NATURE

No. 3930 SATURDAY, FEBRUARY 24, 1945 Vol. 155

CONTENTS

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad.

SELECTION FOR HIGHER APPOINTMENTS

THE importance of efficient management has been much discussed during the past few months, a recent reference being the address by Mr. W. C. Devereux, of High Duty Alloys, Ltd., at the British Association conference on "The Place of Science in Industry" (see *Nature*, January 29, p. 96). The report of the Higher Appointments Committee set up by the Minister of Labour and National Service in July 1943 was therefore awaited with unusual interest*. The Committee, of which Lord Hankey was chairman, was appointed to consider and report upon the arrangements which should be made to facilitate the employment after the end of hostilities of men and women qualified to undertake responsible work in the professions or elsewhere, with particular reference to (*a*) the organization, premises and staff of the Appointments Department of the Ministry of Labour and National Service, and (*b*) the arrangements which should be made for co-operation between the Appointments Department and other organizations and institutions and universities, in Great Britain and abroad. It is thus of fundamental importance with respect to the re-allocation of employment involved in demobilization, though it was not one of the functions of the Committee to consider the quantitative aspects or trends of employment : that is one of the functions of the Interdepartmental Standing Committee on Education and Training, appointed at the same time as the Higher Appointments Committee, and with the same chairman and secretariat, primarily to consider and report on employment prospects in the various professions and callings. Despite this limitation, the present report is an important contribution to the discussion of a subject which was freely ventilated in the papers contributed recently by Sir Ernest Simon, Dr. C. P. Snow and Sir Lawrence Bragg in a recent number of the *Political Quarterly* dealing with the future of the universities, and the report is as emphatic as those papers that attention to this quantitative aspect is a primary condition for the efficient functioning of any appointments department.

The Appointments Department of the Ministry of Labour and National Service was itself an outcome of experience with the Central Register, and the report includes a review of the work of the Department and of the Central Register, supplementing the review which appeared three years ago in the sixteenth report of the Select Committee on National Expenditure for the 1941–42 Session (see *Nature*, 150, 733 ; 1942). Before proceeding to this review, the present report emphasizes the general approach of the Committee to the problem, which is essentially that of making sure, in the interests of the country as a whole, that full and proper use is made in the future of its greatest single asset, the trained ability and intelligence of its men and women. The wisdom of that approach was emphatically supported

* Higher Appointments : Report of the Committee appointed by the Minister of Labour and National Service in July 1943. (Cmd. 6576.) Pp. 62. (London : H.M. Stationery Office, 1945.) 1*s*. net.

at the British Association Conference on "The Place of Science in Industry" referred to above, which, while providing evidence that Great Britain has at its disposal resources of ability and intelligence second to none, showed that in certain fields those resources are quantitatively far short of what is required.

The Committee concludes first that the effort or enterprise of private organizations with their sectional, geographical and often financial limitations cannot provide all the machinery: direct provision by the State is indispensable. Accordingly, the Committee's recommendations provide in some detail for the organization of a national agency for higher appointments. While most of the recommendations relate to this question, the Committee does not consider that the mere provision of an employment agency, however efficient, will by itself be enough. It regards the placing work of the Appointments Department as the focal point of a service for providing men and women and their employers with the best available information, advice and help. The Appointments Department must in fact carry out its task with the widest conception of the public service that can thereby be rendered, or it will not function at all.

With this conception of the practical task, the Committee stipulates three conditions of success. First, the organization must be such as to encourage all men and women within the field to use it. Secondly, it must have the skill and knowledge necessary to assess the ability, actual or potential, of the men and women with whom it deals, and to know the kind of job to which each is most suited, as well as the best advice to give where the choice of a career or training for a career is involved. Thirdly, it must command the confidence of employers, so that they will not only use it to the full and thus provide it with the maximum opportunity for finding jobs, but also be prepared to take an interest in it and help it in its work.

To achieve these aims, the organization must be planned on the right lines and then staffed with the right officers and, like Dr. C. P. Snow and also the earlier memorandum on graduate employment issued by the National Union of Students, the report stresses that in a human problem such as this the indispensable foundation of success is the appointment of the right men and women to tackle it. In the main, the report is concerned with the re-settlement period of four or five years after the War, and does not deal in detail with the ultimate shape of the Appointments Department. The Committee stresses, however, in regard to this question of staffing, that a very substantial proportion of the staff of the Department must, at the outset and throughout the re-settlement period, be drawn from outside the permanent Civil Service. There will be a unique opportunity at that time to obtain the services of men and women with suitable qualifications and experience who are leaving war service, either in Government departments or in the Fighting Services. While those permanent officials of the Ministry who are particularly well qualified for such work should be allotted to the Appointments Department so far as possible, there can be little doubt that among the remaining officials of the Department recruited from outside the permanent Civil Service will be found a number worthy and willing to continue as permanent officers.

Reviewing next the present organization, the report points out that early in the War it became clear that the Central Register is divided sharply into two categories. The demand for those in the first, comprising engineers, scientific workers, etc., was much greater than the supply; while for those in the second, comprising persons with administrative, executive and business qualifications, the exact reverse obtained; and with the supply of such persons increasing with the reduction or closing down of industrial and commercial undertakings, the Central Register proved an unsatisfactory instrument for dealing with persons in this category. The Appointments Register under the new Appointments Department, which began to operate in March 1942, was created to meet this difficulty. The Supplementary Register was abolished, and new decentralized arrangements made for dealing with this second category. The Appointments Branch has thirty-one offices throughout Great Britain and deals not only with all persons other than engineers, scientific workers, and the like who possess higher qualifications, but also with those who fall below the standard required for enrolment on the Central (Technical and Scientific) Register.

The work done by the Appointments Department for private employers has steadily increased, and the Department is already seeking to provide the kind of service which it will have to give on a larger scale after the War. While the work of the Appointments Department has been decentralized, that of the Central (Technical and Scientific) Register, meeting a national rather than a local need, remains centralized. Technical officers were appointed in September 1940 to the five technical sections of the Register, and there are six advisory committees serving architecture and public utilities, chemistry, civil engineering, electrical engineering, mechanical engineering, and scientific research.

Pointing out that the area covered by each employment exchange is far too small for dealing with higher appointments, in which both applicants and vacancies require far more individual attention, the Committee proposes that the appointment offices should form part of the regional organization of the Ministry of Labour, with the exception of the London Appointments Office, which should continue as part of the headquarters of the Ministry. The line of demarcation between appointment offices and employment exchanges should remain just above the level of foreman and clerk. Demarcation by grade and by the level of remuneration are rejected, as is the drawing of a special line of demarcation for each profession or section of industry or commerce. Demarcation by remuneration, for example, would be liable to exclude beginners in many professions and thus deprive the Appointments Department of one of its most important functions.

The number of appointment offices should be as

small as possible, so as to secure a large area and greater prospects of filling vacancies from those on its own register, and to facilitate the employment of more specialized and expert staff. Not more than fifteen offices are recommended, to be situated in London, Southampton, Bristol, Cambridge, Birmingham, Nottingham, Leeds, Manchester, Liverpool, Newcastle-on-Tyne, Edinburgh, Glasgow and Cardiff, with local representatives of the Department in perhaps sixty or more other centres. The areas of these offices should be settled solely with reference to the requirements of the work.

Arrangements for pooling applicants between appointment offices are necessary, and the present system of circulating particulars of vacancies should continue, while particulars of any vacancy for which it appears unlikely that an appointments office can submit really suitable candidates should immediately be circulated to the other offices. Particulars of vacancies of the highest type should be sent to the London Appointments Office, which should be responsible for filling them. Arrangements are recommended for handling centrally vacancies which are likely to be filled by engineers with full professional qualifications and applicants who are likely to be acceptable for such vacancies. Vacancies for scientific workers of any type for which the market is essentially a national market, for example, physicists and biologists, should be dealt with centrally, and where an occupation is handled wholly or partly at the centre, officers possessing high academic and professional qualifications should be employed upon the work. Moreover, since those who possess high professional qualifications are not always employed in a professional capacity, to avoid any undue separation between the work of the Appointments Department in respect of such occupations and the general work, the Committee recommends that the branch dealing with occupations wholly or partly decentralized should form part of the London Appointments Office.

An admirable survey of the work of the appointments office and of the advisory service provides ample evidence of the valuable contribution which such an office and service, properly staffed and run, might make to the effective use of scientific and technical man-power. The Appointments Department, for example, should be well placed to make available to the public information about trends of employment and particulars regarding the various occupations which are rarely available to the university appointments boards, and its advice upon the choice of a career should be based upon the guidance of the Interdepartmental Standing Committee on Further Education and Training. Another suggestion in the report in the same field is the issue of broadsheets dealing with the employment situation.

One of the most important sections of the report is that which deals with public relations and co-operation with other organizations. Leaving on one side the detailed recommendations for bringing the services offered by the Appointments Department to the notice of the general public and in particular to the members of the Forces, the scientific worker will be especially concerned with the measures proposed for interesting professional, commercial and industrial organizations in the area of each appointments office. This is of special importance not merely because many centres are without an appointments office, but also because it is not intended that the new organization should have a monopoly in the work of filling higher appointments. It is intended rather to design an organization which will be used purely on its merits, and accordingly its relation to the existing appointments bureaux of such professional bodies as the Royal Institute of Chemistry and the British Association of Chemists, or the Professional Engineers' Appointments Bureau, which the Institutions of Mechanical, Electrical and Civil Engineers are proposing to establish to assist the re-settlement of engineers after the war, in co-operation with the Ministry of Labour, may be of vital importance.

The recommendations of the report in this connexion are straightforward. First, every appointments office should have a development section devoted to this work, and while local advisory committees are not suggested, it should be a primary duty of the officer in charge of each appointments office to take all appropriate steps to secure the friendly interest of all persons and organizations in the area covered by the office whose co-operation will conduce to success, and to establish relations with knowledgeable persons, including officials of professional institutions, with the view of their giving advice on subjects on which they are experts and expert assistance in exceptional cases, such as interviewing an applicant whose case presents special problems. On the other hand, in view of the experience of the advisory committee of the Department during the War, the Committee recommends that there should be national standing advisory committees representative of the principal professions and occupations, meetings of which can be called when advice or assistance is desired by the headquarters of the Appointments Department. While the Committee holds that the Appointments Department must be responsible for submitting to the employer the best possible list of candidates for any vacancy, subject to this paramount principle, it wishes to see co-operation with other employment agencies, such as the university appointments boards and professional institutions which operate in this field, developed to the highest degree.

Special consideration is given in the report to the university appointments boards, and the Committee considers that the registration of graduates with the appointments offices as well as with the university appointments boards would both assist employers to make full use of men and women with university training and also widen the opportunities for employment of graduates. Concrete suggestions as to the form which such co-operation might take are included in the report, and their adoption might go far to meet some of the criticism of university appointments boards to be found in the National Union of Students' report "Graduate Employment",

as well as in "Redbrick University" and in Dr. Snow's recent article in the *Political Quarterly*. It will be noted that in fact the report provides for two of the three practical steps emphasized as necessary by Dr. Snow: a standing Government committee to report at least once each year on trends in employment of graduates; and that the Appointments Department of the Ministry of Labour should act in close touch with this standing committee and have as its essential task the diffusion of information to undergraduates.

There can be little doubt that a Government department would be much better equipped to discharge such responsibilities as those which the National Union of Students suggests should be entrusted to the university appointments boards. Furthermore, the observations on the staffing of the appointments offices have a close bearing on the staffing of university appointments boards, and if the latter are, as Dr. Snow suggests as the third step, strengthened in the large universities on the Cambridge scale and developed on tutorial lines in the smaller universities, their effectiveness cannot fail to be increased by contact and co-operation with a Government Appointments Department staffed as advocated in this report.

There is a further point with regard to co-operation with the professional institutions which are active in this field. Some of them have old-established and efficient appointments bureaux and may tend to look askance at a new Government agency, at least until it has gained their confidence by good work. The report, which establishes beyond question the need for a national organization, should equally dispose of any fears as to competition and rivalry. What is required is in fact complete and friendly co-operation—a co-ordinated effort to ensure the best possible use of the specialized knowledge and ability which constitute one of the most precious assets of Great Britain. It may well be that one consequence will be some diminution, if not elimination, of overlapping activities in this field on the part of rival professional organizations. The engineers are clearly moving in this direction. Even more fundamentally, it is a reminder that the functions and duties of professional associations change, and that, as Prof. H. Laski has pointed out, in a new age of full employment, their protective and defensive functions may have less meaning and importance, while other duties increasingly invite their zeal and service.

UNIVERSITY GRANTS IN GREAT BRITAIN

SIR JOHN ANDERSON'S statement in the House of Commons on the Treasury grants to be made available to the universities and university colleges of Great Britain during the next few years must have come as a great relief to those who are responsible for the finances of these institutions, for the recurrent grant for general university purposes is to be nearly doubled by an addition of £2,000,000 in each of the next two years, and there is to be a further grant of £1,000,000 for developments in the medical schools arising out of the recommendations of the Inter-Departmental Committee's report, and £500,000 for grants to the teaching hospitals on the recommendation of the same committee. The grants for future years will be reviewed at the end of the two-year period. For capital expenditure, a token sum of £250,000 is to be made available to the University Grants Committee for distribution during the coming year. A sum of £5,900,000 in all will thus be included in the 1945 estimates as a grant in aid of the universities, colleges, medical schools, and teaching hospitals of Great Britain.

The Chancellor's statement is noteworthy not only because of the generous allocation of funds which it discloses, but also because of the evidence it affords of the receptiveness shown by him to the advice tendered by the representatives of the universities and university colleges, and by the University Grants Committee, which is charged with the duty of administering the grant.

The approximate doubling of the grant for general university purposes will, however, provide little more than is required for the long overdue increase in the salary scales of members of university staffs. An increased income of not less than £1,500,000 per annum is needed immediately to adjust these salaries to a level comparable with that prevailing in other professions which are recruited from students of similar training and standard of attainment. It is greatly to be hoped that the lead now given by the Government will be generously followed by local authorities, so that provision will be forthcoming to make university education available to the greatly increased numbers of students who will soon be seeking it. This will require an increase in the existing staffing of departments and a larger provision for maintenance charges of all kinds.

Sir John Anderson stated that in view of the restrictions on building which are likely to operate during the years immediately following the War, it seems unlikely that the universities will have opportunities for any considerable capital expenditure during the next year or two; but he added that if the grant of £250,000 for capital expenditure should prove insufficient, the possibility of its being increased within the financial year would not be ruled out. Capital expenditure is needed not only for the erection of new buildings but also, and more immediately, for the purchase of sites on which the new buildings can be erected. In many universities and colleges the need of funds for the acquiring of land, now available, is a matter of pressing urgency if the opportunity of expansion on to convenient sites is not to be permanently lost. It thus seems probable that the University Grants Committee will receive requests from the universities, during the present year, for a greater total sum than that provisionally allocated by the Chancellor to capital expenditure in 1945. It is obvious, for example, that £250,000 would not go very far towards providing the additional sites now urgently needed by the many colleges and institutions of the University of London alone.

Universities are rightly zealous in safeguarding their autonomy, and satisfaction will no doubt be derived from the fact that, in announcing the special grants for medical schools, the Chancellor did not threaten the imposition of financial sanctions, as did the Minister of Health in a reply he made in the House of Commons a few weeks ago. On that occasion, in a written reply relating to the report of the Inter-Departmental Committee on Medical Schools, Mr. Willink indicated that the Government's acceptance of the principle of increased grants for medical education and research was dependent on a revision of the medical curriculum being carried out at an early date. Such a decision by the Government, taken without prior consultation with the university authorities, however well-founded it might be, would be a grave departure from established procedure and a menace to the academic freedom of the universities.

SCIENCE AND SALVAGE

Science and Salvage
From the German "Verwertung des Wertlosen". Editor, Claus Ungewitter. Translated by L. A. Ferney and G. Haim. Pp. 183. (London: Crosby Lockwood and Son, Ltd., 1944.) 12*s.* 6*d.*

WASTE, begotten of ignorance out of laziness, is no new phenomenon; it is probably coeval with man, if not with his progenitors. But primitive man had neither the knowledge and incentive nor the use of machines to convert his scrap into utilizable material; modern man has all these, but in general fails to apply them on any considerable scale, unless he is compelled thereto by war or by the expectation of profit. Modern industries based upon science have, however, not only realized the need of recovering materials hitherto wasted, but also they themselves have created new wastes to be recovered, such as chemical by-products and metallurgical scrap.

The words 'waste' and 'salvage' are sometimes used loosely. Strictly speaking, a waste material is one which might be recovered and re-used, with or without pre-treatment; but many, including the author(s) of the book under review, use them in connexion with low-grade minerals, with certain constituents of sea water, and even with certain atmospheric gases. Such raw materials, of actual or potential use, can scarcely be called 'waste', and the term should be restricted to substances and articles that have already been manipulated by man, either directly or by means of machines.

The German original of this book, entitled "Verwertung des Wertlosen" (utilization of the worthless), comprises a series of articles that appeared in *Die Chemische Industrie* shortly before the outbreak of the present War; they were published in book-form in 1938, with an introduction by Field Marshal Goering, and may therefore be taken as authoritative and up to date in regard to pre-war German practice, for most of the processes mentioned—few are described in detail—have either originated or been developed in Germany. The amount of work done there in this connexion can only be described as amazing; but, unfortunately, one cannot repress the thought that most of it was undertaken to render Germany as self-sufficing as possible and to build up the *Wehrmacht* with the ultimate object of attaining world domination. In 1939, Germany produced about 80 per cent of her food requirements and almost two-thirds of her industrial raw materials. If, in the future, she were cut off economically from the outside world, and were left with her present territory, it is quite possible that she might live on her own resources. Although starch-bearing tropical crops like rice and cassava could easily be dispensed with, luscious tropical and sub-tropical fruits, tea and coffee would have to go by the board; fats, oil, rubber and fibres could be made artificially, and cellulose in its various forms could be readily produced at home. Further, if metallurgical science continues to advance at its present rate, substitutes for some of the commoner metals and more particularly for certain rarer metals, like tungsten and molybdenum, would be forthcoming. Coal ash, as the authors point out, could supply appreciable quantities of zinc, arsenic, cobalt, nickel, molybdenum, chromium, vanadium, silver, gold, platinum and beryllium. National self-sufficiency in Germany and in many other countries is distinctly possible; but, as many will think, very undesirable in a peace-loving progressive world.

The wide range of subjects discussed in the book may be gleaned from the following abbreviated chapter headings: atmospheric gases, the sea, low-grade mineral resources, peat, forestal products, agricultural wastes, scrap and worn materials, municipal refuse, sewage, chemical by-products and coal ash. Few, if any, of the processes outlined will be unfamiliar to specialists, but even they will be interested in the efforts made in fields other than their own. It is to directors of large laboratories and research institutions, and not least to economists and 'business executives', that the book will make a special appeal. During the War of 1914–18, many patents for the recovery of waste were taken out, and but very few survived the ordeals of peace, the chief reason being that they did not 'pay'. Hence the future of scientific salvage will depend as much upon economic and political conditions as upon advances in science and technology. In certain cases it may well be advisable for Government or local authorities to assist in the initiation, development, and perhaps the operation of processes that may be deemed of primary importance, for it can scarcely be expected that public companies should risk their shareholders' money in such enterprises. Processes essential to public health and the national economy, like the treatment of sewage and of household refuse, would here come into the picture; and generally it may be postulated that public money should be used only for the provision of materials, etc., to meet basic needs, such as those used for food, power, clothing, shelter and communications. Apart from these, it may well be found that many of the ingenious processes evolved are inadvisable and redundant; for example, the recovery of materials that are renewed annually or at slightly longer periods by solar radiation.

Cupidity, ultra-nationalism and bad economics have in the past prevented many of the gifts bestowed by a bounteous Nature from becoming available to the people who need them. If nations could be made to realize, however slowly, by enlightened education that they are all members one of another, and if the fourth term of the Atlantic Charter, that all nations have free access, on equal terms, to the trade and to the raw materials of the world, could be implemented, much of the human effort that may be devoted to

the recovery of waste products could be saved, leaving more time and energy for devotion to constructive and creative work in science, art and letters.

A word of praise is due to the translators for having produced a good, readable version of the original which, if it conforms to type, bears the imprint of what Schopenhauer called the essentially German characteristic—ponderosity. E. H. TRIPP.

A PACIFIC SEAWEED FLORA

Marine Algæ of the Monterey Peninsula, California

By Prof. Gilbert M. Smith. Pp. ix+622 (98 plates). (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1944.) 36*s*. net.

IN most maritime countries there are certain stretches of the coast-line that offer peculiarly favourable conditions for the study of marine life. Such a one is the Monterey Peninsula in California, which is noted not only for the wealth and diversity of its seaweeds, but as the domicile of the Hopkins Marine Station from which, since its establishment in 1892, many important contributions to our knowledge of the marine life of the Pacific have issued. Among these must be ranked the work which forms the subject of the present review. All botanists who have had or may have the good fortune to visit this privileged region will owe a debt of gratitude to the author for giving them the benefit of his prolonged experience of its seaweed population. Smith's valuable book, which deals with the green, brown and red Algæ of the Monterey Peninsula, is, however, far more than a local flora, since approximately three-quarters of the seaweeds recorded from the Pacific coast of North America occur on the shores of the Peninsula. Moreover, it constitutes the first recent taxonomic account of the American Pacific Rhodophyceæ, since the section dealing with this class in Setchell and Gardner's "Marine Algæ of the Pacific" was never published.

The brief introduction contains a useful section on the distribution of the seaweeds on the shores of the Peninsula, which might with advantage have been fuller. The numerous keys for the determination of families, genera and species are supplemented at the end of the book by comprehensive keys based almost entirely on external form and vegetative structure and designed to facilitate the ready recognition of the genera. The classification follows familiar lines; the Chlorophyceæ are grouped according to the scheme adopted by the author in his other books, while the Phæophyceæ and Rhodophyceæ are arranged on the general lines proposed by Kylin. As I have pointed out elsewhere, I am doubtful as to the value of the grouping of Phæophyceæ under Isogeneratæ and Heterogeneratæ, since in my opinion it obscures relationships. Smith is logical in including among the Ectocarpales (*sens. limit.*), in the Isogeneratæ, the genus *Heterochordaria*, which probably has an isomorphic life-cycle, but its inclusion here removes it from similarly organized forms comprised in the Chordariales, with which it is justifiable to assume some degree of relationship. The author also adopts a new basis of delimitation between the genera *Acrochætium* and *Rhodochorton*, referring to the latter all those species of *Acrochætium* in which tetrasporangia are known to occur. This will scarcely find favour with most algal workers; it might be more appropriate to adopt Drew's suggestion of grouping all the species in one single genus *Rhodochorton*.

The designations macrospores and microspores, applied to the eggs and sperms of Fucales, rest on so speculative a basis that they appear out of place in a work of this kind. In general, however, the diagnoses, incorporating a considerable number of new observations of the author's, are distinguished by their clarity and their ample character. This feature, combined with the copious and excellent illustrations (many of them the work of Mrs. C. F. Janisch) and the general finish of the book, contribute to make this one of the most noteworthy taxonomic works on Algæ published during the present century.

F. E. FRITSCH.

FUNDAMENTALS OF RADIO PHYSICS

Physics and Radio

By M. Nelkon. Pp. viii+388. (London: Edward Arnold and Co., 1944.) 8*s*. 6*d*. net.

THE extensive application of radio technique during the past few years has given rise to a need for books on the general basic principles of radio physics. The book under notice goes part way to fulfil this need, and as the author states in the preface, the book should be useful to radio mechanics, wireless operators and students of School Certificate standard requiring a knowledge of the elements of radio.

The first fifteen chapters deal with the fundamental physical principles of electricity and magnetism. Six chapters are then devoted to considerations of the basic properties of valves and their use in various circuits for rectification, amplification and oscillation; these various functions should readily be understood in principle from the treatment given. In a chapter devoted to aerials, the subject is made clearer by several useful analogies with acoustical phenomena. Next follows an account of the fundamental ideas underlying the superposition of intelligence on the carrier wave at the transmitter and its subsequent separation from the carrier at the receiver. Chapter 24 gives first an outline of several phenomena observed in the study of light including reflexion and refraction from the point of view of wave theory; polarization and the differences between longitudinal and transverse waves are also discussed. This outline is intended to serve as an introduction to the behaviour of radio waves in the ionosphere, and suffers somewhat from its brevity; but the treatment given serves to explain skip distance and fading effects. The last of the twenty-five chapters describes a commercial cathode ray oscillograph, and the development of time bases for use therewith. Each chapter ends with a concise summary of the salient points and with a good selection of exercises to be worked out by the reader.

The book is very well written, is liberally illustrated and is eminently suited to the class of reader for which the author intended it. It may even have a wider appeal, for it involves only the most rudimentary knowledge of mathematics, and the calculus is avoided entirely. A very good feature is the inclusion of numerous practical examples which are worked out in the text, so that the student may realize the numerical significance of the various formulæ and properties of circuits.

SCIENCE IN SOCIAL AND INTERNATIONAL PLANNING, WITH SPECIAL REFERENCE TO INDIA*

By PROF. MEGHNAD SAHA, F.R.S.
University of Calcutta

THE League of Nations was formed after the War of 1914–18 to promote goodwill and peace among nations, and it is one of the greatest calamities of history that it could not achieve its objective; but it undertook many important surveys on international affairs, knowledge of which is useful for coming to the heart of the international problem. One is the Year-Book, published by the Labour Organisation of the League, which shows in tabulated form the production of commodities in the different political units of the world. This is indispensable for arriving at a proper estimate of the comparative economic condition of different units. The other was the report of the committee for framing an international calendar for the whole world, which, if it could have been adopted, would have gone a great way to promote goodwill and understanding among the principal nations of the world.

The Year-Book must have been very largely used by economists. I myself, while a member of the National Planning Committee of the Indian National Congress†, tried to form, from the contents of the Year-Book, some idea of the average *per capita* income of the different countries of the world. This proved to be an almost hopeless task; but it was thought that an estimate of the same quantity might be obtained from an entirely different angle, namely, the total energy-production in a country, for we can take wealth to be directly proportional to the output of energy. This is a comparatively easier task, for the energy output is mainly due to the following agencies: (1) Work done by man and domesticated animals. (2) Work done by inanimate agencies: mainly engines using coal, petrol, and other kinds of fuel (bagasse or wood). (3) Work done by electricity derived either from thermal (coal or petrol), or from hydro-electric, sources. Other sources of energy output are negligible at the present time.

Suppose we can estimate the energy output under the three headings accurately, add them up, and divide the whole by the total population of the country. We get a figure which shows the average *per capita* energy output for a country. For the sake of brevity, we shall denote this figure by the term *energy-index*. Let us now see how to calculate the energy-index for a few representative countries of the world just before the outbreak of the present War.

The League of Nations Year-Book gave total production of electrical energy from thermal and hydro-electric sources against every country, so that it is a perfectly simple matter to calculate the contribution to energy-index from electricity for every country. It was 650 for the United Kingdom, 1,700 for Canada, 1,300 for Sweden, and about 1,500 for the United States. These are the most advanced countries of the world, but we may also take some others; the figure was 180 for Mexico, and for progressive countries like the U.S.S.R., it was rapidly increasing from very small figures to those attained by the advanced countries. In countries like Poland, the figure was stationary. For India and China, no figures were available, but according to a Government of India estimate, the total production of electrical energy in India in 1942 was 3,500 million units, so that it comes to only 9 units a head for India. China was rather worse.

It is more difficult to calculate the energy-production from coal or other fuel; for coal mined or imported into a country has many other uses besides energy production, and the efficiency of energy production varies widely. It is not worth while to give all the technical details, but it was concluded that the contribution to the energy-index from coal and other fuel in the United Kingdom amounted to nearly 1,300, and somewhat more in the United States. In India, it could not have been more than 20, for India produces only 26 million tons of coal against Britain's 200 millions, and the use of Indian coal is extremely wasteful.

We, therefore, find that, before the War, the energy-index in the year from inanimate sources amounted in Britain to about 2,000 and in the United States to about 2,500; in India it could not amount to more than 30, and even that is probably too liberal an estimate.

Where does the energy production by man and domesticated animals come in this picture? A man working eight hours a day for three hundred days in the year produces only 180 units, and assuming that one third of the population is engaged in productive work, which is not far from the truth, the average cannot be more than 60 units *per capita* a year. The energy production by animals, by wind and water-power in the Middle Ages would not exceed 20 units, so we are not far from the truth if we say that in the Middle Ages the energy-index in all countries amounted to about 80 units, with small variations from country to country. This is negligible compared with energy production in a modern country, by steam, electricity and petrol, and can be almost entirely left out. Man's function, in the present days of technocracy, is merely directive.

These arguments are simple enough, but we can draw from them some very important conclusions. It is obvious that in advanced countries of the world, man, by harnessing the forces of Nature, has increased the energy-index by twenty to thirty-five times within the last hundred years, and this has caused a profound revolution in society. Let us see what this revolution is.

Most old-fashioned history books tell us only of kings, emperors, nobility, and of the privileged few, and omit entirely the common man; and from their perusal we are apt to form sometimes a romantic, uncritical picture of ancient and medieval times. But critical historical research has shown that even two hundred years ago the standard of living for the ordinary person, and conditions of public health in every country, were appallingly low compared to modern standards. Only a few who possessed slaves could afford to have some 'comfort', but it was not much compared to the standards now enjoyed even by the ordinary citizen in an advanced country of the world. In the sixteenth century, there was terrible mortality among children, and even royal children used to suffer heavy mortality due to

* A lecture delivered before a joint meeting of the British Institute for International Affairs, and the British Association for the Advancement of Science, on November 10, 1944.

† The National Planning Committee was appointed by the president of the Indian National Congress in October 1938, with Pandit Jawahar Lal Nehru as chairman. It appointed twenty-nine sub-committees, held a number of discussions, and framed resolutions for the economic and social regeneration of India. Its activities were terminated in 1941 owing to the incarceration of the chairman.

diseases now found to be preventable, thanks to science.

The philosophy of kindliness and service to our fellow-men was preached by all founders of great religions, and no doubt some great kings and ministers of religions in every country and at all ages tried to give effect to this (altruistic) philosophy. But the efforts were not successful, for the simple reason that the methods of production of commodities were too inefficient to yield *plenty for all*, which is an indispensable condition for practical altruism.

We can therefore hold that, *so far as individual life is concerned*, science has achieved the target aimed at by the great founders of religions in advanced countries of the world. The effects of maldistribution of wealth, due to historical causes, are being rapidly cured by the introduction of social laws.

The advanced States of Europe, and also the United States of America, began to move out of those dreadful medieval conditions during the seventies of the last century, when modern science began to develop and new methods of production were applied on a mass scale. As a result of a century of progress, individual conditions of living and public health have steadily improved in Britain and in many other countries of Europe and America. Probably the best index is afforded by the average life, which has increased from twenty-nine about a hundred and fifty years ago to fifty-eight in 1944 in the United Kingdom, and to sixty-three in the United States, according to reliable reports. Not satisfied with that, Britain is having a social insurance measure on the lines of the Beveridge Plan, which will take care of the man from the 'cradle to the grave'.

Indian Conditions

Let us now come to my own country—India. Figures have been given which show that the energy-index in India is not more than 100 units, or at best 120 units. It is twenty to thirty times smaller than in the advanced countries of the world. The National Planning Committee estimated the average income of the Indian in 1938 to be Rs. 65 or £5, which can be compared to the average income of the Britisher about the same time (nearly £120). This figure, when it was published, was challenged, but our method of approach—which is radically different—leads us to an identical conclusion*.

Recently the Royal Society sent a distinguished ambassador of science, Prof. A. V. Hill, to India, and he took pains, as no other man has previously done, to study first-hand the conditions of public health, and to some extent observe the general economic conditions in India. He has stated his findings publicly, and they are practically the same as mine. By whatever standards you measure, you find 90 per cent of India is still in the Middle Ages. The thin veneer of modernism which travellers find in the great cities of Bombay, Calcutta and Delhi must not lead you astray. Ninety per cent of India is still in the sixteenth century conditions of England. We have terrible child mortality, the conditions of public health are appalling, and 90 per cent of the people have to live in slums. They have scarcely any interest in life, and we are on the brink of disaster, as Prof. Hill has told the British public repeatedly.

* According to a P.E.P. report, the total income of Britain in 1944 was ten thousand million pounds, which makes the *per capita* income a little more than £200. This is due to war inflation, and is compensated by the cost of living. In India, the average income has risen during the War, but the cost of living has increased according to official estimates 2·6 times, and according to non-official estimate, nearly 3·5 times.

The National Planning Committee of the Indian National Congress had rightly concluded that India had been almost entirely untouched by modern scientific methods, and if she wanted to pass out of the present dreadful conditions, she must tackle seriously the great task of applying modern scientific and industrial methods for the development of her potential wealth, as has been done by the U.S.S.R. with signal success within the past twenty-five years.

Is there any indication that the problem is being properly understood by the central or provincial Government circles? The problem is so urgent that nobody can shut his eyes to it, and one would conclude so from the appointment of many post-war planning committees; but the pronouncements made by these committees from time to time only add to the general confusion. Some advocate road building without trying to find out who are the men who will use the roads, and for what purpose and by what conveyance; some advocate agriculture; others think there is an inherent antagonism between agriculture and industrialization; but the ordinary man only sees that the terms of superannuated officers are extended on higher salaries. The fact is that the planners lack *direction* from the centre.

It is obvious that the clearest way to define the objective would be to declare that India's *per capita* income should be progressively increased to modern figures compatible with her resources; and as a necessary first step, India's energy-index should be progressively increased to the figures attained in all modern countries. Let us put a definite target, say 100 units within the next ten years; and we shall also have to use this energy suitably. This is not a large figure, for even pre-war Mexico used to produce 180 units of energy per head, and we produce now only 9 units. Such a declaration, if it is forthcoming, would convince the people, as nothing else would do, of the Government's seriousness of purpose. The Government would have to set up proper machinery for producing electrical energy within the next ten years, and to find a use for the energy for the benefit of India's masses. Let us look at this figure from another angle. It is slightly larger than the pre-war production of electrical energy in the United Kingdom, and according to a P.E.P. report, nearly £600,000,000 was invested in the electrical industries in Britain. Probably a comparable amount will be needed in India, but if the undertakings are properly planned, many of the mistakes committed in the past can be avoided, and a smaller sum may be sufficient. It will also greatly promote trade relations between India and the United Kingdom, as in the case of the U.S.S.R., for India will have to depend for a long time yet to come on imported machinery for her development.

Industry vs. Agriculture

If a policy of progressive electrification of India be agreed upon and undertaken, we shall have to spend most of the energy produced in industrialization. Many critics have seen in this policy a menace to agriculture and to the agricultural population, and have raised the cry of agriculture versus industry. But this is due to confusion of ideas, and a little thinking shows that there is really no conflict between industry and agriculture. As a matter of fact, the position of agriculture in India has been entirely misunderstood, and misinterpreted.

According to the census figure of 1931, which is the latest available to us, only 15 per cent of the popula-

tion of India is urban and 85 per cent is rural, of which nearly 70 per cent is directly dependent on agriculture. Anybody having the slightest knowledge of economics knows that this is a very unhealthy sign. Probably with the exception of China, no other country in the world has such a large percentage of her population on the land. In some parts of Bengal, the holding is two-thirds of an acre per head of the population. The remark of Julian Huxley, referring to the Tennessee Valley of twenty years ago, may be applied with far greater emphasis: "Primitive in their reproductive habits as in their farming methods, they multiply rapidly until they present a typical Malthusian population, pressing hard upon the land's capacity for subsistence".

How has this state of affairs been brought about? We have reasons for believing that before cheap factory goods began to pour into the markets of India, there was a far better balance between the people actually employed in agriculture, and the artisan classes. When industrial revolution started in England, the rural population of England was sucked into production centres, which rapidly grew into large cities, and the urban population grew rapidly. In India, the effect was in the reverse direction. When cheap factory-made goods began to pour into the markets of India, most of the artisan classes—weavers, spinners, blacksmiths, potters and metal workers—lost their jobs and became peasants. With the introduction of railways and steamships, people engaged in the transport trade lost their jobs and were thrown upon the land. The successive famine commissions have rightly diagnosed the excessive pressure on land to be one of the causes of malnutrition and recurrent famines, and recommended that the burden should be taken off the land by providing a large section of the population engaged in agriculture with industrial occupation. But the small amount of industrialization which had taken place in India is totally inadequate for taking the burden off the land.

But one must not forget that in spite of the disproportionately large number of men engaged in agriculture, there is not sufficient margin of safety as regards production of food for India's four hundred millions. The Bengal famine of 1943 appears to have focused the attention of the world on this point, and though this disaster was precipitated by a variety of causes, in which food shortage played a minor part, one must not forget that there is a chronic deficiency of food, both of vegetable and animal origin, and there is consequently permanent malnutrition. India is just on the verge of a crisis, as Prof. Hill has repeatedly stated, and any small cause may precipitate it. The fact is that, owing to over-population, which is itself a consequence of over-ruralization, man in India is making too much demand on the soil, which is not allowed to rest or recouperate. A survey of the productivity of the soil of India recently carried out by Dr. Burns, agricultural commissioner to the Government of India, shows that it produces on the average four times less crops than soil in advanced countries, and according to some sporadic investigations, the soil of India is deficient in nitrogen, phosphorus and potash, and, due to the causes just mentioned, productivity is diminishing year by year.

But why does not the Indian peasant use fertilizers to increase the productivity of the soil, as has been done in other countries? For some reason best known to themselves, neither the Government, nor the Imperial Council of Agricultural Research, has paid any attention to the fertilizer problem, and no synthetic fertilizer industry has grown up in the country which can deliver to the peasant suitable fertilizers at economic prices. According to Dr. Burns, if India is to attain safety in food production, the yield should increase by 30 per cent, and this needs nearly a million tons of nitrogen in the form of ammonium sulphate and other fertilizers. Many parts of India show unmistakable signs of phosphorus deficiency, but nobody has yet surveyed her total needs in this respect.

In short, a native fertilizer industry is indispensable for greater agricultural production, and this alone will consume a large amount of the electrical energy to be produced. But this is not all.

The Indian agriculturist, like agriculturists in other parts of the world, cannot depend upon food crops alone. He has to raise also cash crops such as cotton, jute, sugar, oil seeds and tobacco, each one of which is useless unless it is utilized industrially. Fortunately, the corresponding industries have developed in India, though there is far more scope in this direction. India has almost none, or few, food-processing industries, and her excellent and wide variety of fruits are on the market only for a limited season. There is a great future in this line, but no food-processing industry can flourish without the refrigeration industry. Further, as Sir Harold Hartley has told us in his Mather Lecture, agriculture and forestry can serve as a potential source of raw materials in scores of industries—such as the manufacture of rayon, paper, plastics, liquid fuel, industrial gases—and the development of all these industries requires cheap power.

There is therefore no inherent antagonism between industry and agriculture; and without development of agricultural industries, the rural population of India can never be pulled out of the dreadful medieval conditions in which they find themselves, breeding a Malthusian population which has been a matter of extreme concern to the rulers. For urbanization means better living, and better living leads to moderate increase of population.

Natural Resources of India

But has India sufficient resources for a balanced development of industries and agriculture on the lines just indicated? According to a competent authority, India, like the United States of America, the U.S.S.R. and China, is one of the few political units of the world which has enough potential resources in power, minerals, and forest and agricultural products, for a balanced development of industry and agriculture to produce *plenty* for her population. The first problem to be tackled is that of power. India has, according to the work carried out by the Geological Survey of India, 60,000 million tons of coal within the first thousand feet of the surface. This is a comparatively small figure compared to the enormous resources of Great Britain and the United States, and most of these deposits are to be found in a small region in eastern India. But she has plenty of 'white coal'—water-power resources—awaiting development. According to a very imperfect survey—or should I say an intelligent guess—carried out nearly twenty years ago by an officer of the Government of India, her water-power resources amount to nearly 20 million* kilowatts, and so far only half a million

* The water-power resources of pre-war Russia were estimated in Czarist days to be 14 million kilowatts. A detailed survey carried out early in the Five-Year Plan pushed up the figure to 280 million kilowatts.

kilowatts have been developed. But the figure is probably a gross under-estimate as in the case of the U.S.S.R. The first problem before the Government of India should be, therefore, to carry out an adequate survey of the hydro-electric resources of India, and plan for the development of ample power for industries.

Civilized life in India has, from time immemorial, grown in river-valleys, which have been used for navigation and irrigation. During the British regime, development has been one-sided, namely, for irrigation only, and navigation has been allowed to fall into decay. But both Soviet Russia and the United States of America have, within the last twenty-five years, set a new ideal for river development. We can take, as a typical illustration, the development of the Tennessee River, which before 1933 was a matter of great concern to the Federal Government on account of the destructive floods, soil erosion, and progressive pauperization of dwellers of the valley. But it is now well known, thanks to the initiative of American statesmen, that this river has been completely transformed by the construction of twenty-one dams over the main river and tributaries. These dams serve the multiple purpose of flood-prevention, navigation and power development, and soil erosion has been prevented by auxiliary measures. The hitherto untamed river, instead of being allowed to dissipate its energy on destructive work, is now harnessed and yields 12,000 million units of electrical energy, which is used for great productive works which have sprung up in the valley (metallurgical, chemical and fertilizer industries).

The multi-purpose development of a river valley, the benefits of which have been so strikingly demonstrated by the Tennessee Valley Authority, is applicable to at least a score of river valleys in India. I have made a particular study of the Damodar Valley, an area of 9,000 square miles, which forms the country to the west of the great city of Calcutta. The lower part of this valley, forming the suburban area of Calcutta, was, a hundred years ago, one of the healthiest regions of the world. But after the construction of railways from 1850, and great roads to connect Calcutta with upper India, embankments were reinforced and constructed on the left bank of the river in order to protect these highways from the destructive river floods. These embankments have by no means removed the danger to the highways; for in 1943 there was only a moderate flood which breached the line at numerous points, and seriously interfered with traffic to Calcutta at a very critical period of the history of the country. They have, in addition, turned the country into a malarial swamp. Even the safety of Calcutta is endangered.

I have shown by a preliminary study that this valley can be subjected to the same treatment as the Tennessee, and can be developed for energy generation (to the extent of 2,000 million kW. a year), navigation, and flood prevention. The lower valley can be transformed by auxiliary methods of irrigation into a fine suburban area, where the teeming population of Calcutta can expand.

But the Damodar Valley is not unique. The Sone, the rivers of the Deccan (the Kaveri has been developed to some extent), the Mahanadi, the Punjab rivers, and many others too numerous to mention, can be developed according to the T.V.A. methods for the benefit of India's millions.

This is only a cursory survey of the problems of India and of the way in which we have to look at it. It is regrettable that the Indian leaders have so far paid attention only to the question of political freedom. It is natural that everyone of us should want our country to attain full nationhood and the people have full sovereignty, but the problem of living for millions of Indians cannot be postponed; in fact, we believe that the only way to achieve unity of thought and purpose in the political field, which is now wanting, is first to look at the problem of living for India's millions. To solve this problem successfully there must be a national purpose behind all planning, and I do not see how any planning can be given effect without a National Government, or unless we have a Government which has popular support and is composed of leaders in whom the people have confidence.

ASTRONOMICAL AND GEOPHYSICAL PERIODICITIES

A GEOPHYSICAL Discussion on "Astronomical and Geophysical Periodicities" was held in the rooms of the Royal Astronomical Society on December 8, 1944; the chair was taken by Prof. L. M. Milne-Thomson, and in the absence of Dr. Harold Jeffreys through indisposition, the discussion was opened by Dr. H. R. Hulme.

Dr. Hulme's interest in this problem originally arose in connexion with the reality of the supposed periodical variations in the solar constant. Any time-series of observations can be analysed by the routine method of harmonic analysis, and amplitudes will be obtained which will not in general be zero, even when there is not the slightest reason for suspecting the presence of a periodic variation; such an analysis has, in fact, often been carried out with geophysical data. The first attempt to find a criterion for the reality of a periodic term was made in 1906 by Sir Arthur Schuster, who found that if n independent observations were analysed into their Fourier components the average amplitude ρ of a Fourier coefficient is $2\sigma/n^{1/2}$, where σ is the standard deviation of the n observations; if, then, the observed amplitude is ρ_0, the chance that such a component could arise purely as a result of random fluctuations is e^{-k}, where $k = \rho_0^2/\rho^2$. Thus, if the amplitude found is more than twice ρ, there is some ground for suspecting that the periodicity may be real.

The Schuster criterion, however, takes no account of internal correlations among the data. Thus a naïve view of the problem may give misleading results; if, for example, the observations are subject to disturbances, each of which affects a number of consecutive observations, the effective number of independent observations may be far less than n. Moreover, the criterion is of limited usefulness, since an investigator who thought that the values of a series of observations were all independent of one another would not be likely to make a harmonic analysis of the results. A more searching method of analysing a time-series was given in 1927 by Mr. G. Udny Yule. He considered two types of periodicities: the periodic phenomena where each disturbance affects only the momentary value of the quantity observed; and periodic phenomena in which each disturbance affects all the subsequent values, as, for example, a change of phase. The latter type would be discussed by Mr. M. G. Kendall. Dr. Hulme pointed out that an outstanding problem is to find

how to test whether a given oscillation belongs to one or other of these types.

Mr. H. W. Newton stated that more than two hundred years elapsed between the discovery of sunspots and the discovery of their eleven-year periodicity; the success of Schwabe in discovering the eleven-year cycle in 1610 might be attributed to his systematic work and to the fact that he continued his observations over three or four solar cycles. A graph of the frequency of naked-eye sunspots indicates that an observer with a piece of smoked glass making systematic observations like Schwabe could have discovered the eleven-year cycle; it is possible, however, that observers in the seventeenth century may have been frustrated by a 'submergence' of the sunspot cycle. The observed reversal of the polarity of the magnetic field in sunspots suggests that the fundamental period is twenty-two years; this, however, is not obvious from the diagram of many sunspot cycles as measured at Greenwich, though Turner got a difference from spot area data, 1842–1910, nor does it show up in Maunder's famous diagram (the 'butterfly' diagram) of the cyclical change of latitude of sunspots.

The Zurich 'sunspot numbers' from 1750 until 1911 were subjected to a harmonic analysis by Kimura. As in the customary method of predicting tidal heights, Kimura computed the form of the extrapolated curve after 1911; this prediction was not realized, for the time and amplitude of the next following maximum observed in 1917 were in marked disagreement with Kimura's values. Other analyses had been made by Newcomb, Schuster, Yule, Waldmeier and others; the average length of the cycle may be accepted as 11–13 years. Mr. Newton emphasized the necessity of using a long series of data in any attempt to establish a periodicity or a correlation; for example, the annual excess of turns of a weather vane at Greenwich, direct over retrograde, had been compared with the sunspot cycle, and it was found, rather surprisingly, that a general parallelism existed for some years. This correspondence, however, did not persist, and the parallelism appeared to be quite fortuitous. In conclusion, Mr. Newton showed a diagram of the comparison over thirty years of the monthly sunspot areas and the diurnal inequality ranges in magnitude of the terrestrial magnetic elements D, H and V. The correspondence is very striking, and extends to the details of the curves; later observations confirm the closeness of the correlation, and give values as high as 0·95 for the coefficient of correlation for individual eleven-year cycles.

Mr. M. G. Kendall, in his contribution, explained that although he knew little about astronomy, he believes that many of the oscillatory movements in time-series which are found in geophysical and meteorological data possess similar features to those in economic series in which he is primarily interested. In this connexion he wished to direct attention to the large amount of work which is being done on time-series in quite unrelated fields, the necessity for an interchange of information between workers in different branches of science, and some co-ordination of effort.

The classical method of analysing oscillatory movements is to exhibit the series as a sum of harmonic terms. If, as usually happens, observation differs from mathematical representation, the differences, however large, are regarded as errors of observation in the sense that their effect is instantaneous and does not endure in the future motion of the system. For most practical series, this does not appear to be a plausible hypothesis, because disturbances of the motion, though possibly random in the sense that their occurrence is according to the laws of chance, permanently affect the future motion of the system and are incorporated into it.

The statistical problem is to find a mathematical representation of such a system. The nearest approach to a solution so far advanced was that given in 1927 by Mr. Udny Yule in his paper on sunspots. Yule was led to consider a type of series, which has been called 'auto-regressive', in which the value at any point is partly a function of those at previous points, and partly a disturbance function. One simple form of this type of series can be written

$$u_{t+2} + au_{t+1} + bu_t - \varepsilon_{t+2} = 0,$$

where ε_{t+2} is the disturbance, which can in particular cases be random. Mr. Kendall has recently constructed a number of artificial series of this type and analysed them by the Schuster periodogram method. The results are very striking. Not only does the periodogram fail to reveal the true nature of the series, but also it suggests quite a large number of periods where none exist. He has come to the conclusion that for series of this type periodogram analysis is not worth the labour of undertaking.

Mr. Kendall has also considered the practice of counting peaks in a series as providing an estimate of 'period'. For autoregressive series of the type mentioned, it appears that this is an extremely insensitive method inasmuch as for the majority of values likely to be encountered in practice it will give a value somewhere between 4 or 6 units, whatever the nature of the series. His experimental series and a number of practical economic series do in fact give such values, and the appearance of 'periods' of this kind throws very little light on the true nature of the generating process.

Reference was also made by Mr. Kendall to the technique introduced by Mr. Yule of computing the serial correlations of the series. This appeared to give much more reliable results, but is not without its difficulties. In conclusion, he said that in his view a great deal of the work which has been done on the analysis of oscillatory movements will have to be reconsidered; he is convinced that 90 per cent of the 'periods' which have been claimed by different writers were spurious.

Miss N. Carruthers discussed periodicities in weather phenomena. She said that there are some true periodicities, such as, for example, the annual and diurnal variation of most meteorological elements, but it is doubtful whether they are truly represented by combinations of sine curves. In addition to these, spasmodic oscillations are found in most series of meteorological data. Some may be purely random fluctuations, but others have a tendency to reappear at intervals with the same wave-length, although not, in general, with the same phase. The latter most often persist for three or four wave-lengths only, after which they either end abruptly or change phase unexpectedly. Examining meteorological waves (the irregular kind can scarcely be termed periodicities) with Dr. C. E. P. Brooks, it had been found that determination by harmonic analysis is unreliable, and a year ago they devised the 'periodoscope' which Miss Carruthers described before the Royal Meteorological Society last June. In this form of analysis, by a simple combination of the terms in a series

containing periodicities, a new series is formed in which these were retained with period and phase unaltered. For periods lying within a pre-assigned range, however, amplitudes are magnified, so that, when the new series is plotted, the corresponding periodicities can be readily identified by eye with the aid of key curves drawn on tracing linen. Examples of waves found by this means in London temperature were contrasted with the more regular sunspot cycle (9–13 years) treated in the same way.

Most waves in meteorological phenomena appear to be natural oscillations of the earth's atmosphere. Haurwitz, Lettau and Defant deduced theoretical periods of 6–57 days, all of which have been found in pressure and some also in rainfall. These, however, are not set up without some external stimulus, just as a violin string does not emit its characteristic note of its own accord. The fragmentary nature of these waves can, likewise, be explained by analogy with a violin string ; for if the string receives impulses at intervals incommensurate with its period of vibration, the vibrations break up and change phase abruptly with each fresh impulse. The analogous impulses received by the atmosphere appear to be connected with variations of solar radiation. That these occur at intervals which are not natural periods of atmospheric vibration is indicated by a comparison of prevailing periods in the solar constant and in European pressure :

Solar Constant ..	75, 51, 37, 25, 19 days
Pressure	72, 48, 36, 24, 18 days

A further illustration is afforded by the 3-year wave in the pressure at Darwin, which has been found by C. Braak to break up and change phase about the time of sunspot maximum ; this is probably the same as the waves found earlier in India and the Argentine by Sir Norman Lockyer and identified as $3\frac{1}{2}$-year periodicities.

Other periods indirectly induced by solar radiation are connected with interchange of air between continents and oceans and outbreaks of cold air from the polar regions. The moon induces a semidiurnal atmospheric tide which is a true periodicity, but it is too small to have any appreciable effect on the weather.

Mr. P. M. Ryves summarized the general characteristics of stars the intrinsic luminosity of which is variable ; these constitute only a small percentage of the stars observed, but they cover the whole range of spectral classes from *O* to *M* and *N*. Periods range from $1\frac{1}{2}$ hours to 20 years or more, but periodicities of more than two years generally correspond to small amplitude of variation, and are often irregular or uncertain, and frequently complicated with superimposed shorter periods. There is a very definite correlation between length of period and spectral class, the shorter periods corresponding to the hotter early-type stars and long periods to late types. Though variables can be found with periods anywhere between the limits mentioned, a frequency curve shows three prominent peaks, one corresponding to the RR Lyrids with mean period of about half a day, the second to the Cepheids (really a double peak with a minimum at about nine days), and the third, at a little short of 300 days, to the Mira-type and other long-period variables.

Dealing particularly with the long-period variables, Mr. Ryves mentioned that typical Mira-type stars have a mean amplitude of about five magnitudes, with spectral class *M*3 to *M*8 (90 per cent), or *N* (5 per cent) or *S* (5 per cent), all with emission spectrum, and periods for the most part between 150 and 550 days. The magnitude at maximum varies in individual cycles to the extent of one magnitude or more, and the magnitude at minimum also varies, but generally to a smaller extent. The period is frequently irregular in the sense that any given phase may be unpunctual to the extent of 5–10 per cent, but the mean period is fairly constant. Apart from these oscillations about the mean, there are sometimes permanent changes : (*a*) a sudden change in the length of the period (this has happened more than once in some stars) ; (*b*) a discontinuity, or shift in the phase, without change of period. Mira-type stars show a small progression of spectral class with increasing length of period, and also, but with many exceptions, a progression from symmetrical to asymmetrical light curves, and increase in amplitude. The shape of the curve may vary a good deal from cycle to cycle, and there is sometimes a pause or hump as in the sunspot curve ; this happens more frequently on the ascending than on the descending branch. In some cases the hump is a more or less permanent feature, and shows up on the mean curve. The variables have large space-motions, and are probably revolving about the centre of the galaxy in highly elliptical orbits.

Parallel with the Mira-type variables is another group of stars comprising the red semi-regular variables and the so-called red irregular variables. The fundamental difference is that these have no emission spectrum, or at most a very faint one, and that the amplitude is much smaller, usually one or two magnitudes. The variation is also less regular, both as regards punctuality and the shape of the light-curve. Double maxima, or a tendency for deep and shallow minima to alternate, are common, and a long-term variation in the median magnitude sometimes appears. With irregular variables there may be several maxima at fairly regular intervals, followed by a period of disturbance, after which a new series of maxima appears, quite out of phase with the former series.

Dr. R. Stoneley recalled a paper by Dr. H. Jeffreys that is extremely relevant to the present discussion. Many harmonic analyses had been made of the occurrence of earthquake shocks, notably by Prof. H. H. Turner and Dr. C. Davison. The latter had applied the Schuster criterion to his results, and *prima facie* had found good evidence for the genuineness of a number of the periodicities. Dr. Jeffreys found that the existence of internal correlations among the data would increase the random amplitudes expected in a Fourier analysis, and would therefore vitiate the direct application of the Schuster criterion. The phenomenon of aftershocks following a large earthquake does imply that all the shocks recorded in a catalogue cannot be treated as random occurrences. In the aftershocks of the Tango earthquake of March 7, 1927, the falling-off of the frequencies of the aftershocks is consistent with a regular law of chance that depends only on the time-intervals elapsing since the main shock and a second strong shock on April 1, 1927, but otherwise the aftershocks appear to be mutually independent. The amplitudes obtained for periodicities superposed on this variation are not such as would give any support for the realities of these periodicities.

As was stated at the beginning of this article, Dr. Jeffreys was not present at the meeting, but was asked to comment on the above report. He emphas-

izes that the Schuster criterion is the particular case of Pearson's χ^2 test when the number of degrees of freedom is 2. The analysis of the variation of latitude observations shows the same kind of serial correlation as Yule has considered, with the additional complication that the disturbances do not appear to be derived from the normal law. Fortunately, it was possible to find a long interval when there seems to have been little disturbance. In this problem there is an observational error special to each datum and also a real fluctuation the successive values of which are correlated; the method of maximum likelihood can deal easily with either by itself but becomes prohibitively complicated when the two are superposed.

HÆMOGLOBIN IN THE ROOT NODULES OF LEGUMINOUS PLANTS

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AND
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THE red pigment in the root nodules of a leguminous plant (*Vicia Faba*) was investigated for the first time by Pietz[1]. He believed it to be identical with the red intermediate product which appears during the oxidation of tyrosine or of dihydroxyphenylalanine ('dopa') catalysed by tyrosinase. According to Pietz, the red pigment, by undergoing a reversible reduction, has the function of poising the oxido-reduction potential of the nodule at a level favourable for the proliferation of symbiotic bacteria inhabiting the nodule.

Pietz' conclusion, however, was based not upon the direct study of the pigment, but upon certain considerations derived from the study of oxido-reduction potentials of nutrient media in relation to growth of symbiotic micro-organisms, and the fact that the addition of 'dopa' to the medium favours the growth of these bacteria.

A year later the pigment in the root nodules of a great variety of leguminous plants was reinvestigated by Kubo[2] both *in situ* and in preparations obtained by fractionation of an extract of nodules with ammonium sulphate. He examined the pigment spectroscopically and determined the position of its absorption bands under different conditions. Thus when aerated, the pigment shows two absorption bands, at 575 mμ and 540 mμ, which, on reduction with sodium hyposulphite, are replaced by one band at 555 mμ. In the presence of carbon monoxide the bands are shifted to 570 mμ and 535 mμ, and on treating the pigment with potassium ferricyanide a compound is obtained with three absorption bands, at 625 mμ, 563 mμ and 530 mμ. This latter compound was found by Kubo to react with cyanide, fluoride and peroxide. Finally he obtained from this pigment crystals of hæmin indistinguishable from protohæmin. As the result of these observations, Kubo concluded that the red pigment of the nodules is a hæmoprotein compound analogous to hæmoglobin and acting as a store as well as a carrier of oxygen.

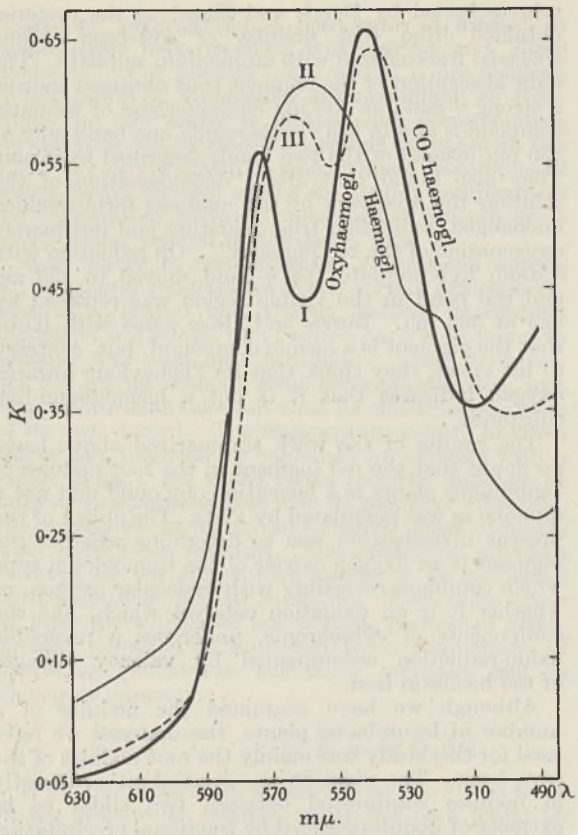
More recently, the nature of this pigment was reinvestigated by Burris and Haas[3] on the material obtained from root nodules of cow-peas (*Vigna sinensis*) fractionated with ammonium sulphate. The light absorption of the pigment thus obtained showed a strong γ-band at 405 mμ characteristic of hæmatin compounds and in the visible region one band only at 530 mμ instead of the two bands described by Kubo. They also found that after "deoxygenation of the solution the spectrum of the oxidized form remains unchanged, indicating true oxidation and not merely oxygenation of the red pigment". On reduction with sodium hyposulphite the γ-band moved to 430 mμ and the band in the visible region was replaced by one at 560 mμ. Burris and Haas agree with Kubo that the pigment is a hæmin compound, but, contrary to his views, they think that its "behaviour towards oxygen indicates that it is not a hæmoglobin-like substance".

The results of the work summarized above leave no doubt that the red pigment in the root nodules of leguminous plants is a hæmatin compound and not a quinone as was postulated by Pietz. The object of the present investigation was to determine whether the pigment is an oxygen carrier of the hæmoglobin type which combines reversibly with molecular oxygen, or whether it is an oxidation catalyst which, like the components of cytochrome, undergoes a reversible oxido-reduction accompanied by valency changes of the hæmatin iron.

Although we have examined the nodules of a number of leguminous plants, the material we have used for this study was mainly the root nodules of the soya bean. The pigment was studied either directly in nodules compressed between two slides or as extracts of nodules purified by fractional precipitation with ammonium sulphate.

The position of the absorption bands of this pigment and of its derivatives was determined with the microspectroscope, and the absorption spectra were determined with the Hilger-Nutting spectrophotometer. This was done only for the visible region of the spectrum, since hæmatin derivatives are more readily differentiated by the absorption bands in this region than by their γ-bands.

One of the main difficulties in the extraction of this pigment from nodules, which have to be crushed for this purpose, is the more or less rapid darkening of the pulp and of the extract due to oxidation of a phenolic substance catalysed by the phenol oxidase. The quinone formed during this reaction oxidizes the iron of the pigment and partly denatures its protein, whereas the melanine which is ultimately formed adsorbs the pigment and masks its colour and its absorption spectrum. However, one can overcome these difficulties in several ways. Thus, by crushing the nodules in saturated ammonium sulphate and washing the pulp in the same solution, the phenoloxidase can be precipitated before it has time to act upon the substrate, which can be afterwards removed. At the same time we have added an excess of sodium azide which poisons phenolase and a small amount of sodium hyposulphite which also prevents the oxidation of the substrate and keeps the iron of the pigment in the reduced state. The reduced state can be more efficiently stabilized by saturating the solution during different manipulations with carbon monoxide. Under these conditions the extracts can easily be fractionated with ammonium sulphate, and the fraction between 65 per cent and 84 per cent saturation, which contains most of the red pigment, is collected.



ABSORPTION CURVES OF HÆMOGLOBIN FROM ROOT NODULES OF SOYA BEAN.

I, Oxyhæmoglobin (prep. *A*); II, deoxygenated hæmoglobin (prep. *B*); III, carbon monoxide-hæmoglobin (prep. *B*); extinction coefficient $k = \frac{1}{l} \log_{10} \frac{I_0}{I}$; Preparation *A* contains probably small concentration of methæmoglobin. Concentration of hæmin per 100 ml. in preparation $A = 4{\cdot}05$ mgm.; in preparation $B = 3{\cdot}46$ mgm. Preparations *A* and *B* are of different degrees of purity and probably contain a small amount of hæmatin not belonging to hæmoglobin.

The hæmin content of this preparation, estimated spectroscopically as pyridine hæmochromogen, was found to be approximately 2 per cent of its dry weight. If we assume that the total hæmatin found belongs to the undenatured red pigment and that its hæmatin content is approximately the same as that of hæmoglobin, the purity of our preparation would be 40–50 per cent. Preparations of this purity were found to be quite suitable for the study of the main properties of the pigment.

Properties and Nature of the Pigment. A solution of this pigment is deep red and its absorption spectrum shows two distinct bands with the maxima at about α–574 mμ and β–540 mμ; the α-band being narrower and lower than the β-band (Curve I).

On treating the solution with sodium hyposulphite, the two bands disappear and are replaced by one band with the maximum at 557 mμ (Curve II). What is more remarkable, however, is that this change can be obtained in the absence of a reducing agent by warming the solution in a Thunberg tube to about 37° C. and evacuating the tube with an ordinary water pump. After boiling for a few minutes the two bands gradually fade away, being replaced by a single band at 557 mμ. On opening the tube and shaking the solution with air, the two-banded absorption spectrum rapidly reappears.

All this clearly shows that the two-banded spectrum belongs to the oxygenated and not the oxidized state of the pigment. Like hæmoglobin, the pigment of root nodules forms with molecular oxygen a loose and perfectly reversible compound. That the iron of this compound, like that of oxyhæmoglobin, is in a divalent state is shown by its reaction with carbon monoxide, and with potassium ferricyanide. On treating the oxygenated compound with carbon monoxide, its two absorption bands are replaced by two more diffuse bands lying at 564 mμ and 538 mμ (Curve III). The addition of potassium ferricyanide to the oxygenated compound changes its colour from red to brown, and its two absorption bands are replaced by the absorption spectrum characteristic of methæmoglobin.

The failure of Burris and Haas[3] to recognize the true nature of this pigment was probably due to the fact that their preparation contained mainly the methæmoglobin derivative with its band at 530 mμ as described by Kubo. Had they dialysed against water a sample of their preparation treated with sodium hyposulphite, they would probably have noticed the appearance of the oxygenated compound with its two characteristic absorption bands.

The affinity of this hæmoglobin for oxygen expressed as oxygen tension in mm. mercury which corresponds to 50 per cent dissociation of the oxygenated compound was determined spectroscopically at 15° C. and was found to be less than 0·1 mm. The relative affinity of this pigment for oxygen and for carbon monoxide, expressed as the equilibrium constant $k = \frac{(\mathrm{HbCO})\,(p\mathrm{O_2})}{(\mathrm{HbO_2})\,(p\mathrm{CO})}$ was determined spectrophotometrically at 15° C. and its value was found to be about 37. It is somewhat higher than the value obtained for myoglobin, but considerably lower than the values found for mammalian blood hæmoglobin. These values should be considered as approximate only, since they have been obtained on samples which were only about 50 per cent pure. They may require a certain correction when the pigment is obtained in a purer form.

That the hæmoglobin is in some way connected with the nitrogen fixation by nodules seems to be supported by two facts: (1) its constant presence in nodules of every leguminous plant so far examined; and (2) the inhibition of nitrogen fixation by a very low partial pressure of carbon monoxide[4]. At such pressures carbon monoxide is known to react mainly with hæmoglobin. However, it is difficult to ascribe to this hæmoglobin any definite function, since the mechanism of nitrogen fixation by nodules is far from being elucidated[5]; moreover, the function of hæmoglobin even in certain invertebrates is not yet properly understood.

General Considerations. The presence of hæmoglobin in root nodules of leguminous plants is of great general interest. It is well known that in animals, outside vetebrates, hæmoglobin has a very irregular distribution, being either completely absent in all representatives of large phyla of invertebrates, or present in only a very few species of a phylum while absent in all other, often nearly allied, forms. Since, however, all cells of aerobic organisms, including bacteria and plants, are capable of synthesizing hæmatin catalysts such as the components of cytochrome, obviously every cell can be considered as a potential carrier of the prosthetic group of hæmoglobin. The limiting factor in the distribution of hæmoglobin in Nature is the ability of cells to

synthesize the highly specific proteins which, when combined with hæm, impart to it the remarkable property of reversible oxygenation. This property, which hæmoglobin shares with only a few natural oxygen carriers, has no analogy among chemical compounds.

The root nodule hæmoglobin represents the first case of the occurrence of this pigment in plants, although other hæmatin compounds such as cytochrome peroxidase and catalase are known in plants. What is, however, more interesting is that neither the plant cells alone nor the symbiotic micro-organisms (*Rhizobium*) cultivated separately are capable of synthesizing hæmoglobin. It is only when the root cells are invaded by specific symbiotic micro-organisms and begin to proliferate that hæmoglobin is formed. *Rhizobium* not only induces growth and multiplication of cells, but also supplies these proliferating cells directly or indirectly with a factor necessary for synthesis of hæmoglobin.

For the plant material used in the present investigation we wish to thank Dr. H. Hunter, Mr. E. G. Thompson, Prof. E. J. Salisbury and Dr. Kenneth M. Smith. This work was assisted by a personal grant from the Medical Research Council to one of us (Y. L. W.).

[1] Pietz, J., *Z. Bakt.*, (2), **99**, 1 (1938).
[2] Kubo, H., *Acta Phytochim.*, **11**, 195 (1939).
[3] Burris, R. M., and Haas, E., *J. Biol. Chem.*, **155**, 227 (1944).
[4] Wilson, P. W., *Ergeb. Enzymfor.*, **8**, 13 (1939).
[5] Wilson, P. W., "The Biochemistry of Symbiotic Nitrogen Fixation" (Madison: The University of Wisconsin Press, 1940).

RUSSIAN RUBBER PLANTS

IN recent years there has been a great deal of interest in the study of rubber-bearing plants that will grow in temperate and sub-temperate climates in connexion with the possibility of establishing sources of supply of natural rubber independent of the tropics. Russian workers have been the pioneers in this field, and it is in the U.S.S.R. that the most noteworthy developments have taken place. The published accounts of this work (mainly in Russian) are unfortunately difficult of access, especially at the present time. It is fitting, therefore, that a comprehensive summary (in English) should now have appeared, with special emphasis on what is so far known of the genetics of the plants concerned and what breeding work has so far been carried out with them*.

A brief history is given of the search for rubber-bearing plants in the U.S.S.R. which first began during the War of 1914–18 and of the expeditions that have been arranged for the purpose. Since that time, several thousand species have been examined, and special methods evolved for detecting the presence of rubber both qualitatively and quantitatively. Apart from latex-bearing plants, many species were found to contain rubber in the mesophyll tissue of the leaves, but successful extraction presented many difficulties. The most promising rubber-bearing plants outside the tropics were found to be those containing coagulated rubber in the roots and underground stems. In these plants the rubber, often visible as strands, was found to be more easily separated from the surrounding tissue than was the case where the rubber occurred in the leaves. Furthermore, it was found to have a markedly lower resin content.

The first plant of this class to show promise as a possible commercial source of rubber, if cultivated, was tau-saghyz (*Scorzonera tau-saghyz*), discovered in 1929 on the Kara-Tau mountains of Central Asia. Several forms or ecotypes of the plant are now known to exist. A good account of the plant is given, its growth characteristics and its behaviour under cultivation. Although possessing a good rubber content in the root, the plant proved susceptible to disease and difficult to cultivate satisfactorily in most areas. For this reason it gave way to other rubber-bearing species brought to light a few years later, which proved to be better subjects under cultivation, such as krim-saghyz (*Taraxacum megalorrhyzon*) and kok-saghyz (*Taraxacum kok-saghyz*).

Both these plants are very similar to the ordinary dandelion in general appearance and possess large, rather fleshy roots in which the rubber is chiefly located. Kok-saghyz is the more hardy plant and may be cultivated over a much wider area of the U.S.S.R. than krim-saghyz. The latter occurs wild in the Crimea region and is liable to be killed in winter except in places where winter conditions are relatively mild. It is for this reason that interest is now centred mainly on kok-saghyz, and the area devoted to it is the largest of all the areas in which rubber-bearing plants are now grown. The plant is usually cultivated in districts where the annual rainfall is not less than 450–500 mm. and thrives particularly in the central part of the U.S.S.R., as in the Orel and Ivanov territories and in the Ukraine and White Russia, also in irrigated lands in Central Asia. It has been grown as far north as the Kotlas region of the Archangel territory. The plant thrives and gives the best yields on low-lying alluvial land, especially good peaty and humus soils and in particular those that have been well manured. In White Russia, experiments have shown that on peaty soils larger yields of roots with higher rubber content have been obtained than has been found possible on mineral soils. For high yields of root, deep, fertile, friable soils rich in nutrients and with adequate moisture are necessary. Structureless soils, which rain turns into mud and which lack nutrients, or sandy soils, are regarded as unsuitable for kok-saghyz.

A good account is given of the methods adopted in the field cultivation of kok-saghyz from the sowing of the seed to the harvesting of the roots. As germination of the seeds is naturally poor or uneven, pre-treatment or vernalization is often necessary. The seedlings are also somewhat delicate and slow-growing. They are easily choked or smothered by weeds in the early stages. For these reasons the crop is a more difficult one to raise than many field crops. Special machinery has had to be devised for dealing with the crop, particularly in sowing the seed, harvesting the roots and in the collection of seed, which is similar to that of the dandelion and dispersed by wind almost as soon as it is ripe.

Propagation by means of root fragments, which is possible with the plant if certain precautions are taken (as recommended by Lysenko), should offer interesting possibilities, but so far does not appear to have progressed beyond the experimental stage. Pieces of the root 1–2 cm. long cut off in the early spring and allowed to callus in moist sand and planted in place of seed make much more rapid growth than seedlings, and when a few days old

* Cultivation and Breeding of Russian Rubber-Bearing Plants. Imperial Bureaux of Plant Breeding and Genetics, Cambridge, and Horticulture and Plantation Crops, East Malling, England. 2s. 6d.

resemble seedlings two months old. This simplifies weeding. Another obvious advantage is that high-yielding individual plants may be rapidly propagated vegetatively in this way. A drawback of this method for large-scale or field planting, according to Mynbaevdel, is that the development of the main root is retarded.

Various insects are known to attack the kok-saghyz plant in different stages of its development, and a good account of these is given. With regard to soil pests the chief of these in the more northerly regions is the wireworm. Cockchafer larvæ, which gnaw through the roots at various depths, may also be troublesome.

Genetical work that has been done on certain other rubber-yielding plants in the U.S.S.R. in addition to the above is also reviewed. These include species of *Asclepias*, *Apocynum*, *Solidago* (golden rod), *Scorzonera*, *Chrysothamnus*, *Parthenium* (guayule) and *Taraxacum*. Each genus is treated in a separate section, and information is given under the headings of: *A*, Taxonomy and Distribution; *B*, Cytology and Reproduction; *C*, Variation and Genetics; and *D*, Breeding. Guayule and the species of *Taraxacum* have received most attention, as might be expected in view of the fact that they have shown most promise as rubber producers.

With regard to guayule the opinion is expressed that the breeding stocks in the U.S.S.R. and in the United States differ considerably in their potentialities and that the Russian are inferior to the American. This is not surprising when it is considered that the American breeders have had continuous access to wild material while the Russians have had to develop their strains from a single collection. The fact that the development of American varieties was monopolized by a private firm until recently (1942) has probably discouraged other breeders from investigating guayule. Improvement with guayule has been effected mainly by selection, rather than by hybridization, which is difficult. Strains yielding as much as 22 per cent rubber are now available, and there has been some improvement in plant-size but little in accelerating the growth-rate, plants being normally harvested in their third or fourth year.

Cytologists may be interested in the remarks regarding the genus *Scorzonera*, particularly tau-saghyz, in connexion with which it is stated: "The diploid chromosome number is 14 and each chromosome has a distinctive morphology; they are all two-armed, 2 pairs having median centromeres and 5 pairs sub-terminal centromeres. It has been found that two races of the species exist, each distinguished by its own chromosomal morphology. In one race, satellites are present in three of the chromosome pairs, one of which is heterozygous for a second satellite. In the second race, satellites are completely absent. Examinations of the root tips of *S. tau-saghyz* have revealed rather a complicated picture of chimaeral polyploidy and aneuploidy. Triploid, tetraploid and hexaploid cells have been discovered both in the periblem and the plerome together with aneuploid cells with 15, 16, 18, 19, 20 or 21 chromosomes. It is assumed that these various anomalous chromosome numbers arise by somatic non-disjunction or chromosome elimination. Trisomic cells have been observed in *S. nervosa* ($2n = 12$) but not in other species of the genus. Chromosome numbers of some other species are as follows: *S. hispanica* ($2n=14$), *S. acanthoclada* ($2n = 14$) and *S. tuberosa* ($2n = 12$).

"Meiotic behaviour in *S. tau-saghyz* is aberrant, and the following abnormalities have been observed: lagging chromosomes, adventitious nuclei, chromosome fragmentation, elimination of chromosomes from the spindle, polynucleate pollen and viable pollen with aneuploid chromosome numbers. It has been found however by Poddubnaja-Arnoldi, Steschina and Sosnovetz (1935) that gametogenesis is regular and that subsequent irregularities, which affect both the megaspores and the pollen grains, are due to the low temperature and high humidity of the plant's normal environment."

In the breeding of tau-saghyz the importance of selecting plants for vegetative vigour is stressed, for the mortality-rate of unselected plants may be very high and reach 100 per cent. The fact that tau-saghyz is very susceptible to disease may, it is thought, be correlated with the scanty soil microflora in its native habitat. The advantages that might accrue from hybridizing tau-saghyz with the vegetable scorzonera (*Scorzonera hispanica*), which has been so long in cultivation and has vigour and a stout root, are emphasized.

Investigations of the cytology of kok-saghyz have been made by a number of workers. "There are eight pairs of chromosomes one of which has satellites attached. Meiosis is normal both in pollen grains and ovules and nearly 100 per cent pollen fertility is reported. The pollen is viable for five days, and fertilization takes place in 15–20 minutes, according to Poddubnaja-Arnoldi and Dianova and 30 minutes at 70° F. according to Warmke. The embryo-sac usually develops from the chalazal megaspore. A high degree of self-sterility is usual although some 'end season fertility' is reported from America; the cause of this is obscure and the possible effects of temperature, light and the age of the plant have been suggested. Cross-pollination, which seldom occurs naturally if insect visitors are excluded, produces 100% fertilization. The fertilized embryo develops normally although supernumerary eggs and sperms are formed quite frequently. It is possible that functional polyspermy may occur occasionally in the endosperm but only triploid nuclei have been observed up to the present. There is no evidence of apomixis in this species and it is regarded as extremely improbable."

Crosses have been made between kok-saghyz and about half a dozen other species of *Taraxacum*. "The hybrids are very highly sterile; normal meiosis occurs but is followed by subsequent degeneration of the gametes or the embryo. In the latter case, irregular nuclear fusions were observed in the early developmental stages. Koroleva (1939) managed to produce an F_2 and F_3 from the cross *T. kok-saghyz* × *T. multiscaposum* by back crossing with the former species."

It is interesting to note that seed of three of the rubber plants here dealt with (tau-, krim- and kok-saghyz) was obtained from the U.S.S.R. a few years ago and small trials carried out at the Royal Botanic Gardens, Kew, and in various parts of the British Isles. Tau-saghyz appeared to be quite unsuited to the climate; but plants of kok-saghyz and krim-saghyz were raised successfully at several centres and good-quality rubber extracted, but only on a laboratory scale. With all these plants yields are very much inferior to those obtained with *Hevea* or plantation rubber. From the point of view of world economy they may be of comparatively little value, and it is only when self-sufficiency is desired that they become of general economic importance.

NEWS and VIEWS

Chair of Logic and Metaphysics at Edinburgh
Prof. N. Kemp Smith

FOR more than a century, largely on account of the eminence of its occupants, the chair of logic and metaphysics in the University of Edinburgh has been very generally, although quite unofficially, regarded as Scotland's premier philosophical chair. Since 1836 there have been four occupants, Sir William Hamilton (1836–1856), Campbell Fraser (1856–1891), Pringle-Pattison (1891–1919) and Norman Kemp Smith from 1919 to the end of the present academic session, when he retires. All four were celebrated for their mastery of the history of ideas, particularly in the eighteenth century and around it: Sir William Hamilton by work which, nominally at least, took its origin from Thomas Reid, Fraser by his unwearying labours on Berkeley, Pringle-Pattison by his dominant neo-Kantianism, and Kemp Smith by his massive study of Kant and of Hume. It is not very reckless to suggest that the last of the four professors surpassed all the others in this common tradition. Our standards in this field are very much higher in the present century than in the last, and only partially because the last had done so much. The intensive study of Kant which is so marked a feature of contemporary British academic philosophy owes more to Kemp Smith's "Commentary" than to the pen of any other English-writing author. His work on Hume, beginning with two masterly articles in *Mind* (1905), and continued in his edition of Hume's "Dialogues" (1935) has (perhaps) concluded with his "Philosophy of David Hume", a book which outstripped all other contemporary work on Hume, British or foreign, by a very comfortable margin. Kemp Smith brought to his classroom the high qualities that he showed in his writings; and all his varied contacts with students, colleagues and the public gained, in addition, from his broad humanity, his deep interest in the social problems of the present day and his catholic appetite for modern history and biography. He knew the United States well, for he was professor in Princeton between 1906 and his return to Europe to serve in the Ministry of Information during the War of 1914–18, and, in 1923, he was a visiting professor in Berkeley, California. A friend to both sides of the Atlantic, he was, is, and, one hopes, will long continue to be, one of the strongest links in the chain of Anglo-American unity and understanding in academic affairs.

Prof. A. D. Ritchie

IN inviting Prof. A. D. Ritchie, at present professor of philosophy in the University of Manchester, to succeed Prof. Kemp Smith, the electors have shown a courageous readiness to avoid too rigid an adherence even to a tradition so firmly established, for Prof. Ritchie, who has accepted the invitation, is as much a man of science as a philosopher. They may, indeed, be renewing the tradition. Sir William Hamilton, among his many pre-professorial activities, had studied medicine and had qualified for the Bar. Superficially, however, there is something like a break in the tradition. Prof. Ritchie's principal philosophical books are about scientific method and the natural history of mind. His other book deals with the comparative physiology of muscular tissue. His fellowship at Trinity College, Cambridge, was earned for his work in chemistry, and he was a lecturer on chemical physiology in Manchester before succeeding J. L. Stocks in the chair of philosophy there. Some may think that first-hand acquaintance with the inferences of experimental science, accompanied by writing upon its general theory, is the best possible preparation for the teaching of logic. As for philosophy in a wider sense, including metaphysics, Prof. Ritchie's varied articles upon many themes, religion and sociology among them, give ample evidence of his interest and capacity. He began, too, in a very favourable environment, his father, D. G. Ritchie, professor of logic in the University of St. Andrews, though he died rather young, being still gratefully remembered as the most brilliant writer among Scottish philosophers at about the turn of the century.

Alexei Abrikosov

ALEXEI ABRIKOSOV has been awarded the title of Hero of Socialist Labour by the Government of the U.S.S.R. Prof. Abrikosov has just celebrated his seventieth birthday. He is a leading specialist in pathological anatomy. He has been successful in combining a theoretical subject with the practical work of a clinic, and was the founder of a new anatomico-clinical branch of pathological anatomy. At the very beginning of his career, Prof. Abrikosov studied the relationships between disease-bearing micro-organisms and the protective powers which the human organism possesses. Allergy, one of the complex problems which arise from this, naturally attracted his attention. He has carried out extensive research on the morphology of the vegetative nervous system and its pathological condition. Applying methods of pathological anatomy, he has made a detailed study of the morphological changes which take place in the tissue as a result of metabolic disorders, avitaminosis and hypo-vitaminosis. For many years Prof. Abrikosov was at the Botkin Hospital, one of the largest in Moscow, and for twenty-five years has held the chair of pathological anatomy at the First Moscow Medical Institute. He was awarded a Stalin Prize for the two volumes already published of a work on pathological anatomy. Prof. Abrikosov still continues active research and teaching.

Research Development and Tax Relief

IN his Budget speech last year, the Chancellor of the Exchequer undertook to provide reliefs of income tax for industry and agriculture during the reconstruction period after the War. A Bill to give effect to these proposals has now been introduced in the House of Commons. So far as scientific research is concerned the allowance given in the Finance Act 1944 (see *Nature*, May 6, 1944, p. 542) is now to be extended to payments made after April 6, 1944. An allowance is also to be made for expenditure for buildings, plant and machinery for research incurred after January 1, 1937. Other proposals are concerned more directly with industry. Allowances are to be made for second-hand as well as new plant. A welcome sense of the well-being of personnel is shown by the inclusion, among industrial buildings qualifying for allowances, of those concerned with welfare, such as sports pavilions. An annual allowance for a period of years is proposed in respect of capital expended on purchasing patent rights after "the appointed day", and a corresponding charge is to be made against vendors of a patent. Agricultural buildings and works will qualify for allowances,

as will also houses built for workers at mines or oil wells which will be useless when the mines or wells are exhausted. The new allowances will apply to expenditure incurred since April 1, 1944.

University of Birmingham

AMONG other matters dealt with by Dr. Raymond Priestley, vice-chancellor of the University of Birmingham, in his annual report to the Court of Governors, is the part to be played by the universities in making possible the great increase of exports of Britain which will be a vital necessity for us in the post-war world, when a premium will be put on industrial efficiency in every field. One contribution is through the production of an increased flow of engineering graduates of the finest possible quality, from among whom will be found not only the professional engineers of the next generation but also men to fill high executive positions in industry. With this object the University of Birmingham is seeking to rebuild and re-equip its Departments of Mechanical and Electrical Engineering. The private appeal to local firms last year for £250,000 has already met with a gratifying response. No specialization can be admitted in the undergraduate stage, though fundamental work in the University engineering laboratories must be supplemented by vacation courses in industry itself. Nevertheless, something more than this preparation is needed by those among our best engineers whose aptitude and potential capacity attract them to administrative and managerial functions.

A gift from Messrs. Joseph Lucas, Ltd., of £112,000, under a seven-year covenant, for the establishment and maintenance of a chair and University lectureship in production engineering, gives a prospect of meeting the need. The University of Birmingham, which serves an area containing the largest concentration of the engineering and metal-working industries in the United Kingdom, is in every way suited to be the home of this development, and the University has agreed to institute a postgraduate course in production engineering, at present to be contained in the Department of Mechanical Engineering. The objects of the new development are to foster through research the full development of every aspect of the science of production engineering and the education through special postgraduate courses of a supply of men who possess not only a sound grasp of the fundamentals of engineering but also a specialized knowledge of production methods and processes and the varied aspects of organization and control. Such a course considerably lengthens the period of engineering education in these special cases, and problems of maintenance of students will be involved. To finance this aspect of the scheme through the first few years, Sir Peter Bennett has generously given £10,000.

Development of the Oil Industry

AT a meeting of the Manchester University Branch of the Association of Scientific Workers on February 1, Dr. H. Steiner gave a lecture on the development of the oil industry. Oil was first produced industrially in 1859, when 300,000 gallons were obtained; by 1938 the production of crude oil had risen to 70,000 million gallons. In the last century the most important product was kerosene; since 1900 the advent of the motor-car has shifted the importance to the lighter fractions of the crude—mainly petrol. Due to the increased demand for the light fraction, production became unbalanced, in that too much high- and too little low-boiling fractions were produced. This was remedied by the cracking process, which by applying heat and pressure, produces lower boiling hydrocarbons from the higher boiling ones.

Later, the demand arose for high-quality petrol for improved automobile- and particularly aero-engines. Branched-chain paraffins were produced which are more resistant to 'knocking' than straight chains and can be used in engines working at high compression and thus high efficiency. The first branched-chain paraffin produced commercially was 'iso-octane' (2–2–4 trimethylpentane). This is made from *iso*-butylene, a constituent of the cracking gases. To-day very large amounts of branched-chain paraffins are produced from these gases by combining *iso*-paraffins such as *iso*butane and olefines (for example, butene) in the 'alkylation reaction'.

A later development to produce high-quality petrol is cracking in the presence of catalysts, which assist in forming branched-chain hydrocarbons. The main technical difficulty is that, in the course of the reaction, carbon is deposited on the catalyst and destroys its activity. By burning off the carbon under carefully controlled conditions, avoiding overheating, the activity can be restored. The most recent method employs so-called 'fluid catalysts', that is, very fine powders, which are dispersed in the hydrocarbon vapours and then passed through the reactors. On emerging from the reactors the catalyst is separated, dispersed in air and then passed through a second heated zone where the carbon deposits are burned off. It is then ready to be used again. A very important development is the production of chemicals from petroleum, mainly from the cracking gases. Finally, probably the most important synthesis is that of butadiene. Of about 600,000 tons required for the United States synthetic rubber programme, about 400,000 tons are made from petroleum, mainly by the dehydrogenation of butene over catalysts at high temperatures.

Animal Concealment and Flash Coloration

MOMENTARY display by animals of conspicuous colours followed by reliance upon procrypsis has long been known. Jenner Weir (*Trans. Ent. Soc. Lond.*, 22; 1869) directed attention to the conspicuous hind wings exhibited in flight by many otherwise cryptic moths and *Oedipoda* grasshoppers, and Lord Walsingham, in 1890 (*Proc. Ent. Soc. Lond.*, 52; 1890), suggested that the sudden change when such flying insects came to rest serves to confuse the visual impressions of a pursuing enemy. H. B. Cott, in his work "Adaptive Coloration in Animals" (1940), devoted several pages and many figures to this 'flash coloration'. An interesting new example of the principle has been described in a letter from Staff-Sergeant J. E. Marson (6th (East Africa) Inf. Bde. Workshops, E.A.E.M.E., South-East Asia Command). "In Ceylon I have noted the effectiveness of the same principle as applied to certain species of spiders. The female of *Herennia ornatissima* (Doleschall) is a medium-sized spider, grey and brown above, with the underside of the abdomen and cephalothorax having brilliant yellow, orange or red markings, according to the maturity of the spider. It spins its web on rubber trees, from stumps of branches to the main trunk. The web is nine inches to a foot in length, and is very close to the trunk at all parts. The centre of the web is tubular and is fastened to the trunk by the tip of the tube. In this tubular depression, the female rests, almost perfectly camou-

flaged by the similarity of colour to the lichens which grow on the tree. If the spider is disturbed, however, a vivid red streak shoots down the trunk, as it jumps and lowers itself on a thread. The red streak stops as it alights further down the trunk with the underside of the abdomen covered. It is very difficult to follow the later part of this movement, owing to the rapid colour change. Many members of the *Eresidæ*, which retreat into their tube-like web endings when disturbed, jump when further attacked, and the same effect is produced by the highly coloured underside of the abdomen. It would appear that this colour change would once again offer protection against a foe attacking at close range."

Parliamentary and Scientific Committee

THE annual report for 1944 of the Parliamentary and Scientific Committee refers to a further increase in the subscribing membership and to the formation of a Parliamentary Action Sub-Committee, which was especially active in connexion with the Finance Bill clauses relating to research. The report includes a summary of the changes recommended by the Sub-Committee on Taxation and Research and of the proposals of Sir John Anderson in his Budget speech last April, as well as of points made to elucidate these proposals during the debate. The principal recommendations in the report on Scientific Aspects of British Agricultural Policy and in the Memorandum on the Organisation and Development of Research in Great Britain issued by the Committee during the year are detailed in the report, which further refers to the preparation of a confidential memorandum on scientific attachés, and to steps taken to encourage the establishment in the Dominions of committees similar to the Parliamentary and Scientific Committee.

X-Rays in Engineering and Industry

A PAPER on this subject read before the Institution of Electrical Engineers in London on February 1 by Dr. V. E. Pullin outlines the development of X-radiography in industry and engineering from the time of Röntgen's discovery in 1895. In the first section, developments in uses and equipment up to the beginning of the present War are recorded in broad outline. In the second, the war-time development of engineering and industrial radiography, particularly with regard to Service requirements and inspection, is dealt with. The third section forecasts future radiographic developments in connexion with modifications in engineering inspection and development. The author also foreshadows the trend of development in X-ray apparatus and equipment. Applications of X-ray crystal analysis in industry and the enormous progress made by radiology in the medical and surgical fields are not discussed.

The Night Sky in March

NEW moon occurs on March 14d. 03h. 51m., U.T., and full moon on March 28d. 17h. 44m. The following conjunctions with the moon take place: March 11d. 21h., Mars 2° N.; March 16d. 10h., Venus 12° N.; March 21d. 03h., Saturn 0·4° N.; March 27d. 05h., Jupiter 3° S. During March no occultations of stars brighter than magnitude 6 take place. Mercury is close to the sun at the beginning of the month, rising about 20 minutes after, and setting 10 minutes before, the sun then. At the end of March the times of rising and setting are 5h. 47m. and 20h. 09m., respectively. The planet attains its greatest easterly elongation on March 26. Venus is a very conspicuous object in the western sky and is well placed for observation, setting at 21h. 54m. and 21h. 04m. at the beginning and the end of the month, respectively. Venus attains its greatest brilliancy on March 10. Mars, a morning star, is too close to the sun for favourable observation. Jupiter moves from the constellation of Virgo into the constellation of Leo during March, and can be seen throughout the night, setting at 7h. 26m. and 5h. 17m. on March 1 and March 31. The planet is in opposition to the sun on March 13. Saturn, in the constellation of Gemini, sets at 3h. 47m. and 1h. 53m. on March 1 and March 31, and is stationary on March 5. Vernal equinox is on March 21d. 00h.

Announcements

THE Committee of the Athenæum has elected the following, under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services: Prof. Sydney Chapman, chief professor of mathematics, University of London; Sir Reginald Coupland, Beit professor of Colonial history, University of Oxford; Sir George Stapledon, director of the Grassland Improvement Station, Ministry of Agriculture and Fisheries, Stratford-on-Avon.

DR. T. MCKEOWN has been appointed to the chair of social medicine in the University of Birmingham. Dr. McKeown, a former Rhodes scholar, has been demonstrator in biochemistry at McGill University, Poulton research scholar and demonstrator in physiology at Guy's Hospital, London, and research worker in charge of Field Social and Economic Survey, Research and Experiments Department, Ministry of Home Security.

THE Board of the Institute of Physics has authorized the formation of a South Wales Branch of the Institute which is to be centred at Swansea. The inaugural meeting of the Branch will take place at 2.30 p.m. on March 10 in the Physics Department of University College, Swansea, when Dr. C. Sykes, principal of the Brown-Firth Research Laboratories, Sheffield, will deliver an illustrated lecture on "Physics in Metallurgy". Visitors will be welcome; admission is free and without ticket. Further particulars of the Branch can be obtained from the Acting Honorary Secretary, Dr. T. V. I. Starkey, Technical College, Mount Pleasant, Swansea.

UNDER the title of "Medical Miscellany List K", Schuman's, of 20 East 70th Street, New York, has recently published an annotated catalogue of more than seven hundred items on various medical subjects and an appendix with more than a hundred and fifty early American inaugural theses. While all branches of medicine are represented, the subjects chiefly dealt with are anatomy, biography, epidemiology, materia medica, history of medicine, neurology and psychiatry, pathology, physiology, surgery and therapeutics. Special mention may be made of the following books: Charles Etienne's work on anatomy (1545), a French translation of Fracastorius' poem on syphilis (1753), Stephen Hales' "Statical Essays" (1731), Florence Nightingale's "Notes on Nursing" (1860) and Allwoerden's "Life of Servetus" (1728).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Ageing of Light

RED-SHIFTS in the spectra of the galaxies are usually interpreted as Doppler effects consequent on recession. Alternatively, they have been interpreted as an 'ageing' of light with time, by which the wave-length of a photon steadily increases. That the two interpretations are substantially equivalent can be seen from the following strikingly simple calculation. I adopt the kinematic model of the expanding universe.

Suppose a photon has left our own galaxy at epoch t_1, when its frequency was ν_1, and has adventured into intergalactic space. In due course it may encounter one of the receding galaxies and be scattered or reflected. I consider only the case of direct reflexion back to ourselves. Let this photon be reflected after traversing a fraction f of the radius of the universe measured at the instant of reflexion; that is, let it be reflected at epoch t_2 when the radius of the universe is ct_2 and the distance of the reflecting galaxy fct_2. Then, since the speed of the photon is c, we have

$$t_2 = t_1 + fct_2/c = t_1 + ft_2,$$

or

$$t_2 = t_1/(1-f);$$

and the photon arrives back at our own galaxy at epoch t_3, where

$$t_3 = t_2 + ft_2 = t_1\frac{1+f}{1-f}.$$

It is then either reflected outwards again or propagated through our galaxy unimpeded. In either case it suffers no change of frequency at our own galaxy, but moves out again into intergalactic space, there to be eventually reflected back to us, and so on. After n such external reflexions back to us, it reaches us at epoch t_{2n+1}, given by

$$t_{2n+1} = t_1\left(\frac{1+f}{1-f}\right)^n;$$

for, as is easily shown, the fraction f measuring the mean free path will be the same at all epochs.

At the first external reflexion, the frequency ν_1 is reduced by the *square* of the usual Doppler factor

$$\left(\frac{1-v/c}{1+v/c}\right)^{1/2},$$

once because of its absorption by the receding galaxy and once because of its re-emission by the same galaxy. Here v, the recession velocity, is by the velocity distance law $fct_2/t_2 = fc$. Hence the frequency is reduced to

$$\nu_1\left(\frac{1-f}{1+f}\right).$$

After n such external reflexions, its frequency is reduced to

$$\nu_1\left(\frac{1-f}{1+f}\right)^n.$$

If now we call ν_0 its present frequency, t_0 our present epoch, we can write these results in the form

$$\nu_0 = \nu_1\left(\frac{1-f}{1+f}\right)^n,\ t_0 = t_1\left(\frac{1+f}{1-f}\right)^n.$$

Hence $\nu_0/\nu_1 = t_1/t_0$ or $\lambda_0/\lambda_1 = t_0/t_1$.

Thus the wave-length of the photon is proportional to the epoch at which it is observed, independent of the value of its mean free path.

If we now pursue the history of the photon *backwards* in time, we see that as $t_1 \to 0$, $\nu_1 \to \infty$. Thus at the epoch of 'creation', $t = 0$, there is a singularity in photon-frequency. This is an inevitable converse of the phenomenon of the ageing of light with time. The result is in accordance with the views, put forward on other grounds, recently reached by Prof. J. B. S. Haldane[1].

This result is compatible with the reception by ourselves of *all* frequencies at the present epoch, including the very high frequencies of the undulatory components of cosmic rays. It is thus possible that high-frequency cosmic rays are relics of the primitive high-frequency radiation.

E. A. MILNE.

Wadham College,
Oxford. Feb. 6.

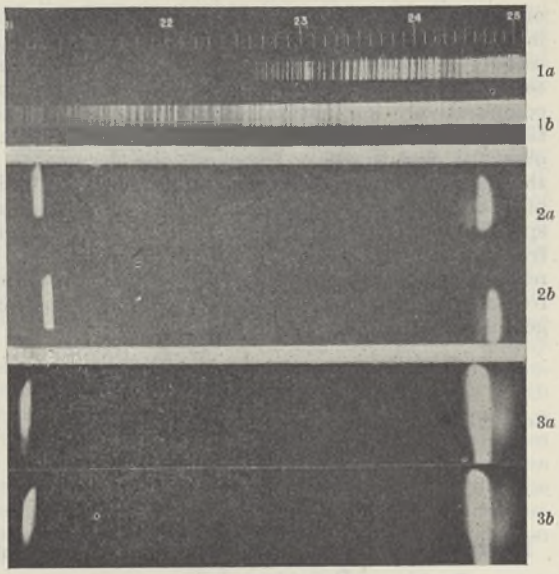
[1] *Nature*, **155**, 133 (1945).

Dynamic X-Ray Reflexions in Diamond

As was first shown by Raman and Nilakantan[1,2,3], the (111) crystal planes in diamond exhibit sharply defined reflexions of monochromatic X-rays incident on them which are distinct from the well-known Laue and Bragg effects. The same authors[3] showed that the positions of these reflexions are in perfect accord with the Raman-Nath formula derived on the basis that they arise from the quantum mechanically excited infra-red vibrations of the crystal lattice.

It has been claimed by Dr. Kathleen Lonsdale[4] that the reflexions the positions of which are given by the Raman-Nath formula are not exhibited by the kind of diamonds which are transparent to the ultra-violet up to 2250 A. To check this claim we have carried out a series of studies with a number of cleavage plates of diamond of this variety, with the result that Mrs. Lonsdale's findings are *not* confirmed. Our experiments were made with half a dozen different specimens, and we find no difficulty in recording the reflexions sought for with every one of them by giving adequate exposures. The real test whether the recorded effects are those being looked for is the dependence of their intensity on temperature. A thorough examination of this was carried out with one of our specimens (N.C. 125) over a wide range of temperatures, namely, from liquid air temperature upwards to 600° C., and over a variety of settings of the crystal. Microphotometric investigations showed no noticeable change of intensity as between 30° C. and − 187° C., while there is approximately a 5 per cent increase in going up to 300° C., and about 15 per cent in going up to 600° C. These changes are in accord with the theoretical formula given by Sir C. V. Raman, if we assume that the frequency change involved in the dynamic reflexion is that of the fundamental vibration of the lattice, 1332 cm.$^{-1}$ in spectroscopic units. These results are illustrated by the accompanying photographs.

The appearance of sharply defined and intense X-ray reflexions of the dynamic kind can only be expected if the vibrations of the lattice have coherent phase relationship over a great many crystal spacings, and this in its turn evidently requires a high degree of crystal perfection. The investigations on diamond by Sir C. V. Raman and others at Bangalore have



1*a*: ABSORPTION SPECTRUM OF DIAMOND (N.C. 125).

1*b*: SPECTRUM OF THE IRON ARC.

2*a* and 2*b*: PHOTOGRAPHS OF THE LAUE AND DYNAMIC (111) X-RAY REFLEXIONS WITH THE DIAMOND AT 600° C. AND AT ROOM TEMPERATURE RESPECTIVELY.

3*a* AND 3*b*: SIMILAR PHOTOGRAPHS TAKEN WITH THE DIAMOND AT ROOM TEMPERATURE AND AT LIQUID AIR TEMPERATURE RESPECTIVELY.

shown conclusively that the diamonds, which are throughout of the ultra-violet opaque type[5,6], possess a high degree of crystal perfection. On the other hand, diamonds of the ultra-violet transparent type have a variable crystal spacing[7], accompanied by a pronounced lamellar birefringence. It is not surprising, therefore, that the dynamic X-ray reflexions given by this type of diamond do not exhibit the same sharpness and intensity as those given by diamonds of the ultra-violet opaque kind. Indeed, even the Laue reflexions given by these diamonds often show obvious irregularities. The fact that only the most intense of the three quantum reflexions indicated by the Raman-Nath formula is observed with diamonds of the ultra-violet transparent type is also readily intelligible when the above considerations are taken into account. We have further verified that, within the limits of the error set by the imperfection of the observed reflexions, their positions agree with those given by the Raman-Nath formula.

The objections which Mrs. Lonsdale has raised against the interpretation of the X-ray reflexions observed with diamond given by the Bangalore workers are thus believed to be without experimental foundation.

R. S. KRISHNAN.
G. N. RAMACHANDRAN.

Physics Department,
Indian Institute of Science,
Bangalore.
Jan. 5.

[1] Raman, C. V., and Nilakantan, P., *Curr. Sci.*, **9**, 165 (1940).
[2] Raman, C. V., *Proc. Ind. Acad. Sci.*, A, **14**, 317, 332 (1941). Raman, C. V., and Nilakantan, P., *Proc. Ind. Acad. Sci.*, A, **14**, 356 (1941).
[3] Raman, C. V., and Nilakantan, P., *Nature*, **147**, 118 (1941).
[4] Lonsdale, K., *Proc. Roy. Soc.*, A, **179**, 315 (1942).
[5] Raman, C. V., and Rendall, G. R., *Proc. Ind. Acad. Sci.*, A, **19**, 265 (1944).
[6] Ramachandran, G. N., *Proc. Ind. Acad. Sci.*, **20**, 245 (1944).
[7] Krishnan, R. S., *Proc. Ind. Acad. Sci.*, **19**, 298 (1944).

Thermomechanical Effect in Liquid Helium II

THE peculiar properties of liquid helium II have been the subject of many experimental and theoretical investigations during recent years. The characteristic features of liquid helium II are its superfluidity (viscosity less than one billionth of that of water) and the thermomechanical effect. The superfluidity has been explained by F. London[1] and L. Tisza[2] by assuming helium II to be in a state of Bose-Einstein degeneracy, a part of the atoms constituting the condensed phase. In a previous communication[3], I have given a theory of the surface-flow of liquid helium II in the form of thin mobile films, and my purpose now is to discuss the thermomechanical effect in helium II assuming the latter to be in the state of Bose-Einstein degeneracy.

Landau[4] has given a different theory based on the model of a 'quantum liquid'. H. London[5] has given a thermodynamical discussion of the thermomechanical effect and has shown (taking the London–Tisza model of helium II) that

$$(dp/dt)_{\max.} < J\rho\varphi,$$

where φ is the entropy in cal. per gm., J is the mechanical equivalent of heat and $(dp/dt)_{\max.}$ is an upper limit to the reaction pressure per degree. The expression for the thermomechanical effect can also be obtained as follows:

The pressure and energy per unit volume in a Bose-Einstein degenerate gas are connected by the relation

$$p = C\Gamma(S)\zeta(S+1)(kT)^{S+1} = \frac{E}{SV} \quad . \quad . \quad (1)$$

S is defined by the equation

$$N(\varepsilon)d\varepsilon = \frac{VC\varepsilon^{S-1}\,d\varepsilon}{1/A.e^{C/kT} - 1} \quad . \quad . \quad . \quad (2)$$

$N(\varepsilon)d\varepsilon$ denotes the number of particles having kinetic energies between ε and $\varepsilon + d\varepsilon$.

As remarked by H. London, S is to be taken equal to 5 in order that the observed discontinuity in the (constant volume) specific heat at the λ-point may agree with the theoretical value.

From (1) we have

$$\frac{(dp)}{(dt)} = \frac{1}{S}\frac{d(E/V)}{dt} = \frac{\rho C_v}{S} \quad . \quad . \quad . \quad (3)$$

where C_v is the specific heat at constant volume (per unit mass). The above relation is roughly in accord with observations. For temperatures 1·393° K. and 1·241° K., C_v is equal to 0·311 and 0·174 respectively.

Thus we have for (dp/dt) at 1·393° K. and 1·24° K., the values $3{\cdot}65 \times 10^5$ and $2{\cdot}04 \times 10^5$, which may be compared with the observed values $1{\cdot}7 \times 10^5$ and $0{\cdot}6 \times 10^5$ respectively, corresponding to the temperatures given above.

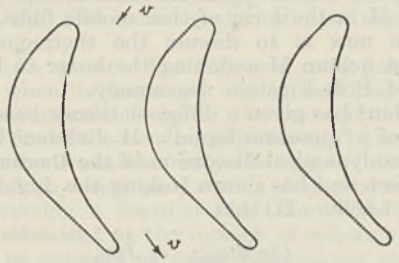
D. V. GOGATE.

Baroda College,
Baroda.
Dec. 17.

[1] London, F., *Phys. Rev.*, **54**, 947 (1938).
[2] Tisza, *Nature*, **141**, 913 (1938).
[3] Gogate and Rai, *Nature*, **153**, 342 (1944)
[4] Landau, L., *Phys. Rev.*, **60**, 356 (1941).
[5] London, H., *Proc. Roy. Soc.*, A, **171**, 484 (1939).

'Singing' Corner Vanes

'SINGING' in wind tunnels has been observed from time to time, and we recently had the opportunity of making a study of the phenomenon in the wind tunnel of the Aeronautical Department at the University of Sydney. This tunnel is of concrete construction, has an enclosed working section, and the aerodynamic design is conventional. The corner vanes are of the constant-width annulus type and are cast in concrete with reinforcing iron rods. The cross-section and spacing are shown in the accompanying figure.



In all, seven notes were observed, and all but one of these were investigated in detail. The table lists the various notes, their origin and relevant experimental conditions. In each case, the note has a maximum intensity in the centre of the space between the cascades, where there is a strong chordwise standing wave. This standing wave is excited by either torsional or flexural vibration of the turning vanes and maintained by the alternate shedding of eddies from the trailing edges of the vanes. The phase of oscillation of alternate vanes differs by π, and the air-space oscillations are similarly related.

Note frequency (n) c.p.s.	Corner	Length of vane (l)	Air speed at corner (v)	$\frac{nc}{v}$	Elastic vibration	$\frac{nl}{\text{partial order}}$	$\frac{nl^2}{a^*}$
246	1st	7 ft.	37 f.p.s.	11·5	Torsional (fundamental)	1720	—
298	1st	7	45	11·4	Flexural (fundamental)	—	651
257	2nd	8	38	11·7	,,	—	734
420	1st	7	64	11·4	Torsional (2nd partial)	1470	—
251	3rd	12	38	11·4	,,	1510	—
249	4th	14	33	13·2	,,	1740	—
280	3rd ?	12	44	11·0	Flexural (2nd partial)	—	655

*a = 22·4, 1st partial; = 61·6, 2nd partial.

That all vibrations are excited by eddies is confirmed by the constancy of the quantity nc/v, where c is the chord. The determination of the type of elastic vibration (see column 6) is made on the basis of the rough agreement with the theoretical variation of frequency with length and harmonic order, as exhibited in column 7 for torsional, and in column 8 for flexural vibrations. From the observed pattern of the sound field of the sixth note, it is certain that in this case the vanes are vibrating with a central node.

It is considered that the oscillations are due to energy transfer in the cycle: mechanical oscillation → air space standing wave → regular shedding of large eddies → forces to maintain mechanical oscillation. This cycle is made possible by the closeness of the natural frequencies of the air column between the vanes to the natural frequencies of vibration of the vanes. The comparative rarity of this phenomenon is attributed to the high damping and natural frequency of the types of vanes more usually employed. Heavy concrete vanes with ends set into concrete walls have very low damping and comparatively low natural frequencies, and calculations of natural frequencies agree roughly with the observed frequencies. In short, the occurrence of the tones is due to a fortuitous approximate equality of the resonant frequencies of the chordwise air spaces between the corner vanes, and the natural frequencies of these vanes. In this connexion, it is to be noted that speeds in the range 35–44 f.p.s. are critical for exciting the air resonance, for these and any geometrically similar corner vanes.

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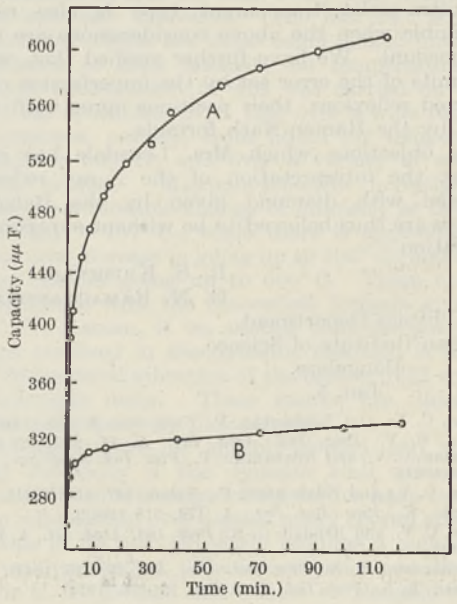
Dec. 19.

Thixotropy and Dielectric Constant of Printing Inks

INVESTIGATING the electric properties of printing inks, it was observed that the dielectric constant of an ink depends on the time it stands undisturbed in the measuring condenser. For dielectric constant determinations a commercial Philips measuring bridge, a Philoscope, was used at frequencies 50 H and 1,000 H. The polarization capacity and the polarization resistance could not be measured.

The condenser was of ordinary cup-form, the diameter being 80 mm. for the cup and 70 mm. for the lid. Two condensers were used—one of iron and another of aluminium, with air capacity of 33 and 41 $\mu\mu$F respectively. No influence of the material of the condenser on the dielectric constant of printing ink was observed.

After filling the space between electrodes with printing ink and moving the lid it was possible to bring the capacity to definite and reproducible values. The capacity increased on ceasing the movement. The time-capacity curve following the first disturb-



ance lies highest, higher than those for the second and following disturbances. But if after several disturbances the ink in the condenser is left to stand overnight, the previous day's disturbance-time-capacity curves can be reproduced.

Two curves for a frequency 1,000 H are represented in the accompanying figure. The ink corresponding to curve *A* contained 14·2 per cent I–G carbon LT and had as a vehicle a varnish with a viscosity of 562 cp. at 25° C. The ink corresponding to curve *B* contained 12·4 per cent of the same carbon, the viscosity of the varnish being 886 cp. at 25° C. Ink *A* was much more thixotropic than ink *B*; its viscosity yield-value was 1·75 times the yield-value of ink *B* in a Couette type viscosimeter. Viscosity measurements with a viscosimeter of the type described by C. F. Goodeve[1] in combination with simultaneous dielectric constant measurements on a precision bridge would enable thixotropic properties to be related to the dielectric constant – time curve, and would make it possible to investigate the phenomenon more thoroughly. I am unable at present, however, to undertake such an investigation for lack of apparatus and funds.

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Stockholm.
Dec. 9.

[1] *J. Sci. Instr.*, 16, 19 (1939).

Molecular Weight of Palmer's β-Lactoglobulin

PEDERSEN[1] made a thorough study, in the electrophoresis apparatus and the ultracentrifuge, of β-lactoglobulin (Palmer[2]). He found that it was a homogeneous protein of molecular weight 38,000 by sedimentation equilibrium and 41,500 by diffusion measurements[3]. Neurath and Cooper, from diffusion and viscosity measurements, quote values of 43,300 and 33,700, depending on the molecular shape. From the X-ray point of view, the limitation in the accuracy of determination of the molecular weight is the estimation of the water content of the air-dried crystal. McMeekin and Warner[4] derived a figure of 35,800 from their measurements of the mean water content and the crystallographic data of Crowfoot and Riley[5]. However, if their lowest value for the water content is used, the molecular weight is increased to 37,200. As the osmotic pressure of β-lactoglobulin solutions has not hitherto been recorded, I have now made some measurements of it.

The sample of protein, kindly supplied by Dr. A. Neuberger, had been prepared and recrystallized three times by the method of Palmer[2]. It was found to be homogeneous in the Tiselius electrophoresis apparatus. For the osmotic pressure measurements the following buffer (*p*H 5·4) was used as solvent: 0·2 *M* NaCl; 0·001 *M* Na_2HPO_4; 0·019 *M* KH_2PO_4. The amount of protein in solution was calculated from the nitrogen content, using the micro-Kjeldahl procedure and nitrogen figures of Chibnall *et al.*[6].

The osmotic pressure measurements and calculations were carried out as described in a previous note[7]. The accompanying table shows the osmotic pressure at 0°, the concentration in grams of dry protein per 100 c.c. of solvent and the molecular weight for a series of experiments. From these data the calculated mean molecular weight is 38,000, with a standard error of 900 and a mean deviation of 700, which is in good agreement with Pedersen's value obtained from sedimentation equilibrium experiments.

Concentration of dry protein (gm. per 100 c.c. solvent)	Osmotic pressure (mm. mercury)	Mol. weight
1·01	4·41	39000
1·085	4·78	38600
1·21	5·297	38950
1·26	5·74	37400
1·732	7·753	38050
2·485	10·91	38800
2·963	13·61	37100
2·963	13·46	37550
4·72	20·73	38800
6·50	30·30	36500

HERBERT GUTFREUND.

Biochemical Laboratory,
Cambridge.
Jan. 4.

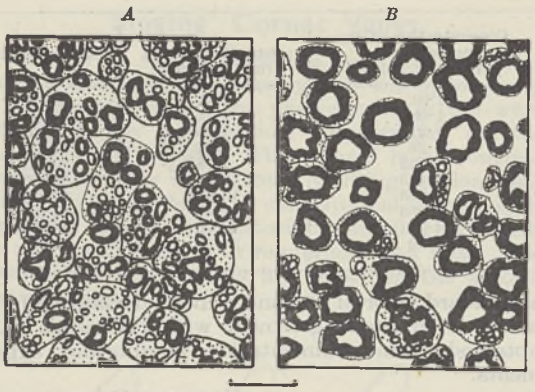
[1] Pedersen, *Biochem. J.*, 30, 961 (1936).
[2] Palmer, *J. Biol. Chem.*, 104, 359 (1934).
[3] Svedberg and Pedersen, "The Ultracentrifuge" (Oxford Univ. Press, 1940).
[4] McMeekin and Warner, *J. Amer. Chem. Soc.*, 64, 2393 (1942).
[5] Crowfoot and Riley, *Nature*, 141, 521 (1938).
[6] Chibnall, Rees and Williams, *Biochem. J.*, 37, 354 (1943).
[7] Gutfreund, *Nature*, 153, 406 (1944).

Effect of Peripheral Connexion on the Diameter of Nerve Fibres

IN recent accounts[1,2,3] of the factors which control the size reached by regenerating nerve fibres, the hypothesis has been put forward that the Schwann tubes which replace degenerating nerve fibres in the peripheral stump control the pattern of fibre sizes by the restriction which they impose on increase of diameter. In the absence of such restriction, the diameter which a regenerating fibre attains depends upon the calibre of its parent fibre in the central stump.

As a result of further experiments, it has now become clear that a third factor, namely, the re-establishment of connexion with a muscle or sensory ending, also has a profound influence on the size attained by regenerating fibres. In these new experiments both peroneal nerves of the rabbit were interrupted by crushing high in the thigh. The nerves were also cut at the knee, and on one side the cut stumps were immediately rejoined, so that functional regeneration occurred. On the other side, the lower end of the nerve was turned aside, so that the fibres formed a neuroma, having no connexion with the periphery. The animals were killed 100 or 200 days later. In the nerves which had not been allowed to make connexion with the periphery a large number of small medullated fibres was found, usually several in each of the Schwann tubes left by degeneration. The nerves which had been allowed to make normal terminal connexions contained fewer and larger fibres. Weiss and Taylor[4] have observed a similar effect; of the two parts into which a regenerating nerve was divided, that which was allowed to become reconnected with the periphery acquired larger fibres.

That length of nerve is not a factor which controls maturation was shown by a second set of experiments. In these the length of nerve to be regenerated was made short on one side of the animal, long on the other. This was done by crushing



SCHWANN TUBES AND FIBRES IN THE PERIPHERY OF CRUSHED NERVES 200 DAYS AFTER OPERATION: (*A*) WHERE THE FIBRES HAVE BEEN PREVENTED FROM MAKING ANY PERIPHERAL CONNEXION; (*B*) WHERE THE FIBRES HAVE BEEN ALLOWED TO INNERVATE A MUSCLE. THE DRAWINGS ARE OF COMPARABLE FIELDS TRACED FROM PHOTOGRAPHS OF WEIGERT PREPARATIONS.

both peroneal nerves at the same level, and lower down, cutting and joining them to the tibial in such a way that on one side the fibres were made to grow to twice their normal length. In spite of the different lengths regenerated, the fibres at a standard level below the crushed points on the two sides were found to be of similar diameter when examined 100 or 200 days after operation.

Evidently, therefore, it was the connexion with an end organ which influenced the size attained by the nerve fibres in the first experiment. When a nerve is crushed, many new fibres grow out down each of the tubes in the peripheral stump. Presumably, if one of these connects with an end organ, it hypertrophies at the expense of the others in the same tube. If no peripheral connexion is made, many begin to medullate, but none becomes large.

Such an influence of the end-organ on the nerve is probably of great importance in development as well as in regeneration, in ensuring that the nerve fibres shall come to have appropriate diameters. But the exact way in which the influence is exercised remains to be discovered; we do not know whether it depends merely upon connexion of the fibres with an end-organ, or upon the actual resumption of function by the system.

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[1] Gutmann, E., and Sanders, F. K., *J. Physiol.*, **101**, 4, 489 (1943).
[2] Sanders, F. K., and Young, J. Z., *J. Physiol.*, **103**, 1, 119 (1944).
[3] Simpson, S. A., and Young, J. Z., *J. Anat.* (*Lond.*) (in the press).
[4] Weiss, P., and Taylor, A. C., *J. exp. Zool.*, **95**, 2, 233 (1944).

Effects of Constant Current in Relation to 'Functional Polarity'

WHEREAS the effect of constant currents on the peripheral nerve has been thoroughly investigated, very little work has been done on the effects of such currents on the central nervous system. However, during the last few years, a number of papers has been published by Scheminzky and his co-workers. They found that the effect of passing a constant current through a frog depended on the direction of the current. While a descending current (that is, in the head-to-foot direction) produced paralysis (galvano-narcosis), an ascending current produced convulsions. Scheminzky thought that it was impossible to explain this phenomenon in any other way than by a 'functional polarity', involving an assumption that the whole of the central nervous system is built up of a series of polarized elements, succeeding each other along the axis of the system. He claims to have discovered "a new law of the general physiology of the central nervous system"—a law which would be rather difficult to understand.

To elucidate this problem, we at first investigated the effect of constant currents on a single centre, namely, the respiratory centre of the frog. If one electrode is put on the bulb, and the other at some point lower down on the spinal cord, a reduction of the depth and frequency of respiration is generally produced when a current of several tenths of a milliampere is passed in descending direction. An ascending current produces just the opposite effect. This evidently resembles Scheminzky's experimental results. But it is easy to demonstrate that the observed effect has nothing to do with the direction of the current; on the contrary, it depends exclusively upon the electrical charge applied to the respiratory centre. The excitatory effect of the cathode and the depressing effect of the anode on the centre remain unchanged if the second electrode is removed from the spinal cord and put on the brain, so that the direction of the current is reversed. The effect also remains the same if the second electrode is put somewhere outside the central nervous system, for example, on the foreleg.

This fact having been firmly established, Scheminzky's observation was followed up with the same point of view in mind. We found that if one electrode is put on the spinal cord and the second electrode outside the central nervous system, the cathode on the spinal cord produced convulsions while the anode did not. A reversal of the Scheminzky phenomenon was not so easy to produce as in the respiratory centre, but finally we found a way to demonstrate it here too. The effect of the current does not, of course, depend upon the place where the electrode (the end of the physical conductor) is applied; it depends on the place where the current enters or leaves the tissues to be affected, the physiological electrode. If, for example, one electrode is put on the head of the animal and the other near the cloaca, the effect on the lower extremities is usually unchanged after cutting the spinal cord, because cutting does not mean anything other than moving the physiological electrode from the brain to the place of section of the spinal cord. Now, after extirpation of a small segment of the spinal cord, if one electrode is placed, as before, on the head, and the second electrode is put on the cut surface of the lower part of the spinal cord, a perfect reversal of the Scheminzky phenomenon can be obtained: with a descending current (cathode on the spinal cord), convulsion was produced, which did not occur with an ascending current (anode on the spinal cord).

In this way Scheminzky's observation is reduced to the well-known catelectrotonic increase and anelectrotonic decrease of nervous excitability, and the stimulating effect of the cathode and the paralysing effect of the anode. The only question to be resolved was why a current passing in one direction (descending) should produce the anodic effect, and in the opposite direction (ascending) the cathodic effect. This behaviour may be explained by another well-known fac., namely, the dependence of the lower

spinal centres upon the higher ones. We know that after elimination by cutting or simply by cooling of the higher (that is to say, upper) centres, for some time at least, the lower centres may be paralysed. So, if the brain and upper centres are nearer to the anode (descending current), their anelectrotonic elimination has a paralysing effect, while their catelectrotonic excitation with an ascending current produced convulsions.

The explanation of Scheminzky's observations, therefore, needs no 'functional polarity', the existence of which is directly contradicted and refuted by the reversal demonstrated in our experiments.

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Changes in the Red Blood Cells in Chronic Infections

THE anæmias of chronic infection have not been elucidated in spite of the frequency of their occurrence. An investigation was undertaken to study the changes in the red cells in these conditions.

The following results were obtained. The red cell count is usually reduced to only a small extent. The hæmoglobin reduction is relatively greater.

In a few cases a high colour index anæmia exists. In most the colour index is either normal or reduced. Analysis of the detailed characters of the red cells shows that there is a marked tendency to increase in the erythrocyte volume and diameter. The thickness of the cells, on the other hand, tends to remain within normal limits, the cells therefore being flat. Associated with this the red cells are resistant to hypotonic saline hæmolysis, and target cells are seen in blood smears in increased numbers.

The individual red cell has been shown to be hypochromic.

The absence of features suggesting excessive hæmolysis of the red cells is confirmed.

The bone marrow function appears to be reduced in respect of erythropoietic function.

The anæmia of chronic infection is therefore dimorphic, that is, there is evidence of two factors at work, one causing hypochromia and another causing increase in the volume and diameter of the cells. The macrocytosis can be related to the defective liver function demonstrated in these cases. The hypochromia is due to defective utilization of iron by the depressed bone marrow.

The level of the anæmia shows a remarkable tendency to be fixed in chronic infections. This has been attributed to the setting of the bone marrow at a new low level by the products of inflammation absorbed from the infected area.

By analogy with cases of non-hæmolytic jaundice studied at the same time, it is suggested that some of the features of the red cells in the anæmias of chronic infections are due to disturbance of the normal effect of the spleen on circulating red blood cells. The anæmia of chronic infection, therefore, may be interpreted as a toxic dimorphic dyshæmopoietic anæmia with hyposplenism.

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A Crystalline Serum Muco-Protein with High Choline-Esterase Activity

IN a recent communication under the above title, we mentioned that "it appears to be an undecided question whether choline-esterases from different tissues, such as blood and brain, are identical"[1]. This cautious statement has caused Mendel, Rudney and Strelitz to say[2] that "it has definitely been established that choline-esterases from different tissues are not identical", and that they have "conclusively demonstrated" the existence of two distinct choline-esterases.

While we were aware of the work of Mendel, Rudney and Strelitz, and agree that their claims may well be correct, we felt that in the present state of knowledge of this enzyme (enzymes) it seems premature to speak of them as having been "definitely established". We might recall that no electrophoretic or closer elementary analysis has yet been reported. Moreover, kinetic studies like, for example, those of Northrop on pepsin, and a study on an eventual shift of the *p*H-optimum in presence of different ions, appear to be necessary before such definite conclusions can be drawn. Recollections of the analysis of well-known problems like the high rennin activity of crystalline pepsin, linked with elementary analysis of both rennin and pepsin preparations, the diaphorase activity of xanthine oxidase, the identity of xanthine oxidase with aldehyde oxidase, etc., make us hesitate to claim so much as Mendel *et al.*

Mendel, Rudney and Strelitz raise another point in their communication which, however, has little or no connexion with the question of the identity of the choline-esterases of brain and serum. They reported earlier the isolation of an extremely active preparation (non-crystalline) of serum choline-esterase, while we reported a less active preparation (crystalline) from the same source. Although, as can be seen from our title, we never claimed to have obtained crystalline serum choline-esterase, they argue that in comparison with their product our preparation is grossly impure. Here again we are inclined to see things more from the point of view of the many established facts which are known from enzyme studies. Crystalline enzymes, even those regarded as pure, are often less active than non-crystalline preparations (for example, Sumner's crystalline catalase and Agner's preparation); for loss of activity is often due to a more efficient removal of certain essential activators. The classical work of Sumner *et al.* showed how the presence of different ions (acetate, citrate and phosphate), as well as different substrate concentrations, were capable of shifting the *p*H-optimum of crystalline urease considerably, so that one and the same enzyme preparation, under slightly different conditions, but at the same *p*H and substrate concentration, showed a difference of activity as great as 70 per cent or more. At *p*H 7·5, for example, crystalline urease is at its optimal activity using phosphate buffers; whereas with acetate buffers its activity is down to approximately 15 per cent.

It seems premature, as Mendel *et al.* have attempted, to calculate how much "inert material" our crystalline preparation contains. All the more, because none of the essential characteristics of the preparations of Mendel *et al.* or ourselves (for example, *p*H-optimum influence of different ions, etc.) was available to make a calculation of this sort possible. These characteristics, as shown by the example of crystalline urease,

can account for very great discrepancies in activity. Incidentally, we are at a loss to see any 'controversy' (a term used by Mendel *et al.*); at best there is a discrepancy, the clearing up of which will have to await the determination of the aforementioned essential characteristics.

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[1] Bader, R., Schütz, F., and Stacey, M., *Nature*, **154**. 183 (1944).
[2] Mendel, B., Rudney, H., and Strelitz, F., *Nature*, **154**, 737 (1944).

Acceleration of Reproduction in Terrestrial Isopoda

MR. A. E. NEEDHAM, in one of his valuable contributions to the micro-anatomy of the Isopoda, remarks[1], "Stimulation of an ovigerous female in the region of the anterior opening of the brood pouch causes premature release of the brood and is elicited with increasing facility as incubation approaches full term".

I was greatly interested in this statement as I have accelerated reproduction in *Armadillidium vulgare* (Latr.) and several other species[2] by keeping them in a temperature slightly higher than that prevailing out of doors. Dr. H. W. Howard has obtained similar results[3].

The duration of the embryonic and larval periods seems, according to different observers, to differ greatly. Pierce[4] writes, "The period of incubation in this species [*Armadillidium vulgare* (Latr.)] is long, between fifty-six and ninety-three days, according to the varying results obtained. As no individuals were secured in copula, the exact time of its duration was not recorded. The development of the eggs may be watched from the exterior. The females should be treated very carefully."

Dr. H. W. Howard, who has had exceptional experience in the breeding of this species in connexion with his valuable work on its genetics, sends me (*in litt.*, Nov. 29, 1944) a long series of records which show the minimum period of incubation to be 39 days; the next lowest is 44 days, and the maximum 78 days, the average of the whole series being about 57 days.

Heeley[5] states, "In *A. vulgare* . . . the embryonic development is short, whilst the larval development is relatively long". He gives the average of the embryonic period as 33 days and that of the larval period as 8 days, both of which surprise me, differing as they do so strikingly from the figures obtained by Pierce, Howard and myself.

Under normal conditions (indoors) the shortest periods I have obtained are 44 + 10 days. Howard's lowest records are 39 days and 44 days.

The figures for twenty-four broods I have bred are as follows:

Number of broods	Average embryonic period (days)	Average larval period (days)	Total incubation period (days)
One	44	10	54
Four	46	12	58
One	48	12	60
Two	46	12	58
Four	48	12	60
Six	49	12	61
Three	52	10	62
Three	58	10	68

These figures refer to the shortest periods, others have exceeded by 10 to 16 days.

The idea of stimulation was quite new to me; I therefore made the following experiments. Some specimens of *Armadillidium vulgare* var. *rufobrunneus* Cllge. were observed on October 1 to have formed brood pouches and on October 8 tiny eggs could be seen within. Taking a specimen between my finger and thumb on October 10, I very gently stroked the brood pouch with a very fine, small camel-hair brush. This was repeated on October 13, 15, 18 and 22. The egg membranes were burst on November 8, making a total number of 31 days for the embryonic period. The larval period occupied 8 days, making a total of 39 days for the incubation period. In a control experiment the embryonic period was 30 days and the larval period 8 days.

Only once have I obtained a brood in 54 days; the average of a long series being 64 days.

An examination of many of the newly liberated specimens showed them to be normal in every way and of the average size.

There was a very noticeable change in the size and appearance of the eggs after the third stimulation in both series.

Under normal conditions, my experience is that the embryos of this species develop very slowly during the first fourteen or fifteen days. The most rapid changes are those made during the last fourteen days before the young leave the eggs.

To what extent stimulation might be applied in other groups of animals, without any deterioration of the young, is a subject well worthy of further investigation.

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[1] *Quart. J. Micro. Sci.*, **84**, 59 (1942).
[2] *N.W. Nat.*, in the press.
[3] *N.W. Nat.*, in the press.
[4] U.S. Dept. Agric., Bur. Entom., No. 64, Part 2 (1907).
[5] *Proc. Zool. Soc. Lond.*, B, iii, 98 (1941).

Survival of *Fasciola hepatica* L. *in vitro*

No systematic attempts at culturing this liver fluke *in vitro* have yet been made. The survival times in published accounts are very short, and physiological work on such short-lived organisms is highly suspect. Ordinary Ringer solutions were used, and the flukes lived from 5 to 12 hr.[1,2,3,4].

In the present work, which is preliminary to the study of the respiratory metabolism, a series of saline solutions were used, and the following results obtained: (1) Borates prolong survival, presumably by control of bacteria. Other controlling agents are either toxic to the worm (acriflavein, merthiolate, silver protein) or have no effect on survival times (sulphanilamide). (2) The optimum *p*H is 8·1–8·5, the optimum temperature 36° C. (3) Wide variations in osmotic pressure, K/Na ratio, and Ca/Na ratio have little effect on survival. (4) The presence of bile salt or peptone has virtually no effect. This is probably because of an increased bacterial flora, which borax and sulphanilamide are incapable of controlling. (5) Sugars increase survival times in the following order: fructose > glucose > galactose = maltose > lactose = sucrose. Disaccharides are thus less effective than monosaccharides, and are evidently not broken down to monosaccharides by enzyme action. Probably they are not reaching the worm's gut. (6) Ligatured worms in glucose survive essentially as long as unligatured controls. This suggests that glucose can enter through the body wall.

Flukes can be kept alive for 60 hours at 36° C. in the following solution: NaCl 150 mM., KCl 10 mM., $CaCl_2$ 1 mM., borax 6 mM., glucose 30 mM., *p*H 8·6. Survival times can be further increased by using fructose instead of glucose, and by the addition of 1/5,000 trypan blue[5], but the medium as stated is simpler and cheaper, and thus more suitable for large-scale work. A survival time of 60 hours, although disappointing, is a considerable advance upon previous records, and is adequate for preliminary tests of the effects of anthelmintics *in vitro*. Certain of these tests have been carried out, and it has been shown that carbon tetrachloride, probably the most effective anthelmintic *in vivo*, is innocuous *in vitro*.

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[1] Müller, *Zool. Anz.*, **57**, 273 (1923).
[2] Weinland and von Brand, *Z. vergl. Physiol.*, **4**, 212 (1926).
[3] Flury and Léeb, *Klin. Woch.*, **5**, 2054 (1926).
[4] Harnish, *Z. vergl. Physiol.*, 17, 365 (1932).
[5] Chu, *Chin. Med. J.*, **54**, 409 (1938).

Control of Red Spider Mites

SINCE the discovery in 1936 of its insecticidal properties, 2 : 4 dinitro-6-cyclohexylphenol[1] has been widely used in the United States for the control of tetranychid mites. Successful control has been obtained of *Paratetranychus citri* (McG.)[2,3] and of *Tetranychus telarius* (L.) on citrus, cotton[4] and hops[5]; on all these crops damage by red spider is of considerable economic importance, and this substance is the only synthetic compound which has been successfully applied to control on a large scale. It is of interest that 4 : 4′ dichloro-diphenyl-βββ-trichloroethane (D.D.T.) is of no use as an acaricide. Later work has established that the phytocidal effect of dinitro-*ortho*-cyclohexylphenol can be diminished by use of its dicyclohexylamine salt without impairing its properties as an insecticide or acaricide.

Experiments recently carried out in the field from this laboratory have established that control of *T. telarius* can be obtained on hops and on greenhouse tomatoes in Great Britain.

The experiments on hops were carried out in Kent in September. Two proprietary dusts and one dust using kaolin as filler were used; all three dusts contained 1 per cent of 2 : 4 dinitro-6-cyclohexylphenol as the dicyclohexylamine salt, and ⅓ lb. was applied to each plant. Both were also applied as aqueous suspensions, and the compatibilities with cuprous oxide and copper oxychloride, and of the salt with nicotine were tested.

Treatment	Mites counted	% killed
Dusts		
Proprietary dust *A* } Dicyclohexylamine salt cont.	2100	94·8
,, ,, *B* } 1% 2 : 4 dinitro-6-cyclohexylphenol	1630	94·3
Dicyclohexylamine salt with dinitrocyclohexylphenol with kaolin	1600	82·3
Flowers of sulphur	1780	26·6
Aqueous Suspensions		
0·05% dinitrocyclohexylphenol	2920	98·4
0·025% ,,	4500	97·0
0·025% ,,	1100	96·6
0·025% ,,	685	97·2
0·025% dinitrocyclohexylphenol + 0·5% proprietary cuprous oxide	1600	91·1
0·025% ,, + 0·5% copper oxychloride	1950	95·2
0·025% dicyclohexylamine salt with dinitrocyclohexylphenol	1140	97·9
0·025% ,, ,, +0·037% nicotine	780	93·3
1% Lime sulphur	2130	65·5
Control untreated	1605	9·8

0·025 per cent of the salt as a suspension gave a 96 per cent kill against 65 per cent with a standard lime sulphur used widely by the growers. With the dusts, a 94–95 per cent kill was obtained against 27 per cent with flowers of sulphur.

The mortality was only slightly reduced by the addition of cuprous oxide, copper oxychloride and nicotine.

It was further found that 60–70 per cent of the eggs were killed by application of 0·025 per cent suspensions of the dinitro compound and of its mixture with the dicyclohexylamine salt.

Experiments to compare the use of dinitrocyclohexylphenol and of its mixture with the dicyclohexylamine salt and the ammonium salt of 2 : 4 dinitro-*ortho*-cresol in killing *T. telarius* on greenhouse tomatoes in October, showed up markedly the superior properties of the dicyclohexylamine salt under conditions where plants are liable to be easily damaged. It was found that on tomatoes, satisfactory cover of the foliage could not be obtained without the addition of a wetting agent.

Treatment	Mites counted	% kill	Damage to plants
0·03% dinitrocyclohexylphenyl	109	77·1	Very slight
0·006% ,,	194	87·6	Slight
0·012% ,,	795	88·0	Some severe damage
0·025% ,,	—	—	Plants killed
0·006% ,, with the dicyclohexylamine salt	561	66·3	Slight
0·012% ,, ,, ,,	725	90·1	Slight
0·025% ,, ,, ,,	524	91·0	Slight
0·018% dinitro-*ortho*-cresol	—	—	Plants killed
0·036% ,, ,, ,,	—	20	Plants killed

Ammonium dinitro-*ortho*-cresylate killed the plants completely at dosages too small to be lethal to the red spider mite. 0·025 per cent of dinitrocyclohexylphenol as the salt gave a 91 per cent kill and caused insignificant damage, while the same concentration of the free phenol killed the plants.

Preliminary experiments with *Oligonychus ulmi* Koch on damsons have given similar promising results.

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[1] Kagy, T. B., and Richardson, C. H., *J. Econ. Ent.*, 29, (1), 52 (1936).
[2] Boyce, A. M., *et al.*, *J. Econ. Ent.*, **32**, 432 (1939).
[3] Kagy, J. F., and McCall, G. L., *J. Econ. Ent.*, **34**, 119 (1941).
[4] Isely, D., *J. Econ. Ent.*, **34**, 323 (1941).
[5] Morrison, H. E., and Mote, D. C., *J. Econ. Ent.*, **33**, 614 (1940).

Control of White Rot in Onions

WHITE rot in onions and other *Allium* species has been recorded in many countries and has increased in severity in England during recent years. The disease is caused by the fungus *Sclerotium cepivorum* Berk., which survives for several years as sclerotia in the soil, and is therefore difficult to control by cultural methods. Ogilvie and Hickman[1] obtained satisfactory control by broadcast applications of a proprietary fungicide containing hydroxymercurychlorophenol; but this treatment did not come into general use, possibly on account of the high cost. Apart from this, no direct control method has been recommended.

In trials made during 1943 and 1944, mercurous chloride (calomel) showed promise as a means of controlling white rot in spring-sown onions, var. James' Keeping. The best results were obtained by the

application of 4 per cent calomel dust to the seed drill at the time of sowing. The drills were opened, the dust was applied and roughly mixed with the soil. The seed was then sown and the drill closed. One pound of 4 per cent calomel dust to 50 yd. of drill appeared sufficient for salad onions raised from March sowings, but 1 lb. per 25 yd. gave better results on bulb onions grown from seed.

Full details of these trials will be published elsewhere, and in view of the prospect of controlling this obstinate disease by an economical direct method, the work is being continued and extended in 1945.

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[1] Ogilvie, L., and Hickman, C. J., *Rep. Agric. Hort. Res. Sta. Bristol for 1937*, 96 (1938).

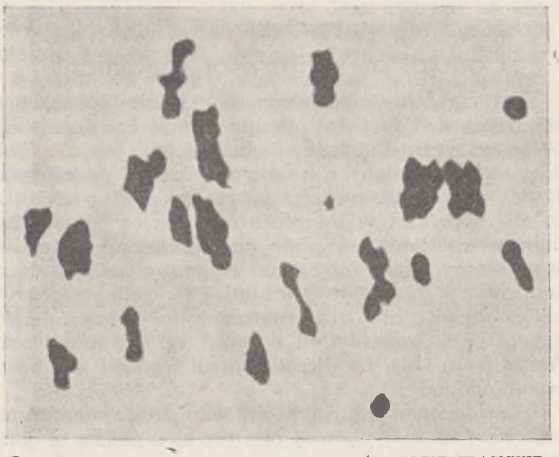
'Bolters' in Potatoes

Carson and Howard in their recent letter[1] consider the possibility that the 'bolter' sport which occurs in many varieties of potatoes is due to chromosome abnormality—excess or deficiency. Their examination of root tips, however, forces them to conclude that there is no chromosome difference between 'bolter' and normal.

Experience has shown that critical study of small chromosomes can only be made at meiosis, using a technique which does not allow contraction[2]. Again the possibility of chromosome loss in roots which need not occur in the germ track must not be overlooked[3,4].

From material supplied by Dr. McIntosh, Edinburgh, and Mrs. McDermott, Sutton Bonington, I have examined normal and aberrant types among the varieties Gladstone, Doon Star and Majestic. While there are no gross chromosomal changes, a small fragment was observed at meiosis in the 'bolter' types but in none of the corresponding normal or, for that matter, 'wilding' types. The accompanying illustration shows this fragment in a 'bolter' form of Gladstone. It is too small to determine whether it is euchromatic or heterochromatic.

It seems likely therefore, although not yet certain, that the mutation is due to the production of this fragment which, of course, will be similar in its effects to the mutation of a group of genes such as Carson and Howard infer from their breeding results. The observation of the fragment, if it is responsible, will, however, facilitate the study of the mutation.



PHOTOGRAPH SHOWING EXTRA FRAGMENT (SMALLEST FRAGMENT, IN CENTRE) AT MEIOSIS IN A 'BOLTER' FORM OF GLADSTONE. ACETOCARMINE SQUASH. THOMAS METHOD[2]. × 2000.

I am much indebted to Mr. S. Revell for technical assistance in this work.

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Merton, S.W.19.
Jan. 9.

[1] Carson, G. P., and Howard, H. W., *Nature*, 154, 829 (1944).
[2] Thomas, P. T., *Stain Technology*, 15, 167 (1940).
[3] Janaki-Ammal, E. K., *Nature*, 146, 839 (1940).
[4] Darlington, C. D., and Thomas, P. T., *Proc. Roy. Soc.*, B, 130, 129 (1941).

Effect of Controls on Stability

DURING the War the introduction of governmental controls has led to many matters being dealt with by an order *fixing* some quantity, price or other variable where a *laissez-faire* system would have allowed them to find their own levels. As examples we have rates of foreign exchange, wages and prices. Not only has this fixing occurred in many instances during the War, but a further extension of control or planning in peace will probably lead to even more variables being fixed in this way.

It is the purpose of this communication to point out the danger that in any dynamic system the fixing of one variable may render the rest unstable; and it will be shown that there is one type of variable particularly likely to lead to this result. (In a social or economic system the change to an unstable state would be shown by the subsequent growth of various peculiar and undesirable 'vicious circles'.)

The theory may be shown in the following way: a dynamic system in general, of n variables, has equations of form

$$\frac{dx_i}{dt} = f_i(x_1, \ldots, x_n) \quad (i = 1, \ldots, n).$$

Near a point of equilibrium (at which the fluxions are zero) the equations may, without serious loss of generality, be considered linear

$$\frac{dx_i}{dt} = a_{i1}\,x_1 + a_{i2}\,x_2 + \ldots + a_{in}\,x_n \quad (i = 1, \ldots, n).$$

For a system to be stable at the equilibrial point, it is necessary and sufficient that the real parts of the roots of the equation

$$\begin{vmatrix} a_{11}-\lambda & a_{12} & \ldots & a_{1n} \\ a_{21} & a_{22}-\lambda & \ldots & a_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ a_{n1} & a_{n2} & \ldots & a_{nn}-\lambda \end{vmatrix} = 0$$

are all negative. (Since we are discussing an actual system, the quantities a_{ij} will all be real.) Further, since we are discussing an equilibrial point which has existed for some time under free conditions, we may suppose it stable.

Now suppose we fix x_n. The stability of the remainder will depend on the real parts of the roots of the equation

$$\begin{vmatrix} a_{11}-\lambda & a_{12} & \ldots & a_{1,n-1} \\ a_{21} & a_{22}-\lambda & \ldots & a_{2,n-1} \\ \ldots & \ldots & \ldots & \ldots \\ a_{n-1,1} & a_{n-2,2} & \ldots & a_{n-1,n-1}-\lambda \end{vmatrix} = 0.$$

The stability of the first system by no means implies the stability of the second system. It is clear, then, that fixing a variable may render the rest of a system unstable.

As a numerical illustration, the system

$$\left.\begin{aligned} \dot{x}_1 &= 6x_1 + 5x_2 - 10x_3 \\ \dot{x}_2 &= -4x_1 - 3x_2 - x_3 \\ \dot{x}_3 &= 4x_1 + 2x_2 - 6x_3 \end{aligned}\right\}$$

leads to the equation

$$\lambda^3 + 3\lambda^2 + 26\lambda + 60 = 0;$$

and this has roots $-2{\cdot}44$, $-0{\cdot}28 \pm 4{\cdot}95\,i$, where $i = \sqrt{-1}$. The real parts being all negative, the system is stable. But if we fix x_3, we have a system with determinant

$$\begin{vmatrix} 6 & 5 \\ -4 & -3 \end{vmatrix},$$

and as the roots are now $+1$ and $+2$, the system is unstable.

We can, however, go further than this. Since the sum of the roots is equal to the sum of the elements in the main diagonal, Σa_{ii}, any change making this less negative will tend to make the system less stable —other things being equal (the argument here is admittedly imprecise). So the fixing of x_n would be particularly likely to lead to instability if a_{nn} was large and negative. We can identify such variables without difficulty; for, as they behave in accordance with the equation

$$\frac{dx}{dt} = \zeta + ax,$$

where ζ is independent of x, but changes with time, while a is large and negative, such a variable (x) will always have the properties that (1) it always moves towards $-\zeta/a$, (2) it moves towards $-\zeta/a$ *quickly*, (3) as $-\zeta/a$ has a as denominator it will be small, and therefore the fluctuations of x will be small.

It is concluded, therefore, that: (1) To fix a sociological or economic variable by order carries some danger of rendering the system, or parts of it, unstable (the latter being shown by the subsequent development of various 'vicious circles'). (2) The type of variable more particularly dangerous from this point of view is one which, under free conditions, changes value at high speed, and, by these quick changes affecting the other variables, fluctuates only through a narrow range.

Not being an economist I cannot give detailed instances, but I have little doubt that some could be provided.

W. R. ASHBY.

Green Ridges, Church Way,
Weston Favell, Northampton.

Vibrations in Telegraph Wires

WALKING near Winchcomb on December 27, we noticed a most curious phenomenon. We were in a slight valley, and the road was crossed by a line of telegraph wires, there being two wires some distance apart. It was about 10.30 a.m. and the sun, shining on the wires, was just beginning to thaw the layers of frost on them. The temperature of the air must have been round about freezing-point, and there was a slight mist. But we felt no breath of wind whatsoever, nor did the dead leaves of trees very near the wires indicate any wind.

But when we arrived on the scene, the wires between two of the poles were vibrating in a very odd manner. The effect was startling as there was no other noise in the neighbourhood, and there appeared to be no cause whatsoever. The wires vibrated with about 4 nodes in them, and with amplitude roughly half an inch; frequency approximately 10 a second. The vibrations went through maxima at irregular intervals, about 2 seconds apart, and we think both wires vibrated independently. The layer of frost was slowly coming off the wires, though some pieces circled round for several minutes. The cause of the vibrations seemed to be the section of the wire just being thawed, and though the vibrations were, of course, transmitted to the neighbouring sections, all the rest of the wire was quite normal. The poles on either side shook considerably, and the effect of putting one's head against them was very like that of being in a bus. But there was no earthquake, all other objects, trees or fences, being quite still. The vibrations were decreasing in amplitude about 10 minutes after our arrival, and when we returned after half an hour, they had ceased completely.

We feel sure an explanation of this phenomenon must involve the layer of frost round the wire. The only suggestion we can make is that when the layer was formed, considerable strains were set up in the wire. When it thawed, the strains were relieved suddenly in various small parts of the wire, each time giving the vibrations a small impulse. There must then be enough such impulses to maintain continuous vibrations. But this theory does not appear very plausible to us. Also we do not think electrical impulses from heavy currents could possibly account for the effect.

F. BAUCHWITZ.

Sidney Sussex College,
Cambridge.

R. N. H. WHITEHOUSE.

Queens' College,
Cambridge.
Jan. 2.

WITH reference to the above communication, we offer the following explanation.

This is a case of self-excited vibration. It would appear that the cross-section of the wire was non-circular due to the secretion of an ice-layer. The cross-section will resemble a short icicle.

If the wire achieves a small downward velocity, and a very slight wind be blowing, aerodynamic reasoning indicates that a force in a downward direction may result. Thus the motion continues, until the elastic forces in the wire stop it. There being now no downward motion, there is no downward force, and the wire commences to rise, in which motion the wind again helps. Thus large vibrations may be set up.

The effect, commonly known as 'galloping', occurs moderately frequently in cold climates; but is rare in temperate zones.

Further information is given in "Mechanical Vibrations", by Den Hartog, p. 343; and the fiftieth James Forrest Lecture delivered by Prof. C. E. Inglis at the Institution of Civil Engineers in 1944.

R. L. G. GILBERT.
V. ROBINSON.
W. N. WILSON.

Clare College,
Cambridge.

X-RAY EQUIPMENT FOR CRYSTALLOGRAPHY

ON November 25, 1944, a meeting of the X-Ray Analysis Group of the Institute of Physics was held in the Physics Department, University of Leeds. The meeting was opened by the chairman of the Group, Sir Lawrence Bragg. Sir Lawrence said that the necessary equipment and assistance had been found for scientific men to carry out emergency programmes of war-time research, and this must be extended in post-war planning. As the progress of crystallography is conditioned by the provision of equipment, it had been decided by the X-Ray Analysis Group to bring manufacturers and users together to discuss design and development, so that in the future suitable apparatus might readily be available.

The first two papers were on the development of the demountable X-ray tubes of Messrs. Metropolitan-Vickers Electrical Co., Ltd., and were presented by Dr. R. Witty and Mr. P. Leech. In the first paper, Dr. Witty spoke about the firm's standard demountable crystallographic X-ray tube, and emphasized the two points on which differences of opinion have been found among the users of the tubes, namely, the automatic gear of the instrument and the stability of the electron emission of the filament. He agreed that early types of automatic gear caused some trouble and loss of time, but considerable improvements have been made during recent years. Filament current will be stabilized either by galvanometer or electronic relays. Mr. P. Leech then spoke about the rotating anode tube with a seal of the Muller-Beck type which is being designed for post-war manufacture. A shielded filament tube is being contemplated to overcome the deposition of tungsten on the target. Ancillary spectroscopic equipment is being designed including low-angle, Weissenberg and high-temperature cameras.

Mr. R. A. Stephen, of Messrs. Philips Lamps, Ltd., drew up a series of specifications for a sealed-off X-ray tube. He said that multi-anode tubes cannot be manufactured at present because of mutual contamination of surfaces. Single-target tubes of copper, cobalt, iron, chromium, molybdenum and tungsten are made; but zinc and manganese targets cannot be used because of the high vapour pressure of these metals. The characteristic radiation output is given by the equation $P = K(V - V_c)^{1\cdot65}$, where V is the applied and V_c the critical radiation voltage. This holds for kilovoltages up to four to five times the excitation voltage of the characteristic radiation. In a good vacuum the insulation is estimated as about 10–20 kV. per mm. A word of warning was given about the use of unknown transformers with self-rectifying tubes, as this may put high electrical strain on the instrument due to the suppressed wave. X-ray windows are usually of 0·12 mm. Lindemann glass, which is capable of standing the required mechanical strain; but it must be carefully shielded from electron bombardment. Beryllium windows are in use, and a beryllium alloy (containing up to $\frac{1}{2}$ per cent titanium) is being investigated as a window material. These metals have the advantage of not requiring to be screened. Figures of absorption of these different materials were compared. Traces of water vapour in the sealed-off tube cause the formation of tungsten oxide on the filament, and evaporation of the oxide and subsequent reformation of water vapour give a reversible reaction which produces deposits of tungsten on the target 10,000 times greater than would be expected. It is therefore essential to use a 'getter' during the life of the tube. The design of a shielded filament was discussed. The minimum safe diameter of a crystallographic X-ray tube with a Lindemann glass window was given as 60 mm. The maximum tolerance loading per unit area of a target is given by the equation

$$T_M = \frac{2W}{\pi k}\{a \log (b/a + \sqrt{1 + b^2/a^2}) + b \log (a/b + \sqrt{1 + a^2/b^2})\},$$

where W is the watts per cm.^{2} on a rectangular focus $2a \times 2b$, T_M is maximum temperature permissible in the target, and k the thermal conductivity of the anode.

Mr. Stephen then discussed the design of the line focus. The usual size is 12 mm. × 1·2 mm. and this gives an effective focal-spot size of 1·2 mm. × 1·2 mm. when the beam is taken off the anode at an angle of 6° to the line focus. If crystallographers were to standardize spectrometer design, then it might be possible to build a tube with a line focus 36 mm. × 1·2 mm. This would give an effective spot-size of 3·6 mm. × 1·2 mm., which would be admirable for use with a slit-type collimator. With a monochromator this beam could be concentrated further into an area of either 1·2 mm. × 1·2 mm. or 3·6 mm. × 0·4 mm., depending upon the direction of reflexion of the beam from the crystal monochromator.

Dr. D. P. Riley, of the Cavendish Laboratory, Cambridge, read a paper on monochromators. Slides were shown of X-ray pictures of liquids with spurious lines due to the characteristic absorption of reflexion of part of the white radiation. These false intensity peaks were shown to be absent when a beam of radiation from a monochromator is used. In designing a monochromator the crystal should be capable of rotation and also a lateral movement parallel to the axis of the tube. A crystal used as a monochromator should reflect a strong beam of sufficient breadth to bathe the sample under investigation. The crystal, which should not be mechanically deformable, should have a reflecting face of 3–5 mm.^{2}. It should also have a high F value, be mosaic but not polycrystalline, and should be reasonably stable to heat, humidity and X-rays. It was said that planes with low Bragg angles are best, but the reflexion must be clear of the main beam of X-rays. Examples of monochromators were given. In using reflected radiation, a beam of wave-length λ may also contain harmonics $\lambda/2$, $\lambda/3$, etc., which arise from the white radiation. The reflected radiation is seriously polarized, and this gives rise to difficulties in intensity calculations on reflexions. It was suggested that tube manufacturers should be asked to give some idea of the state of polarization of the X-ray beams from the tubes they supply. For low-angle work a perfect reflector such as calcite, giving a very sharp beam, is better than a mosaic crystal of the pentaerythritol type.

The discussion was opened by Sir Lawrence Bragg, who urged that if automatic gear is produced it should be really 'foolproof', and that some 'figure of merit' of an X-ray tube should be given by the manufacturers. He also asked that information as to the best form of monochromator should be made available. Dr. H. Lipson (Cavendish Laboratory, Cambridge) asked for greater co-operation between

designers and users; he stated that the filament life in a Metropolitan-Vickers tube is 300–500 hours. Dr. Witty replied that magnetic and electric automatic gear should be 'foolproof'; vacuum relays are being improved, but are more of a problem. Dr. W. T. Astbury (Textile Physics Laboratory, University of Leeds) said that the inventing scientific worker gets little return for his efforts and is often himself held up for lack of apparatus. He believed that for further progress in design, automatic gear in experimental tubes should be kept down to a reasonable minimum. Dr. E. Green (Unilevers, Ltd.) directed attention to a Russian X-ray tube in which a spirally-grooved rotating anode acts as its own molecular pump. Mr. H. P. Rooksby (General Electric Co., Ltd.) described briefly a demountable X-ray tube which has been in continuous use at his laboratory for ten years. Dr. I. MacArthur (Textile Physics Laboratory, University of Leeds) suggested that a monochromator might be placed inside the X-ray tube to produce a maximum intensity. Dr. A. Taylor (English Electric Co., Ltd.) said that from a sealed-off X-ray tube a beam has been obtained in which iron lines have been found present due to the evaporation of iron from a filament lead on to the target of the tube.

Dr. W. T. Astbury opened the afternoon session with a description of the high-output X-ray tubes which have been developed in his laboratories. The rotating anode tube has been evolved in three stages. It has a rotating copper target with a mercury seal and the body is stainless steel. Two difficulties were anticipated with this type of instrument. The first was the stability of the rotating mercury columns. An equation of the overall height of the mercury meniscus rotating with an angular velocity Ω and of internal and external radii a and b is given by

$$h = \frac{\Omega^2 a^4}{g(b^2 - a^2)^2}\left[\frac{b^4 - a^4}{2a^2} - 2b^2 \log_e b/a\right] \simeq \frac{\Omega^2 a \delta}{3g}(1 - \delta/2a), \text{ where } \delta = (b - a).$$

When $\Omega = 500$ r.p.m., then $h = 0{\cdot}3$ in. for the inner and 0·45 in. for the outer rotating system, which agrees near enough with observations. In the latest instrument $(b - a) = \frac{1}{8}$ in., but this can be reduced. Thus it can be said that the mercury column is stable. The second difficulty is evaporation from the mercury into the vacuum, but this has been eliminated by covering the meniscus with a layer of Apiezon oil, and no contamination of the vacuum chamber or anode then occurs. Dr. Astbury described how the first instrument was designed as a gas tube; this was then modified to contain a filament source. The third tube was a completely re-designed instrument which ran at 70 milliamperes and 30 kV. This is the limit of the high-tension equipment at the moment available, but there is no reason why much higher currents should not be used.

A much simpler and cheaper moving target tube has been designed which will be within the reach of any research worker requiring beams of reasonably high intensity. The instrument is continuously evacuated, and the anode is a flat hollow bar (through which runs the cooling water) which oscillates backwards and forwards at three complete oscillations per second. The vacuum seal is made by means of a tombac bellows at each end. A second and slower motion is given to the bar to vary the position of the instantaneous zero of the main oscillation and thus prevent the development of hot spots during running. Alternative methods of sealing the vacuum joint of the oscillating anode were suggested. Dr. Astbury visualizes a long oscillating tube incorporating a series of anodes all sealed by a single pair of bellows and operated from the same pumping system, and each having two windows. (At the time of the meeting the instrument had not been developed to the stage of giving an X-ray beam, but since that time the tube has run steadily at 45 milliamperes and 30 kV. and very good photographs of ramie have been taken in 2 minutes with a $\frac{1}{2}$ mm. collimator and a distance of 2 cm. (see *Nature*, **155**, 108; 1945).

Dr. I. MacArthur reviewed the development of moving-target tubes, and gave special prominence to features such as continuous cooling and vacuum seals in the instruments. The main point is not the overall power of the tube, but rather the maximum loading per unit area of the focal spot. This is determined by focusing, which might be improved by the electron gun method as used by Siegbahn, or by magnetic means. A clean target is also necessary; tantalum filaments were found to be less likely to sputter the anode than tungsten, although they have a shorter life. Dr. MacArthur referred to the possible use of the rotating anode as a molecular pump. He warned would-be makers of rotating anode tubes against porosity in vital metal parts.

Replying to questions by the chairman in the discussion, Dr. Astbury said that the rotating anode of his tube can be changed easily without draining away the mercury, and that at 70 milliamperes and 30 kV. the tube is 8–20 times as fast as a normal Philips tube. Dr. Kathleen Lonsdale described the 50 kW. and 5 kW. moving anode tubes at the Royal Institution. The output of a Shearer tube running at a nominal 5–10 milliamperes and 40–45 kV. was given as 400 watts, and a comparison of the speeds of photography of a normal Phillips tube, a Shearer tube, and the 5 kW. tube was said to be 1 : 8 : 24. The Shearer tube was used with a modified Wehnelt break and an induction coil, and a good beam was said to be maintained over a period of four hours.

Mr. Stephen said that the load on a Philips tube can be increased, but this will reduce the life of the tube. He asked that collimator sizes should be standardized, and then manufacturers would be able to design tubes for special purposes; at present the normal sealed-off tube has to be used on all occasions. Mr. T. S. Millen (Metropolitan-Vickers Electrical Co., Ltd.) outlined the optimum conditions for a rotating anode used as its own molecular pump. Replying to Mr. Rooksby, Dr. Astbury, Dr. MacArthur and Dr. Green said that the porosity of the metal in the rotating anode tube is in the outer casing and not in the anode itself. This leakage is closed by coating lightly the affected parts with shellac. Replying to a question of relative positions of focal spots in the Matchlett and Philips tube, Mr. Stephen said that with $9\frac{1}{2}$ cm. cameras the extra 1 cm. distance between focal spot and window in the Philips tube is immaterial, and is necessary because the windows of the Philips tube are of Lindemann glass. Dr. A. Taylor suggested that alloy targets might be used so that with suitable choice of filters different monochromatic beams might be obtained. Mr. F. A. Bannister (British Museum) told the meeting that minerals can be readily examined using beams from Shearer tubes, the purity of radiation of which is universally accepted.

F. HAPPEY.

GRAMICIDIN S

IT is now well known that Dubos and his collaborators in America (see, among other papers by these workers, R. J. Dubos and R. D. Hotchkiss, *J. Exp. Med.*, **73**, 629; 1941) obtained from soil, sewage, manure and cheese, several species of aerobic, sporulating bacilli which are antagonistic to unrelated organisms, and that they recovered from these organisms an alcohol-soluble, water-insoluble fraction called tyrothricin, which kills many Gram-positive and Gram-negative organisms. From tyrothricin they isolated two crystalline polypeptides —gramicidin and tyrocidine. Tyrothricin is unsuitable for systemic administration (*Brit. Med. J.*, 122, Jan. 27, 1945), but it is a powerful local antiseptic and has been used for the treatment of wounds, affections of the eye, nose and throat, empyema, certain skin affections and other conditions not requiring parenteral administration. It is now marketed by Messrs. Sharp and Dohme, Ltd., Mulford Biological Laboratories, Hoddesdon, Herts, who issue a booklet on its history and use, with a useful bibliography about it.

Russian workers (*Nature*, **154**, 703, Dec. 2, 1944; *Lancet*, 715, Dec. 2, 1944) now report the discovery of another substance of the same kind as the American gramicidin. Prof. G. F. Gause and M. G. Brazhnikova, of the Moscow Institute of Tropical Medicine, report on their search, during 1942, among several hundreds of strains of bacteria from Russian soils for an organism similar to that discovered by Dubos and his collaborators. They often noted action antagonistic to bacteria in their cultures, but only one organism, isolated from garden soil, was remarkably effective. This belonged to the *Bacillus brevis* group and was similar to, but not entirely the same as, the one isolated by Dubos and Hotchkiss (*loc. cit.*). It produced, however, an antibacterial principle which is entirely different from that described by Dubos and his collaborators. This principle readily crystallized out when an alcoholic extract of the acid precipitate of the bacterial culture was poured on to a watch-glass, and it never occurred with the tyrothricin described by the American workers. The Russian authors regard this gramicidin as a new substance, different from other known crystalline polypeptides produced by aerobic sporulating bacteria. They call it 'gramicidin S'. Its antibacterial action against eighteen different strains of *Staphylococcus aureus*, ten strains of *Streptococcus* and against *Diplococcus pneumoniæ*, *Clostridium welchii* and *C. histolyticum* is described by Gause and Brazhnikova. Comparison of it with tyrothricin showed that gramicidin S was rather more efficient in killing staphylococci, while tyrothricin killed streptococci and pneumococci more effectively; and gramicidin S was the less selective of the two. On the other hand, while tyrothricin is not effective against any of the Gram-negative organisms studied, as Dubos and Hotchkiss (*loc. cit.*) also found, gramicidin S prevents the growth of and kills "many varieties" of Gram-negative organisms, including *B. proteus vulgaris* and *Bact. coli*, which are common in infected wounds. The former is resistant to many antiseptics including penicillin.

At the same time, gramicidin S is very stable and is not more toxic than tyrothricin, the lethal dose (L.D.50) for white rats being almost the same. Its antibacterial activity is not destroyed by autoclaving, nor do solutions of it used clinically interfere with the activity of leucocytes. Treatment by the Russian workers of lacerated wounds of guinea pigs infected with *Cl. welchii* showed that the mortality of the animals thus treated was 5 per cent, while that of untreated ones was 53 per cent. When wounds of white rats were infected with garden soil, 100 per cent of the rats died, whereas, when such wounds were treated with gramicidin S, only 40 per cent died.

In the *Lancet* (*loc. cit.*) the chemistry of gramicidin S is discussed by A. N. Belozersky and T. S. Passhina and its clinical use is described by Prof. P. G. Sergiev, vice-president of the Medical Research Council of the U.S.S.R. Sergiev describes the results of treatment with gramicidin S of three hundred cases of gunshot wounds of soft tissue, severe burns, abscesses and anærobic infections. The disappearance of necrotic tissue and appearance of granulations and epithelialization were very rapid. Gramicidin S was also useful for preparing wound surfaces for skin-grafting and for the treatment of empyema, peritonitis and impetigo.

Cytologists will be interested in the statement, in the article by Gause and Brazhnikova, that L. Levinson, of the University of Moscow, claims that gramicidin S favours regeneration of wound tissues and especially "the high nucleic acid content of the cells". If this means that the nucleic acid content of tissue cells is increased, this effect of gramicidin S merits further investigation in the light of E. Stedman's view, discussed in a recent article on the chemistry of cell nuclei (*Edin. Med. J.*, **51**, 353; 1944), that nucleic acid exists in nuclei in salt-like combination with histone and that diminution of histone from any cause might set free nucleic acid, which, by combining with chromosomin, might form a self-reproducing enzymic system analogous to the viruses with the result that, when growth reached a certain stage, mitosis would follow. Stedman suggests that histone may regulate mitosis (see also E. Stedman and E. Stedman, *Nature*, **152**, 566; 1943) and that the decrease of histone below a certain level may in this way render a cell malignant. The origin of histone is not known, but Stedman suggests that the lymphoid tissue may supply it; the nuclei of lymphocytes contain a high percentage of histone and the accumulation of lymphocytes around tumours may represent an attempt to remedy the deficiency of histone which is causing the malignancy. If this conception is correct, the confirmation of Levinson's statement that the cells of tissues treated with gramicidin S have a high nucleic acid content is desirable. For it is conceivable that the reported beneficial effect of gramicidin S upon regeneration of tissues may be due to an increase of nucleic acid caused by gramicidin S, with the result that more is present than the available histone can absorb, so that, as Stedman suggests, the excess combines with chromosomin, and cell divisions, that is, cell proliferation, follow. A further result is, however, conceivable. If gramicidin S treatment were sufficiently prolonged, some cells might be started off on a career of malignancy, especially if other factors were already reducing the available histone. It seems unlikely that gramicidin S itself could reduce the histone, but the possibility needs investigation. If, on the other hand, it could increase the histone, it might prove useful for the treatment of malignancy. The possibility that the American gramicidin and tyrocidin may have similar effects is also worth study. Whether similar effects can be exerted by other bacterial and perhaps fungal products can only be answered by the cytologist.

G. LAPAGE.

KILN SEASONING VENEERS FOR PLYWOOD MANUFACTURE

DURING the War considerable investigation and research work has been carried out at the Forest Research Institute, Dehra Dun, India, on the subject of plywood manufacture. Kiln seasoning has been studied. Two *Indian Forest Leaflets*, Nos. 57 and 61 (published by the Forest Research Institute, Dehra Dun), deal with "Furnace Heated Veneer Drying Kiln" and "Kiln Drying Schedule for Seasoning of Veneers", giving the latest practical information on these subjects. In Leaflet No. 57, after directing attention to the necessity of the thorough seasoning of veneers before gluing and manufacture into plywood, it is pointed out that green veneers can be air-seasoned or kiln-dried, exactly like ordinary wood. The usual method in Europe and America for the quick seasoning of veneers is to dry them in long progressive dryers. This well-known type of dryer is very expensive, the pre-war price being more than 50,000 rupees.

Apart from the considerable price, it was found that this dryer was not essential for the quick seasoning of veneer, especially for the cheaper forms of plywood in so great demand in India, and that cheaper forms of timber seasoning kilns could be used. Experiments in this direction were undertaken and resulted in the furnace-heated veneer-drying kiln described. This is an indirect-heated internal-fan furnace kiln, suitable for the rapid seasoning of veneers before manufacture into plywood. It has been primarily designed for the use of plywood factories in which there is no provision for the supply of steam. The kiln has plenty of heating surface to raise the temperature of the circulating air in a short time. It is provided with four fans for the rapid circulation of air necessary for successful veneer drying. Provision is made for exhausting the moist air of the kiln through chimneys in the roof and for drawing in fresh air through the fresh-air ducts. The kiln is also provided with tracks and trucks, the latter of which are loaded with the green veneers outside and then pushed along the tracks into the drying chamber. It is estimated that 1/16 in. thick veneers of mango take about three hours for complete seasoning, as compared with a few minutes in the costly long progressive dryers of Europe and America. The cost of installation of the one described is estimated at about 5,000 rupees, at July 1943 current prices.

In Leaflet No. 61 the results of experiments carried out on the kiln seasoning of veneers of mango (*Mangifera indica*), salai (*Boswellia serrata*), narikel (*Sterculia alata*) and sissoo (*Dalbergia sissoo*) are briefly described. From the results obtained for the first three of the above species, a kiln-drying schedule for the seasoning of veneers of light hardwoods, commonly used for cheap plywood, is recommended. A short description of different kinds of veneer dryers is also included.

RESEARCHES IN PLANT VIRUS DISEASES

SEVERAL workers at the Rothamsted Experimental Station have recently added to our knowledge of plant virus diseases. A. Kleczkowski (*Biochem. J.*, (2), **38**, 160; 1944) has found that tobacco mosaic virus does not combine with pepsin until it has been denatured by heat. Potato virus *X*, however, is a substrate for the proteolytic activity of pepsin, and combines with it. The same virus is also a substrate for trypsin, which nevertheless combines more with tobacco mosaic virus, which is not a substrate. This action can explain the reversible inhibition of tobacco mosaic virus by trypsin. Invertase does not combine with either virus.

F. C. Bawden and N. W. Pirie have found (*Brit. J. Exp. Path.*, **25**, 68; 1944) that extracts of milled fibre from tomato plants infected with bushy stunt contain some virus combined with chromoprotein to form a non-precipitating antigen. The extracts would, however, precipitate with antiserum when the chromoprotein had been removed. Extracts from healthy plants to which pure virus is added are also non-precipitating.

B. Kassanis (*Brit. J. Exp. Path.*, **24**, 152; 1943) has studied the mechanism of neutralization of infectivity of several viruses by antisera. Unspecific neutralization by normal and heterologous sera is great in proportion to the additional specific effect of homologous antisera. Specific neutralization could only be used to demonstrate serological relationships if sera were of the same age and subjected to comparable storage conditions. Neutralization is not caused by precipitating antibodies, and precipitin titre is not correlated with neutralizing power. Specific antisera for the sugar beet yellows virus have been prepared by A. Kleczkowski and M. A. Watson (*Ann. Appl. Biol.*, **31**, 2; 1944). The virus is not affected between *p*H 5 and 9, though it is relatively unstable. It has not yet been purified, though it is reversibly precipitated by ammonium sulphate, and sedimented by high-speed centrifugation. The precipitin reaction with antisera can be applied to the crude sap, and is useful for diagnosis. Several workers have claimed that virus inactivation by formaldehyde and mercuric chloride is reversible, but B. Kassanis and A. Kleczkowski (*Biochem. J.*, **38**, 20; 1944) have not found this to be so with purified tobacco mosaic virus. Inactivation could be arrested at any stage by dilution or dialysis, but could not be reversed. Loss of infectivity caused by formaldehyde does not seem to depend on changes in amino-nitrogen groups.

Serological reactions and the production of intracellular inclusions have been used by F. C. Bawden and F. M. L. Sheffield (*Ann. Appl. Biol.*, **31**, 33; 1944) to establish relationships between viruses causing necrotic diseases of the potato. Potato virus *B*, and some others not previously described, are strains of virus *X*, and potato virus *C* is a strain of virus *Y*. Virus *A* is not related to *Y* or *X*.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, February 24

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 11 a.m.—Discussion on "Factors Affecting the Nutritive Value of Bread as Human Food".

BRITISH PSYCHOLOGICAL SOCIETY (in Room 134, Tuke Building, Bedford College for Women, Regent's Park, London, N.W.1), at 2.15 p.m.—"Training Industrial Workers" (a) Pearl H. M. King: "Some Suggestions for the Development of Personality through Industry"; (b) Helen Turner: "Proficiency and Skill on the Job"; at 4.30 p.m.—P. M. Freeston: "Children's Conceptions of Adult Life"; at 5.15 p.m.—Madeline Kerr: "The Functions of Visual Imagery in the Formation of Stereotypes".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—Mr. D. R. Barber and Mr. E. H. Amstein: "Factors Influencing the Choice of Photographic Materials for Use in Quantitative Spectrography".

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' SECTION) (at Storey's Gate, St. James's Park, London, S.W.1), at 3.30 p.m.—Mr. N. Hanlon: "The Problems involved in the Establishment of a Large Works in a Country District".

Monday, February 26

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Prof. H. W. Ahlmann: "Summary of Glaciological Researches, 1918–1940".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Location of Industry" (to be opened by Mr. D. B. Williamson).

Tuesday, February 27

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Lieut.-Colonel D. L. R. Lorimer: "Scenes from the Life of a Nomad People—The Bakhtiari of S.W. Persia".

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Mr. C. A. Cameron Brown: "Internal Farm Mechanisation".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir George Dyson: "The Origin and Development of Early Musical Forms", (3) "The Age of Bach and Handel".

ILLUMINATING ENGINEERING SOCIETY (joint meeting with the ROYAL INSTITUTE OF BRITISH ARCHITECTS) (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London. S.W.1), at 5.30 p.m.—Dr. J. W. T. Walsh: "The Relationship between Interior Design in Building and Artificial Illumination".

INSTITUTION OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. F. N. Sparkes and Mr. A. F. Smith: "The Concrete Road, a Review of Present-day Knowledge and Practice".

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Dr. H. P. Williams: "Vertical v. Horizontal Polarisation".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6.30 p.m.—Lord Halsbury: "Safety Pins and Swords".

Wednesday, February 28

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. E. P. Stebbing: "Erosion and Water Supplies".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. I. Lawson: "Multipath Interference in Television Transmission".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 6 p.m.—Mr. R. J. Cross: "Design and Fabrication of Welded Magnesium Alloy Aircraft Tanks".

ASSOCIATION OF SCIENTIFIC WORKERS (HUDDERSFIELD BRANCH) (in the Technical College, Huddersfield), at 7.30 p.m.—Dr. D. G. Drummond: "The Electron Microscope".*

Thursday, March 1

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "Some Physical Problems of the Solid State".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. Richardson: "Stray Losses in Synchronous Electrical Machinery".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. M. B. Morgan and Mr. Thomas: "Control Surface Design".

Friday, March 2

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 2.30 p.m.—Dr. J. C. Swallow: "Some Aspects of Research in the Plastics Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. H. L. Kirke: "Some Aspects of Pre-War and Post-War Television".

Saturday, March 3

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual General Meeting. Mr. A. S. Kennard: "The Early Digs in Kent's Hole, Torquay, and Mrs. Cazalet" (Presidential Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN THE DEPARTMENT OF CHEMISTRY—The Principal, Derby Technical College, Normanton Road, Derby (March 5).

LECTURER IN BIOLOGY—The Director, School of Pharmacy, Robert Gordon's Technical College, Aberdeen (March 6).

BOROUGH SURVEYOR AND ENGINEER—The Town Clerk, Guildhall, Shrewsbury (endorsed 'Borough Surveyor') (March 9).

FOOD AND DRUG ANALYST for service with large Company operating in the Middle East—The Ministry of Labour and National Service, Appointments Department, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.2894.XA) (March 12).

ASSISTANT LIBRARIAN—The Secretary, Royal Society of Medicine, 1 Wimpole Street, London, W.1 (March 15).

RESEARCH INVESTIGATOR to take charge of the section of the Research Department dealing with the CASTING OF NON-FERROUS METALS AND ALLOYS, and a RESEARCH INVESTIGATOR to take charge of the section of the Research Department dealing with the CORROSION OF METALS—The Director, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1 (March 31).

PROFESSOR OF PHILOSOPHY, tenable in the Durham Division of the University—The Registrar, University of Durham, 46 North Bailey, Durham (March 31).

KEEPER OF THE DEPARTMENT OF ANTIQUITIES—The Registrar, The University, Old Clarendon Building, Oxford (March 31).

LIBRARIAN—The Acting Registrar, Queen Mary College, c/o King's College, Cambridge (April 3).

LECTURESHIP IN GENETICS—The Secretary of University Court, The University, Glasgow (April 7).

HEAD OF THE DEPARTMENT OF HOUSEHOLD ARTS—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (April 14).

SECRETARY AND REGISTRAR—The Acting Registrar, University College of North Wales, Bangor (April 21).

PROFESSORSHIP OF MECHANICAL AND MARINE ENGINEERING, tenable at King's College—The Registrar, King's College, Newcastle-upon-Tyne (April 30).

SECRETARY—The Council, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1 (May 1).

LIBRARIAN—The Secretary and Treasurer, University College, Dundee (August 31).

MASTER to teach CHEMISTRY and subsidiary PHYSICS to Scholarship standard—The Acting Head Master, Perse School, Cambridge.

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield.

SPEECH THERAPIST—The Director of Education, Education Offices, Moss Street, Bury, Lancs.

PSYCHOLOGIST (part-time, man or woman)—The Medical Superintendent, Mill Hill Neurosis Centre, Mill Hill, London, N.W.7.

GRADUATE MASTER or MISTRESS to teach Inter.B.Sc. CHEMISTRY to Evening students and SCIENCE or MATHEMATICS in Junior Day Departments—The Principal, Wycombe Technical Institute, Easton Street, High Wycombe, Bucks.

TEACHER (full-time) OF METALLURGY, with CHEMISTRY as a subsidiary subject—The Principal, Enfield Technical College, Queensway, Enfield, Middx.

LECTURER IN GEOGRAPHY—The Secretary, Homerton College, Cambridge.

GEOGRAPHY SPECIALIST (part-time: or full-time if able to offer a second subject which may be required)—The Principal, Diocesan Training College for Women Teachers, Ripon, Yorks.

HEADMASTER OF OUNDLE SCHOOL—The Secretary to the Governing Body, Grocers' Hall, Princes Street, London, E.C.2.

ASSISTANT DAIRY BACTERIOLOGIST—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Race Relations and the Schools: a Survey of the Colour Question in some Aspects of English Education, with a Number of Proposals and Questions. Pp. 56. (London: League of Coloured Peoples, 1945.) [261

The Future of University and Higher Education: a Report prepared by the National Union of Students of the Universities and Colleges of England and Wales. Pp. 16. (London: National Union of Students, 1945.) 6*d*. [261

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1943–44. Pp. 30. (Leeds: The University, 1944.) [311

The Road to Security. By Prof. David Mittrany. (Peace Aims Pamphlet, No. 29.) Pp. 20. (London: National Peace Council, 1944.) 4*d*. [311

Imperial College of Science and Technology. Proceedings of the Conference of Industrial Representatives, No. 2: Industry and University Education, convened by the Vacation Work Committee of the Imperial College Union, London, on 15th December 1944. Pp. v+40. (London: Imperial College of Science, 1945.) [12

Other Countries

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 21, No. 4: Die Samenbildung und die Zytologie bei Agamospermischen und Sexuellen Arten von Elatostema und einigen Nahestehenden Gattungen nebst Beleuchtung einiger Damit zusammenhängender Probleme. Von Folke Fagerlind. Pp. 130. Serien 3, Band 21, No. 5: A Quantitative Study of the Reflexion of X-rays by Sodium and Potassium Chlorides. By J. A. Wasastjerna. Pp. 21. Serien 3, Band 21, No. 6: The Anatomy of *Labiostomella gisleni* Silén (Bryozoa Protochellostomata), with special regard to the Embryo Chambers of the Different Groups of Bryozoa and to the Origin and Development of the Bryozoan Zoarium. By Lars Silén. Pp. 111+5 plates. Serien 3, Band 21, No. 7: On the Exoskeletal Shoulder-girdle of Teleostomian Fishes, with special reference to *Eusthenopteron foordi* Whiteaves. By Erik Jarvik. Pp. 32. (Stockholm: Almquist and Wiksells Boktryckeri A.-B., 1944.) [101

Catalogues

The B.T.L. Photoelectric Turbidimeter and Colorimeter. Pp. 8. The B.T.L. Universal Electric Stirrer. Pp. 8. (London: Baird and Tatlock, Ltd.)

A Catalogue of Books Old and Modern in various Departments of Literature. (No. 497.) Pp. 38. (Cambridge: Bowes and Bowes, Ltd., 1945.) 3*d*.