any possible improvement of an economic nature having regard to the needs of the land, industries, and particularly the marketing of products.

(e) Generally a plan of development in respect of the lands and the land industries over the next 50 years.

(f) The productive potentialities and population supporting capacity of the valley under the system of development which may be recommended.

(g) The provision of amenities, social and cultural, for the increased population that may accrue by the implementation of the recommendations of the Committee.

(h) The administrative organization necessary to give effect to the carrying out of the plan of development recommended; and that in view of its grave importance the question of restoring and maintaining the Murray Catchment area be referred to the proposed expert Committee for urgent consideration."

Realizing the importance of the unified regional planning for the Murray basin, the Commonwealth Government at the instance of the Ministry of Post-War Reconstruction has approached the State Governments of New South Wales, Victoria and South Australia with a view to setting up a Committee of Enquiry consisting of representatives from

the four governments to investigate and report on the possibilities of the regional planning for the Murray Valley.

CONCLUSION

The preceding study of the situation* reveals that the Murray Valley problem in Australia is taking the modern shape, the trend being the acceptance of the policy of national resources development on a regional basis. The public, local authorities and the Government, Central and Provincial, have taken active interest, and some amount of constructive work has been done.

At the same time it is difficult to overlook the slow process through which the works have progressed under the usual bureaucratic methods of the Government so common in pre-War days. More than a century elapsed to consider, investigate, reconsider, report, and recommend on the problems and nothing more than irrigation and navigation has been considered for execution.

The question of developing hydro-electric power at the Hume Dam was raised in 1924, and the problem still remains to be considered, although it has been considered several times already. Resolution has been recently passed (1944) to carry on negotiations with the relevant authorities 'as a continuation of discussions entered into in 1930.'

The slowness of pace in Australia reminds us, incidentally, of the move of our Government, Central and Provincial, on the problem of the Damodar River which has been taken up on many occasions of catastrophic flood but subsequently kept down in cold storage. The Damodar problem has been considered, investigated and recommended upon since 1857, and the cycle of inaction is still in progress. The proposal for the construction of dams on the river and its important tributaries, as made by expert engineers, was always before us since 1864, but no constructive work was undertaken in course of these 80 years.

In contrast with these procedures, we see the comprehensive work done by the Tennessee Valley Authority in the U. S. A. The river authority was created in 1933 by Mr Franklin D. Roosevelt almost immediately after his presidential election. The early history, however, is equally slow, lengthy and conflicting, until Roosevelt came into power and was able to elbow through all the oppositions, and cut clean through the smothering red tapes.

The TVA, being given full power to plan and execute on the river basin development, has been able, in course of its 12 years of existence, to harness about 20 million acre foot of water

* Most of the information has been freely drawn from a pamphlet on River Murray Water Act, 1915-34, printed by the Government of Bengal.

in two dozens of colossal dams it has built, to maintain 650 miles of the river for year round navigation—now carrying more than 160 million ton-miles a year, and to develop 12,000 million units of electricity annually. The TVA has also been responsible for soil conservation of the Valley, farm demonstration to teach scientific agriculture, production of fertilisers, increasing fishery five times, national defence etc. All these speedy achievements are to be ascribed to the appointment of the TVA, an autonomous organization of experts who were vested with the authority of planning and executing the Valley's economic problems in a comprehensive

and unitary way. TVA is unhindered by the red tapes of bureaucratic governments, the ups and downs of party politics, or mutual jealousies of the different States.

From the comparative studies, one would feel that the old form of governmental machinery should be thoroughly changed to keep pace with the present world of speed and progress. The necessity of this change becomes imperative when one is confronted with the problem of resource development on the basis of river basin as the natural regional unit, which requires State support and necessary legislation to carry the plans into operation.

RESEARCH AND TAXATION

THE scientists and industrialists all over India will heartily welcome Hon'ble the Finance Member's significant proposal to allow for income-tax purposes expenditure on scientific research in his recent budget speech. The Hon'ble the Finance Member Sir Jeremy Raisman said:

"I am also proposing to allow for income-tax purposes expenditure on scientific research. The proposals follow generally the provisions in the U. K. Finance Act 1944, which have been described by the Chancellor of the Exchequer as 'a comprehensive attempt to relieve from taxation altogether funds devoted by industry to the support of fundamental research, to the translation of laboratory research to production and to the full-scale development of the product'. The proposals, in brief, are the allowance of current research expenditure as it is incurred, the allowance of payments to recognized research bodies and institutions and the allowance over a period of five years or over the life of the assets, if shorter, of research expenditure of a capital nature."

A Bill containing provisions for these reliefs, we understand, has been put before the house to amend the Income-tax and E. P. T. Acts.

In making this proposal, the Finance Member has closely followed the example of the U. K. Government which have made provision in the Finance Act 1944 to relieve from taxation funds devoted to the conduct of research. In his Budget speech last year, Sir John Anderson proposed relief from taxation funds devoted to research. Previously a distinction was drawn for income-tax purposes between capital and revenue expenditure on research. It was time for modifying the distinction, and the Chancellor proposed that any research expenditure of a capital nature, including expenditure on laboratory buildings, plant and machinery, should be allowed for a period of five years, or for the life of the asset, if shorter. This expenditure should be deducted from profit for income-tax purposes. This should also apply to any payment, whether for capital pur-

poses or not, made by an industrial concern to a central research body approved by the Department of Scientific and Industrial Research.



Sir Jeremy Raisman

The Chancellor of Exchequer further proposed a special allowance of 20 per cent of the cost of new plant and machinery and suggested that, as a part of post-war policy, the obsolescence allowance should be given when plant and machinery are scrapped. An annual depreciation allowance of 2 per cent, with an initial allowance of 10 per cent as an immediate instalment, was prescribed in the case of factories and buildings associated with them for welfare purposes or storage.

We understand from a report in *Nature*

(February 29, 1945) that a Bill to give effect to the proposals for the provision of relief from income-tax for industry and agriculture during the reconstruction period after the war has now been introduced in the House of Commons. The allowance provided for in the Finance Act 1944 with respect to scientific research is now to be extended to payments made after April 6, 1944. Expenditure incurred on buildings, plant and machinery for research after January 1, 1937 is also proposed to be entitled to allowance. Industrial buildings concerned with welfare, such as sports pavilions, houses for workers at mines or oil wells, agricultural buildings and works, it is stated, can also qualify for allowances.

The proposal of the Finance Member embodies a sound principle calculated to further scientific and industrial research in India. Research is a social service where benefit is shared by the whole nation and represents the most fitting case to which such relief should be conceded. This reform in taxation

measures was long over-due, and it is encouraging to note that the Government have at last realized its importance and have indicated their readiness to undertake the reform. The freedom from taxation of research funds is supposed to create conditions in which scientific and industrial research can make the largest contribution to the progress of the nation. This freedom, when secured, will serve as a great impetus to industrialists to make available larger sums of money for financing research projects which heavy burden of excess profit tax and income tax have normally prevented them from undertaking. If scientific and industrial research is to have its own way in the post-war period, this provision for relief from income-tax is a *sine qua non*. Although the idea originated in Britain, the Finance Member deserves to be congratulated for having taken a leaf out of that country's happenings and suggested a similar measure destined to exert a great influence on the future scientific and industrial life of India.

THE CELL-WALL AND IMPORTANCE OF ITS STUDY IN MODERN RESEARCHES

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INTRODUCTION

WHEN the cell was discovered by Hooke in the middle of the 17th Century its wall was regarded as *interstitia* and not its part. Long after, in early 19th Century, Paul Moldenhawer demonstrated by his new method of maceration that each cell had a wall of its own. This led to the study of the origin, structure and growth of the cell wall. The most outstanding contribution in this connection was made by Nägeli and von Mohl. Eames and MacDaniels (1925) writing about these authors say "Grew and Malpighi laid a substantial foundation for the science of plant anatomy; Nägeli and Mohl built the superstructure. More recent workers have determined the principles of construction and elaborated the superstructure, adding details, but have modified the framework only in minor ways".

In a cell the living protoplast is the structural and functional unit, but there can be no doubt that the membrane (C. W.) which surrounds it plays a part of considerable importance in its life processes and the cell-wall may be regarded as the non-living record (?) of some of the metabolic activities of the protoplasm. The mechanism of deposition of such a wall and its further growth and development are as

yet imperfectly understood, but the application of modern methods of investigation has helped us to a great extent in understanding the submicroscopic morphology of the cell-wall, and also has yielded information of considerable importance to the solution of the problem of its growth.

IMPORTANCE OF ITS STUDY AND SCOPE

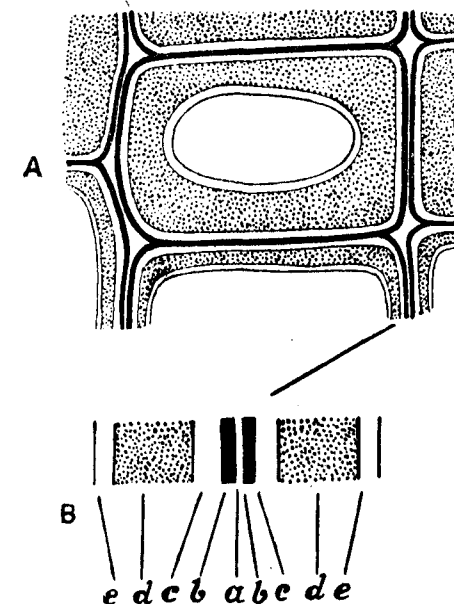
Apart from possessing a general scientific interest the study of the morphology of the cell-wall, particularly of fibres, has some practical objectives of importance to industry, such as, the phenomena of penetration of wood by preservatives, digestion of pulp wood, easy separation of fibres for textile purposes, and so on (Scarth, Gibbs and Spier, 1929). All these require a clear understanding of the chemical and physical properties of the intercellular substance (middle lamella), the primary and secondary layers. Much work has been done on cell-wall anatomy in other countries, but in India the importance of its study has only recently been realised and so far as I am aware, its study has been undertaken by Kundu, Banerji and Ray and Sarcar on jute and other fibres of economic importance.

The study of the cell-wall is a problem to success-

fully solve which a thorough knowledge of botany, chemistry and physics is necessary. The botanical aspect *i.e.*, the growth and development of the cell-wall is as important as the determination of its chemical changes taking place in the walls during the growth and differentiation of a cell. Again a thorough knowledge of some of the branches of physics is essential in order to investigate and understand the submicroscopic structure of the cell-walls from their physical properties, such as, anisotropy, porosity, hydration, etc., by applying such methods as X-ray analysis, examination under polarising microscope, hydration, etc.

THE WALL OF ADULT CELLS

The adult wall is grossly divided into different regions due primarily to their difference in chemical and physical properties. Eames and MacDaniels (1925) divided it into *middle lamella*, *primary*,



TEXT FIG. 1. (From Bailey). A. Diagrammatic cross section of a tracheid with parts of seven others. B. Enlarged section of a common wall illustrating the terminology applied to different layers of the wall, more highly magnified.
a. Truly isotropic intercellular substance (=middle lamella), b. primary wall, c. outer layer of secondary wall, d. central layer of secondary wall, e. inner layer of secondary wall (tertiary of Eames).

secondary and *tertiary* layers or walls. Later researches, particularly that of Kerr and Bailey (1934), have proved that the so called middle lamella is really different from the cell-wall. Bailey and Kerr therefore proposed the following terminology for the distinct layers of the wall:

(1) *Middle lamella* or the intercellular material:

amorphous, isotropic, mainly composed of pectic compounds, often lignified (Manning, 1888-91, Allen, 1901, Ritter, 1925, Harlow, 1927, Majumdar, 1940 and others).

(2) *Primary Wall or Cambial Wall* or its homologues: faintly anisotropic, more of pectic than of cellulose material, capable of growth and extension and can undergo reversible changes in thickness.

(3) *The Secondary Wall*: additional wall layers deposited within the primary wall; positively anisotropic, lose their potentiality for growth and extension.

Anderson (1935) thinks that this terminology may be used without danger of being misunderstood. But Majumdar and Preston (1941) consider that the terminology proposed by Kerr and Bailey cannot be applied to all cell-walls. If a cell is extending with no obvious changes in wall thickness as happens in fibres, then the wall may be referred to as *primary*, and when a cell has ceased to extend, subsequent wall depositions may be called *secondary*. But in cases like collenchyma where the layers of thickness are deposited long before extension has ceased the wall can neither be called, according to Kerr and Bailey's definition, primary nor secondary. Therefore nomenclature of wall morphology proposed by Kerr and Bailey is much too rigid to include types like collenchyma. Majumdar and Preston have, therefore, suggested 'thickened primary' for such walls.

Again detailed investigation of the wall of the collenchyma of *Heracleum* (Majumdar, 1941, Majumdar and Preston 1941) has shown clearly that the wall of the adult cell is composed of *three* distinct zones; a peripheral, an intermediate region of cellulose lamellae embedded in intralamellar pectic substances, and an inner zone. These three regions differ from one another in both chemical and physical properties. The outermost layer is less extensible and less able to respond to swelling reagents, and under various treatments frequently becomes ruptured in characteristic ways when the intermediate cellulose layers swell out in a balloon or spiral like manner. The recognition of these distinct layers in the wall raises the question as to whether the term *tertiary* should be retained for the innermost layer which differs both chemically and physically from the outer zones.

METHODS OF INVESTIGATION

The following methods are employed (Anderson, 1935; Miller, 1938; Frey Wissling, 1939):

(1) *Direct observation of untreated walls* reveals presence of definite layers, surface markings, striations, radial lines, pits, unequal thickness, etc.

(2) *Use of specific solvents*, e.g., of cellulose, pectin, lignin etc., their extraction and examination.

(3) *Colour reactions*—phloroglucinol tests as an

index of lignification, methylene blue and ruthenium red tests for index of pectination, etc.

(4) *Differential staining*—staining depends largely upon H-ion concentration and the iso-electric point of the material to be stained, e.g., fixing material in chromoacetic acid and then using basic and acidic dyes of contrasting shades, and then washing in buffer solution of certain critical H-ion concentrations (Naylor, 1926).

(5) *Ash analysis*—to find out kind of and various minerals in the wall.

(6) *Use of polarising microscope*—to distinguish isotropic from anisotropic substances; it also furnishes information on the orientation of the submicroscopic units of the wall.

(7) *Use of Spierer lens*—images produced by this lens indicate presence of definite structural units of ultramicroscopic dimensions; provide evidence of micellar structure of the cellulose walls. Seifriz (1936) named these units 'super micelles'.

(8) *Measurement of refractive indices*—different lamellae of the walls have different refractive indices.

(9) *Use of fluorescent light*—This detects degree of lignification of the walls; they are irradiated with ultra-violet rays which on passing through lignified walls become visible due to fluorescence. Intensity of fluorescence varies with degree of lignification.

(10) *Hydration*—Under different swelling reagents structural relations appear that are invisible under unswollen state; lamellae are counted by this method.

(11) *X-ray analysis*—indispensable for knowledge of ultimate structure of the cell-wall. By this method actual size of the molecular and atomic aggregate in the wall, their distance apart and their spatial relationships are studied.

Conclusions so far arrived at from such studies may be indicated as follows:

(1) *The cell-walls are not chemically homogeneous*: Chemical substances that may enter into the composition of the cell-wall are:—

- cellulose*—typical α , β , γ , types, hydro-cellulose, oxycelluloses;
- hemicelluloses* or pseudocelluloses which include pentosans, xylan, araban, galactosan and mannosans;
- pectic substances*—pectic acid, pectates, pectin; *lignin*, *suberin*, *cutin* and other constituents like resin, gums, tannin, minerals, colouring matters, proteins, fats, alkaloids, phospholipides, etherial oils, callose and others.

(2) *The cell-walls are not physically homogeneous*: The cell-walls under different treatment show definite lamellation (which usually vary in their refractive indices), striations and surface mark-

ings of various kinds. They also show anisotropy of swelling, of tensile strength, of absorption (dichroism), of refraction, and porosity (Frey Wyssling, 1930). To these Frey Wyssling adds *holopermeability* for salts and sugars, *penetrability* for colloidal dye stuffs like Congo red. Further the fibres of cellulose can be transformed into fibres of cellulose esters, such as nitro-cellulose or cellulose acetate without dissolving them or changing their form. Such transformation has been named by E. Wyssling as *permuloid* or *topochemic* reactions.

ORIGIN AND THICKENING OF THE CELL WALL

To explain growth in thickness of the cell wall Mohl (1853, 1858) advanced his well known *Theory of Apposition*. In 1864 Nägeli suggested that the cell wall was composed of submicroscopic units or *micelles*, crystalline in nature, arranged in definite layers; each micelle was surrounded by a film of water and that growth involved in the intercalation of new micelles between the old ones (*Theory of Intussusception*). The exact mechanism of the origin and cell-wall growth is not distinctly known. Whatever little is known is based on the study of walls of fibres, such as rhea or ramie, flax, cotton, jute, etc.

According to Aldaba (1927) the wall originates by a process of transformation of hyaline membranes. Farr and Eckerson (1933-34), and Farr and Sisson (1934) think that in cotton fibres during development they have been able to prove the presence of free ellipsoidal particles of cellulose covered with a thin layer of pectic substance in the cytoplasm (*Ellipsoidal Particle Hypothesis*). They think these have something to do with the deposition of wall layers. Anderson and Kerr (1938) on a reinvestigation of the cotton fibre found the so-called ellipsoidal particles in the cytoplasm to be really small plastids containing starch. They forthwith discarded this theory of Farr and his co-workers.

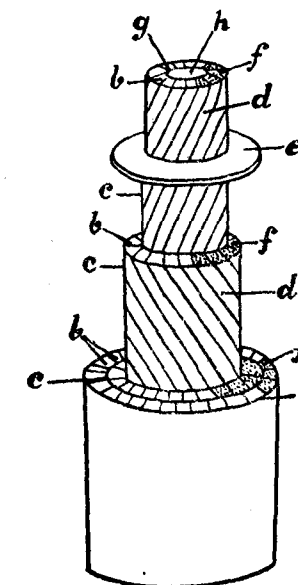
Sponsler (1934) is led to believe that in the process of cell wall formation units of monosaccharoses are condensed into polysaccharose chains, the bordering protoplasm taking an active part in the process. Lüdtkke (1931) in wheat plants found whole series of intermediate products from saccharose (xylose and glucose) to cellulose formation in a series of transitional stages. Bonner (1935) considers young cell-wall to be living (cf. Wiesner, Hansteen-Cranner, Eames and MacDaniels (1925), Sharp (1934); Wood (1924), however, considers the presence of significant amounts of protoplasm in the cell wall to be improbable). Bonner and Hayn (1935) consider that certain ions enter the wall from the protoplasm, cause greater repulsion between micelles and an increase of micellar hydration, thereby increasing the plasticity of the cell wall.

THE FINE OR THE ULTRA-MICROSCOPIC STRUCTURE OF THE CELL WALL

The micellar theory of Nägeli has been proved to be substantially correct by modern investigations. The work of Frey (1926-28), Frey Wyssling (1930), Herzog (1925), Astbury, Marwick and Bernal (1932) with *polarised light*, and of Meyer and Mark (1928), Meyer (1929-31) and Clark (1930) with *X-ray examination* proved that the cell wall is composed of sub-microscopic units or *micelles* which are elongated and of a crystalline nature. The crystalline micelles are separated from one another by a non-cellulose intermicellar *hydrophilic* colloidal material. The hydrophilic nature of the material is proved by the fact that organic liquids like ether, chloroform, fail to cause swelling of the wall when immersed in them. The micelle is composed of a bundle of basic cellulose groups or molecules. The basic cellulose molecules appear to be in long glucose residues (glucose minus a molecule of water). Length of a chain has been variously estimated to be from 50—1000 of these glucose residues (Mayer, 1929; Sponsler, 1929, '30, '31; Freudenberg, 1932; Seifriz, 1934; Gibbs, 1935). These chain like cellulose molecules are grouped in parallel rows into a bundle or micelle (Davidson and Richardson, 1936). The number of parallel chains present in a single micelle is from 40—60, its length is estimated to be from 50 to 100 $m\mu$, and diameter from 2.0 to 6.6 $m\mu$ depending upon the source of material. Size may vary in different plant parts, or even in the same cell-wall. The forces that hold the glucose residues together in the long chains are the primary valence forces, while the forces holding the chains together in the micelle are those of molecular cohesion. In fibre cell the micelles are grouped into fibrils that collectively make up the cell wall (see also Kundu and Preston, 1940; Preston, 1941; Majumdar and Preston, 1941). Czaja (1934) after extensive studies of metachromatic staining finds that the molecular hypothesis adequately accounts for differential staining obtained (Anderson, 1935).

Sponsler (1926-33), and Sponsler and Dore (1926) consider that the evidence for existence of micelles as definite entities in the cell wall seems to be inadequate; according to them the wall is composed of long parallel chains of glucose residues running lengthwise of the fibre. The chains are oriented in such a way as to form a spatial lattice of three dimensions. The cellulose wall is thus considered to be a complex system built up of very thin molecular layers, each composed of long chains of glucose residues. Certain layers extend lengthwise of the wall, some extend across the wall and other layers form definite angles with the lengthwise layers. A single

fibre cell-wall may be made up of some 40,000 of these lattice units in thickness. The wall of a fibre cell like cotton consists, according to Sponsler, of an enormous number of parallel molecular layers and not of a system of brick like units as suggested by the micellar hypothesis. Sponsler (1929) thinks that since the inner surface of the wall adjacent to the protoplasm has a definite molecular pattern the forces of crystallisation at this surface may form a part of the mechanism by which glucose molecules become converted into cellulose (Anderson, 1935).



TEXT FIG. 2. (After Lüdtkke). Diagram of a small fragment of a cellulose fibre cut away to illustrate the structure of the wall: a. primary wall; b. layers of secondary wall; c. thin film of non-cellulose material separating the layers in the wall; d. spirally wound bundles of fibres; e. cross elements separating the fibre wall into segments; f. fibrils composing the spiral elements; g. innermost layer of the wall; and h. cell lumen. (From Anderson).

According to Hess (1928), Lüdtkke (1931), Farr and Clark (1932), Farr and Eckerson (1933-34) and Farr and Sisson (1934), the cell wall is composed of definite cellulose units microscopically visible, each unit being enclosed in a thin film of non-cellulose material that serves to cement the units together. Farr and Eckerson consider this non-cellulose constituent to be pectic material with its nature apparently varying in different walls. This theory of cell-wall structure finds support in the behaviour of cell-wall during swelling, in dissolution by various reagents and in the reaction to certain dyes. Certain cellulose staining dyes frequently fail to impart colour to cellulose walls except when these walls are sub-

jected to mechanical pressure. This pressure ruptures the non-cellulose constituent and permits the stain to reach the cellulose particles.

In this connection the observation made by Majumdar (1940) on the chromic acid macerated collenchyma cells appears to be interesting. It is the iodine and saturated zinc chloride solution that gave the most interesting results. Iodine and zinc chloride solution gives a light blue colour reaction to cellulose. In transverse section this reaction is immediately noticed, but in macerated material a different action was observed. When macerated cells are treated with iodine solution and then immersed in zinc chloride they swell. The cells are white and lustrous except that in some cases transverse blue lines are seen in the thickness of the wall in the region of the bars. These lines are variously distributed, sometimes closely spirally, sometimes distantly. In optical section they are seen in the outer part of the wall but do not reach the lumen; in surface view they are often seen to stretch right across the cell. After some time the light blue colour is seen to spread along the surface as individual patches up and down from the transverse blue lines. It takes a comparatively long time for the whole cell to turn light blue, but generally the blue reaction is confined to the region of the cell where these transverse streaks first appear, while the remaining regions, in many cases, remain without any colour. When, however, the cell is treated with zinc chloride first and then iodine solution the whole of it at once takes a brownish or violet colour characteristic sometimes of cellulose.

The explanation of the above phenomenon appears to be that when zinc chloride causes the swelling of the inner layers the outer layer cracks and through these cracks iodine enters and turns the cellulose layer blue, then iodine diffuses through the lamellae up and down, and the colour reaction spreads. It starts from the individual cracks and then moves along the cellulose lamellae, and if the cracks are very close the whole region is stained by the coalescence of all the light blue patches. These transverse and irregularly transverse cracks appear to be responsible for the characteristic ballooning described in collenchyma and other fibres (Kundu and Preston). This is quite in accord with the explanation given by Anderson and Kerr (1938) of a similar phenomenon observed by Sakostschikoff and Korsheniowsky (1932) in 18–20 days old cotton fibres stained with strong chlorzinc iodine solution. The outer layer (p.w.) always appears quite distinct. It gave faint signs of darkening with osmic acid, but hardly so pronounced as to allow any definite conclusion to be drawn.

Anderson and Kerr (1938) hold that cellulose in primary wall (p.w.) forms an open meshwork of fine

thread like strands that frequently anastomose. These strands can be made visible by staining the wall with Congo red or chlorzinc iodide and examining between crossed nicols. Balls (1919) found two opposing systems of fine spirally wound threads of cellulose in the walls of 10 days old fibres. When the long axis of fibre makes an angle of about 45 degrees with the planes of nicols a third system of transverse strands of cellulose becomes visible in many fibres. Therefore Anderson and Kerr assume the presence of three systems of fine thread like strands in the make up of the cellulose frame work of the primary wall.

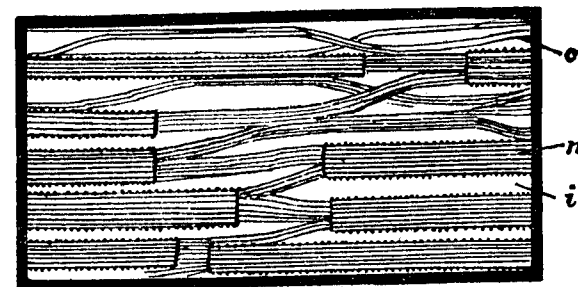
According to these investigators the first secondary deposition takes place as a layer of anastomosing strands that wind in a steep spiral (20 to 30 degrees) around the inner surface of the p.w. with frequent reversals. The cause of the laminated or stratified nature of the secondary wall (s.w.) is little understood. Balls thinks that there is a correlation between the number of lamellae and the number of days during which thickenings take place. But Kerr (1937) contends that the wall is a continuous matrix of cellulose and the laminated appearance in swollen sections is due to alternations of dense and less dense zones of cellulose. He showed that when cotton plants are grown under constant illumination and at approximately constant temperature no growth rings are formed in the fibre wall. He thinks that the distribution and thickness of growth rings in the wall of the cotton fibre can be varied at will.

Collenchyma cells of *Heracleum* (Majumdar, 1940) show beautiful lamellation of their walls when macerated by retting in water, or in 5% chromic acid. Staining reactions show the presence of pectin—rich—cellulose—poor lamellae alternating with pectin—poor—cellulose—rich lamellae. Retting in water completely removes the pectin—rich—cellulose—poor layers. Strong hydrochloric acid treatment of sections also does the same thing. In water retted fibres iodine followed by 60% sulphuric acid gives a pronounced cellulose reactions and the wall become clearly lamellated showing light blue and dark blue zones alternating throughout the whole wall thickness.

Lüdtke's conception of the cell wall seems to explain certain facts better than other theories. The wall is built in segments separated by definite cross elements. The lamellae are believed to be caused by very thin films of non-cellulose materials enclosing bundles of spiral fibrils which serve to act as a glue binding the cellulose segments together in the wall. This structural system is based on the behaviour of cell walls during swelling and solution in various reagents, and the reaction of fibre cells to certain dyes, especially chlorzinc iodide noted above.

Bailey and Kerr (1935) think that there is no reliable evidence to indicate that the matrix of the

cell wall is composed of entities of visible size bound together by a non-cellulose material. They believe that such putative entities are actually heterogeneous fragments that are shredded or disrupted from an originally continuous and coherent matrix. If these are discontinuous in the structural pattern they are confined to the submicroscopic field, i.e., the realm of micelles and molecular chains.



TEXT FIG. 3. Scheme of the submicroscopic structure of a fibre by Frey Wyssling. *c*=Cellulose chains; *m*=crystalline cellulose (=micelles *sensu* Nægeli), *i*=intermicellar spacings (from *Sc. Progr.*)

Frey Wyssling in 1935 proposed at the International Botanical Congress a modified scheme of the Micellar Theory (1936, 1939). The difficulty with regard to the original theory of Nægeli arose in this way: The crystalline nature of the micelles were re-established by Meyer and Mark in 1930. But its brick like structure as envisaged by Seifriz (1929) was criticised. How can a brick like structure show such tensile strength as is found in textile fibres? Meyer and Mark thought that the cohesive forces between the crystallites would be sufficient. Then the controversy arose about the length of the molecular units. The X-ray analysts showed a minimum length of about 600Å, whereas Staudinger (1932) measured by his viscosimetric method cellulose chains of 10,000 to 15,000Å, i.e., 1 to 1½ μ in length. Frey Wyssling's modified scheme, he thinks, satisfies both points of view. The X-ray analysis of fibres (Astbury, 1933; and Meyer and Mark, 1930) confirmed the result that the fibres must be built up of crystalline rodlets of cellulose. Hengstenberg and Mark (1928) calculated that the rodlets are about 60Å broad and at least 600Å long. Both the polarising and X-ray methods furnish the same result, and establish definitely, that the fibre walls are rodlet mixed systems. According to Frey Wyssling "the cellulose chains are several times longer than the crystalline micelles revealed by the X-ray analysis. There must be regions where these chains crystallise together and other regions where they are not sufficiently close or regularly parallel to form a crystalline lattice. In the older theory the cellulose was the dispersed phase and the intermicellar system the dispersion medium, while here the intermicellar spaces

appear dispersed within the cellulose as a dispersion medium". Then by deduction he envisaged a *reticular system* holding that the micellar and intermicellar systems are continuous and penetrate each other (*cf.* Bailey, 1938, where he speaks of the existence of two continuous interpenetrating system). Therefore, the micelles of Nægeli correspond to crystalline regions within a continuous, porous structure. In this scheme individual micelles do not exist. The cellulose chains are very long, slender, and practically endless. They form a micellar framework with crystalline regions which cause the remarkable *intrinsic double refraction* first discovered by Ambrohn in 1910, but significance not understood at the time. He seems to have proved further that the intermicellar system of cell wall is an intercommunicating *heterocapillary* one. The anisotropic swelling is caused by the uptake of water into the intermicellar system and the unusual penetrability of this system is explained by its continuity, which permits rapid diffusion in all directions. The discrepancies of density and double refraction are caused by the empty spaces in the micellar system.

The following conclusions may be drawn from facts so far accumulated:

- (1) Chemically the cell wall is heterogeneous.
- (2) Physically the cell wall is also heterogeneous including optical heterogeneity.
- (3) The cell wall is extraordinarily anisotropic.
- (4) The cell wall is submicroscopically porous.
- (5) It is also holopermeable to salts and sugars, and permeable to colloidal dye stuffs like Congo red. It also gives permutoid or topochemic reactions.
- (6) The cell wall can be divided into primary, secondary and perhaps into tertiary layers or regions. The lamellae differ in chemical and physical properties.
- (7) The skeletal framework of the wall is made up of practically 'endless' cellulose chains forming a micellar framework with crystalline regions (=micelles of Nægeli), called by Frey Wyssling a reticular system. The intermicellar system is a continuous *heterocapillary* system.
- (8) The chains are oriented, almost longitudinally, parallel to the fibre axis, but in the majority of cases a *spiral* structure, flat or steep, obtains.
- (9) The intermicellar spaces are filled with non-cellulose materials of amorphous and colloidal nature.
- (10) During the stretching of the primary wall the orientation of the submicroscopic structure also changes, as in collenchyma; in walls of fibres, like jute and hemp, during development the inclination of the originally spirally wound initial changes in accordance with change in dimension at some stage of growth.

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CONSERVATION OF METAL RESOURCES AND THE FUTURE OF GLASS INDUSTRY WITH SPECIAL REFERENCE TO POST-WAR PLANNING IN INDIA

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(Continued from the last issue)

In a recent publication¹ the writer described the development of the modern Indian glass industry. The early attempts to establish the industry had not been very successful and even the association of a number of foreign experts such as Germans, English, Austrians etc. did not prove very helpful. Some of these factories, however, struggled hard and exist even to-day, though under different names. A careful analysis of the so many failures in these early attempts leads one to ascribe them to the following reasons:—

1. Lack of efficient organization and quarrel between experts and financiers.
2. Foreign experts' ignorance of Indian conditions and financiers' impatience for quick results.
3. Lack of technical skill on the part of Indians and consequent dependence upon foreign experts.
4. Improper location of the factories in some cases, as for example a factory at Rajpur (on the Dehradun—Mussoorie Rd).

The Japanese methods initiated by Mr I. D. Varshney were successful and the reasons might have been the suitability of the Japanese furnaces to small units, comparatively less expenditure in the initial stages and the ease of working them. Further no machinery was required for Japanese types of furnaces. This success was largely achieved due to the supply of workers trained at the Paisa Fund Training Centre, Ambala and Bahjoi mainly through the efforts of Mr I. D. Varshney, the doyen of the Indian glass industry. The workers trained under German workers helped in the growth of the glass industry, since their methods of working were better than those of the Japanese. The technical staff of several of the present leading glass factories in India has either been trained at these works or under persons who received their training there. In fact, the Indian Industrial Commission paid a tribute to the ability of the glass industry to supply the demands during the last Great War mainly to the efforts of this training centre and appreciated its work in the following terms.

"Useful work has been done by the Paisa Fund at Talegaon Glass Works and it is certain that the recent

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developments of the glass industry in India have only been possible by reason of the blowers trained in this factory".

While, as a result of the war impetus, the industry was undergoing expansion in the country, an event of a rather threatening character, which in the post-Great War years brought the Indian Glass Industry almost to the verge of ruin, also happened during this period. Japan seized the opportunity when other exporting countries were engaged in the war and established a very substantial market in India where it had almost no position before the war. In spite of all the efforts, India could only supply a part of country's requirements. During the four years of the last Great War, the Japanese imported very large amount of machinery from the U. S. A. and established a well organized glass industry based on mass production.

Apart from the development of this industry on modern lines, the manufacture of glass bangles, a specialized article of Indian requirements, was also being pushed on in India chiefly at Firozabad in the United Provinces where it is said to have been started from the Mughal days. This began entirely as a cottage industry with very little co-ordination and the art of making bangles has passed down from generation to generation with the result that there is now a definite class of Muslims at Firozabad known as Shishgars (the glass makers). During the early days, bangle-makers used local made crude glass and broken pieces and melted them along with soda ash from reh or with saltpetre in their crude wood-fired furnaces. The products were not very attractive and could be sold only at very low prices in comparison with the superior imported Czechoslovakian and Japanese bangles. One of the reasons why this branch of the glass industry did not face many failures, although not very prosperous, was the indigenous character of the technique; it was not an imitation of other people's practice; also it did not require large furnaces, complicated machinery etc., hence it did not involve much capital expenditure and consequently it had less risk of heavy losses. It is estimated that during these attempts the country suffered a total loss of about half a crore of rupees even in these small adventures.

These scattered attempts continued till the outbreak of the last Great War in 1914, which gave an impetus to the glass industry due to the stoppage of imports from the major exporting countries such as, Germany, Austria, Belgium etc. The production of the older units increased and new factories were started to meet the sudden demands. Several glass bangle factories were also started at Firozabad and it was during this period that this section of the industry became somewhat established at this centre. The industry had thus considerable expansion in its activities.

CONDITION OF THE GLASS INDUSTRY IN THE ALLIED COUNTRIES DURING THE LAST GREAT WAR

It may not be out of place to mention here that the condition of the glass industry in some of the principal Allied countries was not very satisfactory at the outbreak of the last Great War. For instance, in England, a considerable portion of her requirements particularly in optical and scientific glassware, was supplied principally by Germany which was at that time sufficiently far advanced in the technique of glass manufacture. Due to the unsatisfactory condition of the home industry and the total stoppage of all exports from Germany, Great Britain was exposed to severe hardships. In this connection the following remarks of Professor Turner are worthy of mention:

"The glass industry is carried on very largely by rule-of-thumb methods.

No courses of instruction in glass manufacture appear to be given in the United Kingdom.

Very little trustworthy literature exists in the English language on the subject of glass manufacture.

There is great need of research in glass-making processes".²

"We all know fully well how certain industries had to be created; the production, for example, of scientific glassware, such as flasks, beakers, and all other types of apparatus ungraduated or graduated, almost all of which had been imported before the war, had now to be made, and in very large quantities, in order to supply, not only the scientific institutions which were important customers before the war, but also the innumerable laboratories set up to control all kinds of war munitions. Optical glass now needed in a vastly increased quantity for naval and military purposes had to be provided. The lamp working industry, which did not exist as an industry, or, at any rate, was a wholly negligible quantity, assumed enormous dimensions and supplied all sorts of surgical glass instruments, mine-horns and general scientific ware."³

War is a dreadful happening, but such times also bring home many deficiencies in the organization of the country. For instance, regarding the industries and their functions, the last great war clearly demonstrated:

(1) That industries play a very fundamental rôle in ensuring prosperous and stable conditions for the welfare of the country, both in times of peace and war.

(2) That as such the State being the ultimate custodian of the interests of the people is responsible to ensure that the industries are properly developed.

(3) That State measures in their different forms such as tariff protection, technical aid, financial assistance etc., can be effective in creating circumstances for their healthy development.

(4) That no industry which does not bring to its aid the application of scientific knowledge can hope to survive in modern industrialization, and consequently application of scientific knowledge and

² Turner, W. E. S., *J. Soc. Glass Tech.*, 20, 1, 1937.

³ *Ibid.*, 5, 139, 1922.

¹ Atma Ram, *J. Sci. & Ind. Res.*, 3, 66, 1944.

abundant and regular supply of trained workers constitute one of the fundamental essentials for industrial development.

Even before the last Great War, many of the glass producing countries, for instance, Germany, France, the U. S. A., Switzerland etc., had been following the policy of protecting the industry from unfair foreign competition. The U. S. A. granted protection to the extent of 60-80%. The last Great War brought home to these countries the necessity of developing these industries so that they could be independent of foreign exports. The production of glass articles of different varieties expanded in all the countries and new industries, particularly scientific glassware and optical glass, were created.

POST-GREAT WAR DEVELOPMENT IN OTHER COUNTRIES

(a) *Introduction of the Machine and its Influence on the development of Glass Industry.*—An important event in the history of glass industry during this period was the increasing use of machinery in glass manufacture. Before the Great War, although few machines such as Owen's machine had been invented, and their use had proceeded beyond the experimental stage, they were not largely in use. During and after the Great War, there was a rapid and widespread introduction of machines both automatic and semi-automatic for different processes of glass manufacture and practically the entire character of the industry both commercial and technical underwent a fundamental change. In mechanization, although different countries have taken part, it is largely the American talent that has made the manufacture of glass a highly mechanized industry for mass production. The introduction of machines has had a very great influence on other branches of glass manufacture such as the type and size of furnaces, the kind of fuel used, the type of raw materials etc. Moreover, the introduction of the machines had a great effect upon the location of the industry, it being no longer necessary to locate factories in the areas guaranteeing availability of skilled glass workmen. The training of both the operatives and supervising staff based on an understanding of fundamental scientific principles assumed a central rôle in the development of the industry. Whereas, the credit of inventing the machines goes principally to the inventors; their real success on a commercial scale has in no less degree been due to the combined efforts of the physicists and chemists by placing at the disposal of the operatives the type of glass best suited to the particular machines. For instance, the success of the automatic blowing machines has been possible through the supply of proper type of glass, having the requisite characteristics of viscosity.

(b) *Beginning of the Science of Glass Technology.*—Although the art of glass manufacture had

attained a sufficiently high degree of perfection in some of the European countries such as Germany, Austria, England, Czechoslovakia, etc., most of the processes and their implications, if at all understood, were still closely guarded secrets of the inventors and manufacturers. The art of making optical glass was almost a monopoly of the firm of Schott and Abbe of Germany. As such, the manufacture of glass mostly remained a skilled art of the practical glass maker without its scientific basis being understood. One of the important events brought about by the happenings of the Great War which changed the entire aspect of the manufacture of glass was the application of science which gave birth to modern glass technology. It was realized during this period that without a proper understanding of the scientific implications of the processes glass industry could not make a headway. Several laboratories were opened in different countries; scientific societies dealing with glass were organized and several important organizations were established. The various laboratories that were started during and after the war have provided not only the place for the discovery of new processes and understanding of the old ones but have also been largely responsible for a supply of trained workers who are the back bone of modern industries.

The basis of each operation is being understood in the light of scientific knowledge. The feelings of empiricism and secrecy, so common in the pre-Great War period, have disappeared making room for the full fledged science of glass technology. It is natural, therefore, that those who still believe in secrecy and empiricism cannot expect to stand in the field of competition backed by scientific findings and training.

POST-GREAT WAR CONDITIONS IN INDIA

Thus the period following the last Great War witnessed a steady progress towards perfection of the glass industry in Europe and America. In India, however, the industry had a different history in the Post-Great War period.

Shortly after the conclusion of the war, imports of glassware began to pour into India at a very rapid rate and the temporary prosperity enjoyed by the industry due to abnormal conditions created by the war almost disappeared. Such a sequel was, in fact, predicted by the Indian Industrial Commission who based their argument on the finding that other neutral countries had also developed their resources, particularly the manufacture of glassware. Moreover the belligerent countries after return to normal conditions began to intensify their industrial activities with a view to get back lost markets. The Indian glass industry which was still in its infancy fell an easy

prey to such conditions with the inevitable result that the market was dumped by foreign imports, and several factories had to close down. As a matter of fact, the year 1920-21 witnessed the highest imports (Rs. 3½ crores) of glass articles into India.

The glass bangle industry also had had a bad shaking and the market was full of the Japanese type of bangles (Reshmi) which were cheap and attractive. This severe external competition brought in its trail internal competition with the consequent decline both in quality and quantity of the goods produced. The industry struggled and passed through the worst phase of its existence till the Swadeshi Movement of 1930. The Indian articles again appeared on the market in increasing quantities. During this period there was an all-round improvement in the different branches of the industry and the quality of the articles improved considerably. The manufacture of scientific glassware was also initiated and this has been responsible for meeting the demands of this type of glassware during the present war.

PRESENT POSITION OF THE INDUSTRY

It was under these circumstances that the present war broke out which has again given a great impetus to the Indian glass industry. The import of glass articles into India has substantially diminished and there has been considerable expansion in the activities of the industry. In addition to the increased production of the already produced glassware, some new types of articles such as electric bulb shells, neutral glass, signal glass, boiler gauge glass have been produced, and although their quality may not, in some cases, be comparable to that of the imported stuff, they have succeeded in meeting the war requirements of the country. Prior to this period, having passed through a state of chronic depression and, consequently, of technical backwardness, the industry has not been able to fully utilize the opportunities created by the war and many important and key materials such as optical glass, toughened glass, fibre glass, foam glass, etc. which have made glass an article of war strategy, are not produced in the country.

The industry is concentrated in a few centres mainly western U. P., Calcutta and suburbs and the Bombay area. Factories are, however, scattered all over the country and although so far no particular attention has been paid in deciding the location of factories, consideration of the availability of market in the area appears to have had a predominating influence in such selections. The total number of factories including glass bangle factories of Firozabad is about 150. There is quite a large number of small cottage bangle works not covered by the Fac-

tories Act and these together produce a substantial portion of the total quantity of glass bangles produced in the country. The size of the glass factories is not very large, and the number of factories with a capital exceeding a few lakhs of rupees is indeed very small. The biggest glass factory in the country is the U. P. Glass Works which, although the oldest and biggest producer of sheet glass, also manufactures different type of blownware articles.

The total production of glass articles in the country before the war including that of glass bangles was valued at about one and a half crores of rupees. The present figures for the production of glass articles are not available and, even if they are, they cannot be very reliable in view of the high fluctuations in prices. Moreover, due to the scarcity and control of many of the materials and fuels the total production capacity of the industry has never come into play. It is believed, however, that in tonnage the production of the glass articles has become doubled.

The quality of the articles produced in India had shown improvement before the outbreak of the present war, but of late due to several reasons such as the restricted supply of chemicals, shortage of fuels, difficulty of transport, and also in the absence of foreign competition every article having become saleable, the quality of the products has somewhat deteriorated. The appearance and finish of the articles are not very satisfactory. They are rather dull and in some cases are even deformed. The annealing is poor, and this is one of the major defects of the Indian products. Due to bad annealing, Indian made articles give way under slight changes of temperature; their mechanical strength is also low. The articles develop cracks during storage. In some of the factories, the annealing kilns are of crude designs and are wasteful in fuel and unhealthy to workers. In the absence of a properly determined annealing schedule, the routine procedure, as practised, has hardly any value. In these days of shortage of fuel and chemicals, it can easily be realized that if the technique and operation of annealing which is one of the most important operation in glass manufacture can be properly organized, the quality of the glass goods will considerably improve, and the amount of fuel and chemicals required on an overall basis will also be reduced.

There is at present, with very few exceptions, very little control exercised on quality during production. Most of the operations are still carried out by the rule of thumb, and secrecy still guides the field of manufacture.

There has been a tendency towards the employment of better types of furnaces, but in many cases the subsidiary furnaces such as the annealing kilns, glory holes, etc. are very disappointing, particularly

in view of the great developments that have taken place in this particular field.

With the exception of a few centres that have been training students in glass technology and the advice and help which the manufacturers may have been receiving from the Government departments such as the Glass Technologist to Government, United Provinces, the Glass Chemist to Government, Bombay, there is no central institution to advise and help the industry in its efforts to develop on modern lines.

Very little information is available on the resources of raw materials required for the glass industry and much less about their properties. No organized survey of the raw materials has been carried out so far and unless the raw materials are properly charted, it is difficult to see how the industry can develop. The Industrial Research Bureau had organized the survey of glass raw materials and quite an extensive work was done, but so far no report on the results has been published.

FACTORS FAVOURABLE TO THE INDUSTRY

Let us now examine whether the glass industry in India has the essentials for its successful establishment in its favour or it is one which has to depend on imports from other countries. In any such examination, the following broad items have to be considered:

- (1) Availability of raw materials ; (2) Market ;
- (3) Direction, both technical and commercial ; and
- (4) Location of factories.

(1) *Availability of raw materials.*—The basic raw materials required in the production of glass are sand, soda ash and lime. The other materials required for special purposes are felspars, manganese dioxide, zinc oxide, lead oxide, borax, selenium, arsenious oxide, cobalt oxide, chromium oxide, sulphur etc.

Sands and lime are available in the country and with the establishment of the soda ash factory by Alkali and Chemical Corporation of India and the Tata Chemicals, Limited, this important material which has hitherto been imported from abroad will also be produced in the country. Some of the other materials required for special purposes are also available. Selenium, borax etc. are still imported, but after the termination of hostilities there will be no serious difficulty in obtaining these chemicals. Fuels and refractories, although not included amongst the raw materials, constitute an important item of expenditure in the production of glass. The material produced by the refractory manufacturers in the country is regarded as satisfactory. Prior to the declaration of war, pots required in glass manufacture used to be imported from Japan, but in the

absence of Japanese imports a number of glass works are making their own pots. The Ganga Glass Works, Balawali, which had been making some pots even before the outbreak of the present war, have specialized in this particular branch and their products have in some respects been found even superior to the imported Japanese pots. It may, therefore, be said that the resources of the principal raw materials are abundant in the country.

(2) *Market.*—Regarding the market, as already pointed out, India imported glass goods to the extent of about 1½ to 2 crore of rupees before the outbreak of war. The total production in India has been estimated at about the same figures. Moreover, with the increase of industrialization and general advancement in the economic life of the country, standard of living is expected to be raised. There is every possibility of greater utilization of glassware and, as already discussed, if the quality of the Indian glass can be improved the total consumption of these articles will increase very considerably. It is evident, therefore, that as regards market there is a wide scope for the industry.

(3) *Direction, both technical and commercial.*—Taken as a whole the glass industry is highly technical in nature and requires for its development a sound knowledge of sciences like physics and chemistry, and of engineering with special reference to furnace designing. The present advanced position of England, America and other countries in this industry is largely due to the increasing application of scientific methods to glass manufacture. In India, the present conditions of technical training in glass manufacture and arrangements for research are not at all satisfactory. It is to be feared that with the prevailing backward state of technical knowledge the industry may not be able to stand the severe competition to which it is likely to be exposed after the present war. The industry does possess natural advantages, and if it could have the benefit of trained Indian personnel there is no reason why it should not be able to establish itself more firmly than before. The present war more than anything else has brought into prominence the necessity of having trained technicians in the country.

There is plenty of labour available in the country for the glass industry and the average worker has shown remarkable aptitude and skill. It will not be incorrect to say that, given the opportunity, an average Indian worker will not be found inferior to any worker anywhere in the world. There is a great and urgent need for raising the technical standard of the personnel and for ensuring the supply of really capable and trained men to the industry.

(4) *Location.*—The proper location of the industry as one of the determining factors for its success is

now being critically studied practically all over the world. The P.E.P. (England) has recently published a very extensive report on "Location of factories in Great Britain". Location of factories is certainly a very debatable topic and can occasionally make all the difference between success and failure. The most salient points governing their location are constant availability of raw materials, nearness of markets, and supply of efficient labour and suitable climate. Some people, however, lay great emphasis on locating factories near the source of raw materials. This is, always not very helpful, and sometimes question of freight on finished goods and nearness of market become the deciding factor. Glass is a fragile article and liable to greater losses during transit if it has to be hauled over long distances. Being voluminous, the freight is also not inconsiderable. It is apparent, therefore, that the nearness of the market plays an important part in the location of the glass factories and this is evident from the success of so many factories far removed from sources of raw materials, such as those in northwest U. P. and the Punjab.

POTENTIALITY OF THE INDUSTRY

From the foregoing account it is easily seen that the various factors which are considered essential for the success of any industry are such as to favour its growth and development in this country. A remarkable feature of the industry is that it shows signs of prosperity and progress whenever economic conditions such as those prevailing during the war which prevent the exporting countries from exporting glassware into India are obtainable. This has been amply demonstrated by the ability of the industry to meet the sudden demands created in the successive wars to the best of its capacity. After the last Great War it passed through a crisis which may have involved its very existence. That may be one of the reasons why the glass manufacturers have been rather too cautious during the present war, since without proper measures from now similar catastrophe may overtake them after the termination of present hostilities. Whenever conditions have been favourable, the industry has undergone expansion and improved the quality of its products. These happenings make it clear that there is nothing inherently wrong with the industry ; it has never enjoyed a period of prosperity to overcome the difficulties that have retarded progress.

CAUSES OF THE BACKWARD STATE OF THE INDUSTRY

We may now analyze the various factors that have contributed to this stagnation in spite of the industry possessing potentiality for development and the essentials that govern the success of an industry

being favourable to its growth. One who has read the history of the growth of this industry in other countries specially in the Great War and Post-Great War period will easily realize the important part which economic conditions and State aid have had on its growth. For instance, in England the glass industry particularly the manufacture of scientific and optical glassware which had undergone considerable expansion during the war, has had to face competition from foreign countries after the termination of hostilities, and it was ultimately in 1932 that the Import Duties Act afforded the necessary protection. The effect of these circumstances can be easily realized from the following words⁴ of Prof. Turner :

"The war period of some four and a third years gave these industries the opportunity for progress and consolidation ; but commercial conditions in such a period are also different from those of peace times and it was feared by some that the strength of post-war competition from Germany and Czechoslovakia, which had previously been the source of supply, would be so great that the new industries might again relapse. But the lesson that chemical and general scientific glassware was a vital necessity for the control of munition's supplies had been thoroughly learned, and in consequence they were included in the materials which received special protection from the tariff imposed under the Key Industries Duty. This measure of state aid clearly gave, and has given, invaluable assistance".

After experiencing a heavy shake-up the Indian Glass Industry represented to the Government to have its case examined by the Tariff Board for protection and the Government agreeing to this request directed the Tariff Board (President, Dr John Matthai) to undertake the investigation. The Indian Tariff Board examined in a very critical manner the various causes that contributed to this stagnation and in a masterly analysis of these circumstances the Board came to the following conclusions⁵ :

- (1) "We are, therefore, satisfied that on the balance, the glass industry does possess certain natural advantages as to justify its claim for protection."
- (2) "We are convinced that unless any tariff assistance granted to industry is supplemented by suitable organization for training and research, the progress of the industry will be slow and incommensurate with the burden which our proposals will place on the country."

The Tariff Board therefore recommended :

- (1) grant of protection to the industry, and
- (2) the establishment of a Central Institute in glass technology to help the industry in technical matters.

The Government, however, did not agree to the recommendations of the Tariff Board mainly on the ground that soda ash, one of the principal raw materials for glass, was not available in the country, but to help the industry they agreed to give a certain

⁴ Turner, W. E. S., *Proc. Soc. Glass Tech.*, 22, 28, 1938.
⁵ *Rep. Indian Tariff Board*, 52, 101, 1932.

amount of rebate on the amount of soda ash used. The idea of establishing a Central Institute receded to the background. Several years later, in 1938, the U. P. Government which is the home of the glass industry and particularly that of the glass bangle industry opened a glass technology section attached to the Department of Industries and appointed Dr A. Nadel as the Glass Technologist, who has continued in that capacity.

It is a well accepted principle that when any enterprise is to face serious competition from outside it invariably develops internal competition amongst its individual members. The Coal industry is another instance, where the price of coal before the war had fallen to a ridiculously low level and consequently there was increased adoption of crude methods of mining. The inherent consequences of such internal competition are wasteful methods of production, low wages, inferior quality of products and so on, which contribute to its rapid decline.

It is generally argued that the backward state of the industry is due to lack of application of scientific methods to industrial production which placed other countries in a strong position, but the application of scientific methods to produce the best products which may be called healthy competition is a consequence of prosperity and favourable economic conditions. It would be unwise to deny the paucity of trained men in the country, but the conditions had been so severe that even the few trained men could not find suitable employment in the country and their training obtained on a high expenditure almost could not be of any use. The internal competition produced a feeling of individualism and suspicion amongst the different manufacturers with the result that they could never organize themselves against foreign competition. After the Great War, the glass manufacturers made an attempt to organize themselves into an All India Glass Manufacturers' Association, but it did

not make much headway. The organizational defects of struggling industry can be removed to a considerable extent under conditions of economic stability.

To sum up, the main causes of this stagnation may be ascribed to (1) unfavourable economic conditions, (2) lack of internal organization, (3) low technical standard, and (4) absence of a Central Institution.

SOME POST-WAR ASPECTS

Case for Protection.—The foregoing considerations will inevitably lead one to infer that glass industry now occupies a key position; it is not a war time industry. In fact, provided circumstances remain favourable it has a great potentiality and, as discussed in the last issue, it is expected to play a far more important rôle in the post-war period. The causes of its unsatisfactory position have already been analyzed. The Tariff Board in 1932 had established that the industry had suffered from unfair foreign competition, specially the Japanese, and needed some protection. But the conditions of 1932 have now changed and need reconsideration. The recent assurances repeatedly given by the Hon'ble Sir Ardeshir Dalal with his characteristic emphasis that the policy of discriminating protection to deserving industries will be liberalized have, therefore, aroused great confidence in the mind of glass manufacturers who with the end of war in sight had again begun to be obsessed with the repetition of past experience.

Critics of the Government generally argue that protection was not given to the glass industry in order to safeguard the British interests, and the Government do not generally encourage Indian industries. In the case of glass industry, this view does not seem to be borne out by facts, since most of the imports of glassware into India have been from countries other than the U. K. ; the major portion coming from Japan. (Table I).

TABLE I*
PERCENTAGE OF VALUE OF EACH KIND OF GLASSWARE IMPORTED
FROM DIFFERENT COUNTRIES IN INDIA DURING 1938-39.

	Czecho- slovakia	Japan. 54.1	Italy.	Ger- many.	British Empire.	U.S.A.	Austria.	Belgium.	Others.
Bangles	39.1	54.1	...	1.8	2.1	...	...	...	2.9
Beads and false pearls	32.8	36.3	20.1	6.7	...	...	2.1	...	2.0
Bottles-Sodawater bottles	...	64.4	...	20.7	18.0	...	...	...	0.9
Other bottles and phials	5.1	64.0	...	20.3	6.6	...	...	...	4.0
Lampware	15.5	13.7	...	48.9	8.1	4.5	7.4	...	1.9
Scientific glassware	...	20.7	...	57.0	18.6	...	...	...	3.7
Sheet and plate	2.9	30.2	...	12.3	12.2	...	...	40.6	1.8
Tableware	5.8	72.2	...	6.8	10.3	...	...	...	4.9
Other kinds	4.8	52.1	2.5	10.9	16.0	...	...	...	...

* SCIENCE AND CULTURE, 9, 286, 1944.

These figures clearly show that the rejection of Tariff Board's proposals did not help the British Glass Industry, but incidentally assisted Japan to capture a good market in India. It was probably the insistence on technicalities (the chief argument being that soda ash, the principal raw material being still an imported product, the industry did not satisfy the conditions of Fiscal Commission) that a well presented case was rejected.

One may argue that after the grant of protection, the industry being comparatively free from foreign competition will neglect the interests of the consumers and no attempt will be made to improve methods of production and cheapen the goods. This is rather an extreme view. After all no industry, howsoever, patriotic the Government may be, can be given a life long protection and the grant of protection for a certain period amounts to giving a chance to the industry to prepare itself to ultimately withstand unfair foreign competition. Glass industry, as recommended by the Tariff Board presided over by an eminent economist like Dr John Matthai, deserves such a consideration.

Development of the Industry on Modern Lines. But protection alone is not the panacea for all evils. The industry will have to be organized on modern lines. The technical standard which is one of the contributory factors to cheap and quality production will have to be raised. The present position and size of many of the factories is not very conducive to many of the technological developments. After the last Great War, glass has become a highly technical industry and the Tariff Board was right in stressing this point. Unless the size and working of the factories can become of the economic standard, it is difficult to see how the aid of modern technological knowledge can be brought to bear upon the development and progress of the industry. In the absence of these conditions it appears even futile to lay much stress on the high standard of training or employment of foreign experts. The field for the display of their talents is a prerequisite to their employment and must naturally come first.

The quality of the products has to be improved and the fears of the consumers that in the absence of competition the industry shows little anxiety for quality may not be altogether unfounded. During such times when every article is saleable, the producer is really on test, since in normal periods he will have to appeal to the consumer for patronage to purchase his goods. No doubt, the scarcity of some essential materials has contributed to this deterioration in quality, but the existence of free and sufficiently large market has also had its effect and in the absence of technical guidance, small units hurriedly established have adopted wasteful methods of production and consequently the quality of products

is low. Maintenance of quality and raising standards of production will always be the responsibility of the industry because no State aid, howsoever large, can help an industry establish itself, unless it can also call quality of its products to its aid.

Central Institute.—But to organize the industry on modern lines, the existence and association of a well equipped and staffed central technical institute is very essential. Such institutions have been of immense help in the survey of raw materials, standardization of goods, dissemination of information, training of workers etc., all of which have contributed to the development of the industry. The absence of a technological institution and of trained workers constituting a bottleneck has been emphasized ever since the Industrial Commission (1918). The Tariff Board, in fact, proposed the establishment of a technological institution for glass as a condition to the grant of protection. At this stage of technological advancement in industries, one need not stress the importance of the application of scientific knowledge to industrial production and the part played by institutions in this development. It is, therefore, a happy augury that the Council of Scientific and Industrial Research is now actually engaged in the establishment of a Central Glass and Ceramic Research Institute at Calcutta. But the condition of the industry will have to be improved so as to be in a position to absorb and utilize the researches carried out at the Institute. The development and utility of the Institute are very largely dependent upon and very intimately connected with the prosperity and progress of the industry. For the Institute to be of real service, there should not only be intimate but sympathetic contact between the Institute and the industry. It is hoped that the industry will take an active interest in its development and make liberal contribution to the establishment of the Institution which is expected to be something like a hospital to ensure its welfare.

Technical Training.—The paucity of trained men in this country has long been recognized as one of the contributory factors for stagnation in this industry. The first rectification of this defect, as already mentioned, came through the efforts of the Paise Fund Glass Training Centre at Talegaon. In 1937 it was the Benares Hindu University which took initiative in providing facilities for training in glass technology on more modern lines and, although the standards may not fully be comparable to that attained in foreign countries, partly due to lack of funds, the progress made during the short period of about seven years has been quite substantial. Its graduates are finding increasing employment in factories and some of them are now holding responsible positions. It is necessary that in post-war period when much emphasis will be laid on techni-

cal training, the facilities of this institution should be increased by suitable contributions. It will not be too much to expect the industry to which its services are of immediate assistance to come forward with liberal donations. It is necessary, however, that such departments should be in close contact with the industry; may be this much needed contact has not so far been achieved. In spite of there being a Central Institute providing facilities for higher training and research, the important function of such teaching departments cannot be overemphasized and experience shows that it can best be fulfilled in a university. Along with the training of technologists, the training of operatives is equally important. With the exception of what was achieved at the Paisa Fund Glass Training Centre, not much organized attempt has been made in this direction and the feelings of individualism have been partly responsible for it. The recent establishment of an Operative Training School (at Bahjoi) by Mr. Varshney is indeed a very timely step. It is believed that this step which is just another contribution of this pioneer will be augmented to the benefit of the industry.

But in a country which is yet to develop the now well established and standardized processes for the manufacture of several new type of glass articles such as optical glass, chemical resistant glass, toughened glass, plate glass etc., the training of Indian personnel in other countries and the importing of foreign technicians for a temporary period will assume more than usual importance. Although Indians have received training in foreign countries and foreign technicians have been employed in India, the need of a co-ordinated plan as an integral part of post-war developments has never been felt so forcefully as at present and the industry in general is most fortunate for the keen interest shown in this regard by the Hon'ble Sir Ardeshir Dalal.

Since this subject is to actively engage the attention of the Government, senior scientists and industrialists of the country, it will perhaps be premature rather imprudent on the part of the present writer to say much about it. One of the main defects of the system of sending Indian men abroad has been that the persons were sent for training without previously making suitable arrangements for their employment after their return. The results have, in some cases, been rather discouraging, and there are instances when people had to earn their livelihood in professions completely different from their training. The expenditure on this training, therefore, if considered objectively, has amounted to national waste. There is no doubt that in drawing up a scheme of foreign training which is expected to be quite gigantic, full advantage will be taken of this experience. Such training should be given in

subjects or processes for which there is arrangement with the industry to absorb them immediately on their return, and before selecting suitable candidates for training, requirements of the industry should be first studied. In fact, during their training the trainees should definitely work with the aim of developing these processes in the country. With regard to the subjects for training with a view to developing new processes in the country consideration should be given to the fact that a mere mention of glass, porcelain etc. may lead to confusion, since even the production of one article involves several operations and the co-ordinated services of different type of technicians. To lay stress on only one aspect or to expect one person to be an omnibus expert will be an error, and some failures in the past, either with Indian trained men or with foreign technicians, may be traced to this mistake.

The training of personnel will also involve the question of financial adjustments with the firms where the trainees will work, or whose experts or technical knowledge may have to be imported into the country. A pointed reference to this aspect was recently made by Sir S. S. Bhatnagar in his address to the Institution of Engineers (India). It may be a comparatively simple affair to arrange the training of personnel in general scientific subjects, but training in special processes will certainly involve these complications. This question, therefore, is neither purely scientific nor entirely commercial. What can be achieved by close co-operation has been amply demonstrated by Canada. As late as 1940, she did not produce even a single piece of optical glass, but has now succeeded in producing various types of optical glasses and instruments within a year. In this connection, the following extracts from an article by Dr W. M. Hampton^a are worthy of note:

"A Government company, Research Enterprises Limited, was formed during 1940 to erect a factory in Toronto for the manufacture of various instruments, and in some cases the raw materials which were necessary for them. When it was decided, about October 1940, to commence the manufacture of optical glass there, Colonel W. E. Phillips, the President of the company, approached Chance Brothers & Co., Ltd., through the Canadian and British Governments, with the suggestion of co-operation. As a result of that approach I visited Toronto in November 1940 in order to ensure the most rapid development of the new undertaking. The result was that an arrangement was reached whereby the fullest information concerning the manufacturing technique was transferred to the Canadian factory, and certain physicists from Canada came to England and were trained in the art and technique of making optical glass. These physicists remained at our works for some two to three months and were attached to our own personnel, so that they had the fullest opportunity of learning all that we could teach them about the manufacture of optical glass. A number of other people were recruited in this country, some from the Canadian Forces here and some from our

^a W. M. Hampton—*Proceedings of the Physical Society*, Vol. 54, Part 5, 1st September, 1942, No. 305. Pages 392 to 393.

own staff, and were given a special intensive course before being sent to Canada for starting up the new process. Further, when manufacture began, one of our technicians went to Canada for some months in order to assist in overcoming the initial difficulties, so that the closest co-operation was maintained and is still being maintained. When it is realized that in November 1940 the optical-glass plant consisted of merely the walls of what was to be a factory, and that the first melting was successfully made in June 1941, and that by the end of 1941 a considerable number of meltings of first-quality glass had been made, it will be realized that, owing very largely to the enthusiasm and drive of the Canadian executives, a very remarkable result has been achieved. There has throughout been the closest co-operation between the Canadians and ourselves, and it can be said that there has been no serious hold-up or difficulty in transferring the manufacture from this country to that.

"The factory occupies about 16 acres, but only a portion of this is devoted to glass manufacture. The pots used are being made by a casting process which is essentially that employed in the Bureau of Standards, namely, the slip-cast method, by which clay treated with a small amount of alkali to give a fluid suspension is poured into a plaster mould. This method, which is well known, has the advantage of being more rapid than the old hand method, and also provides a pot which is considerably drier than that by the old process, and it therefore dries in a relatively short time. When required for use, the pot is preheated in one of the batch of pot arches, then transferred to the gas-fired regenerative furnaces and filled with the appropriate batch. Because of the relatively small tonnage employed in an optical glass factory, a mechanical system of weighing is uneconomic, and, therefore, weighing and mixing are done by hand. The scoops and pans used for handling the batch are of stainless steel. All the sand before being used is run through a magnetic separator to avoid any risk of extraneous contamination. The city gas-fired furnaces are of the regenerative type and were built by American companies to R.E.L. designs. The empty pots are placed in the furnace by a hydraulic pot carriage, which goes under the name of "Winnie". The rest of the procedure for making, cutting up, moulding, examining, and so on, is an exact copy of that employed at our works in this country, and, in fact, the Canadian factory may be said to be a modernized version of our works. The differences are merely those which are possible because of the existence of an entirely new site and of the possibility of organization from the commencement. The types of glass being made at present are about six, which are the main types in general use for optical instruments. The clays available in Canada have not so far been found appropriate for the more extreme types of glass, but the manufacture of these is visualized, and the continuing co-operation between Canada and Britain will, when necessary, ensure the provision of pots of the appropriate resistance to attack to enable all types of glass to be made.

"Since the Canadian factory makes not only glass but also instruments, R.E.L.'s customer is in effect itself, whereas in this country the grinding and polishing work is done by separate firms, a method which has both advantages and disadvantages.

In considering the rapidity with which this works was put in hand, it should be remembered that at the time it was being built there was no lighting restriction, so that the factory was built continuously day and night, and there was at that time practically no restriction on the quantity of labour available. These comments are not intended to detract in any way from the achievement of Colonel Phillips and his colleagues, and I can only add that collaboration with them has been simple and complete."

Internal Organization.—Due to severe internal competition the feelings of individualism and suspicion have been quite common in the glass industry. After a period of hard struggle, it is now enjoying

a period of prosperity and is comparatively free from the effects of external competition. But apart from expanding production with a view to capturing markets, little has been achieved by way of internal organization and stabilization. The Bengal Glass Manufacturers' Association is a notable example and the attempt has been quite successful. Provincial organizations unless coordinated by a central body are apt to be sometimes detrimental to progress by indulging in rivalries. The organization of the All India Glass Manufacturers' Federation is, therefore, a timely move, and if the enthusiasm continues it is expected to be a very useful organization. The Glass Industry in India comprises within its fold a very important cottage industry, namely, the bangle industry, which has been preserved in this country by the artisans of Firozabad and other places in the face of heavy competition. Although for its materials *i.e.*, the bulk glass, it primarily depends upon modern methods of manufacture, the art of bangle making along with the decorative processes will, for some time to come, remain a cottage industry for the display for individual skill. Any organization of the glass manufacturers will have to protect the interests of this class of workers and create conditions for the employment of better and healthy methods of manufacture. It is hoped that they will not be left out in outhouses like the poor relations of a rich man.

Apart from the industrial organizations; the influence of technical societies on the phenomenal development of the glass industry has been very fundamental. In England, for instance, the Society of Glass Technology has exercised a very great influence on the progress and internal organization of the industry by way of providing common platform for discussions in an unbiased atmosphere. It has been a leader in the scientific field and has helped in the establishment of international organizations such as the International Convention on Glass and International Congress. Similarly in the U. S. A., the American Ceramic Society is a very powerful body and is probably the biggest in the world on these subjects. Although these societies are mainly technical in outlook, they differ from the purely scientific bodies by throwing open their membership to professional men, industrialists, artisans etc., and it is probably in this respect that they have played a fundamental rôle.

In India, the Indian Ceramic Society was established about twenty years ago, but since the industry passed almost immediately into a period of depression, the society also could not make much headway. It is time that it should be revitalized and integrated into an effective organization of the industries concerned. The opening of the Indian Section of the Society of Glass Technology is a timely contribution to this end.

State Control.—During war time when the essential aim is somehow to ensure supplies, the establishment of new factories is likely to become rather haphazard, depending more on the war situation, and their unsuitability becomes apparent only in post-war periods. The essentials of location for practically all types of factories are more or less the same; the predominating factors may be different for different industries. For instance, for glass the nearness of market has been responsible for the success of a large number of factories situated far away from the raw materials and fuels. Some amount of control has to be exercised on the location of factories. The need for such an intervention was felt in the case of the sugar industry when, after the grant of protection, a large number of factories were established in the United Provinces in a small area each competing for the sugar cane grown in the locality thus throwing a great burden on the railways for handling cane for them from long distance. The situation became serious and, in fact, the U. P. Government restricted this uncontrolled growth by a zonal system. Here is an example when uncontrolled development may even offset the benefit of

protection and lead to unhealthy rivalries. The State can help to avoid this competition by exercising the necessary control on the location of factories in consultation with the Manufacturers' Organization. Another direction in which State control can be of help is to avoid the growth of a large number of factories attempting to engage in the production of goods of only one type, while there may be enough field for the manufacture of articles not yet manufactured in the country. This should not imply that monopoly should be secured for some particular factories.

These are only some of the aspects with which the future of glass industry in this country if it has to play a rôle discussed in the previous issue, is intimately bound up, and in any scheme of post war plans their consideration is desirable. The condition of the industry is very backward and so the efforts to improve it will have to be concentrated and properly co-ordinated. The author claims no finality to the examination of these problems and has written these lines in the hope of focussing attention and initiating discussion on the future of glass industry in this country.

A LETTER FROM EINSTEIN

PROF. ALBERT EINSTEIN in accepting the offer of the Bimala Churn Law Gold Medal, made by the Indian Association for the Cultivation of Science, writes to the President and the Secretary of the Association as follows:

January 31, 1945.

Gentlemen,

I accept with great humbleness and gratitude the award of the Bimala Churn Law Gold Medal as a sign of appreciation and sympathy.

May I add the hope that in a not too far future intellectual curiosity and striving for truth will become stronger forces in humanity than political passions.

Yours very sincerely,

A. EINSTEIN

The Institute for Advanced Study,
School of Mathematics,
Princeton, New Jersey,
U. S. A.

Notes and News

FRANKLIN D. ROOSEVELT

PRESIDENT ROOSEVELT has died. It is not easy to accommodate the death of a man who was only the other day one of the world's greatest and most responsible figures to whom millions of men and women looked for the initiation of a brave new world. A great leader of peace as well as of war, he died at the critical moment when the decisive stages of the war are being fought and victory has become only a question of time. With the prospect of peace drawing near, it is a great tragedy to be deprived of his inspiring leadership the world stands so much in need of, as the equally urgent and pressing problems of peace are about to come up for solution.

America's most renowned and popular President after Abraham Lincoln, Franklin Roosevelt's name will go down in history as one of the greatest statesmen of the age. He presided over the affairs of his country during the most critical period of her existence that began with the great economic depression. When Roosevelt came into power in 1933, the U. S. A. presented problems created by a plutocratic democracy *viz.*, those of unfettered individualism and unbridled capitalism. It was no small task to temper such a society with adequate measures of State control in the teeth of serious opposition from Big Business. His New Deal was a great experiment and a bold attempt at transforming an individualistic society saturated with the free and adventurous spirit of the early colonists into a national State and a political union. It helped America to recover from the serious effects of the depression that threatened to strangle the entire economic life in 1929-1932, and rally all her forces against Axis aggression in 1941.

To us scientists, Roosevelt appeals not so much because of the superb statesmanship with which he handled political and economic issues, but because of his recognition, and sincere conviction in, the application of science as a panacea for many social and economic evils. The Tennessee Valley Authority which he established in 1933 by an Act of the Congress represents the most far-reaching adventure in regional planning outside Russia. The story of the TVA often told through the columns of our journal is a story of harnessing the waters of a capricious river by scientific methods for the development of a prosperous valley, once a useless and unsafe region. To Roosevelt goes the credit for starting a new experiment in regional planning and scientific development and a new form of administrative machinery that can function in spite of party politics. "Many hard

lessons", said the president, "have taught us the human waste that results from lack of planning. Here and there a few wise cities and countries have looked ahead and planned. But our Nation has 'just grown'. It is time to extend planning to a wider field, in this instance (*i.e.* TVA) comprehending in one great project many States directly concerned with the basin of one of our greatest rivers." It was at one time widely held that the democratic form of government is not suitable for the planned development of the country. The success of the TVA and of the great constructive measures carried out by the Bureau of Reclamation has unmistakably shown that the democracies can also plan as successfully as the totalitarian States.

With the outbreak of war in Europe in the autumn of 1939, Roosevelt clearly realized that American involvement in it was inevitable despite all efforts to maintain neutrality, and took steps to mobilize the scientific talent and resources of the country. The creation of the National Defence Research Committee in June, 1940, and the Office of Scientific Research and Development in June, 1941 by executive order of the President has been largely responsible for bringing scientific talent to bear on the successful conduct of the war. His Government has been extremely generous in disbursing sums on defence research, which have amounted to several billion dollars.

To be simultaneously a leader of peace as well as of war is a rare phenomenon. His presidency was unquestioned during his eight years of office in peace and remained unchallenged even after Pearl Harbour. His rise to power closely coincides with Hitler's rise in Europe. He wielded enormous power but, unlike the power of the Nazi dictator, it was freely granted to him by the Nation and Congress which could at any moment withhold it from him. Roosevelt has passed away, but he will be remembered as one of the greatest leaders that democracies have ever produced.

PRESIDENT ROOSEVELT'S LETTER TO DR VANNEVAR BUSH

THE following letter which appeared in *Science*, December 15, 1944, was addressed by President Roosevelt to Dr Vannevar Bush, Director, Office of Scientific Research and Development. The Office, it might be recalled, was brought into existence in June 1941 by an executive order of the President to co-ordinate and direct all defence researches. The

letter expresses the President's deep and abiding faith in the methods of science and technology for the creation of conditions essential for 'a fuller and more fruitful life.'

Dear Dr. Bush:

The Office of Scientific Research and Development, of which you are the Director, represents a unique experiment of team-work and co-operation in co-ordinating scientific research and in applying existing scientific knowledge to the solution of the technical problems paramount in war. Its work has been conducted in the utmost secrecy and carried on without recognition of any kind; but its tangible results can be found in the communiqués coming in from the battle-fronts all over the world. Some day the full story of its achievements can be told.

There is, however, no reason why the lessons to be found in this experiment cannot be profitably employed in times of peace. The information, the techniques, and the research experience developed by the Office of Scientific Research and Development and by the thousands of scientists in the universities and in private industry, should be used in the days of peace ahead for the improvement of the national health, the creation of new enterprises bringing new jobs, and the betterment of the national standard of living.

It is with that objective in mind that I would like to have your recommendations on the following four major points:

First: What can be done, consistent with military security, and with the prior approval of the military authorities, to make known to the world as soon as possible the contributions which have been made during our war effort to scientific knowledge?

The diffusion of such knowledge should help us stimulate new enterprises, provide jobs for our returning servicemen and other workers, and make possible great strides for the improvement of the national well-being.

Second: With particular reference to the war of science against disease, what can be done now to organize a program for continuing in the future the work which has been done in medicine and related sciences?

The fact that the annual deaths in this country from one or two diseases alone are far in excess of the total number of lives lost by us in battle during this war should make us conscious of the duty we owe future generations.

Third: What can the Government do now and in the future to aid research activities by public and private organizations? The proper roles of public and of private research, and their

inter-relation, should be carefully considered.

Fourth: Can an effective program be proposed for discovering and developing scientific talent in American youth so that the continuing future of scientific research in this country may be assured on a level comparable to what has been done during the war?

New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful employment and a fuller and more fruitful life.

I hope that, after such consultation as you may deem advisable with your associates and others, you can let me have your considered judgment on these matters as soon as convenient—reporting on each when you are ready, rather than waiting for completion of your studies in all.

Sincerely yours,
Franklin D. Roosevelt.

NATIONALIZATION OF IMPORTANT INDUSTRIES

THE Government of India have at last come forward with something like a statement of their future industrial policy. A recent announcement from New Delhi, wherein the Government have provisionally expressed their intention to nationalize a number of important industries, to look after general industrial development, and to secure necessary measures and controls to regulate balanced and regional development, will stimulate great interest among industrialists, scientists and others deeply concerned with the economic regeneration of India. The fundamental object of industrial development will be, the report adds, to increase national health by the maximum utilization of country's resources in men and material, to secure a high and stable level of employment, and to prepare the country for adequate defence.

With this end in view, the Central Government propose to undertake, in consultation with the Provinces and under provision of the India Act, the development of certain important industries as a Central subject. Such industries include the iron and steel, the manufacture of prime movers, automobiles, tractors and air-craft, ship-building and marine engineering, the manufacture of electrical and heavy machinery and the machine tools, chemical textiles, cement, power alcohol and electric power industries. Ordnance factories, public utilities, and railways which are already very largely State-owned and State-operated will continue to remain so. The bulk generation of electric power will be a State concern as far as possible. Besides, the case of coal is proposed to be examined and dealt with separately. All

other industries will be open to private enterprise, subject to varying degrees of control.

In order to gain experience of the management of industries, the Government have indicated the possibility of certain industries being managed by private agencies or public corporations for a limited period. Ship-building, manufacture of locomotives and boilers and some other key industries may be run by the State as well as by private capitalists.

Apart from direct ownership and management of certain key industries, the Government propose to undertake a co-ordinated development of transport and electric power, an efficient survey of mineral resources, and the promotion of scientific and industrial research and higher technical education. Adequate financial support to research organizations set up by industrial associations has been indicated. Industries will be given facilities in procuring capital goods from abroad and also expert services, and to this effect, organizations will be established in the U. K. and the U. S. A. As further encouragement, the Government will buy the products of Indian industries in preference to those of foreign ones.

Controls will be introduced to secure balanced investment in industry, agriculture and social services. Improved provisions for fair wages, decent conditions of work and living, a reasonable security of tenure, safeguard against excessive profits to private capital, equitable distribution of assets as far as possible, and ensurance of quality in the final products of the industry are contained in the report. Government propose to take power by legislation to license the starting of new factories and the expansion of the existing ones. They are further contemplating to constitute a board to advise the Government in the matter of granting licenses for the industries to be taken over by the Government.

To the list of subjects for Central responsibility, we may add the multi-purpose development of India's water power resources. The difficulties arising out of the division of responsibility in this matter have been stressed in the editorial article of the present issue, and it is imperative that the Central Government should undertake the main responsibility for the development and utilization of water resources. We, however, reserve our comment on the various issues raised by the proposed nationalization of important key industries until we have seen the full text of the proposals not yet to hand.

CENTRAL WATERWAYS, IRRIGATION AND NAVIGATION COMMISSION

THE Government of India have decided, according to a press report, to set up a Central Waterways, Irrigation and Navigation Commission. The object of this Commission would be to plan and co-ordinate the organizations that would examine the potentialities

of Indian rivers. It would further co-ordinate the development of rivers passing through more than one Province or State.

The Commission will be able to advise the Central, Provincial and State Governments on waterways, irrigation and navigation problems throughout the country. It will conduct surveys and investigations with a view to securing utilization of India's water resources and press forward schemes for the conservation, control and regulation of water and waterways in consultation with Provincial and State Governments. The Commission will advise the Centre in respect of principles governing water rights, inter-provincial disputes, and on the appropriate basis of agreement between the parties in dispute. It will also advise the Central Government in regard to the settlement of priorities as between various projects.

INDIA'S PETROLEUM RESOURCES

THIS formed the subject of two lectures delivered by Mr D. N. Wadia, Mineral Adviser to the Government of India, Planning and Development Department, on the occasion of the award of Jay Kissen Mukherjee Gold Medal made to him by the Indian Association for the Cultivation of Science. In the beginning, Mr Wadia described the extent of distribution of petroleum belts on the earth's surface. Starting from the Pacific coast of the American continent, belts run through Morocco, Central Europe, Russian Oil fields, Iraq, Iran, Beluchistan, Sind, the Punjab, north-eastern Assam, Burma, Malaya, Sumatra, Java, Borneo, Philippines, Formosa, and terminates in Japan. The petroleum belts correspond to the zones of younger folded mountains (tertiary) on the earth's crust. He pointed out that this folding of mountainous zones was just the cause of petroleum formation, and further these zones supplied the ideal structures for the accumulation and preservation of mineral oil in the accessible layers of the earth's crust.

Discussing about the origin of petroleum, he mentioned that petroleum was formed from the subterranean decomposition of organic matter, mostly by distillation of the protozoa and other animals of that period, and largely also from the vegetable plantation life of the period. Regarding the sites for accumulation of organic sediments in which the oil occurs, the gulfs, estuaries, and deltas along the coasts of the seas of certain geological period when organic matter was abundant are found to have offered conditions favourable for the formation of petroleum. The anticlinal dome structures, he pointed out, are the best and most favourable structures, but a reference to the oil-field structure of the different places of the world will show that the anticlinal

structure is not always present, and other structures exhibiting monoclinical and homoclinical folding are also favourable, provided other conditions of petroliferous pervious beds being capped by impervious beds are satisfied. In such geological structures oil always occurs in the pervious beds (sand-stone, sand etc.) filling the void spaces overlain and underlain by some impervious-beds like shales and clays. In the pervious beds again oil which is a liquid hydrocarbon is also associated with gaseous hydrocarbons, and in such structures gas always occurs in the upper portion of the anticlinal crests. He also discussed the complexities in such structures like asymmetric anticlines, faulted and disturbed state etc.

He then referred to the problems arising from migration of oil from the place of origin, i.e. the source rock, to certain places where suitable reservoir rocks provided more favourable conditions of storage. There are many instances of the escape and loss of the mineral oil from the original reservoir in the strata due to faulting, erosion and truncation of the mother-rock, and from its over-lying strata due to deep weathering and denudation of anticlines etc. Such examples have been quoted from salt-range and other places of the Punjab. Mr Wadia estimated world's total reserve of mineral oils at 65,000 million barrels and world's annual production at 22,00 million barrels. India's reserve is yet difficult to estimate, but as a rough estimate India's annual production may be placed at 83 million gallons, and India's annual consumption at 400 million gallons.

In India there are two important petroliferous belts, namely (i) the extension of the Iranian belts to Beluchistan-Punjab, passing through the Potwar-salt range tract, (ii) the Arakan-Burma belt beginning from north-east Assam, passing through eastern regions of Assam across the Arakan range along the Irawaddi in Burma and thence, through Arakan coast, extending to Straits-settlements.

Oil exploration in India is yet in the early stage, fitful and defective, although it began in 1800 in Arakan, in 1820 in Burma, and in 1870 in the Punjab. But the history of exploration in India is one of long record of drilling failures and disappointments. Oil-exploration is an extremely expensive and risky enterprise, but intensive geological exploration supplemented by geo-physical prospecting in areas like East-Beluchistan, the N. W. Punjab, foothills zones, the alluvium and sand-covered tracts of the southern Punjab, salt range, Assam etc. may yield encouraging results. Mr Wadia pointed out that the oil resources of a locality must be based on critical study of geological principles of oil generation, migration, storage and the structure. As an illustration, he referred to his discovery of the Joya-Mair oil-field (Potwar) in 1926, and discussed the geologi-

cal features that guided him in this discovery. He gave some account of oil fields of India and divided them into three important groups (i) the Punjab, (ii) Assam, and (iii) Burma.

Referring to the future prospect of petroleum in India, he emphasized that search for oil should be confined to regions of lower and middle tertiary rocks, for permo-carboniferous or mesozoic oil is so far unknown in India. He stressed the possibility of concealed oil field in Assam and the Punjab, underneath the alluvium, and of recent formation. The geophysical, gravity, seismic, magnetic, and electrical methods alone can be of service in tracing sub-surface oil fields.

Mr Wadia considers the Potwar area of the N.W. Punjab a more promising area than Sind-Beluchistan. In conclusion, he referred to the two potential petroleum zones in India, (i) Palaeogenezone at the foot of the Punjab Himalayas, on the analogy of the Iran-Iraq belt at the foot of the Zagros stage, and (ii) the Gulf of Cambay.

UNIVERSITY GRANTS IN GREAT BRITAIN

In a recent statement in the House of Commons, Sir John Anderson, Chancellor of Exchequer, has disclosed, according to a report in *Nature*, that a sum of £5,900,000 would be available as a grant in aid of the universities, colleges, medical schools, and teaching hospitals of Great Britain for the year 1945. The recurrent grant for general university purposes has been strengthened by an addition of £2,000,000 in each of the next two years, which has nearly doubled this grant. Following the recommendations of the Inter-Departmental Committee's report, the Government have made a further grant of £1,000,000 for developments in medical schools, and £500,000 in aid of the teaching hospitals. Further, a grant of £250,000 for capital expenditure has been placed at the disposal of the University Grants Committee. This last sum is intended for expenditure on such items as the erection of new buildings, purchase of sites on which to build new buildings etc. Many universities and colleges are now in need of funds to acquire lands and build houses so that they can offer wider facilities for higher education, now badly needed in Britain. It is apprehended that the grant provided for this purpose will prove insufficient, but the Chancellor has assured the House of the possibility of this grant being increased within the financial year if such need arises.

It is stated that about £1,500,000 from the grant for general university purposes will be immediately required for increase in the salary scales of members of the university staffs. It is realized that the salary scales offered to such members are not comparable with these available in other professions employing

men of the same qualifications. While making these grants, the Government have not attempted to encroach upon the autonomy of the universities by imposing any conditions, however justified.

This increased provision for funds will enable the educational authorities in Britain to strengthen the foundation of education and research. Signs of constructive activity and preparedness for peace are visible in all Government measures. In England, money is flowing from the Treasury in million pounds to ameliorate the teachers' lot. In India, sugar coated words and tall promises of the high officials of New Delhi, broadcast through radio or publicized through other propaganda machinery, are what our benevolent Government can offer to encourage the hard hit and starving teaching profession.

AERONAUTICAL RESEARCH IN BRITAIN

At a recent meeting of the Parliamentary and Scientific Committee, Sir Henry Tizard advocated a block grant from the Government of at least £1,000,000 for aeronautical research on the problems of civil aviation. Construction of aircraft for the fighting services has now engaged all aeronautical research and, as Sir Henry revealed, there is virtually no civil aircraft in Britain today. He urged the creation of a new Aeronautical Research Council under the Lord President of the Council. The Chairman of the said Council should be an experienced industrial engineer and should have executive control. The work of this body, when created, would be directed exclusively to research problems relating to civil aviation.

Sir Henry was not very optimistic about the employment of a large number of civil machines in the post-war years. Internal air service, he said, might be expected to yield a revenue of about £8,000,000, i.e. 2.5 per cent of that from the railways, and a force of some 80 aircraft would be sufficient for the service. He further expressed the view that regular and economic trans-Atlantic service would not be possible so long as the planes do not fly about the 40,000 feet level and develop a much higher speed, which can alone be effected through intensive research on the problems of civil aviation.

Close at the heels of Sir Henry's lecture comes the announcement by Sir Stafford Cripps, Minister of Aircraft Production, of a scheme to build a great aviation research centre in Britain, to be financed by the Government. The new station which is expected to secure a level of achievement in civil aviation comparable with that attained by the British Air Research Centre at Royal Aircraft Factory at Hampshire (started in 1910) will be located in the Bedfordshire area chosen after a very careful survey.

NATURAL RESOURCES OF THE ANDHRA AREA

A symposium on the 'Natural Resources of the Andhra Area' was organized under the auspices of the Andhra University at Waltair in 1940, when the Indian Academy of Sciences was holding its sixth annual session. On this occasion, a number of distinguished scientists read papers on the faunal, floral, mineralogical, electrical and chemical resources of the area and discussed the possibilities of future industrial development of this region. The University has now done well to collect these papers and publish them under a single volume which will serve as a highly useful and stimulating record of diverse natural resources on which to work out the plan of post-war industrial development of this area. The sixteen papers included in the volume have dealt with fauna, flora and plant resources, fossil flora, fruits, mineral and metalliferous resources, power resources and hydro-electric schemes, and the resources for organic chemical industries, ceramic industries, wood distillation and power alcohol, dyes and tans, paper, oils, gums, waxes and resins, and paint and varnish industry, of the Andhra area. The delay in the publication of the volume which ought to have appeared earlier, it is explained, has been due to unavoidable war-time limitations.

TECHNICAL WORK AT THE INDIAN WATERWAYS EXPERIMENT STATION, POONA, DURING-1942-43

THE Annual Report (Technical) of the work done during the year 1942-43 at the Central Irrigation and Hydrodynamic Research Station, Poona, now renamed as Indian Waterways Experiment Station, together with an index for 1938-42, has just been published by the Government of India (price Rs. 7-8 or 11s. 6d.; available from the Manager of Publications, Civil Lines, Delhi). This is the sixth annual report of the station since it became a Central Station and contains extracts of papers and detailed description of experiments dealing with a wide variety of problems in connection with rivers and canals in various parts of India. Descriptions are further illustrated by necessary diagrams, maps and photographs and are full of statistical data. The report is intended for use as reference by research workers and officers engaged in Irrigation and Railway Divisional offices and in other river research laboratories which have to deal with similar problems. The Director of the Station, in a letter just circulated, has expressed his willingness to give assistance to those who ask for it without charge provided this does not involve model work, special inspections or the expenditure of a considerable amount of time.

PRINCIPLES OF CEREAL STORAGE

THE Government of India have recently issued a publication entitled 'Principles of Cereal Storage'

by E. P. Coyne. This is a timely publication, when the problem of food shortage is so acute and when there is need for saving every seer of grain available in India to-day. The production of food grains in India even in peace times falls far short of the demand that increases every year with the growing population. Increased production either by promoting higher yields from existing areas or by extending the area under cultivation is a prolonged process, and as such the saving of grains during storage has become all the more important. According to an official estimate, 600,000 tons of wheat and rice are annually lost during storage. Damage by rodents alone probably accounts for a million tons of all food grains (cereals, pulses, etc.), with similar amounts lost from insect and moisture damage.

The book deals with the important factors in food conservation, e.g. climate and moisture damage, standard types of storage, grading of godowns, and general hygiene. These refer specially to present conditions when large stocks of grain are being held by Provincial and State Governments and when we hear so often of wastage of huge quantities of food grains in Bengal and elsewhere, due to damage caused by defective storage.

Damage by insects is mainly caused by beetles, moths, and mites, and it is estimated that a single pest *Calandra bryzae* (rice weevil) sometimes causes a loss of stored wheat valued at nearly one crore of rupees a year in India alone. Remedial measures by fumigation and its application are discussed in detail.

Methods recommended for the control of both house rats and field rats will be very useful not only to those who have to store in bulk but also to the ordinary householder.

It is gratifying to note that the Directorate of Storage, Government of India, is devising means of application of new and improved control measures in laboratory and practice, collecting information from India and from foreign sources, disseminating the same and co-ordinating the activities throughout India in the interest of grain conservation. It is to be hoped that each of those scientific methods of food storage would receive the closest attention of Central, Provincial and States Governments now that they are the principal custodians of India's food supply.

TRAINING IN DAIRYING AT BANGALORE

With a view to meeting the growing demand from the Provinces and States for trained personnel required for implementing post-war development plans, and for filling up higher posts in Dairy Departments, the Government of India have decided to in-

crease the number of students to be admitted for training at the Imperial Dairy Research Institute, Bangalore, from 30 to 85 with effect from July 1945. The Institute provides three courses of training, viz., (1) a two year course for the Indian Dairy Diploma, (2) a post-graduate course for 15 months, and (3) a short course for three months.

It is now proposed to increase the number of students for the Indian Dairy Diploma course from 20 every alternate year to 25 a year, i.e., (50 students, 25 in the first year and 25 in the second year), for the postgraduate course, from 10 students to 25, and for the short term course, to 30 students a year (i.e., 10 students per course). The total number of students in residence will thus be 85 a year.

For this purpose Government have sanctioned in all Rs. 1,40,500 (Rs. 88,000 non-recurring and Rs. 52,500 recurring).

PALYNOLOGY

PROF. P. B. SEARS of Oberlin College, Ohio, Mr A. H. Hyde of the National Museum of Wales, and Mr D. A. Williams of Standough Hospital, Cardiff, suggest the term *palyndology* (Greek *paluno* to strew or sprinkle) for the study of pollen and other spores, their dispersal, and applications thereof in the October issue of the bulletin entitled "Pollen Analysis Circular".

In recent years the study of pollen has come much to the fore. Research is now being directed towards fundamental problems relating to the liberation, dispersal and deposition of air-borne pollen. The results will have obvious implications in the field of floral biology and should also be of value to the meteorologist. The pollen analysis of peat has become one of the most important techniques used in the study of post-glacial vegetation. Pollen analysis of coal is an aid for correlating coal-seams. The pollen of insect flowers is receiving attention as a means of determining the sources of samples of honey. All these studies have, up to the present, been referred to under the general heading of pollen analysis. It is hoped that the new word will be commendable.

ANNOUNCEMENT

We have great pleasure in informing the readers of SCIENCE AND CULTURE that the National Institute of Sciences of India have made a grant of Rs. 750 out of the Rockefeller Foundation grant to our Association. The grant has been made in two instalments of Rs. 500 and Rs. 250 respectively for the year 1944-45, and we seize this opportunity to express our sincere thanks to the National Institute of Sciences and the Rockefeller Foundation for this generous grant.

SCIENCE IN INDUSTRY

INDUSTRIAL UTILIZATION OF BAGASSE

A SERIES of interesting articles on the industrial utilization of bagasse have appeared in the March 1945 issue of the *Journal of Scientific and Industrial Research*. Bagasse is the residue of sugarcane from which the juice has been extracted by crushing and is the main by-product of the sugar industry. It is now largely used as fuel for steam raising purposes in the sugar industry itself, but it may also serve as an important raw material for economic production of activated carbon, resin and plastics, insulating and pressed boards, wrapping paper and straw board, and may further be used as a cattle feed in mixture with molasses. Problems connected with the industrial utilization and development of bagasse have been variously investigated in the laboratories of the Imperial Institute of Sugar Technology, Cawnpore, the Forest Research Institute, Dehra Dun, and the Council of Scientific and Industrial Research, Delhi, and the articles present a good summary of the work carried on in this country and abroad.

Although bagasse finds its main use as a fuel in the sugar industry, its high water content amounting to about 48 per cent. makes it a very low grade fuel. Its calorific value is only about 4,400 B.T.U., but may be increased to 8,350 B.T.U. for the absolutely dry variety. A pound of coal, on an average, may be taken to be equivalent to 3 lbs. of bagasse in calorific value, and one pound of bagasse can produce, with boilers and furnaces of suitable design, 2½ lbs. of steam. Before use as fuel, it is compressed into bales by hydraulic press. Briquettes of bagasse, formed by the application of pressures of the order of 5,000 lbs. per sq. in., have been successfully tried in Australia. But the most important factor is the way in which it should be burned on account of its very high moisture content. Methods of burning, applicable to other types of fuel, can not be tried in the case of bagasse without appreciable loss of fuel efficiency. Its use as fuel involves the design of special furnaces which are described in an article by K. S. Arnold and D. K. Brahma. The authors hold that high combustion efficiency can be attained even with such poor grade fuel through the use of properly designed and correctly proportioned furnaces.

The high porosity and low ash content of bagasse make it a very suitable, and at the same time cheap, raw material for activated carbon whose industrial uses as decolorizer, deodorizer, purifier, etc. are too well-known to need mention. The Imperial

Institute of Sugar Technology first started investigations into the possibility of utilizing bagasse for the production of activated carbon. Of the various methods available for its preparation, the one involving the treatment of the raw material with chemicals followed by carbonization and, in some cases, by further activation by gases has given the most encouraging results. Zinc chloride has proved the most efficient activator. K. S. G. Doss and N. S. Jain who have discussed these methods in a separate article state that carbon obtained from bagasse compares well with the imported variety and can be economically produced in India. According to an estimate quoted by these writers, the cost of manufacturing activated carbon in India amounts to Rs. 640/- per ton and may further be reduced, as improvement in the design of furnace and other equipment takes place.

The paper on 'Bagasse-resin and its Plastics' by Prakash Narayan and S. S. Bhatnagar discusses the possibility of manufacturing resin and plastics from bagasse. The use of ligno-cellulosic waste, such as cane-bagasse, as the raw material in the plastic industry has the great advantage that it is cheap and available in plenty. The authors believe that bagasse will become a potential raw material for plastics, specially in the manufacture of articles in which transparency and colour are unimportant.

Insulating and pressed boards, known under various trade names, are now extensively manufactured from bagasse in the U. S. A. In 1937-38, the Forest Research Institute, Dehra Dun, studied the American methods of producing such boards from bagasse under Indian conditions and obtained encouraging results. Mr S. Chattar Singh who has reported on these investigations at some length states that the Asplund or Defibration process has been found to be very suitable for Indian conditions. Samples of boards prepared in the laboratories of the Institute compared favourably with the foreign-made boards so far as their physical properties such as thermal conductivity, sound absorption coefficients, resistance to moisture and mechanical strength are concerned. The smallest economic unit capable of turning out 1,600 tons or 4,800,000 square feet of boards annually requires a capital expenditure of about Rs. 12 lakhs on peace-time price level. The cost of production of one ton of insulating and pressed boards has been estimated at Rs. 270-8-0. Bagasse indeed constitutes a suitable raw material for the manufacture of wrapping papers and straw board, but in view of its huge requirement for this

purpose, their manufacture from bagasse does not at present appear to be a practical proposition.

Bagasse screenings obtained through the use of 49 and 64 mesh screens may be used as cattle feed. The screenings, although deficient in protein content, contain practically the same amount of carbohydrates as other roughages and are comparable to Timothy hay. Bagasse screenings, in mixture with molasses, another by-product of the sugar industry, are reported to have yielded the best results. Mr H. S. Chaturvedi, in his article on 'Bagasse for Cattle Feeding', explains the value of 'Bago-molasses', consisting of 2 parts of molasses and 1 part of bagasse screenings, as a suitable cattle feed.

The foregoing does not exhaust the list of industrial uses of bagasse. Possibilities of manufacturing cellulose from bagasse have been investigated. Dry distillation of bagasse in Cuba has yielded methyl alcohol and formic and acetic acids, and their commercial production in near future is not beyond the realm of practicability. Composted with press-mud, it has further been applied as a valuable manure. Thus Bagasse offers an excellent example of how a by-product once discarded as an industrial waste may be the starting point of a number of important industries.

GLASS-TO-METAL SEAL

The direct glass-to-metal seal represents a great technical improvement in sealing operations. This new device has been particularly welcomed by the electrical industries where sealing between metal and glass accessories is a regular routine work. The *Review of Scientific Instruments*, November, 1944, reports the successful application by the Sprague Electric Company of this new process of sealing in the manufacture of capacitors and resistors. In the case of capacitors, the usual ceramic terminals are supplanted by glass bushings which are then directly sealed to the metal capacitor containers. The details of the process developed by the Company are not revealed, but it is stated that the metal rings with 'matched' temperature coefficients of expansion, previously in use, are now dispensed with. In the case of resistors, the special glass tube containing the resistance unit is sealed to the metal ends.

The new technique has solved the vexed problem of providing adequate safeguards against leaks and moisture. The direct glass-to-metal seal which results in a solid and integral unit at the place of seal has eliminated such defects characterizing older instruments. The removal of organic bushings and other materials liable to be attacked by fungus has effected a better protection of the component parts. Further such seals have proved highly efficient, both electrically and mechanically. The new process has been

satisfactorily applied to any metal including steel, brass and monel metal. The technique has been so perfected that more than 10,000 glass-to-metal seals, it is reported, are now produced each day.

GLASS FIBRES

Fifty years ago, it was a fantastic idea to think of glass fibres that are now being made for the manufacture of textiles, table cloths, neck-ties, and decorative fabrics as common articles of daily use, and of special fabrics for industrial applications. As a material for textiles, glass was always attractive to the technician by reason of its non-inflammability and resistance to the effects of high temperatures, which are rare properties of fibres in common use. The production and perfection of glass fibres to their present stage represent a remarkable achievement of the glass technologists. In *Scientific American*, December, 1944, William H. Page gives an interesting account of the various uses to which glass fibres have been put during recent years.

Edward Libbey, of the Libbey Glass Company, is reported to have first succeeded in drawing coarse glass fibres from the heated ends of glass rods in 1893. Continuous glass fibres are now drawn by allowing molten glass to pass through tiny holes in the base of the melting chamber. The filaments, as they emerge from the holes, are wound on a winder revolving at a high speed. Since filaments emerge at a speed much lower than the speed of revolution of the winder, these are attenuated into fine filaments of diameter considerably smaller than that of the holes. Staple fibres of length varying from 15 to 18 inches are formed by allowing jets of high pressure steam to strike thin streams of glass emerging from the holes and then wound on a revolving drum to form a veil resembling a cobweb. Standard textile machineries with modifications to enable them to handle glass textiles have been used to twist continuous filaments and staple fibres, and very fine glass fibres have been produced in this way. The incredible fineness and tensile strength of such fibres may be reflected from the fact that fibres having a diameter of 23 one-hundred-thousandths of an inch can withstand a tensile strength of more than 250,000 pounds per sq. in. Finer fibres with greater tensile strength have, however, been produced experimentally.

Glass fibres have been used singly and in combination with asbestos fibres, rayon, silk or cotton for various specialized applications. Glass asbestos articles have proved very suitable when resistance to high temperatures and to repeated flexing, high strength, and light weight are important considerations. In combination with rayon, silk, etc., glass fibres have been employed for the manufacture of

neck-ties, scarves, wearing-apparel accessories and various decorative fabrics. The production of such articles for civilian use is now curtailed to make available greater quantities of glass fibres for military use.

Glass fabrics impregnated with suitable varnishes are largely used for the making of insulating tapes, braids and cloths in the electrical industry. Such fabrics, besides being very light, have high electrical resistance and have enabled design engineers to build smaller and lighter motors, transformers and other electro-magnetic machines. Flameproof and moisture-resistant fabrics suitable for use as air-craft battery cover, oil pressure switch diaphragms, air-craft tape for expansion joints of hot air ducts, protective clothing for workers, etc. are now made of glass fibres with a coating of synthetic rubbers.

Glass fibres in combination with a plastic resin have given rise to a new structural material for the construction of load-bearing parts of aeroplanes. The material is light, possesses high structural strength and can be readily fabricated. Layers of glass cloth are impregnated with resin and placed, one on top of another, until a laminate of the desired thickness is built up. Such plastic glass laminates have remarkable tensile, compression and impact strengths and are likely to be used on a large scale in air-craft construction. It is stated that such laminates have tensile strengths varying from 50,000 to 80,000 pounds per sq. in., compression strengths of over 50,000 pounds per sq. in., and impact strengths of over 30 foot-pounds.

An important war application of fibre glass consists in its use as glare shields for magnesium parachute flares of about 1 million candle powers. Such flares are used to illumine the targets before bombing operations.

DESIGN OF ROAD CURVES

The design of road curves has become a subject of considerable interest and experimentation in recent times, for it has been realized that for smooth and good driving a simple circular curve with straight approaches at the ends and following the topographical configuration of the land is not always the best and the most efficient course. In traversing such a straight-circular curve, a driver generally experiences a good deal of lurch which at high speeds may become dangerous for his own as well as the safety of other motorists. To minimize this awkward feeling and give the driver a maximum economy of comfort, an adjusting transitional curve is generally interposed between the circular and the straight course, the nature of this curve being such that its radius or degree of curvature is continually

changing with reference to a certain fixed point. Varied mathematical expressions have been obtained for these transitional curves, and among the reports of various investigators, the recent work of Professor Royal-Dawson in this field observes particular mention. He has attacked the problem from both dynamic and psychological view points and has arrived at interesting and useful conclusions. According to him the most conspicuous factor in any road curve is the fixing of a standard unit for the rate of change of centripetal acceleration about which a good deal of uncertainty exists at the present moment. The values of these standard rates of acceleration are classified according to the limiting speeds of vehicles, particular attention being concentrated on the sensation produced by a car heading towards a right-hand turn over a badly designed roundabout at speeds varying from 10 m.p.h. to 15 m.p.h.

From several observations it is found that a converging stream of cars travelling at a speed of 10 m.p.h. round an island 140 ft. in diameter could easily absorb an incoming vehicle of 20 ft. average length and also travelling at the same speed, provided the converging stream under consideration has gaps of 46 ft. in between, which would correspond to a traffic density of 800 vehicles per hour per lane. On working a little further, one can show that a car moving under the above conditions would take only 17 seconds to pass a quarter roundabout and 24½ seconds to pass half the roundabout as measured from the tangential edge in both the cases.

Very few motorists, however, seem to realize this, because actually it is found that the cars which pass roundabouts usually travel at speeds far higher than those considered, without any regard to the danger involved not only to themselves but even to the pedestrians who happen to cross the roads.

The difference in driving a light and a heavy vehicle has been solved by considering two types, one representing a 1 ton car of 8 ft. wheelbase with a locking angle of 30 degrees and a steering-gear ratio of 6:1, the other a 10 ton car of 16 ft. wheelbase and a steering-gear ratio of 12:1, the locking angle being the same as before. From these considerations, steering is regarded psychologically as a series of jerky hand movements with "rest" periods in between, each stroke or jerk representing a fragmentary transition and each "rest" period a circular arc. It can be shown graphically that a given transition may be followed by a motorist within a fairly wide range of spontaneous hand movements on the steering, and it is then only a routine to ensure that the resultant curve conforms reasonably to the general course of the road. The dynamic aspect is clarified by showing that the inherent physical effort

in steering the heavy type vehicle (10 ton weight), combined with the necessity of turning the steering wheel through an angle four times as large as that required for a light vehicle (1 ton weight) over the same curve, renders it imperative to design road curves conforming to the exacting requirements of heavy class vehicles instead of adopting standards suitable only for light cars, as is very often done in practice.

The tests carried out on wholly circular and wholly transitional layouts have gone to prove that for sharp curves and moderate speeds a transitional curve imposes less physical effort than a circular one. For curves of very large radii and high speeds, however, a different set of dynamic and psychological factors are brought into play so that for a good design of such large curves the value of the unit for the standard rate of change of centripetal acceleration should be lower than for curves designed for moderate speeds, if a reasonable margin of safety has to be ensured. According to Professor Royal-Dawson, the ideal curved road course, when such is within the limits of practical design and construction, is a wholly transitional curve, because psychologically it has a greater speed-potentiality than any combination of a transition and a circular arc, while mathematically such a curve represents the shortest route from amongst the "circular-transition" combinations, (measured from some point on the tangent to the given mid-point) and, therefore, from the commercial user's aspect is the most economical.

S. K. G.

AGRICULTURAL DEVELOPMENT AND MINERAL FERTILIZERS IN INDIA

P. E. MEHTA

AGRICULTURE has always been the primary industry of India even from early days. The proportion of population dependent on agriculture has risen from 65% in 1872 to 75% in 1940.

Nine-tenths of the population of the country still continue to live under rural conditions and even the factory labour of the towns as well as the commercial classes continue to retain the connection with the villages from time to time from which they have migrated.

The agricultural production of India was directed during the last hundred years towards the securing of an exportable surplus of raw products, to meet India's obligations resulting from her connection

VEGETABLE TANNING MATERIAL IN INDIA

Owing to war, tanners in India are finding it increasingly difficult to obtain sufficient supplies of tanning materials from indigenous sources to meet the growing military and civil requirements. Forest Research Institute, at Dehra Dun, in its leaflet No. 72, gives a complete survey of the vegetable tanning materials found in India. The big industrial concerns only deal with four tanning materials, viz. babul bark (*Acacia arabica*), myrobalans (*terminalia chebula*), avaran bark (*cassia auriculata*) found in abundance in India, and black-wattle bark (*Acacia mollisima*) which is now being cultivated in South India and is imported from Africa to a large extent. Of the others, the following may be of considerable use to the tanners, viz. aoule bark (*Emblia officinalis* syn. *Phyllanthus Emblica*), beleric myrobalans (*Terminalia belerica*), dhowa leaf (*Anogeissus* Sp.), divi-divipode (*Casalpinia coriaria*), gother fruit (*Zizyphus Xylopyrus*) hopea bark (*Hopea Parviflora*), arjun bark (*Terminalia Arjuna*), karanda leaves (*Carissa* Sp.), mangrove barks (*Cariops* and other Spp.), remuja bark (*Acacia leucophoca*), sain bark (*Terminalia tomentosa*), sal bark (*Shorea robusta*), sonari bark (*Cassia fistula*), tenpods (*caesalpinia digyna*).

The leaflet gives a list of plants whose tannin content has been investigated quantitatively, and also those whose tannin content is negligible or not quantitatively determined. The correct Latin names with their synonyms, English names, trade names, and vernacular names are arranged alphabetically. The list also includes the localities, habit and habitat, and part or parts of plants that are supposed to be used in tanning. A bibliography at the end of the pamphlet contains details of each species noted in the leaflet.

with outside countries and not to meet her own requirements.

The following few examples give an idea as to how the agricultural policy is based not on internal requirements but for outward obligations. India produces 52% of the groundnuts, 95% of jute and 45% of rice of the world; the first two commodities being mainly exported.

The outbreak of the war in 1939, and later the occupation of Burma by the Japanese brought with it a clearer recognition of the importance of agriculture in India, as the import of rice from Burma was completely cut out.

The term fertilizers includes a number of mineral substances, limestone, marl, gypsum, phosphate of lime, green sand, green manure, guano, kainite (K_2SO_4 , $MgSO_4$, $MgCl_2$, $6H_2O$) and nitre (KNO_3 , $NaNO_3$, etc.) which are of value for adding to the soil to increase its supply of plant food and also in some cases to correct its physical condition. Some of these have other uses over and above that of fertilizers. The most important raw mineral for fertilizers is phosphate of lime. This occurs as crystalline phosphate of lime or apatite associated with crystalline rock phosphate.

Apatite: $3(Ca_3(PO_4)_2 \cdot Ca(F, Cl)_2)$

When pure it contains 90% tricalcium phosphate, 10% calcium fluoride or calcium chloride.

The material entering the trade contains varying quantities of Al and Fe phosphates with earthy impurities including clay, silica, lime etc. Among the most important phosphates are:

Collophane $Ca_3(PO_4)_2 \cdot CaCO_3$, Strurite $NH_4(MgPO_4 \cdot 6H_2O)$, Wavellite $(4AlPO_4)_2Al(OH)_3 \cdot 9H_2O$, Vivianite $Fe_3(PO_4)_2 \cdot 8H_2O$, Staffelite $3Ca_3(PO_4)_2 \cdot CaF_2$, $CaCO_3 \cdot H_2O$, Triplite $(Fe, Mn)_3(PO_4)_2 \cdot (Fe, Mn)F_2$.

Apatite deposits of economic workability are not very common; the largest deposit being found in European Russia. Mineralogical studies in recent years with the help of X-rays have shown that its composition is best expressed as $Ca_5(Ca_3F)_2(PO_4)_6$. Apatite which is commercially known as rock phosphate is by no means uniform in its occurrence and varies from bed to bed and even in the same bed laterally. It is found in igneous rocks. It may be seen as veins in metamorphic rocks and as a product of replacement in sedimentary rocks.

Fluorapatite when pure contains 55.2% CaO , 41.3% P_2O_5 and 3.7% F. For market purposes the combined alumina and iron content should not ordinarily exceed 2.5%.

The lump phosphate and coarse material of high grade are merely crushed and sized for marketing. The unconsolidated material (matrix or muck) is generally of low grade and requires beneficiation by flotation methods.

DIFFERENT TYPES OF PHOSPHATES

Triple super-phosphate.—This is manufactured by mixing the high strength phosphoric acid with raw high grade phosphate dust in mixers. It contains about 45% of available plant food.

Super-phosphate.—Phosphate rock containing 70 to 74% tri-calcium phosphate is finely ground to about 200 mesh sizes. It is well mixed with an equal quantity of sulphuric acid and heated, the product passes through different complicated stages before

use. Super-phosphate contains 20 to 22% of available plant food.

An interesting process of making super-phosphate has been developed by the T.U.A. in America. If 0.46 lb. of olivine is fused with 1 lb. of phosphate rock a product results containing 22.8% total P_2O_5 of which 21.4% is a citrate soluble and therefore available for plant food. Thus a product somewhat more concentrated than ordinary super-phosphate can be made by a simple fusion process with no expenditure of sulphuric acid. Another advantage of the olivine phosphate process is the presence in the product of soluble magnesia an additional plant food.

The Singhbhum Dunite (Olivine) belt is very near the Dhalbhum phosphate belt, so the proximity of the raw materials is very advantageous. Due to the great paucity of sulphur in India, any process which does not involve the use of sulphuric acid is of great advantage.

Calcium meta-phosphate.—It is glassy in appearance and contains 60 to 65% P_2O_5 , practically all of which is available as plant food in contrast with 20 to 22% available in super-phosphate.

USES

A very large part of the phosphate production of the world undergoes some treatment before use. The chief use of phosphates is in preparation of fertilizing materials for agriculture, 90 to 95% of the world output going ultimately into agricultural use. Phosphate rock is also the raw material for the manufacture of phosphorus element, phosphoric anhydride (P_2O_5) and phosphoric acid. The chief centres of use of phosphatic rock and fertilizers are Europe, North America and Japan.

In the mineral returns of India the pre-war valuation of apatite from Singhbhum is about Rs. 15/- per ton and that of phosphatic nodules of Trichinopoly containing 55 to 60% tri-calcium phosphate about Rs. 10/- to Rs. 12/- per ton.

DEPOSITS OF APATITE IN INDIA

The best known occurrence is found in the copper belt of Dhalbhum (East Singhbhum). The mineral occurs as a constituent of lenses of apatite—magnetite—biotite—chlorite rock in the main over thrust zone, intermittently for a distance of 40 miles between Dhatkidih in Seraikela State and Khejurdih in Dhalbhum.

The Tata Iron & Steel Co. has done considerable prospecting near Kudada and adjoining areas but they hold no mining lease.

The percentage of P_2O_5 in the ore varies from 20 to 25 on an average. The ore is amenable to crushing and concentration by magnetic separation

of the magnetite and consequent improvement of grade to 35 per cent of P_2O_5 .

The reserves of the ore in this area in three distinct belts taking an average depth of 200 ft. are taken as 700,000 tons. The total output between 1918-38 was 28,000 tons. Mr Murray of Rakha mines holds some leases but no data of the output or the reserves are available.

Near Sitarampur a village 25 miles N. W. of Vizianagram a lens of the rock is estimated to have 5,000 tons of apatite taking average depth of 30 ft.

A typical sample gives the following analysis:

P_2O_5	...	40.50%
CaO	...	53.76%
SiO_2	...	1.52%
F	...	3.47%
Cl	...	0.55%
H_2O	...	0.22%

At Jothwad in Narukot-State, Rewa Kantha Political Agency there are apatite-rich rocks associated with manganiferous rocks.

The mineral occurs as a constituent of apatite—spessartite—pyroxene—quartz rock and apatite—spessartite—piedmontite rock and frequently constitutes upto 30% of the volume of these rocks. No estimates are available.

Phosphate rock and nodules are found in the Trichinopoly district of Madras, South Arcot and Pondicherry, Mussorie in U. P. and Jhelum in Punjab.

FOREIGN DEPOSITS

The largest known deposits of apatite in the world occurs in Kola peninsula west of White Sea in Russia. The apatite occurs in nepheline rock containing aegirite and magnetite in small quantities. The deposits are about 500 to 600 ft. thick and contain 20 per cent to 35 per cent P_2O_5 .

The following gives an idea of the consumption per annum of phosphate rocks in different countries² before the present war.

U. S. A.	...	3 million tons
U. S. S. R.	...	2 (probably) million tons
France	...	2 million tons
Italy	...	¾ to 1 million tons.
Japan	...	¾ to 1 million tons.
Germany	...	¾ to 1 million tons.
U. K.	...	½ million tons
Spain	...	½ million tons
New Zealand	...	½ million tons
Australia	...	½ million tons
India	...	negligible

Basic slag.—The basic slag from the steel furnaces contains phosphorus. As the Indian iron ore is poor in phosphorus compared to foreign, the phosphorus content of the slag averages from 3 to 5% which is uneconomical for commercial use as a fertilizer, but by amelioration with apatite a profitable fertilizer might be produced.

Potash in Flue-dust of Blast furnaces.—The flue-

dust from blast furnaces contains a certain amount of potash which may be used as a fertilizer. The quantity available is very little and still will have to be used as such; the concentration of the potash in the dust being both difficult and uneconomical.

In 1913, W. A. A. Christie investigated the salt range occurrences and in the Mayo mines alone 21 places were found in which potassium bearing minerals occurred. The percentage of potash varied from 6.8 to 14.4% on an average. In Nurpur mines where the percentage of potash is 13.6 the mineral kainite was recognised.

Bone and bone-meal.—The total tonnage about 100,000 tons³ is not adequate compared to the requirement of the country and most of it is exported to foreign countries in the raw state. Recently a company named Malabar Fertilizers Ltd., has started making bone-meals in Travancore State with a daily output of 20 tons.

Feldspars.—The potash feldspars orthoclase and microcline, whose composition is expressed by the formula $K Al Si_3 O_8$, contains as expressed in percentages the following:

Al_2O_3	...	18.4%
SiO_2	...	64.7%
K_2O	...	16.9%

Feldspars are widely distributed in many igneous and metamorphic rocks but in most cases they are so intimately mixed with other minerals, that their extraction is not commercially practicable, and it is only when they are found in pegmatites that they are worked.

The possibility of using feldspars as a fertilizer because of its potash contents has been suggested but no commercially practicable means of extracting the desired element has as yet been found.

PROSPECTS

In view of 75% of the population of India depending on agriculture the resources of phosphate rock seem to be poor from our present knowledge. The existing deposits must be proved and intense prospecting work done for finding out new deposits. Methods of concentration of P_2O_5 must be tried in laboratories with maximum recovery. Methods of separating K_2O from the feldspars must be found out. Moves are afoot in establishing fertilizer industries in Travancore by the State authorities and by the Imperial Chemical Industries near Dhanbad in conjunction with the Bihar Government. The salts contemplated for production will mainly be of sodium and ammonium. The problem of the utilization of Indian rock phosphate demands more research than it appears yet to have received.

The imperative necessity of establishing fertilizer industries all over the country can be seen from the position of the acreage under tilling in British India.

DISTRIBUTIONS OF LAND⁴ IN BRITISH INDIA
IN MILLION ACRES

	1940-41	in percentage
Forest	68	13.3
Not available for cultivation	87	16.9
Cultivable waste	98	19.1
Current fallow	45	8.9
Net area sown	214	41.8
Total	512	100.0

It is seen from above that more than half the acreage is not cultivated every year and 30% remains fallow due to lack of proper nourishment to soil.

YIELDS IN LBS. PER ACRE OF SOME CROPS FOR 1938
IN DIFFERENT COUNTRIES

Crop	Siam	Egypt	Korea	Italy	Germany	India
Rice	1,297	3,136	2,464	4,928	—	834
Wheat	—	1,882	—	1,434	2,464	728
Cotton	—	440	—	—	—	97

The above table points remarkably the low productivity of land in India as compared to other countries.

It will not be out of place to quote here the observation of Rao Bahadur Bal, Agricultural chemist to the Government of C. P. and Berar. Dr Bal contends "that soils of our province have now reached a stationary rate of fertility at a low yield level, as a result of cultivation over many centuries without adequate returns or organic matter and phosphate and due to the lack of proper soil management." He therefore suggests that the problem before us is not one of preventing any further deterioration of soil fertility, but is one of finding ways of improving the soils which have more or less reached a minimum stage of fertility.

It is suggested that fertilizer industries should be distributed throughout the country and not centred round certain places to alleviate transport difficulties.

The forest policy of the State should be changed so as to help the ryots to get sufficient timber for fuel so that the uneconomical burning of the manure in place of fuel could be stopped.

The large scale on which we are raising oil-seeds of all kinds suggests vast possibilities of using them in the building up of new industries like paints and varnishes, oils and other lubricating products. India which is at present the importer of the above commodities should be made an exporter and the profits thus accruing from agriculture will go to enrich the people of the country. In the same way other commodities should not be allowed to be exported in the raw state, but efforts made to export them in a manufactured or semi-manufactured state.

In conclusion it must be borne in mind that our fundamental problem is that of adjusting our food resources to the growing population of the country. The prospects of expanding our land resources by bringing uncultivated land under cultivation do not compare well with the rate of increase of our population; and so the sociological aspect of the problem which is out of scope here has to be considered.

It is not in the larger interest of this country to adhere to a scheme like that to which the Eastern Group Conference would commit it resulting in the exploitation of its agriculture in the interest of the Empire, viz., this country has to export agricultural products in return for manufactured goods and machinery.

The price which India has to be paid for such agricultural expansion in the abandonment of a programme of developing her heavy industries is not worth the trouble.

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MEDICINE AND PUBLIC HEALTH

VITAMIN FIGHTS CANCER

A GROUP of research workers of Mount Sinai Hospital have recently reported in *Science*, January 12, 1945, the result of their investigations on the effect of a new member of the vitamin B series on mice cancers. The new vitamin is the folic acid and is also known as the L. casei factor. It was injected in tiny doses into the veins of 89 mice that had developed breast cancers. The injections, given daily, were continued for four to six weeks. The tumours disappeared completely in 38 of the total batch, and 49 of the mice are still living. Only one of the treated mice developed a new tumour. The results were compared with 60 cancerous mice that were not treated with the new vitamin. None were relieved of tumours; on the contrary, 14 mice developed fresh tumours, and only 20 have survived to this date.

The effect of this new vitamin on cancer in the human beings has not so far been studied. The authors stated that the very limited supply of the vitamin prevented similar experiments with human beings from being undertaken. The L. casei factor whose chemical structure and many other properties are still unknown is at present extracted with difficulty and after costly operations.

The nature of action of this vitamin on cancerous tissue is also not known. The anti-cancer activity of a number of extracts such as material from spleen, yeast and barley, which had been previously noticed, led the present investigators to suspect that some vitamin was responsible for this, and they started investigations on this new vitamin B complex when its discovery was announced.

MEPACRINE VS. QUININE

THE stoppage of the supply of quinine from Java, following the Japanese occupation of the island, has led to a wide application of the synthetic anti-malarial drug mepacrine B.P., variously known as 'atebrine' or 'atabrin' and 'quinacrine hydrochloride' of the U. S. Pharmacopoeia, for the control of malaria. Mepacrine, as is well-known, has an acridine nucleus with a long side-chain ending in a substituted amino-group. The fact that the use of mepacrine as a substitute for quinine was forced on the Allied doctors and not resorted to as a matter of choice has given rise to an impression in several quarters that the synthetic drug is inferior to natural quinine. A statement issued by the Medical Research Council's Committee on Malaria (*Brit. Med. Jour.*, Nov. 18,

1944) now places on record that such impressions are largely without foundation. The United States Board for the Co-ordination of Malarial Studies has evaluated the relative merits and demerits of the drugs by wide investigations in civilian, Army and Navy establishments and has concluded that quinine or totaquinine has neither any advantage nor disadvantage compared to mepacrine for routine suppression and treatment of malaria. Mepacrine is an equally reliable and efficacious drug for the control of malaria, and large scale production of quinine or totaquinine, although necessary inasmuch as anti-malarial drugs are not available in sufficient quantity, is not, however, indispensable from any consideration of superiority. The findings of the Medical Research Council's Committee on Malaria have also been similar to those of the U. S. Board. The statement of the Committee further appears to indicate that mepacrine has nothing to fear from quinine even when unlimited supplies of the latter are available and will be used with equal preference for treatment and control of malaria.

DEATHS FROM MALARIA IN BRITISH INDIA

A STATEMENT laid before the Central Assembly by Mr J. D. Tyson, Secretary, Education, Health and Lands, Government of India, shows the number of deaths from malaria in different provinces of British India during the years 1938-43.

In 1938 in British India, 1,577,865 deaths occurred from malaria. Of these, 50 were in North-West Frontier Province, 5,015 in the Punjab, 315 in Delhi, 489 in Orissa, 819,057 in U. P., 1,320 in Bihar, 416,521 in Bengal, 302,250 in C.P., 29,790 in Bombay, 1,686 in Sind, 1,190 in Madras, 181 in Assam, and 1 in Ajmer-Merwara.

In 1939 the total number of deaths reported was 1,411,614. Of these, 30 were in N. W. F. P., 2,477 in the Punjab, 243 in Delhi, 754,068 in U. P., 4,73 in Bihar, 592 in Orissa, 341,321 in Bengal, 267,432 in C. P., 28,833 in Bombay, 1,546 in Sind, 1,394 in Madras, 202 in Assam and 3 in Ajmer-Merwara.

In 1940, 1,393,079 deaths were recorded. Of these, 36 were in N. W. F. P., 3218 in the Punjab, 319 in Delhi, 717,319 in U. P., 3,777 in Bihar, 497 in Orissa, 369,448 in Bengal, 265,265 in C. P., 29,602 in Bombay, 2,106 in Sind, 1,271 in Madras, 197 in Assam and 14 in Ajmer-Merwara.

1,408,068 deaths occurred in 1941. Of these, 93 were in N. W. F. P., 4,366 in the Punjab, 288 in Delhi, 707,456 in U. P., 1,057 in Bihar, 589 in Orissa,

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388,381 in Bengal, 269,253 in C. P., 32,099 in Bombay, 2,731 in Sind, 1,335 in Madras, 205 in Assam and 215 in Ajmer-Merwara.

In 1942, 1,513,476 deaths took place. Of these, 67 were in N. W. F. P., 17938 in the Punjab, 1,149 in Delhi, 747,462 in U. P., 378 in Orissa, 426,573 in Bengal, 285,573 in C. P., 28,905 in Bombay, 2,911 in Sind, 1,827 in Madras, 256 in Assam and 436 in Ajmer-Merwara. The figure for Bihar was not available.

In 1943, 1,775,316 deaths occurred from malaria. In N. W. F. P. there were 70 deaths, 6,861 in the Punjab, 952 in Delhi, 800,694 in U. P., 769 in Orissa, 674,330 in Bengal, 254,109 in C. P., 32,819 in Bombay, 2,498 in Sind, 1,787 in Madras, 290 in Assam and 137 in Ajmer-Merwara. The figure for Bihar was also not available in 1943.

The figures of deaths given for Assam, Madras, Ajmer-Merwara, Orissa, Bihar and N. W. F. P. were for municipalities only.

DEXTRAN AS A SUBSTITUTE FOR PLASMA

A. GRONWALL and B. Ingelman, of the Institute of Physical Chemistry, University of Uppsala, have investigated the possibility of using dextran as a substitute for plasma in the treatment of shock and have reported their results in *Nature*, January 13, 1945. In the usual treatment for shock, the volume of the circulating blood requires to be increased by

the infusion of a liquid which must contain colloids that exert the same colloidal osmotic pressure as the plasma proteins. The colloids must have a molecular size that renders impossible their passage through the walls of the capillaries, should not possess high viscosity, should admit of repeated intravenous injections, and should not remain long in the blood or stored in the organs.

Dextran is a water-soluble high molecular carbohydrate which is formed in solutions of sugar infected with the bacterium *Leuconostoc mesenteroides*. The authors prepared, by well-controlled partial hydrolysis, dextran solutions suitable for infusion. By experiments with dogs, they established that the concentration of dextran in the blood fell to zero in the course of 3 to 4 days. No storage of dextran in the organs could be detected even after repeated large infusions. This, the author explains, is probably due to its decomposition into glucose and relatively low molecular fragments that can easily pass the kidney filter.

In shocks from bleeding, and histamine shock developed artificially in rabbits and cats, they have obtained rapid and lasting effects on the blood pressure, heart action and respiration. Clinical investigations prompted by these initial successes with animal experiments have indicated that dextran is better suited than gum arabic, pectin or polyvinyl pyrrolidone as a plasma substitute.

PROCESSED SOYA BEAN IN BALANCING INDIAN DIETS

D. K. CHATTERJEE

(Continued from the last issue)

TREATMENT OF SOYA BEAN AND IMPROVEMENT OF DIGESTIBILITY

Theoretically, diketopiperazines are anhydrides produced by elimination of water during condensation. Simple methods of hydration were unsuited in this case as they affected the quality of protein. Sometimes it rendered the protein of soya bean completely useless as a nutritional factor in diet. So in practice, we found out our own method by which these diketopiperazine rings were eliminated and whereby the bulk of the amino-acids was found linked in the old polypeptide way of linkage. Side chain condensations and cyclic formations were controlled as far as possible. The entire protein was homogeneous in structure and quality.

This new soya bean protein with modified structure neither resisted proteolytic digestion nor proved

degraded nutritionally. The previous specific reactions indicating diketopiperazine rings were mostly absent.

The chemical treatment mentioned above plus autoclaving with 15 lbs. of pressure per sq. inch for 5 minutes and then blowing out the steam succeeded in liberating the soya protein from the cellulose envelope.

It was also found that during these experiments parts of the cellulose were converted into oxy and hydroxy cellulose.

Experiments on Digestion.—While studying the digestion of soya protein, we took up a comparative study of the digestion of protein from different sources. In our experiments, amino-acids were accepted as the digestible form of protein hydrolysis products, and accordingly the liberation of amino-

acids was measured. In these experiments, conversion of the proteins into amino-acids was taken as the index of digestibility. The degree of conversion was computed by a rate of increase in acidity. Sorensen's formal titration method was applied for the measurement of the increase in acidity. A comparative study of digestibility was made after experiments with (1) Raw soya bean powder, (2) Treated soya bean powder, (3) Goat's meat, (4) Pork, (5) Cow's milk.

Hydrolysis of all the five materials was conducted under similar conditions. The hydrolysis was done on water baths and the temperature of the hydrolysate was kept within 57°C. in the beginning but raised to 70° for the last one and half hours. pH was kept between 5 and 5.4. Activated papain was used as the proteolytic enzyme. The activation of papain by hydrogen sulphide was necessary for arriving at the amino-acid stage of the hydrolyzed. The amount of papain added to each of the hydrolysates was always the same but it was introduced by

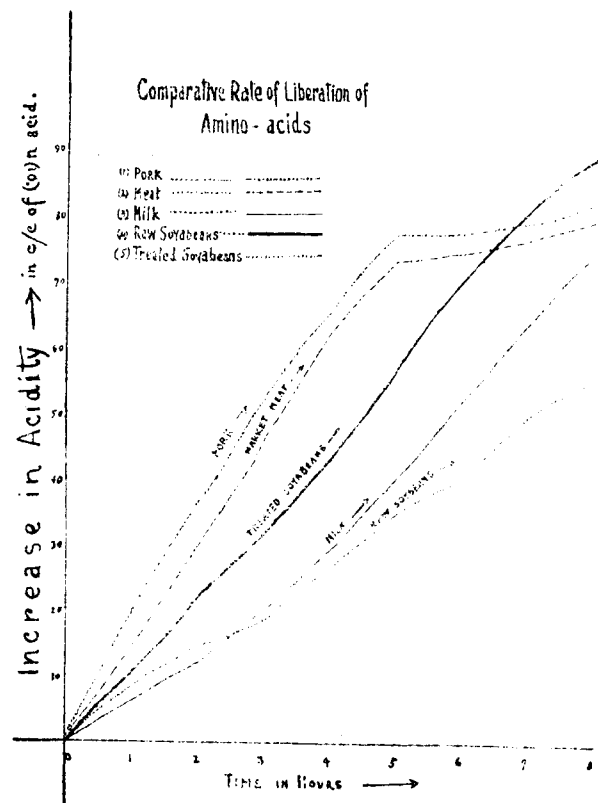


FIG. 1.

instalments of small quantities. Equal quantities of hydrolysates were filtered before titration and phenolphthalein was always used as indicator. Only in the later stage of pork and meat hydrolysis, the

hydrolysate was assuming brownish colour, but this was decolourized by precipitation with silver chloride as per instructions of Sorensen ; Jessen and Hansen.

The results obtained have been drawn on the graph: (Fig. 1). These indicate different rates of increase in acidity resulting from the liberation of free carboxyl groups of amino-acids. These amino-acids are in a digestible form. So their increase corresponds to the increase in the rate of digestion.

In case of meat and pork the rate of increase in acidity was very rapid for the first five hours, but after that the increase was extremely slow. But in other cases, no such sudden rise was observed the increase was very regular. At the end of 8 hours, treated soya bean showed the maximum increase. This shows that at the end of 8 hours, treated soya bean has the maximum digestibility.

A biological experiment with treated soya bean flour on rats showed that after continual feeding for 7 days, all the rats increased in weight, without any deterioration in their general condition. The feeding was continued for over two months and the progress observed was proportionate and satisfactory as during the first 7 days of the experiment. The feeding experiments were started after a starvation of 24 hours. These rats were kept under the following conditions :—

1. Each of these rats was separately examined for its general condition—both at the beginning of our experiments and at their conclusion.
2. No other food except treated soya bean flour was supplied to them during the period of experiments. (By treated soya bean flour we mean a powder in which diketopiperazine rings were converted and the cellulose envelope was loosened by chemical treatment).
3. Only fresh water was given as drink. Through our experiments we observed :—
 - i. At the end, the quantity of treated soya bean flour taken by these rats gradually became much less than what was taken at the beginning, just after starvation. But this did not seem to affect the general health or outward appearance of the rat in any way. In fact, they were more playful and glossy and their body weight also increased.
2. There was no evidence of any vitamin deficiency after this treatment.
3. The quantity of faeces increased in direct proportion to the quantity of soya flour eaten.
4. The nature of faeces was not changed but they were comparatively soft.

The following table shows the details of our experiments. To show the rate of the loss in weight and subsequent recovery, records of the body weight were made before a starvation of 24 hours :—

The graph and the table support our statement that the actual removal of diketopiperazine rings of linkage and liberation of protein from its first cellulose grip improves the digestibility of soya bean protein to a great extent.

The oil when frozen out gives about 14 per cent of solidifying glycerides and 86 per cent of non-solidifying glycerides.

The average characteristics of soya bean oil can be summarized as :

1. Specific Gravity	...	0.918
2. Saponification value	...	189.45
3. Iodine value	...	127.60
4. Acid value	...	0.30

Animal No.	Date	Body wt. of the Rats	Quantity of Treated Soya-bean eaten	Nitrogen in grammes in Food (Intake N)	Nitrogen in grammes in Faeces (Excretion N)	Nitrogen Retained	
						in grammes	in per cent
I	1st Day	9½ oz.	0	0	0.17	—	—
	1st Week	7½ oz.	3 oz.	5.07	0.254	4.816	95
	2nd Week	9 oz.	5 oz.	8.8	0.88	7.92	90
	3rd Week	9½ oz.	2 oz.	3.45	0.30	3.15	93
	4th Week	9½ oz.	2 oz.	3.45	0.35	3.10	90
	5th Week	9¾ oz.	2½ oz.	4.31	0.52	3.79	85
II	6th Week	10 oz.	2 oz.	3.45	0.36	3.09	89
	1st Day	9 oz.	nil	nil	0.186	—	—
	1st Week	7½ oz.	5 oz.	8.8	0.88	7.92	90
	2nd Week	8 oz.	5 oz.	8.8	0.66	8.14	93
	3rd Week	8 oz.	2 oz.	3.45	0.30	3.15	93
	4th Week	8½ oz.	2 oz.	3.45	0.40	3.05	88
III	5th Week	9 oz.	3 oz.	5.18	0.60	4.58	88
	6th Week	9½ oz.	2½ oz.	4.31	0.30	4.01	93
	1st Day	8 oz.	nil	nil	0.15	nil	nil
	1st Week	6½ oz.	3 oz.	5.18	0.65	4.53	80
	2nd Week	7¼ oz.	2½ oz.	4.31	0.65	3.66	85
	3rd Week	7½ oz.	2 oz.	3.45	0.25	3.20	92

The bitter taste and disagreeable odour due to the presence of some volatile ketones and aldehydes may be improved by distilling them off under steam. The steam treatment also improves the keeping quality by rendering the original enzyme inactive.

Fat (17 per cent).—The Indian soya beans, with which we worked in our laboratory, have an unusual fat content ranging from 15 to 20 per cent. The darker coloured beans contain a little more oil than the lighter coloured ones.

The soya bean oil consists almost entirely of neutral triglycerides. After saponification about 9 to 9½ per cent of pure glycerine was obtained. Indian soya bean contained more than 1.7 per cent of unsaponifiable matters. Upon slow cooling at about 10°C. the oil loses uniformity and separates out into two fractions ; the solid fraction settled in the bottom of the vessel.

The colour immediately after extraction is pale yellow, but when the moisture content exceeds 4 per cent, the colour becomes darker. On the other hand, when on storage, phosphatides separate out, the colour becomes lighter. If sufficient time is not allowed for the separation of "foots", the oil appears to be dark and cloudy.

On storage, the acidity increases and this is due to the fat-splitting process in the oil. On storage we also marked changes in specific gravity, saponification value and iodine value.

The composition of a sample of soya bean oil, extracted from the Sikkim variety of "mammoth yellow large" seed shows :—

Linolic Acid	...	App. 50%
Oleic Acid	...	29%
Linolinic Acid	...	2½%
Stearic Acid	...	3%
Palmitic Acid	...	8%

Also traces of Arachic acid was obtained.

The importance of soya bean oil as a remarkably nutritional product, centres principally round its high percentage of unsaturated fatty acids and phosphatides. The oil contains about 81 per cent of unsaturated fatty acids which renders it highly digestible. Munk and his colleagues have shown that under conditions when 9 to 14 per cent of tristearin is assimilated, the corresponding figure of triolein or tribolinin is 68 per cent. Soya bean oil containing (1) Phospholipins, as cephalin and lecithin—2.5 per cent., (2) Non-saturated fatty acids—81, (3) Sterol substances which are related to Vit. D and both male and female gonadic hormones, (4) Carotene (Pro Vitamin A)—about 12,000 U.S.P. units per oz., (5) Other undetermined and undefined units of vitamins E, D, E, F and K should not fail to fulfil the most rigorous demands of the nutritional experts. The above nutritional substances were identified from oils extracted from processed beans.

On refining the oil, lecithin is completely lost, unsaturated fatty acids are almost precipitated by alkali and along with them go out the vitamins, sterols, and other remedial and nutritional materials.

Phosphatides (3.00 per cent).—Phosphatides exist in soya beans in two different states. As free phosphatides, they are present in the oil droplets of soya bean cotyledons and the palisade and the aleuron layer and in bound state it exists as protein phosphatide compound. The free phosphatide which forms only a small part of the total phosphatide can be easily extracted by ethyl alcohol (29 per cent). This is always less than 1 per cent. We formed wrong impressions, in our earlier estimations and were inclined to declare this quantity of phosphatide to be the only quantity present in Indian beans. But when heat was applied during extraction or extraction was made with slightly alkaline solvents the percentage of phosphatide increased. The extraction of phosphatides also differed in proportion to the amount of moisture contained in the seeds. For an excellent extraction, the optimum moisture content should be between 7 per cent to 12 per cent. The extraction of phosphatides from dry beans is always less efficient than phosphatides obtained from slightly moist ones. This phenomenon has been explained as the result of the influence of moisture in deranging the existing bonds of the "bound" phosphatides. The usual time taken for the extraction of soya bean oil in laboratory Soxhlet does not exceed one and half hours, during which time about 12 syphonings are completed, but for the extraction of phosphatides an extra four hours was usually required.

In course of experiments of extraction of soya bean phosphatides with different solvents, we found that though hot ethyl alcohol proved to be the best

solvent for phosphatides, carbon tetrachloride and ethyl ether were better for solvents for extraction of oil.

Though various recommended methods were tried with single and mixed solvents, our best results were obtained in the following way:

Ethyl Alcohol 95 per cent was used, and the temperature of the extracting solvent was raised to 75°C. The processed soya bean samples were ground to 50 mesh fineness. For each gramme of powder, about 160 c.c. of solvent was used.

After extraction, the liquor obtained was cooled to 20°C. when the oil and alcohol separated out into two layers, the upper layer being an alcoholic solution of phosphatides and their carbohydrate compounds, while the lower layer contained mostly oils. The upper layer was treated with calcium chloride to give a satisfactory separation by coagulation of the phosphatides and carbohydrates from alcoholic extracts. In one of his very recent publications, Horvath pointed out that "Soya bean lecithin was bound to a carbohydrate which is only partially removed by organic solvents". We found that it also contained nitrogenous matters of various nature.

The phosphatides of soya bean are mainly lecithin and cephalin. They were fractioned into (a) fraction insoluble in cold ethyl alcohol, which was found to contain more than 50 per cent cephalin, (b) fraction soluble in cold ethyl alcohol, which was found to contain lecithin in combination with carbohydrates.

Soya bean lecithin was mostly found in bound state. So it should be extracted by ether while ethyl alcohol could not extract it entirely. A part of the lecithin was found to exist in firm chemical combinations with a carbohydrate of di- or polysaccharide type. Before removing the lecithin, it was necessary to boil the carbohydrate-lecithin compound with a solution of 5 per cent H_2SO_4 for at least two and half hours.

The pure soya bean lecithin has the usual physical properties of animal lecithin but it is more inclined to darken through oxidation, and some of its salts of heavy metals behave differently from corresponding salts of animal lecithin.

The cephalin content in soya bean oil is usually more in quantity than lecithin. Soya bean cephalin separates from the lecithin on their difference in solubility in cold ethyl alcohol. This method of separation is often very troublesome, as the presence of lecithin in the fraction partly protects cephalin from being precipitated.

Cephalin obtained from soya bean as colourless solid body shows little or no difference with that isolated from animal sources.

Vitamins.—In their publication, Piper and Morse writes: . . . "It is one of the few plant seeds that contain both of the vitamins necessary to life in higher animals including man". Daniels and Nichols (1917) studied the vitamin content in a qualitative way, and they found that a diet containing 60 per cent of soya bean as the only source of vitamins made possible the production and rearing through the suckling periods to successive litters of young rats. In the experiments of Osborne and Mendel (1917B), the result indicated that soya bean contains a sufficient quantity of water soluble vitamins necessary for the promotion of proper growth. During their experiments which lasted 200 days the rats grew normally and no eyesoreness, common to rats on diets lacking sufficient fat and water soluble vitamins was noted. Our experiments also have afforded us an opportunity to carry out researches on the comparative vitamin contents of treated and untreated soya beans. The presence of Vitamin A, B₁ and E was noticed in considerable proportions in raw beans but during chemical treatment for the improvement of digestibility, about 25 per cent of Vitamin B₁ was lost. Vitamin D and K were also present but no correct estimation of the quantity was possible. In diets prepared from raw soya bean, Vitamin C is completely absent. In the processed soya bean, it is possible to add a proportionate quantity of Vitamin B₁ (from Rice Polish) and Vitamin C (from Amla) to render the nutrition more balanced. In one of our feeding experiments, in which we added as much as 15 mgm. of Vitamin C per ounce of powder we found that the results obtained were very satisfactory.

Carbohydrate (16 per cent by difference).—In about 20 per cent of the samples received from northern U. P. and Nepal, appreciable quantities of starch were detected. Only on rare occasions the starch percentage was insignificant.

Of the total quantity of carbohydrates, more than 4 per cent dissolved in 95 per cent alcohol did not reduce the Fehling solution immediately, only on boiling with mineral acids, the reduction of the solution was brought about. This particular portion of carbohydrate when treated with nitric acid, yielded acetic and mucic acids. Carbohydrates responding to these tests have been characterized by Tollen as Galactans.

We also found pentosans about 2.9 per cent, raffinose 2.1 per cent and dextrine 2.75 per cent as principal constituents of the carbohydrates. The high percentage of cellulose originally present got converted into more useful forms such as oxy and hydroxy cellulose during these treatments for the structural conversion of diketopiperazine linkage of soya bean amino acids.

These converted carbohydrates when tried on rats for digestive tests gave very satisfactory results.

Minerals (5 per cent).—The ash is very rich in phosphoric acid and potassium. Although the presence of iron, magnesium, calcium and sodium in fairly good quantities was detected, we preferred a further treatment with calcium lactate to increase the calcium content. By increasing the calcium content, the calcium phosphorus ratio could be made to approach 2:1.

Amongst other minerals, it contains, calcium 0.25 per cent, total iron 7.1 mgms. per cent, and ionisable iron 6.35 mgms. per cent. The ash was alkaline in reaction.

In dealing with soya bean as food, we have hardly touched upon its excellent industrial prospect, but experiments done in different lines, emboldens us to remark that every component of this wonder bean can be recommended as a source for big industries.

While, however, considering the deficiencies in the diet announced by the Government report at the beginning of this contribution, we can state that soya bean made more digestible after proper treatment is most suited as a balancing adjunct to the poor Indian diet. It shall at least supply people with the required quantity of biologically useful protein and unsaturated fats at a small cost.

A consumption of two ounces of soya bean powder to start with will almost balance the defective diets of an average Indian who is averse to meat diet and which he cannot afford for economic reasons and cannot use a sufficient quantity of pure milk.*

I tender my hearty thanks to Mr. Amiya Kumar Banerji, B.Sc., Chemist to the Indian Health Institute and Laboratory Ltd., for helping in carrying out some of the most important experiments, without which this contribution would have remained incomplete.

BOOK REVIEWS

A Survey of General and Applied Rheology.—By G. W. Scott Blair. Sir Isaac Pitman & Sons Ltd., London. Pp. XVI+196.

Dr Scott Blair has contributed considerably to the development of the new Science of Rheology. So a book on the subject from his pen is very welcome. The author intends the book mainly for the practical rheologist particularly for young physicists and chemists who have become rheologists by profession. The introductory chapter that comprises the history of the development of the science of rheology is an interesting and masterly survey of rheological knowledge beginning with the earliest records available on the subject. The rest of the book is divided into two parts. The first part contains analysis of the rheological phenomena and a critical review of the different methods of measurements of the various elements into which the complex rheological properties may be resolved. The second part deals with the interpretations of these measurements. The author here discusses the advantages and disadvantages of the different mechanistic models as well as the mathematical expressions for the representation of the phenomena and finds "that it is not widely realized how great a part the subjective testing of materials still plays in industry". He arrives at the conclusion that infinitely long time will elapse before mechanical measurement of all the rheological concepts of importance in industry will be made possible. Hence the author attempts in the last four chapters to bring psychophysical conceptions as far as possible into scientific alignment. The book is written throughout in a literary style rarely met with in scientific literature. The usefulness of the book has been increased considerably by inclusion of extensive classified references to literature on this subject.

K. B.

Soil Fertility as the Basis of Public Health.—(News Letter on Compost). Published by the County Palatine of Chester Local Medical and Panel Committee.

The three issues of the News Letter which appear in February, June and October of each year under the general title of "Soil Fertility as the Basis of Public Health" are published by the County Palatine of Cheshire Local Medical and Panel Committee as the result of their careful observation of the health of the people under their charge. Each number consists of some 50 pages of closely printed matter comprising correspondence, reprints of articles from agricultural or horticultural literature, and re-

ports of public discussions notably those which have taken place in the House of Lords.

A study of these most interesting and important publications brings to mind a story illustrative of the British method of handling revolutions. The young communist excited after listening to Hyde Park oratory exclaims—"What we want is a couple of good machine guns." "What you want, my lad," says the kindly London policeman, "is a couple of asperins—move on." When we read such statements as "that the intrusion of quality into crop production automatically eliminates the statistician" and further that "the NPK mentality will have to be utterly discredited and destroyed," there arises a vision of agricultural research laboratories and their staffs disappearing in a rattle of machine guns. On the other hand it may be doubted whether the application of a mild sedative in the shape of rather old fashioned conservative criticism will stem the tide of new ideas revealed by these publications to be flooding in by various channels over the fields both of agriculture and of economics.

The foundational thesis of the Compost News Letter is to emphasize the need for a universal obedience of the "law of return" i.e. to give back to the soil all that has been withdrawn during the growth of the crop. In this return is included not only N.P.K. but unnumbered other elements living and non-living or it may be at least catalytic. Strangely it would appear that even international politics have entered into the question. After the third of Germany's five wars, i.e., the Franco-German war of 1870, attention was chiefly given to the views of the German scientists Liebig, Schwann and Virchow. The French school was overlooked. It was Prof. Bechamp who urged the consideration of the lowest units of "life" which he declared were to be found not in the well recognised cell seen in the visible structure of living things but in what he termed "microzymases" or "little bodies" which he declared could actually be seen under the microscope, particularly in the blood stream. The essential point of the controversy between the "organic" and "mineral" schools is in the words of Lord Geddes in the House of Lords debate: "Is the supply of these little living bodies essential to the continued vitality of human beings or is it not?"

The use of properly prepared compost manure provides an unbroken living chain from soil to crop and from crop, by way of animal, back to soil again.

The importance of this chain is borne out by the varied and extraordinary evidence from all over

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the world published in these News Letters. Of this evidence perhaps the most important is given in the form of a Supplement to News Letter No. 9, June 1944, which is devoted to an account of "the People of the Hunza Valley."

Hunza lies to the north of Kashmir in the heart of the Karakoram range of mountains. This people numbering some 10,000 is a remnant of an old wave of migration which has survived 600 years. They are a courageous, hardy and happy folk. Although the people are 99% illiterate they have achieved difficult engineering works without mathematics, agriculture without chemistry, sufficiency without trade, health without medicine, and morality without moralizing. Their religion is a modification of Islam. High principle and healthy active life enables them to maintain racial purity while avoiding close inbreeding or artificial birth-control. Their national game is polo. There are no police and no murders. Their system of agriculture has been commented upon by Sir Robert McGarrison. It involves utilization of all available water by carefully devised terracing and in the present connection *all waste material is returned to the soil.*

This is an outstanding case of a whole people happily supporting itself through a fundamentally correct maintenance of soil fertility.

Among the varied and interesting evidence brought forward in the numerous contributions to the three numbers of the News Letter under review the following remain in the memory—viz., the manginess of the lions in Cecil Rhodes' private Zoo at Cape Town, when they were fed on frozen meat and their prompt recovery on return to freshly killed fare;—the way in which of two stored bins of wheat-grain, the rats attacked only the sample grown on soil manured with organics; and such horticultural evidence as is afforded by the checking and final overcoming of virus disease in raspberries and strawberries by liberal application of compost. We learn that both the Government and the Municipalities of South Africa are becoming "compost-minded." It may well be regretted that it has taken so long to realize the true basis of South Africa's wealth.

The frequently raised question of cost is being met by the invention of the "muckshifting crane", devised by Mr F. Sykes of Chantry Chute, Wiltshire and now manufactured by the well-known agricultural engineers, Messrs. Ransom and Rapier of Ipswich. Thus compost-making is being "mechanized". Mr Sykes calculates that he can now produce compost at 1s. 8d. per ton.

In the realm of laboratory research attention is drawn to the problems connected with the activities of fungi in the compost heap and the possibility of

utilizing woody matter through their activity and also the possible importance of penicillin effect in controlling the specific reactions in the composting process.

Altogether for the modest subscription of 5 shillings per annum, payable to Dr Picton, Hon. Secretary, Saddler's Close, Holmes Chapel, Cheshire a remarkable supply of provocative and stimulating reading is provided for the increasing number of those concerned in the various activities of the Grow More Food Campaign.

G. J. F.

The Peckham Experiment.—A study in the living structure of society by Innes. H. Pearse, M.D. and Lucy. H. Crocker, B.Sc. Published by George Allen and Unwin Ltd., London, 1943. Price 12s. 6d. net.

The work described in the book, is stated to be the outcome of the long continued interest of Dr Pearse in Infant Welfare arising out of her experience in this field in the East End of London. The joint author specialised in natural philosophy, taught biology in secondary schools and later on collaborated with Dr Pearse in the experiment described.

In social welfare work in general, selection is made for operation, of groups defined by age or sex, or economic condition or some similar characteristic. Such a separation is artificial and tends to ignore the real social forces that bind the units forming society. The fundamental social unit is the family, which is set up when a man and a woman agree to live together and have children, as part of society. In the Peckham experiment, an attempt was made to organise welfare work covering the entire family unit, and extending to the principal problems of health welfare as affecting all its members at different periods of their lives. A Health centre was established in 1926, in the Peckham area, providing facilities for the normal recreational activities that parents, and children—babies, small boys and girls, as well as adolescents—normally may be expected to take part in or seek facilities for, after work or school. At the same time there was an efficient health service, with medical advisers and biologists, willing to help at every stage in the growth of the family—mating, conception, childbirth, weaning as well as early education of the very young. The building is so designed that all general activities are observable without intrusion. This speciality in construction was necessary, not only for the observing biologist to do her work without breaking into any group, but also for the members to have the feeling of being part of an integrated social group. A member of a family could see other members of his or her unit at play or engaged in other activity,

without breaking up his or her own group activity. The design of the building was to promote sociability, through general visibility. The environment provided was to help the members of the family to develop through familiar nurture at each step to the non-familiar by gradual process of familiarisation in a normal social setting. The members of the family were not to develop by themselves, but to move together, through mutual interaction of their individual changes, and gains, and with the new social environment set up in the centre by their own activity.

The authors, through their observations at the centre have accumulated valuable data regarding deficiency in health and vital functions as well as defects in social functioning. A series of excellent photographs illustrate the different activities and aspects of work at the centre.

The details of the experiment can best be studied at first hand and should be studied by all social welfare workers. To the scientific student accustomed to concise statement of observations, some of the chapters will appear to contain unnecessary repetitions. The biological analogy of social functions is also occasionally pressed too far. The family life of the working class in England is rightly diagnosed to be suffering from social poverty. It is also correct that the family as such should be encouraged to take initiative in removing its defects. The centre aimed at securing this result. It is stated that a centre like that organised at Peckham can be self-supporting if each family contributes on an average two shillings a week. The initial capital outlay will however have to be furnished by a committee or a Trust or the State. From the statements regarding family life of the members available in the report, it can be gathered that the membership is confined to the wage earners, whose families have leisure. Their income is said to range from three pounds and a half to five pounds a week. Ninety per cent of the families are of wage earners either permanently employed or in regular and good employment. As the writers state "it does not represent any socially submerged, or financially impoverished populace". The Peckham centre has therefore furnished opportunities of health overhauls as well of making social contacts to these families, who had leisure and comfort but did not have opportunities of using their leisure to advantage. Although the writers have laid very great stress on function and the importance of appropriate functional adequacy in different periods of life, the experiment says nothing about the outlook on life of the members. Is it enough to give people opportunities of making their bodies healthy and getting to know each other like healthy animals? In the social group selected by the writers, wages it

is said were not lacking, nor capacity, nor good will (as the authors put it). Was it merely lack of family and social opportunity that prevented integration as suggested? Was it not due to the lack of that amount of financial as well as organisational strength, which could have enabled the members to get together the necessary fifty thousand pounds to organise the centre? Had they this surplus saving for spending for their improvement? Was it not also due to failure on the part of the diversely employed two thousand families, to realise that they should have and could have a common social life? The family as a social unit has existed since the beginning of human culture. Among the modern primitive tribes, like our Mundas and Santals (or it was so also with the early Celts and ancient Germans of Europe) the solidarity of the family is extended to the village which is often an extension of the founders' families, and later comes to represent the extension of the family functions to the community occupying the same territory. The sharp division of labour, and dense aggregation of population brought about by modern industrial conditions has disrupted the earlier pattern. To make the units which are no longer kin-groups, function again, in the modern changed environment, as semiautonomous parts of a large organism, requires that the component units should be conscious of a common social purpose, and should have the necessary economic opportunities. We agree with the writers that "personal, family and social opportunity for knowledge and for action . . . should be the birth right of all". It is regrettable that the War led to the closing of the centre and the termination of this valuable experiment.

K. P. C.

Shakespeare's History Plays.—By E. M. W. Tillyard Litt.D. Chatto & Windus. viii + 336 pp. 18s. net.

The Olive and the Sword.—By G. Wilson Knight. Oxford University Press. 102 pp. 6s. net.

As the years roll on, the spate of books on Shakespeare shows no sign of diminishing. That, indeed, is not something to wonder at. What is wonderful is that so much of it should be of such excellence. And when Dr Tillyard or Mr Wilson Knight are the authors, everything is possible. They are old workers in a field from which they have always garnered a rich harvest—the meticulous scholarship of the one is as detectable as the enthusiasm of the other. The two books under review have something in common, and here and there touch common ground. But both try to recover the Elizabethan tradition,—Dr Tillyard by citing from contemporary literature covering a wide field, portions

of which, at least, were unexplored. Mr Wilson by reading between the lines of the text and deciphering the evidence as reflected in Shakespeare's use of imageries, analogies and words. Where, however, Mr Wilson is frankly topical Dr Tillyard aims at more permanent and precise valuations. With Mr Wilson, he underlines the essential moral background against which the Elizabethans saw historical events; and both are at pains to point out that "Shakespeare's thinking functions continually in term of moral order." But whereas Mr Wilson abstracts and generalises, Dr Tillyard delves into the Elizabethan heritage of a cosmic background and puts forward arguments already familiar to readers of his *Elizabethan World Picture* as forming the basis of the history plays. Incidentally both refer to the Ulysses speech almost from the same standpoint, but Dr Tillyard's constant cross-references to contemporary ideas give a special significance where Mr Wilson is breezily discursive.

It is in his studies of historians like Hall and Holinshed as illustrating his thesis regarding the existence of a cosmic order which an able King preserves and an inefficient King disturbs with violent consequences, that Dr Tillyard has done the most valuable work. It places Shakespeare's conception of history in a new light and connects his plays not only with the chronicle plays but with the morality plays as well. At the same time it gives to the two tetralogies an unity that we had only vaguely apprehended. The patriotic motive is, of course, sufficiently underlined by both—by Mr Wilson with a topicality that Englishmen will relish. Dr Tillyard's precise scholarship is evident in every page and must overwhelm the lay reader into admiring acquiescence.

On the interpretation side, it might be possible not easy to disagree with Dr Tillyard. The weight of authorities cited is all in his favour and in point of judgment, his exact knowledge of the age re-

inforces arguments which would otherwise (as in Mr Wilson's book) have remained stimulating generalisations at best. As an example, we might refer to the rejection of Falstaff by Henry V. The vitality of the creation has so deflected judgement and emphasised our sympathies that we do not realise the impossibility of Falstaff as the boon companion of a young King who despite all his escapades was never a fool. It is in Shakespeare's defence of Henry V from the charge of heartlessness, that the significance of the cosmic pattern is understood and the connection between the sections on "The Background" and "Shakespeare" is appreciated. The scheme of alternation between a good King and a bad King has a Hegelian symmetry which re-acts on our interpretation of each play.

In one respect, Mr Knight goes behind Dr Tillyard. He was the first to work out the intimate connection between the cosmic world and the individual man—the peace or disturbance in the one being reflected either magnified or caricatured in the other, a point which has been more convincingly worked out in his *The Wheel of Fire*. But the present work is much less pretentious and far more topical. The discovery of Hitlerism in the Tamburlaine type is more interesting than illuminating and shows how Shakespeare bids fair to pass out of the artistic stage into the scriptural where each text becomes the theme of a sermon. Yet there is much in the volume that is original and revealing. In the light of Dr Tillyard's exposition of the Tudor Myth, the rehabilitation of Henry VIII as a definitely Shakespearean play deserves the closest attention. But we confess once again to our inability to appreciate the attempt to allegorise and moralise Shakespeare's plays. Further, the imagery motif is being too much overworked and the labour spent is not commensurate with the results achieved.

D.G.

LETTERS TO THE EDITOR

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

ON THE ASSAY OF ALKALOIDS IN KURCHI BISMUTH IODIDE

KURCHI bismuth iodide is usually assayed according to the British Pharmacopoeial¹ method of assay for emetine and bismuth iodide as modified by Evers and Smith² and by Karkun and Guha.³ For the assay of alkaloids, the salt is decomposed in acetone solution with strong hydrochloric acid, and citric acid is added to form a compound with bismuth soluble in ammonia. The alkaloids are set free by addition of ammonia and are extracted out with chloroform and dried and finally weighed. Karkun and Guha mentioned that in some samples the liquid after the addition of ammonia remains turbid, probably due to resinous impurities, and the presence of the precipitate promotes emulsification. This formation of emulsion is rather common with average samples, and when emulsification occurs, the extraction of alkaloids is hindered, often leading to low results in the assay.

This precipitate is liable to contain bismuth hydroxide; citric acid is added to prevent its formation, but the quantity suggested, namely, 0.5 gm. in 10 c.c. of water for 0.3 gm. of the substance, has been found to be insufficient in most cases. If the quantity of citric acid is increased to 1.0 gm. the formation of bismuth hydroxide can be safely avoided.

Even after adopting the above change, turbidity is often observed in the ammoniacal liquid. On filtration a clear solution is obtained, from which the alkaloids can be extracted with chloroform without any difficulty.

In the ammoniacal liquid, the free alkaloids exist in the form of a fine suspension, part of which may be retained on the filter along with the impurities. This alkaloid can be recovered by extracting the filter with several portions of chloroform, until all the alkaloid has been removed, and adding this chloroform to the main chloroform extract.

By adopting the above modifications in procedure, any difficulty due to emulsification can be easily avoided, and a uniformity in the results of assay is obtained.

S. MUKHERJEE
B. C. DUTTA

Bengal Immunity Research Laboratory,
Baranagar, Calcutta,
21-2-1945.

¹ British Pharmacopoeia, 1932.
² Evers and Smith, *J. Pharm. Pharmacol.*, 11, 758, 1938.
³ Karkun and Guha, *J. Proc. Inst. Chem.*, 15, 59, 1943.

PHASIC DEVELOPMENT OF PADDY

SERIES of investigations have been continued in this Institute to study the nature of the phasic development and the problem of vernalization of certain important varieties of paddy grown in Bengal. Recently Parija and Pillay^{1, 2} have investigated in this connection the effect of pre-sowing temperature treatment and anaerobiosis on drought resistance, flood resistance and yield. Sarkar^{3, 4} has tried to vernalize certain varieties of paddy by light treatments and has shown that short days accelerate ear-emergence, increase growth rate and grain yield. Hedayatullah and Sen⁵ have noted the effect of pre-sowing high temp. treatment on few *aus* varieties. The preliminary results in this series on certain *aus* varieties have already been reported⁶, and certain observations on few *amon* varieties are given below:—

Eight varieties of *amon* paddy viz., Bhasamanik, Latisail, Patnai, Jhingasail, Chinsura II, Badkalamkati, Nagra and Tilakkacheri were given pre-sowing treatment of (a) high temperature (34°–35°C) for 3, 7 and 15 days by means of the vernalization apparatus; (b) cold temperature (6°–8°C) for 15 and 30 days. Further the effects of different post-sowing photoperiods of short-day cycles (8 hours light period alternating with 16 hours dark period); of long days cycles (17 hours light period alternating with 7 hours dark period) and also different combinations of the two cycles (long days⇌short days), at different ages of the seedlings on growth, tiller output, initiation of flowering and yield were noted.

The results indicated that pre-sowing temperature treatments either warm or cold are of varietal nature. Chinsura II, Badkalamkati and Tilakkacheri responded to high temperature treatment and showed an earliness of 18, 13 and 5 days respectively, while the other varieties showed no appreciable earliness. No effect was also seen in the matter of earliness of flowering as a result of pre-sowing cold treatment. The effect of pre-sowing temperature treatment on earliness has been given in Table I.

The pre-sowing treated seedlings when further allowed to grow under controlled cycles of light and dark periods, showed an increased vegetative growth and tiller output with a significant earliness in ear-emergence under conditions of short day lengths. The effect of different photoperiodic treatments on tiller output has been given in Table II.

It was seen from the table II that short day lengths induced an increase in tiller output than the

TABLE I

EFFECT OF PRE-SOWING TEMP. TREATMENT ON INCIDENCE OF EAR-EMERGENCE AS COMPARED TO CONTROL

(Mean of 10 plants)

+ indicates earliness; – indicates delaying effect.

Varieties	Control in days	Pre-sowing temp. treatment				Earliness or late due to			
		Warm (34°-35°C)		Cold (6°-8°C)		A	B	C	D
		A—3 days	B—7 days	C—15 days	D—30 days				
Bhasamanik ...	125	125	125	129	123	Nil	Nil	–4	+2
Latisail ...	120	120	121	122	120	Nil	–1	–2	Nil
Patnai ...	126	—	126	123	125	—	Nil	–3	+1
Jhingasail ...	122	—	122	121	125	—	Nil	+1	–3
Chinsura II ...	125	—	107	127	126	—	+18	–2	–1
Badkalamkati ...	119	—	106	—	—	—	+13	—	—
Nagra ...	127	—	127	127	129	—	Nil	Nil	–2
Tilakkacheri ...	128	—	123	123	129	—	+5	+2	–1

TABLE II

POST-SOWING PHOTOPERIODIC TREATMENTS ON TILLER OUTPUT

(Mean of 10 plants)

Treatments	Age in days	Bhasamanik	Latisail	Patnai	Jhingasail
Control ...	68	2.5	Nil	Nil	Nil
	77	2.5	3.0	4.0	4.0
	89	11.0	11.5	4.0	4.5
	108	12.0	11.5	4.5	5.0
Short days ...	68	5.0	4.0	Nil	Nil
	77	5.0	4.0	1.0	1.0
	89	16.0	13.0	5.0	5.5
	108	16.0	13.0	6.5	7.5
Long days ...	68	3.0	1.0	Nil	1.0
	77	8.0	3.0	2.0	1.0
	89	14.0	11.0	4.0	2.0
	108	14.0	11.0	4.0	2.0
Short days (15 days) }	68	3.0	Nil	Nil	Nil
Long days (15 days) }	77	3.0	5.0	2.0	5.0
Long days (15 days) }	89	16.0	13.0	10.0	13.0
	108	16.0	16.0	11.0	12.0
	68	2.0	2.0	Nil	1.0
	77	6.0	6.0	2.0	2.0
Short days (15 days) }	89	11.0	15.0	5.0	9.0
	108	11.0	15.0	6.0	10.0

long day conditions in all the varieties as compared to the control. It was interesting to note that after short days if a period of long days was allowed to follow then a further increase in tiller number was noted. But when the sequence of the day lengths was reversed, to that of long days followed by short days, then a decrease (except in Latisail) in the number of tillers resulted.

The induced effects of these different day lengths on the time of ear-emergence, showed a significant earliness in all the varieties under short day conditions of while long day conditions delayed the ear-

emergence. If after short day treatments of 15 days an equal period of successive long days was given then the induced earliness of the short days remained and behaved independently of the following day length. Similar behaviour was noted in case of reversed photoperiods of long days first and then followed by short days i.e., the induced delayed effect brought about by long days persisted even if a period of short days followed. If the normal cycle of light⇌darkness be disturbed by introducing a period of extended darkness of 72 hours then delaying effects both in tiller output and ear-emergence

resulted. The effects of photoperiodic treatments on the incidence of ear-emergence have been summarised in Tables III and IV.

Bengal Immunity Co. Ltd. Calcutta, for sanctioning a suitable grant to carry out the above scheme of investigations and to Prof. D. M. Bose, the Director

TABLE III
EFFECT OF DIFFERENT POST-SOWING PHOTOPERIODIC CYCLES ON THE INCIDENCE OF EAR-EMERGENCE
+ indicates earliness; - indicates delaying effect.

Varieties	Age at the time of treatment	Control	Different photoperiodic cycles		Difference from control due to	
			A—Short days for 15 days	B—Long days for 15 days	A	B
Bhasamanik	68 days	126.0	112.8	127.8	+13.2	-1.8
Latisail	68 "	120.8	105.3	126.5	+15.5	-5.7
Patnai	76 "	125.0	111.0	126.5	+14.0	-1.5
Jhingasail	76 "	124.5	112.5	127.7	+12.0	-3.2
Chinsura II	89 "	121.3	112.7	118.7	+8.6	-2.6
Bhadrachari	89 "	119.0	106.0	115.2	+13.0	-3.8
Nagpur	89 "	127.5	121.5	133.0	+6.0	-5.5
Kilakacheri	89 "	126.5	120.0	134.0	+6.5	-7.5

TABLE IV
EFFECT OF POST-SOWING PHOTOPERIODIC CYCLES ON THE INCIDENCE OF EAR-EMERGENCE
+ indicates earliness; - indicates delaying effect.

Varieties	Age at the time of treatment	Control	Different photoperiodic cycles			Difference from control in		
			C—Short days (15 days) Long days (15 days)	D—Long days (15 days) Short days (15 days)	E—Normal days (3 days) alternating 72 hrs. dark (15 days)	C	D	E
Bhasamanik	68 days	126.0	114.0	124.8	131.0	+12.0	+1.2	-5.0
Latisail	68 "	120.8	112.5	125.2	128.0	+8.3	-4.4	-7.2
Patnai	76 "	125.0	118.2	126.7	-136.0	+6.8	-1.7	-11.0
Jhingasail	76 "	124.5	120.0	131.0	134.0	+4.5	-6.5	-9.5

The above results clearly indicated that (a) to pass the photostage of paddy short days are essential, (b) long days at photostage delayed the earing, (c) when once the photostage was passed under short day conditions even successive long days showed no delayed effect, (d) delaying effect induced by long days at photostage was not recovered by successive short days, (e) periods longer than 24 hours cycle showed delaying effect. Further work on the definite range and duration of photostage and the variations in the light and dark periods, essential for inducing earliness, are in progress and the detailed results would be published elsewhere.

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Bose Research Institute,
Calcutta, 7-3-1945.

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BAND INTENSITY DISTRIBUTION IN RELATION TO COMPLEXITY OF SUBSTANCES

Tawde and Trivedi¹ have reported some results on the problem of vibration temperature in relation to rotation temperature in band spectra. They adopt a method in which gross intensity distribution is measured along band systems of two different molecules, viz., CN and AlO excited and observed simultaneously in the same excitation source. This led the authors to undertake a similar problem, but bearing on other aspects. We undertook investigations on the same band system arising out of substances of chemically different compositions in the same excitation source, a problem somewhat analogous to that of Lochte-Holtgreven² on C₂ and CH bands. The nature of the investigation is entirely different from the work of Johnson and Tawde³ who examined the C₂ (Swan) system under varied excitation conditions.

Carbon arc in air was selected as the source of excitation because of the existence of temperature equilibrium in it, as established by various experiment by independent methods. The arc was fed in its lower carbon anode with (a) powdered oxide of aluminium (Al₂O₃) and (b) metallic aluminium in the form of filings to give the band system of AlO (B²Σ→X²Σ). The observations were extended to BeO (1²Σ→1²Σ) bands obtained respectively from substances, beryllium oxide (BeO) and metallic beryllium powder. The arc conditions were kept strictly constant in all the four cases.

Intensity measurements were made by the well-known methods of photographic photometry used by Johnson and Tawde, Tawde and Desai⁴ and others. On the assumption of the Boltzmann distribution of vibrational energy, effective temperatures were calculated for each of the four cases mentioned above. The values are given below :

Band system	Effective temperature	
	Oxide substance, T _o	Metallic substance, T _m
AlO (B ² Σ→X ² Σ)	2570° K	3525° K
BeO (1 ² Σ→1 ² Σ)	3330° K	4590° K

The above results show a marked difference of about 1000° between the temperatures derived from the oxide and metallic substances in the same arc. The absolute value T_m for AlO system 3525°K agrees quite well with Tawde and Trivedi's result 3450°K. The ratio T_m/T_o for both the systems comes out to be nearly the same i.e., 1.38 for BeO and 1.37 for AlO.

The different temperatures derived for the same band system may probably be attributed to the particular chemical composition of the substance giving rise to the system. It should happen that the substance, before excitation of the particular band system concerned, passes through various thermal processes induced by the energy of the arc. These energies must evidently differ for metallic substance and its given oxide. They should, under constant arc conditions, be proportional to the temperatures computed from the band spectra. Under certain limitations and with available knowledge of the constants of the substances used, we have found that the agreement is good.

If radial temperature slope is, as shown by Tawde and Trivedi assumed to exist within the arc, the different substances according to their chemical composition and binding are removed to that region of the arc where they get appropriate energy for the formation of the molecule and stable excitation of the system. The computed temperature then corresponds to that region. Actually, it was noticed in every case that different zones of the arc had to be focussed to record the systems, which is an evidence for the above view. For instance, in the case of AlO system arising from oxide substance, it was the outermost fringe (flame portion of the arc) that was identified as rich in these bands. For this, we should expect to get the lowest temperature as has been found here.

The observations, therefore, prove that in spite of band system remaining the same and excitation source remaining the same, the intensity distribution is a function of the complexity of the substance which breaks up or oxidises to form the given radical.

The details of the results and other aspects which remain to be discussed will be published elsewhere in a full paper.

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Bombay, 22-3-1945.

¹ *Nature*, 140, 463, 1937; *Proc. Phys. Soc.*, 51, 733, 1939.
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REPRODUCTION OF A GIVEN TIDE BY THE PNEUMATIC TIDE-GENERATOR

In a previous communication¹ the general principle of the pneumatic tide-generator was described. The widths of the feed- and exhaust cock openings at any instant were given by $y = m \frac{dh}{dt}$, where $\frac{dh}{dt}$ is the rate of tidal rise or fall of water level at that

instant, and m the constant of proportionality. The value of m is however different for feed and for exhaust, and to avoid confusion we may put $z = n \frac{dh}{dt}$ for the instantaneous width of the 'exhaust' opening. The derivation of the formulas assume that the feed or exhaust of air takes place under a constant pressure across the tidal cock.

The tidal generator was employed to reproduce a particular tide in a small pilot model of the Kulti-gong river. Both the feed and the exhaust slots were figured according to the above formula. The experiment was performed with feed pressure of air at 27 cm. of mercury (=5 lb./sq. in.) and the rising part of the tidal curve (fig. 2) was satisfactorily reproduced without retouching the cock figure or adjustment of the regulating cocks (trimmers). The maximum change of pressure in the pneumatic chamber caused by the displacement of water was nearly 30 cm. of water head or only about 8 per cent of the feed pressure.

Owing to certain considerations the exhaust nozzle of the pneumatic tidal cock was not connected to any stabilised vacuum of the similar order although the above formula was employed on the assumption

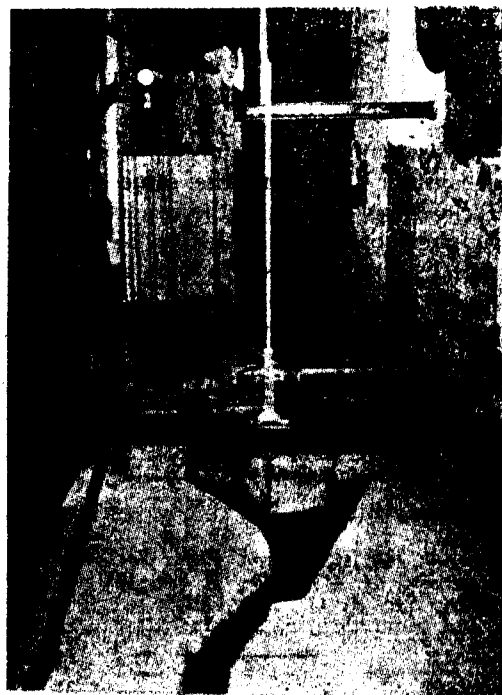


FIG. 1. Downstream end of the pilot model of the Kulti-gong river (tidal), with control board, etc.

of stabilised exhaust. The exhaust was, in the experiment, kept open to atmosphere and the ebb took place under the pressure of its own head, i.e., the difference of level of water in the pneumatic

chamber and open tidal section. Evidently enough, as the ebb proceeded the head diminished so that the exhaust of air was rendered slower than desired. This necessitated the adjustment (opening out) of a trimmer cock, indicated by the setting (iv): the general settings of the experiment being as follows:

- (i) Normal filling of water, when both sections have the same level, at -0.16 ft.
- (ii) Feed pressure of air during flow tide, kept steady at 27 cm. of mercury (or 5 lb./sq. in.).
- (iii) Tidal cycle 2 min. 55 sec.
- (iv) Auxiliary trimmer cock during exhaust at ebb stages: At 14 hr. opened at dial mark 4, and at 16 hr. opened further at mark 2.

The reproduction of the tide is shown in fig. 2.

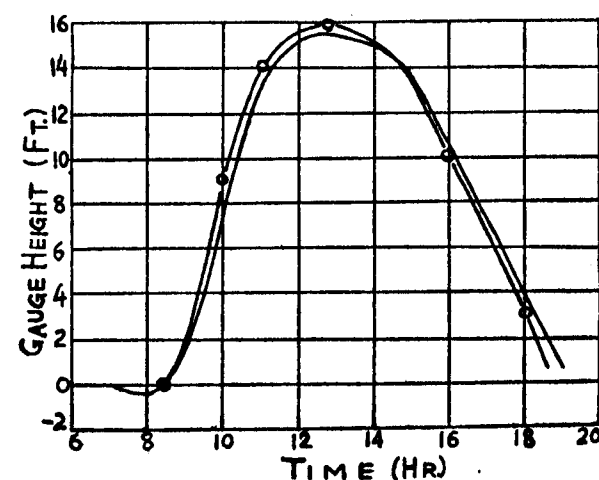


FIG. 2. Reproduction of a tide by the pneumatic control. The curve with circles is experimental.

As noted before, the exhaust should, for certain reasons, be better released in atmosphere than connected to the suction line of the compressor. Under such condition the width of the exhaust slot should be modified to $z = \frac{1}{p} n \frac{dh}{dt}$, where p is the water head at any instant for which the rate of ebb is noted.

Details will be published elsewhere.

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