NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

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NATURE

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THE BALANCE OF SCIENTIFIC MAN-POWER IN BRITAIN

IN October 1944 the Standard Oil Development Co. in America made its silver anniversary the occasion for a "Forum on the Future of Industrial Research". The proceedings were issued by the Company in the following year in book form, and the volume makes interesting reading at the present time in view of topical discussions and trends in Great Britain. The papers and discussions centred round three themes : what should be the guiding principles and objectives for the commercial programmes of industrial research and development organisations ; how small business can serve itself and be served by industrial research and development ; and the place industrial research and development organisations should allocate to future work directed primarily toward national security. They thus canvassed questions that were afterwards discussed in Dr. Vannevar Bush's report, "Science : the Endless Frontier", and one discussion at least covered the same theme as that of the conference arranged by the Manchester Joint Research Council for October 16, 1945, on "Research and the Smaller Firm".

What stands out from these discussions to a British observer is, first, the recognition of the overwhelming importance of a supply of scientific man-power of the highest quality ; and secondly, a distrust, which sometimes seems to be carried much too far, of Government-organised or -sponsored research. Nowhere could there be found clearer recognition that both industry and the universities must have their share of the best scientific minds of a country. Industry itself would quickly suffer if by financial inducements or other means it succeeded in attracting into its direct service so many of the first-class men of science that both teaching and research at the universities was left largely in the hands of less able men.

While this is generally recognized in the discussions at this 'forum', American opinion, so far as represented there, appears to be content to leave the distribution to chance and to shy at any attempt to lay down a system of priorities or control. Moreover, while, as was demonstrated at the 'forum', the research association movement in Great Britain has inspired certain co-operative developments in the United States, those developments have taken the form of trade associations or co-operative groups, such as the Institute of Paper Chemistry and the New England Industrial Research Foundation, quite independent of State support. Even the paper on the United States Government research agencies presented by Dr. W. C. Schroeder could not dispel the veiled distrust of Government research which was apparent.

That distrust doubtless owes something to the absence in the United States of the tradition and high standards of the British Civil Service, which bring their own contribution to the building up of a Scientific Civil Service such as is now proceeding. But both in Britain and in the United States, the more recognition that the first problem in industrial

research or in academic research is to secure men of the highest quality, and then to provide them with the conditions which are most stimulating to creative work, will not by itself avert competition between industry and the universities, if not with the Government service also, for such men; and such competition might easily have disastrous results. We cannot leave the matter just where it has been left by the report of the Barlow Committee on Scientific Man-power. Moreover, all four of the 'working parties' that have so far reported testify to the backwardness of certain sections of British industry in regard to research—indeed, it is difficult to see that the Working Party for the Boot and Shoe Industry has itself any clear conception of what really constitutes research as distinct from what industrialists in the United States commonly call 'trouble-shooting'. Further, the able statement on research in the report of the Working Party for the Cotton Industry calls into question the whole basis of the research association from the point of view of utilizing most effectively the resources of man-power and material available for research. That proposal presumably emanates from the Research Sub-Committee, which included, besides its academic members, men like Mr. J. T. Marsh and Mr. J. Baddiley, with long experience of industrial research; and accordingly must be taken as *prima facie* evidence of the existence of some doubt as to whether the effort being expended in the research associations would not yield greater results in some other way. The Pottery Working Party referred to a widespread feeling of dissatisfaction with the achievements of the research associations. If there are any foundations for such doubts, the whole question should be explored without delay. It is known that the Department of Industrial and Scientific Research has plans in hand for a considerable expansion of the research association movement, and besides the proposals from the Cotton Working Party there have been others from the working parties for the pottery and for the hosiery industries which involve expansion in that direction. Before such developments are allowed to compete with the universities and with private industry for the limited supply of available scientific man-power, we should be quite clear as to the way in which that man-power can be most effectively utilized from the national point of view.

Dr. Roger Adams, in the 'Forum' already mentioned, well emphasized the two-fold dependence of industry upon the universities, both for the fundamental research which is the basis of all applied science, and for the supply of trained scientific workers for the conduct of research within industry and of those capable of understanding and applying to the purposes of industry the results of such research. That has equally well been put in the reports of the 'working parties' in Britain for the pottery and the hosiery industries as well as for the textile industry. The need for a widely interpreted reciprocal relation between science and industry; the importance of having enough men of high ability trained to do the necessary scientific work; the impossibility of science making its true contribution to industrial progress unless research workers create an organised body of knowledge relating scientific theory with industrial practice, and unless industry on its side has enough men in high positions who are capable of understanding scientific principles—these points, explicitly stated in the report on the cotton industry, are equally implicit in those for pottery and hosiery.

The Working Party for the Hosiery Industry is well aware of these relations and of the wide field for research which now confronts the industry, but none of its recommendations indicates that the importance of the quantitative factor to which Dr. Roger Adams referred is fully appreciated: the danger that at the present time the better conditions which industry is able to offer may deplete the university departments of their ablest and most promising men, both in research and in teaching. The development of the Wool Industries Research Association Station in Nottingham into a Hosiery Research Institute, the establishment of a Hosiery Research Council and a Hosiery Design Centre, the imposition of a compulsory levy upon a yarn-usage basis on all hosiery manufacturers and the establishment with other textile industries of a general textile research organisation, are excellent things; as are also the promotion of close relations between the Hosiery Research Council and Institute with the universities, technical colleges, textile and other professional and scientific institutes, research associations, etc., and development of an efficient industrial relations service to ensure the widest dissemination of research findings among industrialists who are expected to apply and develop them. But recommendations such as these, however excellent in themselves, may well be ineffective unless we grapple with the real core of the problem of this potential competition between the universities, industry and the Government departments for scientific workers. Moreover, to implement the further recommendation that the Hosiery and Knitwear Council considers seriously the establishment of some organisation for the hosiery industry that would be responsible for the collection, collation and publication of the results of research in the economic and sociological fields, the maintenance of contact with professional and scientific research institutions concerned with these fields, including the universities, and the pursuit of such research on its own account, presupposes further demands on the universities for trained workers in much the same field as the proposals of the Clapham Committee.

A fresh appraisal of the whole research association movement, and particularly its relation to the universities and the research departments of individual firms, may be an essential element in planning the adequate distribution of man-power resources in Great Britain. It might also be valuable in dispelling some of the false ideas regarding the functions of the research association to which the Pottery Working Party refers. Any vigorous industry with private research establishments, that report points out, moves rapidly ahead of its co-operative research associations in knowledge of the application of scientific work. The function of the research associa-

tion should be continuously to unfold the fundamental scientific background of the industry, reaching into many different fields of scientific knowledge. The Pottery Working Party urges that all large potteries should have private research departments, but it recommends also a statutory levy on all pottery firms to provide the funds for co-operative fundamental research, and it inclines to the view that contributions to the research association should be split into two parts, one—compulsory—used to support fundamental research, and the other—voluntary—to finance co-operative technical consul ing service.

An inquiry into the research association movement should give an indication of the magnitude of the justifiable demand from that quarter for scientific talent. Correspondence in *The Times*, flowing in part from an article from Sir Ernest Simon and two subsequent articles on the universities of Great Britain, has pointed to some doubts as to the extent of the demand of industry on the universities for trained man-power. Sir Ern st Simon accepts the contention of the Barlow Report that the task set before the universities is to double their output of students in ten years, with a large expansion of research in all fields; but Sir Cyril Norwood has questioned the soundness of some of the assumptions of the Barlow Committee as to the numbers of potential students not yet reaching the universities, and the capacity of business and industry to absorb a greatly increased number of graduates.

It must be admitted that, in spite of the work of the Hankey Committee, the Ministry of Labour and National Service has provided no convincing evidence that the professions and industry generally can absorb a much larger number of graduates, and some of the experience of the appointments department is disturbing, particularly the high level of current unemployment among technical specialists in certain occupations. Even if employers generally do not make all the use that they might of appointments offices, the existence of so much unemployment among highly qualified men, particularly those more than forty years of age, cannot altogether be disregarded in considering the scale of university expansion. None the less, it is reasonable to anticipate an increased and sustained demand for graduates alike for scientific research, in industry and business, in the Government service and in professional appointments of all kinds at home and overseas. The crucial problems unfolded in this correspondence lie rather in the means by which the development of the universities to provide this larger supply of graduates is to be implemented. The difficulties found by the Universities of Oxford and Cambridge in expanding to the degree desired have led Lord Cherwell to propose the transfer of engineering training from the universities to degree-giving institutes of technology, and a like proposal has been made that cities such as York, Bath and Norwich should be made centres of university education devoted to a special subject or related group of subjects. Such proposals have been rightly criticized as inconsistent with the whole ideal of university education. Sir Charles Grant Robertson has pointed out that a start could well be made by bringing existing university colleges such as Nottingham, Southampton and Exeter to full university status, and powerful support has been forthcoming for the view that not segregation of subjects or studies but a closer integration of the humanities and the sciences in university education, and an attempt to reconcile the need for breadth of understanding and sympathy with the need for specialization, are imperative to enable the universities to provide men and women of the type required in the world to-day.

The case for and against a Royal Commission to examine the whole aims and problems of university education in the world to-day has been argued both from that point of view and also from that of planning the development of the universities when the immediate post-war stress is relaxed. Even those most confident in the ability of the University Grants Committee, as it is now reconstituted and with its wider terms of reference, to handle all the problems of development and co-ordination that will arise, seem a little uncertain as to whether something more, at least an inter-university academic council, is required to ensure the maintenance of independence, in view of an obvious danger of bureaucracy and regimentation, while securing the co-operation in development that the grant of public aid on such a greatly increased scale rightly implies. It may be that the universities have yet to find the best form of co-operation in practice, but something more is required in addition to the creation of effective machinery to prepare a general plan of university development with generous Government financial support.

The implementation of such a plan requires a measure of co-operation between industry, the universities and the Government service in regard to the distribution of man-power in order to realize its purposes. It is not sufficient for the universities themselves to make appropriate adjustments between their teaching and research staff, or to secure that, as the Cotton Working Party insists, they have complete freedom as regards the scope and direction of fundamental research carried out in their laboratories. It is not even enough for individual firms to recognize that, for the time being, universities must be conceded priorities in regard to men for research and for teaching. A system of priorities in man-power, such as is indicated in the Barlow Report, cannot be left altogether to chance. It must be reviewed continually in the light of the changing situation, or of such appraisals as that suggested of the research association movement. When priorities are laid down authoritatively, there must be some means of ensuring that, without placing irksome restrictions on the movements of scientific workers themselves, conditions of service and remuneration are so balanced, as between the universities, private firms and Government departments, that there is no untoward impediment to the natural flow and distribution of scientific talent in accordance with the national interest. It would scarcely be possible in peace-time to impose restrictions that would prevent

sectional interests, whether private firms or Government departments, attracting to their service by reason of prestige or of financial advantage, some few scientific workers who, from the national point of view, might be better employed, for example, in academic research or teaching, without adversely affecting the mobility and interchange of men of science which the Barlow Committee on scientific staff recognizes as so valuable. The growing dependence of the universities of Britain on State support should, however, make it increasingly easier for the Government to ensure through the Royal Society or the University Grants Committee that conditions in the universities and in Government departments are sufficiently in balance with those in industry to maintain a steady and adequate stream of recruits of the highest quality.

ESSAYS IN NEW ECONOMIC TECHNIQUES

The Industrialisation of Backward Areas

By K. Mandelbaum, assisted by J. R. L. Schneider. (Institute of Statistics, Monograph No. 2.) Pp. viii+112. (Oxford: Basil Blackwell, 1945.) 10*s.* 6*d.* net.

Small and Big Business

Economic Problems of the Size of Firms. By Joseph Steindl. (Institute of Statistics, Monograph No. 1.) Pp. v+66. (Oxford: Basil Blackwell, 1945.) 7*s.* 6*d.* net.

MR. MANDELBAUM'S volume is a fascinating essay in quantitative planning of a type of which we may expect many examples in coming years. Poland, Hungary, Bulgaria, Rumania, Yugoslavia and Greece are to be industrialized at a rate surpassing that experienced in the leading industrial countries in the nineteenth century. The implications —income distribution among various classes, rates of growth of the various categories of industry, capital requirements for each, etc.—are worked out in considerable detail. In a sense the detailed figures are mere guesses, but they are based on good analogies, and there is an element of double entry present which serves as check. The work is scholarly, and in its quantitative aspect authoritative. Human, social and political difficulties are admittedly neglected.

Technical assistance is to be provided from abroad and £750 million of capital spread over five years; this represents more than half the new capital required. It is suggested that the foreign sources will charge the modest rate of 4 per cent per annum, to include interest and amortization. When one thinks of the sweat and toil and horrors of the Industrial Revolution in Britain and the ardours and starvation during the recent Five-Year Plans in Russia, one cannot but feel a little wistful—which is not the same as critical—at this proposed journey de luxe by South-East Europe to an increase of 50 per cent in its national income in no more than five years.

There are matters for criticism. There is no demographic 'model' to supplement those for production. An increase of 400,000 a year in the population is assumed. As one of the primary objects of the plan is to find employment for 8,000,000 hands at present surplus, there are grounds for anxiety about the future equilibrium. The birth-rate in these regions has been falling recently, but is still above the replacement level. It may be that the fall will continue down to Western European levels and that industrialization is likely to expedite the process. None the less one would have liked a full analysis both of birth- and death-rate trends with a view of forming some estimate of the total increase that may have to be catered for. Mr. Mandelbaum's methods may well be used as a model for plans regarding India and China; but in the case of those countries a demographic forecast is essential. Even if one takes the optimistic view that under the influence of industrialization the birth-rate in India and China will eventually reach, say, the American level, the fall in the death-rate owing to improved conditions is likely to cause such a vast increase of population during the transition as to reduce the whole experiment to absurdity—unless deliberate measures are taken in advance to reduce the birth-rate.

Mr. Mandelbaum's chart of industrialization is not a forecast but a plan. Private enterprise, it is recognized, is not likely to bring it about, even if stimulated by the protection of infant industry. The governments are expected to play an active part. This may well be necessary. When, however, Mr. Mandelbaum recommends deficit spending as a method, he errs gravely. Deficit spending has recently become a popular nostrum; but it has a firm foundation in scientific analysis, in the light of which its merits depend on there being in the country an excessive propensity to save. To take it out of its context and recommend it for countries where, by hypothesis, savings are altogether insufficient to meet urgent requirements is quite unjustifiable. It is much to be hoped that when the International Bank for Reconstruction and Development comes to formulate the conditions on which it will guarantee large loans for long-range projects—and South-Eastern Europe is clearly an eligible candidate for such loans—one condition will be that the government of the receiving country is not running an appreciable deficit.

The economic trends are applied too mechanically. When dealing with rates of progress outside experience it is necessary to consider whether the social adaptability of any people can stand such a strain. Furthermore, it is necessary to inquire whether the south-eastern European peoples in particular have capacity for work, technology and organisation—even with the aid of foreign assistance—that would be necessary for the plan. Their present backward condition is *prima facie* evidence of a deficiency of such qualities. It may, of course, be due, as Mr. Mandelbaum suggests, to political misfortunes and the competitive start gained by other countries. But this cannot be taken for granted.

Further, there is a deeper criticism. By what criterion is this development desirable? Is it enough to demonstrate that the standard of living would be raised? Economists are often taken to task for assuming without warrant that the maximum production of material goods should be our paramount aim. Careful economists are not open to the charge, since they introduce "the disutility of labour" or "the preference for leisure" as a determinant in their equations defining the economic optimum. From a Western point of view the impoverished and semi-employed condition of the south-eastern European peasantry may seem lamentable and pitiable. Mr. Mandelbaum would have their governments make a great drive to retrieve them. His scheme is an imposed plan; there is no safeguard enabling the people to opt in favour of a peaceful life. It is

ominous that Mr. Mandelbaum at one point is willing without sign of qualm to throw in double or multiple shift working to facilitate the progress of the plan. Will these peasants be happier living in urban dwellings, built at a cost of £175 each, and working through the night in a mill? The old economics insisted on freedom of choice in theory, although in many cases it was admittedly unreal in practice. It is a weakness, however, to give up the theory.

Mr. Steindl's monograph is nearer to reality and is of great immediate interest. Using American statistical data as a basis for generalizations regarding the relations of size, cost, efficiency and profit in business, he analyses the implications and mutual consistency of the generalizations with great skill. The trend of the argument is in favour of large size; on the other hand, when a certain size is reached, monopolistic or oligopolistic features in the situation may tend to retard progress. "There are sufficient grounds to believe that the cause of technical progress in the present stage of development is not well served by either big or small business. There seems to be something wrong with both of them."

Mr. Steindl has a fine mastery of analysis, and his book is an outstanding contribution. There is a small slip on pp. 37–38. He is right in holding that if we accept Keynes' theories there is no need in the existing situation to reckon interest on capital in, when measuring relative efficiencies; but he is wrong in implying, as he appears to, that we need not reckon in the amortization of capital either. The resources required for increasing capital intensity could always be spent on current consumption; their absorption is a genuine cost.

It must be recorded that in this volume, too, the human factor is neglected, less obviously but this time without any safeguarding disclaimer. Searching about for a reason why small entrepreneurs accept unusually high risks at low remuneration rather than become employees, Mr. Steindl lights upon the explanation that it is to maintain "a higher social status". It would be difficult to find a more striking example of complete disregard of the passions and values that animate ordinary people outside the study. Again, when persons prefer to deal with old customers, this is due to "force of habit, ignorance or laziness". This is the economic steam-roller with a vengeance! Luckily economic wants are not so pressing in the United States (from which the data for this study are derived) that people must needs sacrifice the more precious things of life in order to add somewhat to material income. Even the poor British may have some little room for non-economic aims.

TEXT-BOOK OF OPTICS

Optique Instrumentale

Par Prof. G.-A. Boutry. Pp. x + 540. (Paris: Masson et Cie., 1946.) n.p.

THE strength and spirit of the contemporary renaissance in French optics can be felt behind this admirable book, which carries its subject through more than five hundred pages without allowing the interest to flag. As the author explains in a preface, the treatment is based on his course of lectures in instrumental optics, given at the École supérieure d'Optique. Side by side with this course, the students receive another on optical computation, which subject is therefore omitted from the present treatise. For a similar reason, namely, the existence of Danjon and Couder's "Lunettes et télescopes", astronomical optics is only briefly dealt with. What is left, that is to say the main body of the subject, is set out with skill and enthusiasm in twenty-two chapters, of which the last six are separate monographs.

Perhaps the most valuable of these monographs is the one which treats of the visual microscope. Objective, illuminating system and mounting are given equality of status in the discussion, which is refreshingly practical in outlook. An account of the phase-contrast method is included, but this is below the standard of the rest of the chapter; Zernike's name is consistently misspelt in the text, and the captions of Fig. 340(*b*) and (*c*) are misleading. These two photographs actually illustrate the appearances with a 'positive' (that is, phase-advancing) annular strip and a 'negative' straight strip, and were used by Zernike in support of his view that for most purposes the annular form of strip is preferable.

In the first seven chapters of the book, the basic theory of centred systems is developed, always with an eye to practical application, from its beginnings through Snell's law (Descartes' law), focal lines and caustics, the Herschel and Abbe conditions, Airy's condition and the properties of spherical aberration and coma. Mathematical demands on the reader are kept down to the minimum throughout and no systematic account of the Seidel theory is attempted. Considerable space is devoted, on the other hand, to the details of Gaussian theory and its application to thick lenses. Chapters 8 and 9 set out the principles underlying the practical designing of achromatic doublets and of eyepieces.

The next three chapters deal with prism-trains and with cylindrical systems. An incorrect theorem on p. 217 (to which M. Boutry has directed the attention of reviewers) fortunately has no serious consequences later.

Chapters 13 and 14 are devoted to the human eye and the amelioration of its defects; a welcome feature is the short but valuable section on visual acuity. Chapter 15 is of a more miscellaneous character; under the title "geometrical properties of visual instruments" are discussed such questions as field-size, depth of field, perspective and relief, and image-brilliance in different parts of the field.

The main part of the book concludes with a chapter on resolving power. In its lucidity of exposition, and in the ground it succeeds in covering with the help of very little mathematical formalism, this chapter is one of the most striking in the book. Especially helpful is the way in which the author himself raises and tries to meet the honest doubts which are likely to assail a thoughtful student confronted for the first time with the Huyghens–Fresnel theory.

The attitude to the subject which vitalizes the whole book is expressed in a few pregnant sentences in the preface, which are worth quoting here. After pointing out that students must contrive to assimilate in succession the two very different outlooks of geometrical and of instrumental optics, M. Boutry goes on: "Leur préparation est complète dès que, rompus et assouplis, l'expérience et l'expérience seule aura pu leur enseigner la manière dont on doit, en pratique, fondre les deux dogmes. Aucun autre professeur ne peut terminer leur formation: c'est confesser peut-être que l'Optique instrumentale reste un art; cela ne diminue point les hommes qui la créent chaque jour."

E. H. LINFOOT

BIOLOGY IN SOVIET RUSSIA (1917–42)

Advances in Biological Sciences in the U.S.S.R. within the Recent 25 Years, 1917–1942

Symposium. Editor-in-Chief: L. A. Orbeli. (In Russian.) Pp. 356. (Moscow and Leningrad: Academy of Sciences of the U.S.S.R., 1945.) 26 roubles.

THIS volume, compiled by some thirty authors, represents an attempt to summarize the work in the main branches of 'pure' biology, carried out in Soviet Russia during the period 1917–42. The summaries cannot be called critical, and their main aim is made abundantly clear by the introductory sentences to each section, which all plainly stress, in monotonous similarity of words, that the blossoming out of every particular branch of biology followed the Revolution and was due to the Soviet attitude to science. Completeness of the record of achievements is not claimed in the preface, which indicates that war-time difficulties made it impossible to obtain summaries of the work in a number of biological sciences. As a result, the volume lacks summaries on geology, experimental biology and genetics, to mention only the most conspicuous gaps.

Individual contributions vary from comprehensive reviews of the main results obtained by Soviet scientific workers in a particular branch of biology, to mere lists of authors and subjects. Such lists might have been of great value to men of science of other countries, but unfortunately throughout the volume no references are given, except by the author's name and the date; a number of, apparently, important papers are quoted from manuscript. An accurate bibliography of all the publications mentioned in the text would have, probably, occupied fewer pages, while supplying an incomparably more useful record of the progress of Soviet science. The need for such bibliographical work is pointed out in the conclusion to the summary on zoological systematics and faunistics, where it is stated (p. 183) that ". . . the recognition of achievements of Soviet science is not always proportional to the actual value of the work; we often meet with an under-estimation which has a political basis and is due to unwillingness to draw attention to achievements of Soviet science in particular. However, in many cases, the underestimation of achievements of Soviet science is, so to speak, due to technical reasons, for example, simply to the lack of knowledge about the respective works, and in many cases the fault is ours." A footnote explains that in 1937 only about 25 per cent of Russian papers were quoted in the *Zoological Record*, whereas in 1913 the percentage was about 50. This is ascribed to the interruption of the work of the Bureau of International Bibliography at the Academy of Sciences, a point worthy of the attention of international bodies concerned with scientific bibliography.

It would be impossible to review all sections of a volume of this kind, but brief indications of the main items may be useful.

The section on physiology contains articles by L. A. Orbeli, A. G. Ginecinsky, A. V. Tonkikh and M. I. Vinogradov, on nervous physiology; by N. P. Rezviakov on electrophysiological investigations; by A. G. Ginecinsky on vegetative processes; by G. V. Gershuni on sense physiology; by E. M. Kreps on comparative physiology; and by A. G. Ginecinsky on physiology of embryos.

Advances in biochemistry are summarized by V. A. Engelhardt, who stresses that the development of this branch of science in Russia has occurred almost entirely during the Soviet period.

The chapter on animal systematics and faunistics, by twelve authors, is the longest in the volume and consists mainly of an enumeration of books and papers dealing either with taxonomic groups or with various local faunas. The lack of references in this section is particularly serious, since it helps a taxonomist little to know that a revision of a genus in which he is particularly interested was published by a Russian author in 1938, if there are no means of finding a reference.

As already stated, a summary on geological work is missing, and only palæontological achievements are reviewed by A. A. Borisiak (palæozoology) and by A. N. Krishtofovich (palæobotany).

Botanical sciences are represented by summaries on systematics and floristics, by B. K. Shishkin; on plant ecology, by E. M. Lavrenko; on plant physiology, by N. A. Maximov; and on microbiology, by B. L. Isachenko.

The last section of the volume deals with the theoretical principles of medicine, and includes summaries by A. I. Abrikosov (pathological anatomy), N. N. Petrov (malignant growths, especially cancer), and N. N. Anichkov (pathological physiology).

INTRODUCTION TO ALTERNATING CURRENT MEASUREMENTS

Alternating Current Measurements at Audio and Radio Frequencies

By Dr. David Owen. (Methuen's Monographs on Physical Subjects.) Second edition, revised. Pp. vii + 120. (London: Methuen and Co., Ltd., 1946.) 5*s*. net.

THE present author maintains the quality of the many preceding monographs on basic up-to-date physics, but does not quite give that aspect the electrical engineer requires, although the material may be ideal for educational purposes in *ad hoc* physics. The practising engineer looks on electrical measurements as a tool to enable him to do something else, to get data to assist him in solving his problems. Thus, while the author gives an excellent survey of the basic circuits which are usable for the regular measurements of the usual electrical parameters, including frequency, with their proofs, he is not always clear in describing their limitations, especially when measurements above 1000 cycles per second are demanded. While he gives a clear exposition of the principle of the Wagner earth, he nowhere else insists on an earth connexion to a suitable point in his circuit; neither is the reader warned about the necessity of shielding inductances and other components, and told where the shield should be connected. All these are vital practical points affecting the possibility and accuracy of an electrical measurement.

Nevertheless, within his scope the author has laid foundations which should put a student in a good position to understand the basis of practice when he meets it in non-educational laboratory work, and should prompt him to exercise ingenuity in devising measurements when he is faced with the usual problem in industry, the paucity of high-grade measuring apparatus.

L. E. C. HUGHES

EXPANSION OF PLANT SYSTEMATICS

THE Systematics Association held a very successful meeting at the Herbarium, Royal Botanic Gardens, Kew, on the afternoon of October 5. Members were welcomed by Sir Edward Salisbury, director of the Gardens, who briefly outlined the long service of Kew to plant taxonomy and the intimate co-operation between the various departments with the common aim of advancing research in the many problems of plant classification. He was pleased to see such a large attendance, and was certain that the exhibits so carefully prepared by members of his staff would arouse much interest.

The theme underlying the series of exhibits was to illustrate examples of the diversified problems involved in plant systematics, the various methods of investigating such problems, and some of the results obtained. The exhibition occupied the ground floors of two of the large wings of the Herbarium, and consisted of living plants, herbarium and museum specimens, microscopic preparations, books, manuscripts, diagrams, charts, and maps, with considerable and pleasing individuality shown in the arrangement of the various subjects. In spite of the intentionally wide range covered by the sum of the exhibits, the general *motif* of plant classification obviously unified the whole series.

The history of the progress of botanical taxonomy from 370 B.C. to A.D. 1946 was illustrated by a collection of books and manuscripts selected from the Kew Library, which now contains more than 50,000 volumes. Many rare and valuable works were shown, and emphasis was laid on those which marked noteworthy advances in plant classification. Another series of botanical books (about thirty in number altogether) showed something of the activities of the Kew staff in very recent years. Attention was directed to the large exhibition of paintings and drawings demonstrating the history of botanical illustration from 120 B.C. to A.D. 1946. A selection of original paintings for the *Botanical Magazine* and of paintings of dissections of plants difficult to preserve adequately showed the value of hand-colouring in the making of permanent records of living plants. The importance of drawings in the revision of genera was exemplified by *Sphæranthus*, *Camellia*, and *Streptocarpus*. A selection of original drawings, with dissections, for a new work on the British Flora now in preparation were remarkable for their combination of artistic merit with scientific accuracy and adequacy.

Two large families, those of the orchids and the grasses, served to illustrate the difficulties of classification due to incomplete correlation in different categories of characters. In *Polystachya*, a large genus of Orchidaceæ, only some of the accepted sections are natural in the sense of being based on a full correlation of characters. Other sections are distinguished by only one or two characters and show much reticulation with other sections. The tribes and genera of the Gramineæ provide even more striking examples of reticulation. This was illustrated by the spicate inflorescence in relation to a wide range of other morphological, anatomical, and cytological characters. The emphasis, in earlier classifications of the grasses, on the gross structure of the inflorescence resulted in some very unnatural groupings. By taking a more synthetic basis, a much more generally satisfactory division into major tribes has been obtained, though problems of parallelism and reticulation still remain, especially those of causal and phylogenetic interpretation. *Lepturus* and segregated genera represent particularly well some of the problems involved and their possible solutions. The desirability of major changes in classification was also made clear in the genus *Carex*, which has more than a thousand species. Detailed morphological and distributional studies have suggested classificatory sequences which reveal possible phylogenetic lines linking tropical and temperate species. Problems of 'relationship' were further demonstrated by the occurrence of similar characters in groups widely sundered in well-known systems of classification. For example: Symplocaceæ, Rosaceæ, and Theaceæ; Anonaceæ and Aristolochiaceæ; Ochnaceæ and Primulaceæ; and Magnoliales, Hamamelidales, Aceraceæ, Platanaceæ, and Lauraceæ respectively show some characters in common. *Pentaphragma* has been referred to both Campanulaceæ and to Saxifragaceæ, and, more recently, has been made the type of a new family, Pentaphragmataceæ, which anatomical characters suggest may be related to Begoniaceæ. On the other hand, a long-established group like the Glumifloræ is probably based on superficial resemblances, particularly of habit: the sedges and rushes are better classified with or near to the Liliales, and the grasses perhaps placed near the Zingiberales. Odour is determined by chemical constituents of plants; similarities in these are, or may be, taxonomically valuable characters. It is, at least, not to be ignored that 'valerian' odour occurs in *Valeriana* (Valerianaceæ), *Viburnum* (Caprifoliaceæ), and *Pentstemon* (Scrophulariaceæ), and the 'fenugreek' odour in *Trigonella* (Leguminosæ) and *Lysimachia* (Primulaceæ).

Similar difficulties to those met with in classifying seed-bearing plants also occur in the Cryptogams, sometimes with further complications. The genus *Psalliota* (the mushrooms proper) consists of 'species' or 'microspecies' extremely difficult to separate one from another by any definite, and constant, characters. With such fleshy organisms, adequate paintings of living plants are essential as permanent records. In the smuts, so-called 'physiological races' occur which are morphologically indistinguishable but are limited to different hosts; while, conversely, on the same host morphologically distinct kinds may occur. Hybridization frequently complicates the work of the taxonomist, and the occurrence of hybrid swarms is being frequently proved. The Robertsonian saxifrages, as they occur in western Ireland, were used to exemplify, by a fine series of recently collected specimens, the possibilities of unravelling the tangle resulting from interspecific crossings. The results of controlled hybridization combined with cytological investigation were indicated by living plants, dried specimens, and paintings, in: *Saccharum* × *Sorghum* hybrids; × *Sacchariantus coimbatoriensis* ($2n = 132$), a hybrid between *Saccharum spontaneum* ($2n = 112$) and *Erianthus ravennæ* ($2n = 20$); and × *Euchlæzea mertonensis* ($2n = 30$

and $2n = 40$), a perennial hybrid between *Euchlæna perennis* ($2n = 40$) and *Zea mays* ($2n = 20$). Seeds and living plants of *Ricinus communis* from Manipur State showed the genetic nature of certain 'varietal' characters. The cytology of species of *Magnolia* has proved the existence of diploids ($2n = 38$), tetraploids ($2n = 76$), and pentaploids ($2n = 95$), and correlation between the chromosome number, geographical distribution and morphological features.

Taxonomic investigations can only be adequately conducted at a large central institution, since taxonomy is essentially a comparative study, and large series of specimens are a *sine qua non* for reaching sound conclusions. It follows that the taxonomist is dependent in a very large degree on field collectors —and to well-trained collectors he owes a great debt. The need for much more intensive collecting, particularly in tropical areas, throughout the seasons in any one locality was well shown by an exhibit of precocious development in tropical African plants of savanna communities. In many species the flowers and leaves develop at different seasons, and a travelling collector often collects only flowering or only vegetative material. To know the seasonal life-history is a taxonomic need. This was further illustrated by some South American plants with comparisons between seedling and adult states (*Chondodendron candicans*, *Cassia* spp., *Catostemma* spp., and *Apeiba petoumo*). Juvenile characters may, or may not, be apparent in the mature plant, but are always of taxonomic importance. Ontogeny was also illustrated by living sporelings and beautiful microscopic preparations from fronds of different ages of the fern-royal (*Osmunda regalis*). The nature of the venation and the outline changing with increasing age were very clearly demonstrated.

The taxonomist is always concerned with distribution, both as a help in understanding causes and for its own sake. Two exhibits were concerned with plant geography. The phytogeographical regions of extra-tropical Eastern Asia were illustrated by large- and small-scale original maps showing correlations between the ranges of taxonomic groups and plant communities, physiography, and climate. Specimens of *Notholirion*, *Pæonia*, *Nomocharis*, *Malus*, *Tulipa*, *Tripterygium*, and *Camellia* were chosen as examples of the researches on which the synthetic results have been reached. The great sub-continent of India has not only a rich endemic element of its own but also has received floristic contributions from neighbouring lands, especially from the east and north-west. Emigrants (generic or specific) from the Eastern Mediterranean flora are well marked in the Cruciferæ, Fumariaceæ, Capparidaceæ, Caryophyllaceæ, Rosaceæ, Labiatæ, and Boraginaceæ. Routes of migration were shown on a map, and migrants selected from the above-mentioned families were used in illustration.

In modern taxonomy, full and carefully prepared descriptions are demanded. Sometimes statistical methods can be applied with advantage. Unfortunately, the combination of taxonomist and biometrician is rare, and few statistical methods have been devised for the special use of the taxonomist. The attention of biometricians might well be directed to this fact. The genus of the elms (*Ulmus*) has recently been investigated by the use of new criteria based on specially devised statistical methods, and an exhibit illustrated these methods and the results obtained by their use.

While much taxonomic work has to be based on gross morphology, there is increasing recognition of the need for correlating this with anatomical structure. Anatomical methods have great use, and some acknowledged limitations, in taxonomy, as have all taxonomic methods in isolation; but the forthcoming publication of a new work, prepared at Kew, on the anatomy of Dicotyledons will stimulate interest in the subject. An exhibit illustrated the diagnostic value of the internal microscopic structure of the leaf, petiole, stem, and secondary xylem, as well as that of microchemistry.

Taxonomists working at Kew are fortunate in having not only the great collections in the Herbarium and Library at their disposal, but also in being able to study a wide selection totalling some 45,000 species (excluding culti-species) in the living condition in the Gardens. The need for experiments, with taxonomic aims in view, on living plants is fully realized, and it is intended to increase facilities in this direction. One exhibit illustrated the need for caution in reaching taxonomic conclusions previous to such experiments. Transplant experiments with *Plantago major* have shown the high plasticity of this species and proved that some so-called 'subspecies' and 'varieties' are no more than 'habitat forms'. In *P. coronopus*, phenotypic diversity is even greater than it is in *P. major*, but until controlled experiments have been made, the separation of genetically distinct varieties and habitat phenotypes of one genotype is impossible.

Taxonomy has to serve all branches of biology—hence its basic importance. A convincing demonstration of its use in applied botany was provided by an arrangement of specimens of *Sorghum* and *Cymbopogon*. The former genus gives one of the world's most important cereals, providing a staple food to millions of human beings as well as to livestock. For many years there was much confusion over the numerous cultivated species and varieties. An intensive and extensive study at Kew resulted in the production of a standard monograph which has been invaluable to economic botanists. *Cymbopogon* is a genus of grasses yielding essential oils. Previous to a detailed taxonomic study, it was not possible with certainty to determine the source of any particular oil derived from a species of *Cymbopogon*.

Particularly striking general features of the exhibition, as viewed by a visitor, were the wealth and diversity of the interesting problems raised by studies grouped as taxonomy, the almost innumerable treasures housed yet accessible at Kew, the considerable progress being made in taxonomic research, and the broad outlook shown by the modern taxonomist, with his full appreciation of the help he can give to and the help he can obtain from his colleagues in other branches of biology. Visitors engaged in the teaching of biology must have received many suggestions.

At the business meeting, the Systematics Association was placed on a firmer foundation than hitherto by the adoption of a simple set of rules. All biologists interested in problems of classification and evolution are invited to join the Association and take part in its increasing activities. Particulars can be obtained from the secretaries: Dr. R. Melville, Royal Botanic Gardens, Kew, Surrey, and Mr. H. W. Parker, British Museum (Natural History), South Kensington, S.W.7, or from the treasurer: Mr. E. B. Britten, British Museum (Natural History).

METHODS FOR MEASURING STRESS AND STRAIN IN SOLIDS

IN present-day engineering design, a stage has been reached when, not content with vastly improved materials and design procedure, the engineer must know the actual stresses throughout the machine or structure when under test, in order that weaknesses can be corrected in production models and avoided in future designs. Thus the designer, by a method of 'successive approximation', progresses towards the ideal of equal life for every part exemplified by Longfellow's famous "One Horse Shay", every part of which collapsed simultaneously after long service.

In aircraft, every pound of unnecessary weight in the engine or airframe means a pound less payload. Consequently, in aeronautical design more than any other branch of engineering, weight must be pared to the very minimum compatible with safety; while, on the other hand, the probability of a fatal accident if some part or other is of insufficient strength is far higher than in other forms of transport. It is axiomatic, too, that greater speed calls for greater precision in design. That safety has not, in fact, been sacrificed for lightness is shown by the fact that not more than 1 per cent of the accidents to civil aircraft are attributable to structural failure.

It is an official requirement that, before a particular aircraft design is approved, the test structure—in particular the wings—must withstand 1·2 times the design load without failure. For this purpose, a prototype is tested in a large straining frame. During the test, as much information as possible is collected about the distribution of stress, so that any possible weakness can be eliminated with the least delay.

Until quite recently, the only apparatus available for measuring strain during test was some form of visual-reading extensometer. The number of stations at which readings could be taken was extremely limited under these conditions, and the process of taking readings very tedious. A desperate need was felt for some type of strain gauge which would enable a very large number of readings to be made in a short time at each stage of loading. This need has at last been met, by the invention of the electrical resistance strain gauge and of the acoustic strain gauge.

The electrical resistance strain gauge has the following great merits: (1) it is very light and compact; (2) it can be placed in almost any position, for example, inside a wing, on thin sheet and curved surfaces; (3) once stuck on, it requires no further attention; (4) no mechanical adjustment is required; (5) electrical recording lends itself to making a very large number of readings in a short time; (6) all readings can be taken at a central control point; (7) it lends itself to autographic recording, and can be used with automatic switching devices; (8) it can be left in position ready for a repeat test at any time; (9) it can be used for recording rapidly fluctuating stress, and is practically free from inertia effects; (10) if three such gauges are combined, owing to the short gauge-length the principal stresses can be computed without previously knowing their directions; (11) if a sufficient number of gauges are used, analysis of the stresses in every part of the structure can be made.

The rapid progress in recent years in the invention of accurate and convenient apparatus for measuring strains played no small part in the improvements in aircraft and other design during the War, and the Manchester Branch of the Institute of Physics arranged a conference on the subject during July 11–13. Technicians in widely different industries have not been slow in following the lead of the aircraft industry in applying the electrical resistance strain gauge to their special problems, and the first session of the conference was devoted to the characteristics and applications of this type of gauge.

It had been the intention to cover not only the gauge itself, but also a full discussion of the electrical systems employed in different circumstances; unfortunately, due to the unavoidable absence of Dr. E. P. George, of the G.E.C. Research Laboratories, and of Mr. A. Cogman, of the de Havilland Aircraft Co., Ltd., comparatively little discussion was heard of the electrical technique*. However, Mr. E. Jones's paper on "The Physical Characteristics of Electrical Resistance Strain Gauges" aroused lively discussion.

Mr. Jones, after mentioning that the change in resistance when a fine wire is strained is only partly due to the changes in dimensions, but also depends on the change of resistivity of the material from which it is made, gave reasons for preferring cupro-nickel to nichrome wire. The latter is not easy to solder, and, due to the greater temperature coefficient of resistance, the temperature matching of nichrome gauges must be fifty times as good as that with eureka. Seventy per cent of the gauges made of eureka wire are found to give linear response up to 5 per cent strain. After describing various methods used for manufacturing these gauges, Mr. Jones discussed the technique required to minimize errors. The gauges are stuck in the prepared positions using cellulose acetate cement. For each measuring gauge, there is a dummy gauge for temperature compensation, mounted on unstressed metal in thermal contact with the test piece. Each pair is selected by matching, so that, by arranging the measuring gauge and the dummy in adjacent arms of a Wheatstone bridge, and applying a suitable voltage, the gauge resistance is compensated for temperature changes. To prevent serious zero drift, the gauge current should not exceed 35 milliamp. in static tests, but for dynamic tests larger currents are permissible. For high-precision measurements, as for observing wind-tunnel forces, the current is limited to 5 milliamp. It is always necessary to allow sufficient time (say half an hour) after switching on the current for a steady condition to be established. In practice, an extension of 1 per cent in metals is seldom measured. The upper limit of frequency for accurate response is estimated at about 10^5 cycles per second in the case of rapidly varying strains. There is a gradual zero shift with repetition of dynamic strain.

A serious problem frequently encountered is that of protecting the gauge from moisture, since, due to the high gauge resistance, very good insulation is essential for avoiding error due to leakage. Nevertheless, by covering the gauge with a special wax, it can be made to function successfully even under water. In this connexion, Mr. H. Bull, of S.R.E. Admiralty, mentioned instances of gauges applied to ships' hulls for the study of stresses in the neighbourhood of welds. The plate on which the gauge is already fixed is heated to 125° C., using infra-red lamps and, immediately on removing these, a protective wax is

* A good description of the principles of this gauge was given by Dr. A. C. Redshaw before the Royal Aeronautical Society on March 28, 1946. Many papers on methods of application have been published in the *Proceedings of the Society for Experimental Stress Analysis*, U.S.A.

poured over the gauge, thus excluding all moisture. Gauges so prepared have worked well in sea-water over a long period. Other speakers discussed the effect of thickness of adhesive on the steady temperature difference between gauge and test piece. Dr. A. C. Redshaw reported favourably on a new type of woven gauge in which the wires are interrupted and carry end connexions at regular intervals for ensuring uniformity. These gauges, in which the wire is interwoven with artificial silk, he had found to give remarkable consistency.

Mr. E. Jones, questioned as to the adaptability of the normal type gauge to curved surfaces, said that they can be used on curvatures down to $\frac{1}{2}$-in. radius. The usual gauge-length for aircraft structures is $\frac{1}{2}$-in. or larger, but gauges no longer than $\frac{1}{16}$ in. have been successfully employed for special jobs.

Strain gauges are conveniently adapted for many different types of measuring instrument. The exhibits shown by the Royal Aircraft Establishment, Farnborough, included dynamometers, manometers, micrometers, and accelerometers which record by this means. It was pointed out that the ring type of dynamometer affords perfect temperature compensation, as the compression gauges mounted opposite those in tension eliminate the necessity for dummy gauges. Dr. E. Orowan (Cavendish Laboratory) gave a brief description of a cylindrical steel pin, about 2 in. in diameter, forming part of a rolling mill bearing, which had been machined away in four places for longitudinal gauges, the compensating gauges being in a circumferential groove. This device is being used for measuring the forces and torques during rolling operations. As the economics of steel mill operation demand that the rate of rolling should be as high as possible without overstressing the mill, an accurate knowledge of these forces is of great importance.

Technicians concerned with the measurement of rapidly changing stress have not been slow in exploiting the great possibilities of the strain-gauge, with its ease of installation, lightness, freedom from inertia effect and robustness as compared with mechanical tensometers. By transforming strain directly to change of electrical resistance, all mechanical parts can be eliminated, and the gauge signal is readily recorded, either by a high-frequency galvanometer or, after suitable amplification, on a cathode-ray oscillograph.

Equipment of this kind is already in use for studying the fluctuations of strain in aircraft propeller blades, strains due to gusts, manœuvres, and landing in aircraft, for industrial machinery of widely varying types, the performance of fatigue testing machines, and so on. The choice of amplifier depends on the particular application, and frequency modulation is often employed. The L.M.S. Research Laboratories reported at the conference that, using a high-frequency carrier, they can record at 100 yd. from the gauge.

Another interesting form of strain gauge, namely, the acoustic strain gauge, was discussed by Mr. Bull, of S.R.E. Admiralty. These gauges were first tried in Germany. In Great Britain, the Steel Structures Research Committee was the first to use them. The present form of gauge, due to the Building Research Station, has given excellent results in the hands of the Admiralty (S.R.E.) Shipwelding Party and on steel bridges. Mr. Bull said that with acoustic gauges the return to zero is much better than with resistance gauges. The gauge consists of a stretched wire, the natural frequency of which varies with the strain. The latter is measured by the pitch of the note given out when the wire is excited. This is obtained by the beat method, using a master gauge having a micrometer tensioning head. Alternatively, a cathode-ray tube may be used, in which the two oscillations are connected on the x- and y-axes and brought into step. Aural matching, though quite feasible, is rather trying to the nerves. Owing to the necessity for long-distance recording, an elaborate system of post-office type selection with satellite points and master control was adopted. Six hundred of these gauges could then be recorded in the space of two hours. Though not nearly as fast as some resistance-gauge systems, this rate of recording is certainly a great feat. In the application of this method to welding investigations in ships' plates, one of the practical drawbacks is the magnitude of the temperature stresses which occur in day-time. Most of the work, therefore, must be done in early morning or late evening.

Mr. R. S. Jarratt, of the Building Research Station, described the application of acoustic strain gauges to the measurement of strains in bridge girders. He suggested that the gauge signal, being of audible frequency, could, if required, be transmitted by radio, so reducing very much the amount of screened cable required for distant recording. Using screened cable, the Building Research Station has recorded at a distance of 600 ft.

The morning session on July 12 was devoted to photo-elasticity. The present writer contributed a paper entitled "A Review of some Recent Developments in Photo-elasticity", a summary of which follows :

Advances in equipment and materials have been mainly due to the replacement of Nicol prisms by 'Polaroid' and to the use of synthetic resins having high stress-optical coefficients. The glyptal 'bakelite', known as *BT* 61–893, has excellent properties, but is in very short supply. Glass-clear phenol-formaldehyde resin can be more readily obtained and has a high stress-optical sensitivity.

Improvements in the technique of preparing models, due mainly to Frocht, have made possible the accurate observation of boundary stresses in plane models.

Three separate methods have been employed for solving 3-dimensional problems—the 'freezing', the 'scattered light', and the 'composite model' methods. The most adaptable of these is the 'freezing' method, for which either 'Bakelite' *BT* 61–893 or phenol-formaldehyde resin (for example, 'Catalin' 800 glass clear) can be used. When heated the material reaches a softened condition in which Hooke's Law is accurately obeyed, but the Young's modulus is of a much lower order than at room temperature. The stress-optic law has been shown to hold accurately in this condition. A three-dimensional model is heated to the softened condition (to about 110° C. in the case of *BT* 61–893 and about 80° C. in the case of p–f resin) and the load applied. After maintaining the temperature for some 15–30 minutes to allow the strain to reach a steady condition, the model is cooled to room temperature. The model thus 'sets' or 'freezes' in the strained condition, and on removal of the load, loses only a small proportion of its strain and birefringence. If a plane slice is cut out of the model (using fine cuts and a cooling fluid), it will show the fringe pattern corresponding to the stresses existing in the complete model.

As shown by Hiltscher (1938) the 'frozen' birefringence can be measured by examining a slice (3 mm.

thickness) in convergent light, using a polarizing microscope in exactly the same manner as for crystals. This method will give, for any point, in a slice taken in any direction in the model, the orientation of the three principal stresses, their order of magnitude, and the value of the three principal shear stresses. The chief drawback of the 'freezing' method generally is the production of edge stress in heating, and research is needed into methods for preventing its occurrence.

In the 'scattered light' method, due to Weller, a narrow collimated beam of polarized light is passed through the model, and fringes in the interior of the model can be seen by viewing at an angle to the direction of the beam, owing to the effect of scattering.

The 'composite model' method, originally suggested by Favre, as its name implies, uses a model built up of two materials (having the same elastic modulus). An inner, birefringent section is encased in an outer part which has no stress-birefringence, so that the stresses in the middle part only of the 'sandwich' are shown.

For separation of the principal stresses at interior points on a plane model it is necessary, by some means or other, to determine $P + Q$, the *sum* of the principal stresses. The isochromatic order, shown by the fringe pattern, gives $P - Q$ only. The classical method for finding $P + Q$ is that of the lateral extensometer as designed by Coker. Three alternative methods were reviewed by the present writer, namely the 'Four Point Influence Method'—a process of relaxation—the 'Method of Oblique Incidence' (as used by Drucker), and the individual measurement of the principal stresses by means of an interferometer.

Some instances of the application of photo-elasticity to special problems were discussed by the author. Perhaps the most valuable photo-elastic work of all has been the determination of stress concentration factors at holes, notches, and fillets, of great importance where components are subjected to repeated or reversed loading.

Mr. H. M. Ross (Kodak, Ltd.) followed with a colour film illustrating stress in a rail and chair under fluctuating loads, and a remarkable slide showing, in colour, the stress waves resulting from the impact of a hammer on a nail embedded in a block. He also described techniques for photographing fringes.

Next, Dr. E. Orowan described briefly an ingenious combination of photo-elastic and photo-electric technique for showing the fluctuations in load in a rolling mill. The skill with which Dr. Orowan applies scientific technique in such unpromising surroundings deserves great admiration.

The discussion on photo-elasticity centred mainly around the behaviour of materials during the 'freezing' process. Photo-elastic observations represent purely elastic conditions of stress, and, for singly connected bodies, the stress distribution is then exactly as in the prototype, being independent of the elastic constants.

On the important question of how exact the collimation should be, Mr. Heywood stated that the fringe patterns shown in an exhibit of pieces of mechanism in 'Bakelite' prepared by Rolls Royce had been made without a collimating lens. There was not the least blurring of the fringes in these photographs. As the interest in any given model usually centres around a small portion of the boundary, indistinctness due to imperfect collimation can be avoided by bringing this portion into the centre of the field.

Several speakers emphasized the need for a full exploration of the possibilities for improving the materials at present available, and directed attention to the difficulty in obtaining photo-elastic glyptal resin in Great Britain. The need for closer contact between those especially interested in photo-elasticity was recognized, and the possibility of forming a photo-elastic group, or society, in the near future, to create an opportunity for workers in this field to meet and exchange views on questions of materials and technique was discussed [see *Nature*, October 5, p. 478].

The afternoon session on July 12 must be passed over very briefly. Mr. D. E. Thomas (Armament Research Dept.) and other speakers described the application of X-ray technique to the measurement of strain in metals. To avoid surface stress due to machining, it is necessary to remove the surface layer by etching to a depth of 0·01 in. Members of the Admiralty Staff further described portable X-ray apparatus for taking strain measurements on welded ships' plates, etc. It was pointed out that the X-ray method is the only non-destructive way of determining surface residual stresses.

Mr. C. E. Phillips (National Physical Laboratory) described different mechanical-optical extensometers, the variety of which appears to be almost infinite. He said that each different type of problem calls for a special design. He also made the point that *stress* is not a measurable quantity. We strain a material, and this induces a stress in it; but it is *strain* which must always be measured. Even in applied photo-elasticity, one feels, with all due respect to Coker and Filon, that it would be more correct to speak of a 'strain-optical' than of a 'stress-optical' effect. Nevertheless, in many materials, when they are stressed beyond the limit of proportionality, the birefringence follows the *stress* more closely than the *strain*. In such a question, the microscopic heterogeneity of the material no doubt plays an important part.

Remembering Griffith's remarkable results on the strength of glass fibres, one is forced to the conclusion that the *strength* of a material in the mass is entirely a statistical effect. Similarly, examination of single crystals of ferrite shows widely different maximum and minimum values of Young's modulus, and these values differ from that for an aggregate of crystals.

It is clear that those quantities which form the entire basis of the engineer's calculations—strength, elastic modulus and stress—are, after all, statistical quantities applicable only to material in the mass. It is indeed fortunate for the engineer that, in respect of these quantities, his materials exhibit such high homogeneity and isotropy.

There are still many questions to be resolved regarding the transition from X-ray results to engineering quantities. In the application of these methods (as in that of many others) to industrial problems, one must guard against the tendency—all too common—to regard them as a machine which must automatically give the right answer. It is not the tool itself, but its intelligent and skilful application, which produces reliable results.

The exchange of experiences and information afforded by a conference such as that held at Manchester is one of the best ways of acquiring mastery in the application of modern methods. The Manchester Branch of the Institute of Physics and, in particular, Dr. F. A. Vick, are to be congratulated on the success which attended their efforts.

W. A. P. Fisher

ANALYSIS OF THE ELECTRICAL RESPONSE OF THE HUMAN CORTEX TO PHOTIC STIMULATION

By W. GREY WALTER, V. J. DOVEY and H. SHIPTON

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IN 1934, Adrian and Matthews[1] showed that rhythmic electrical potential changes could be recorded from the occiput in man when the subject's eyes were illuminated by a bright flickering light. These electrical rhythms were shown to be generated by the visual projection areas of the brain, and their relation to the spontaneous 'alpha rhythms' of the human electro-encephalogram, which they sometimes resemble, has often been discussed.

Both on theoretical grounds and from the observations reported below, it seems likely that the resemblance between the rhythms evoked by photic stimulation and those occurring spontaneously in the resting subject is superficial, though there is a subtle and complex relationship between them.

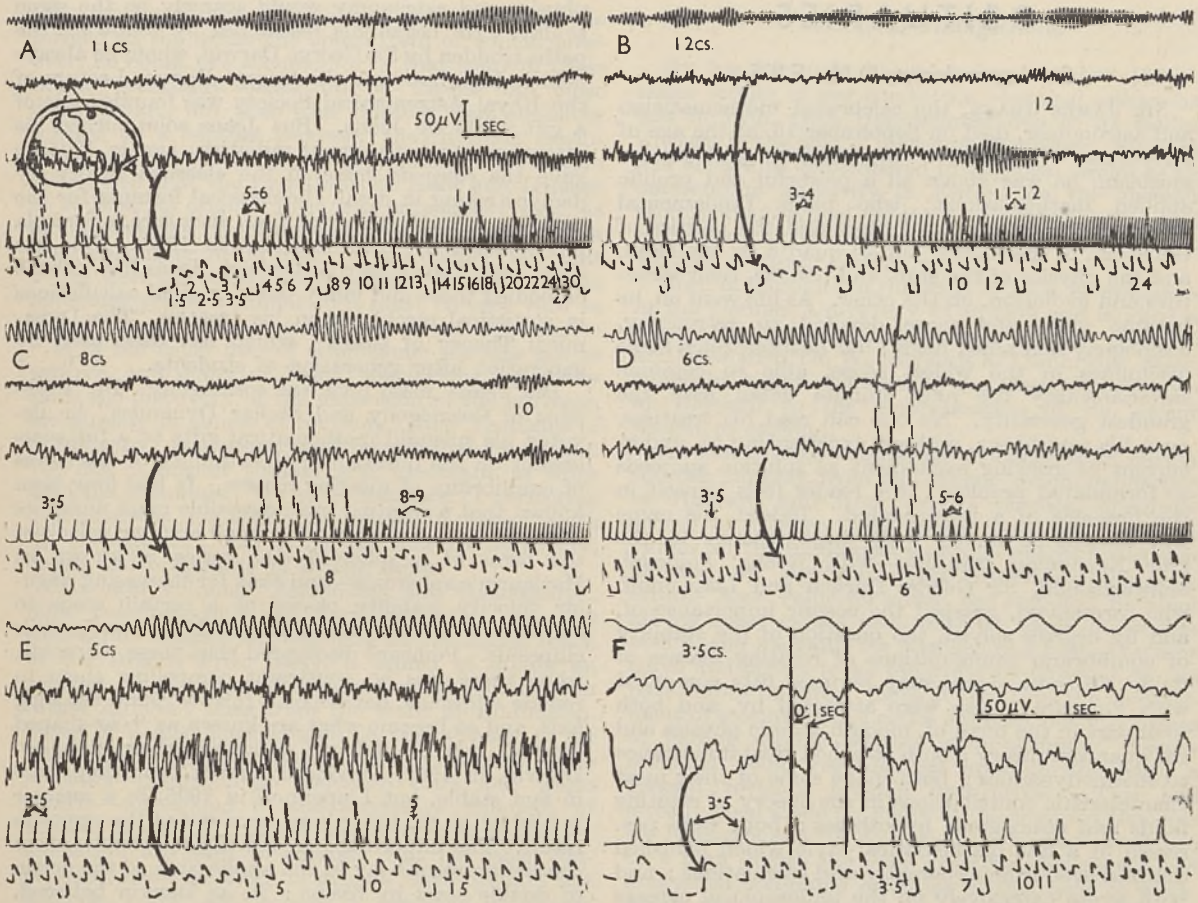
There are two technical difficulties in studying the evoked potentials. First, it is desirable to provide a bright source of light which can be made to flicker at frequencies between one and a hundred flashes per second without variation in intensity or duration of each flash. Such a source is now available in the form of the 'high power stroboscope' (for example, the instrument manufactured by Scophony, Ltd.) in which the duration of the flash is of the order of 10 μsec. The second difficulty is that the evoked potential changes, like the spontaneous ones, are usually too complex to be interpreted by the unaided eye[2]. The combination of rhythmic stimulation with frequency analysis of the resulting records provides a sensitive method of studying central nervous activity. Its value in animal experiments has already been demonstrated by the workers in the Brain Institute in Moscow under the direction of Sarkisov, using very tedious mathematical analyses[3,4]. The system of continuous automatic analysis described by Walter[5,6] and Baldock and Walter[7] considerably extends the scope of interpretations. With this equipment the frequency analysis of the primary trace is automatically inscribed as a band spectrum on the same record every ten seconds in a contrasting colour (shown dotted in the records reproduced). The frequencies covered are from 1·5 to 30 c/s. Using these two electronic accessories, together with a four-channel ink-recording electro-encephalograph, the responses evoked by flickering light in a number of normal subjects and a few clinically abnormal ones have been studied. The results may be summarized as follows.

(1) There is very great variation between individuals in respect of: (*a*) amplitude of response, (*b*) selectivity of the response at different frequencies, (*c*) effect of other external stimuli and mental activity, and (*d*) constancy from time to time. In some subjects scarcely any rhythmic activity can be seen in the primary traces at any frequency, while in others the evoked potentials are of the order of 50 μV. up to frequencies of 15–20 f/s. In those subjects with a well-marked response there is usually a 'resonance' frequency at which the response is both larger and less complex than at other frequencies. This frequency is not necessarily that of the dominant resting alpha rhythm, but it is often related to some component of the resting electro-encephalogram revealed by analysis. Thus in the subject of Fig. *A*, the resting analysis showed no consistent alpha components; but the evoked response resonates quite sharply at 11 flashes per sec. (f/s) in the occipital pole, and at 12 f/s in the parieto-occipital region (*B*). In this subject, who is a marked visualist, the evoked response was larger with the eyes shut (or with a diffusing screen within the near point) than with the eyes open. Another subject (Fig. *C*) has a prominent resting alpha rhythm with two components at 8 and 10 c/s. The evoked rhythms show a less-distinct resonance at 8 c/s in the occipital pole and at 10 c/s in the parieto-occipital areas. In this subject, who uses mainly auditory and kinæsthetic imagery, the responses were larger with the eyes open, and the 8 c/s resonance point was associated with vivid subjective kinæsthetic sensations. In a third subject, the resting analysis shows components at 6, 8 and 10 c/s, while the evoked resonance was at 6 f/s in the occipital pole on this occasion. At other times this subject showed a marked resonance at 3·5 f/s in the parietal region, but never at 8 or 10 f/s.

In all the subjects so far studied the evoked response, at flicker rates from 7 to 14 c/s, like the resting alpha rhythm, was diminished to some extent in amplitude and regularity by mental activity involving visual imagery, but the relative effectiveness of various types of task varied greatly from subject to subject. In subjects with a pronounced response at frequencies below 6 c/s, the effect of mental activity was less clear. With practice, most subjects were able to recognize the resonant condition by a subjective change in sensation. When the resonant response is in a brain area other than the visual projection centres, the subjective experience is usually somatic, kinæsthetic or abstract.

(2) In children below the age of 12–14 years (and in a few young adults) the responses were relatively large (of the order of 100 μV.) at the lowest frequencies; but insignificant above 6–7 f/s (Fig. *E*). In this child, aged ten, there was a prominent resting alpha rhythm at 10 c/s but no tendency to a response resonance at this frequency. A prominent feature in most records of this type is the downward (negative) 'spike' following the slower primary positive component of the response. The time relations of the latency and duration of the response are shown in Fig. *F* taken from the same child at a higher recording speed. In such records the analysis shows a large second harmonic content, associated with the extreme asymmetry of the 'saw-tooth' wave-form.

(3) In all subjects, analysis of the response showed considerable harmonic content, particularly at flicker rates from 1 to 7 f/s. In some records components up to the 6th harmonic can be detected in the spectrum, the 2nd, 3rd and 5th being the most usual. These harmonics might be attributed merely to the inherent complexity of the nervous processes responsible for the wave-form, but phase-discriminating topographic analysis often permits identification of these harmonic components as separate entities apart from the fundamental evoked rhythm in areas of the brain other than the visual projection areas.



ANALYSED ELECTRO-ENCEPHALOGRAMS TAKEN DURING EXPOSURE TO FLICKERING LIGHT. IN EACH RECORD THE TOP TRACE SHOWS THE RESPONSE AT A SELECTED FREQUENCY AS INDICATED. THE SECOND AND THIRD TRACES ARE THE ELECTRO-ENCEPHALOGRAMS FROM THE REGIONS INDICATED BY THE HEAD DIAGRAM. THE FOURTH TRACE SHOWS THE FLASHES OF LIGHT AS SEEN BY A PHOTO-ELECTRIC CELL BETWEEN THE SUBJECT'S EYES. THE FIFTH TRACE (DOTTED) IS THE FREQUENCY SPECTRUM OF THE RECORD INDICATED BY THE ARROW. THE AMPLIFICATION AND TIME-SCALE FOR *A*, *B*, *C*, *D*, *E* ARE GIVEN IN *A*. THE ANALYSER SCALE IS ADJUSTED TO A CONVENIENT SIZE FOR EACH RECORD

The amplitude and distribution of the various harmonics is particularly sensitive to the influence of other stimuli. Sub-harmonics in the band from 4 to 7 c/s are prominent in some subjects who show these rhythms in the resting records, when the flicker is at a frequency from 8 to 14 f/s. Similar sub-harmonics are seen in certain conditions in other subjects, when the flicker frequency is rapidly varied between about 10 and 15 f/s. The latter effect is accompanied by unpleasant 'swimming' sensations.

(4) By employing an electronic trigger circuit the flashes can be synchronized either with the unfiltered brain rhythms or with any selected component of them derived from one of the resonant circuits of the automatic analyser. With the first arrangement any tendency to resonance can be clearly demonstrated, since each flash evokes a response which in turn produces a flash, and so on; the system (lamp-visual cortex—amplifier—trigger—lamp) settles down to oscillate at a frequency depending upon the latency of the cortical response and the phase of the response wave-form used to actuate the trigger. A number of modes of oscillation can be observed depending upon the details of the experimental conditions, which are too complex to summarize.

The method may have clinical as well as physiological application. For example, in an epileptic patient whose resting E.E.G. analysis showed a large component at 8 c/s, together with a number of other frequencies, synchronization of the flash alternately with the components at 16 and 8 c/s regularly evoked a brief larval seizure discharge of the characteristic wave and spike type, although the patient was under the influence of large doses of anticonvulsant drugs and was almost free from spontaneous attacks. This observation appears to support the hypothesis, based on study of analysed epileptic records, that certain types of seizure are due to exact synchronization of cerebral rhythms previously slightly out of step.

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[2] Dawson, G. D., and Walter, W. Grey, *J. Neurol. Neurosurg. Psychiat.*, **7**, 119 (1944).
[3] Livanov, M. N., *J. Physiol.* (U.S.S.R.), **28**, 172 (1940).
[4] Livanov, M. N., and Poliakov, K. L., *Bull. Acad. Sci. USSR.*, **3**, 286 (1945).
[5] Walter, W. Grey, *Electronic Eng.*, **16**, 9 (1943).
[6] Walter, W. Grey, *Electronic Eng.*, **16**, 236 (1943).
[7] Baldock, G. R., and Walter, W. Grey, *Electronic Eng.* (1946) (in the press).

OBITUARIES

Sir James Jeans, O.M., F.R.S.

Sir James Jeans, the celebrated mathematician and astronomer, died on September 16, at the age of sixty-nine. Expositor of science, philosopher, musician, he was above all a powerful and prolific applied mathematician, who made fundamental advances in the theory of gases and the physics of the atom, of the photon and of quanta on one hand, and the physics of the stars and nebulæ, their structure and evolution, on the other. As life went on, he became more and more devoted to astronomy, cosmogony and allied fields; but he interpreted these disciplines in the widest sense, able to combine simultaneously the most minute detail with the grandest generality. No one can read his treatises, even his text-books, without experiencing an undercurrent of growing excitement as solution succeeds to formulated problem; the reader feels himself in the presence of a master-mind. Indeed, his name will always be linked with those masters in the true Newtonian tradition—with Roche, Poincaré, Schwarzschild, Sir George Darwin and Liapounoff, who formulated, grasped the cosmic importance of, and by degrees solved, the question of the stability of equilibrium configurations of rotating masses of fluid. Of these, Jeans may be most fitly compared with Poincaré; both were attracted by, and both took part in the birth of, modern atomic physics and the quantum theory; both attached great importance to thermodynamics; both made some of their most characteristic contributions in the theory of rotating fluids and cosmogonic hypotheses; both were possessed of a fine mathematical style which banished dullness even from apparently arid calculations; and both wrote extensively on the philosophical aspects of science.

James Hopwood Jeans was born at Southport in 1877. He was educated at Merchant Taylors' School and Trinity College, Cambridge, from which he graduated as second wrangler in the Mathematical Tripos of 1898; he became a fellow of Trinity in 1901. After lecturing for a short while at Cambridge, he was appointed in 1905 to a chair of applied mathematics at Princeton, which he occupied until 1909. He then returned to Cambridge as Stokes Lecturer. He soon gave up formal teaching for research, and obtained in 1917 the Adams Prize for his superb essay, "Problems of Cosmogony and Stellar Dynamics", published in 1919. He had previously published (in 1914) his "Report on Radiation and the Quantum Theory" for the Physical Society. He was elected a fellow of the Royal Society in 1906, at the early age of twenty-eight, was awarded a Royal Medal in 1919, and served as secretary of the Royal Society during 1919–29, a period which was marked by a great revival of interest and quality in that Society's *Proceedings*. He was created a knight in 1928, and was awarded the Order of Merit in 1939. Latterly he had held a professorship of astronomy at the Royal Institution. He was president of the Royal Astronomical Society during 1925–27, and had been awarded its Gold Medal in 1922. He had the notable distinction of being made a research associate of Mount Wilson Observatory in 1923. Several universities, at home and abroad, honoured him with their doctorates.

These distinctions were merely the outward adornments of a life devoted to pure science, without which physics and astronomy would scarcely be the same to-day. He began his researches by following the paths trodden by Sir George Darwin, whom he always held in high honour: the George Darwin Lecture of the Royal Astronomical Society was founded out of a gift made by Jeans. But Jeans soon turned his attention to the theory of radiation, and in 1905 he gave the *coup de grâce* to the classical theory by demonstrating in detail the classical formula for the partition of radiant energy in an enclosure, a formula put forward by Lord Rayleigh in 1900. This has since been known as the Rayleigh–Jeans law. Jeans embodied these and many other original calculations in statistical mechanics in his treatise "The Dynamical Theory of Gases", which has been used by generation after generation of students.

But Jeans' main love was cosmogony. In "Problems of Cosmogony and Stellar Dynamics" he devoted his splendid mathematical gifts to a full-scale assault on the question of the stability of the forms of equilibrium of rotating masses. It had long been known that a rotating incompressible mass under its own gravitation assumed for small angular velocities the form of a spheroid—the series is known as Maclaurin's spheroids—and that for increasing angular velocity stability passed at a certain stage to ellipsoids with three unequal axes—known as Jacobi's ellipsoids. Poincaré discovered that these ellipsoids, when there was no constraint compelling them to remain ellipsoids, developed a furrow round the long axis, and so became what are known as 'pear-shaped figures', but he did not ascertain their stability. Darwin, in 1902, convinced himself that they were in fact stable, but Liapounoff in 1905, in a memoir published at St. Petersburg, announced the opposite result. The importance of a decision between these conflicting results lay in the application to the origin of double stars by fission: if, as Darwin believed, the pear-shaped figure was stable, then this figure could evolve quasi-statically into a double star as the furrow deepened; but if, with Liapounoff, we consider the pear-shaped figure as unstable, then, when the stability of the Jacobian series ends, a cataclysm will result. Jeans investigated the potential of what he called a 'distorted ellipsoid' by a new analytical method, abandoning the method of ellipsoidal harmonics previously used. This enabled him to locate an error in Darwin's calculations, and to confirm Liapounoff.

This investigation is conducted in masterly fashion in the Adams Prize essay. But Jeans did not confine himself to the abstract rotational problem: after summarizing the fundamental paper by Poincaré in the *Acta Mathematica* of 1885, with its treatment of linear series and points of bifurcation, he analysed in turn the rotational problem, the tidal problem and the double star problem, for incompressible and compressible masses, and considered also Roche's model; he gave an account of Roche's limit for a satellite, and traced the cataclysmic process by which a stable double-star configuration might evolve from the instability of pear-shaped configurations. His plan was to work out unsparingly the main mathematical problems, and then, without any putting forward of a preconceived theory, to investigate the bearings of these abstract solutions on the possible origins of the various types of celestial body. He concluded that spiral nebulæ might be formed by the ejection of matter from the sharp lenticular edge of a rotating compressible mass, at antipodal points determined by the net tidal force due to the rest of the universe;

that condensations of stellar magnitude would be formed in the arms (the spiral form of which, however, he could not account for); that some of these might eventually break up by fission into close double stars, but that wide doubles were probably formed by a capture process; that nothing resembling a solar system could be produced by rotation alone, and that the hypothesis of Kant and Laplace in at least its original form was untenable; that, as an alternative, the hypothesis of disruption by a tidal encounter fitted many of the facts; but that if this were the actual origin of the solar system, then planetary systems similar to it must be very rare in Nature, so rare that possibly ours is the only one.

It is the usual fate of cosmogonic theories not to survive, and many of Jeans' conclusions, especially since the discovery of the expansion of the universe, are already in course of revision. But "Problems of Cosmogony" was grand stuff from beginning to end. We saw a master thinker and executant at work with his materials. He set a standard of perfection of scholarship in a field often marred in others' hands by propaganda; the work was marked by power, depth and originality of a high order.

His later volume, "Astronomy and Cosmogony", more comprehensive and more ambitious, was less successful. Besides reconsidering and enlarging much of the Adams Prize essay, it aimed at giving an account of the internal constitution of the stars on rather different lines from the work of Eddington. Some of Jeans' mathematics in this volume is far from clear. His conclusions that the different types of stars—giants, main sequence stars and white dwarfs—correspond to the successive removals of the M, L and K rings of electrons from atoms by ionization are hard to accept. But his other conclusions, that the stars in general have 'liquid', not gaseous, cores, and consist of elements of atomic number 95 or so, are perhaps more acceptable to-day than when they were published. There is, however, scarcely a page of even this second treatise which is not rich in fascinating suggestion and inspiring possibility; on each page we see a master mind confronting itself with the grandest problems, of formidable difficulty, posing them, simplifying them, and making some progress with even the most intractable.

Jeans influenced astronomical investigation in many other domains besides those mentioned above. He first gave the name 'equation of transfer' to the equation which traces the intensity of a pencil of radiation through an absorbing and emitting medium, an equation in daily use in investigations on stellar atmospheres; and he first directed attention to the phenomenon of radiative viscosity. He made the suggestion that the source of stellar energy might be the mutual annihilation of protons and electrons; and he, more than anyone, stood for the belief that the universe is doomed to a 'heat-death'. He did not form a school of research in the ordinary sense; but everyone who is interested in the beginnings, evolutions and endings of the various members of our universe is in a sense his pupil. We have lost a great leader.

Jeans had a brisk business-like manner in ordinary conversation, not at all suggesting the deep academic thinker that he was; but it developed in the lecture theatre into a winning persuasiveness. He was extremely modest, a most courteous correspondent and a scrupulously fair opponent in a controversy; and he gave freely of his friendship to many. He was twice married.

E. A. Milne

Prof. Otto Hönigschmid

By his untimely death during October 1945, a tragic victim of war conditions, chemical science has lost in Prof. Otto Hönigschmid one of its leading workers in the field of inorganic chemistry. His name will always be remembered in chemical circles as the outstanding authority in Europe on the chemical atomic weights, and for the active school of research he built up at Munich after his appointment there in 1922 as professor ordinarius.

Born in Horovitz in Bohemia in 1878, he graduated in the German University of Prague and studied as a research student under Moissan in Paris (1909–10) and later with Th. W. Richards at Cambridge, Mass., where he learnt and applied the methods developed at Harvard to the determination of the atomic weight of calcium.

At that period, cumulative evidence from various sources, notably from the atomic weight laboratory at Harvard and from Guye's physical chemistry school at Geneva, had shown that Stas' classical values for the fundamental atomic weight ratios were affected by significant and hitherto unsuspected errors. Stas' value for silver, the standard to which all his other values were referred, came under suspicion, and his value for nitrogen had been shown by Guye and others to be too great by as much as one part in four hundred. Since at that time the measurement of stoichiometric ratios afforded the only means of finding atomic weights with accuracy, density methods being regarded as approximate only, a general revision became imperative. This had already been made for many of the common elements by Richards and his co-workers, who had developed to a high degree the very exacting preparative and analytical technique essential in this field of work. Much, however, remained to be done, and Hönigschmid on his return to Europe dedicated his energies to researches of this nature.

In Vienna, Hönigschmid made, at this period, what was then claimed to be the first really accurate determination of the atomic weight of radium, using as the starting material preparations containing 840 mgm. of the pure element. Twenty-two years later, this work was repeated in Munich, using the much larger quantity of 3 gm. of element, put at his disposal by the Union Minière du Haut Katanga, of Brussels, and which was initially 98·83 per cent pure. This large quantity enabled a very effective fractional crystallization to be made without reducing unduly the quantity of the final pure material. The atomic weight found was 226·05, the present International value; which was only 0·08 unit greater than the earlier one.

Hönigschmid's most active period of research began after his promotion from the directorship of the inorganic and analytical laboratories at the Technische Hochschule, Prague, to the University of Munich, where he founded a laboratory devoted entirely to the determination of atomic weights by analytical methods.

From this laboratory, year after year, appeared a stream of papers embodying improved techniques for the preparation of chemically pure substances, and for their analysis, and containing fresh data of the highest accuracy on atomic weight ratios. Up to 1938 he and his co-workers had re-determined the atomic weights of upwards of forty elements, which led to numerous revisions in accepted values.

Hönigschmid was the first to determine the atomic

weights of hafnium and rhenium, and his careful work on radium, thorium, uranium and ionium as well as on the radiogenic leads contributed in no small degree to the body of direct chemical evidence which supports Rutherford and Soddy's theory of radioactive disintegration.

To the Munich school belongs the chief credit of establishing on a firm basis that important substandard, the atomic weight of silver, with sufficient accuracy to enable it to be used as a reference standard for the halides of elements of low atomic weight such as lithium and sodium. Hönigschmid directed attention to the small difference between the atomic weight of silver derived from the synthesis of silver nitrate made in 1907 by Richards and Forbes and that from the lithium perchlorate/lithium chloride/silver ratios measured three years later by Richards and Willard. The former, assuming nitrogen to be 14·008, gave for silver 107·879, whereas the latter yielded 107·871—a small difference indeed, but one which would cause a much greater uncertainty in the atomic values for light elements. To investigate this, Hönigschmid, Zintl and Thilo re-determined the nitrate ratios by the reduction in hydrogen of specially purified silver nitrate, and by this analysis obtained precisely the same value, to 1 part in 150,000, for the ratio silver nitrate/silver as that found by synthesis eighteen years earlier at Harvard.

This research, published in 1927, was followed in 1929 by the work of Hönigschmid and Sachtleben in which barium perchlorate was used to link silver to oxygen. These two researches led to closely concordant results which confirmed the higher of the two values for silver and went far to settle the discrepancy. Subsequent work on silver has supported Hönigschmid's conclusion, and the uncertainty now in this standard probably does not exceed two units in the third place of decimals.

The development of the mass spectrograph by Aston, and the discovery that many chemical elements were mixtures, gave a new direction and impetus to chemical work. Chemists were concerned to know how much reliance could be placed on the new physical method and whether the very significant differences between many of the chemical and physical values were to be explained by chemical or by physical errors. On both sides of the Atlantic, in the two chief schools for this type of work, at Harvard and at Munich, numerous re-determinations were undertaken, with the result that in most cases the mass spectrograph values were found the more reliable and pointed the way to the elimination of chemical errors. In these activities Hönigschmid and his pupils played an important part. For example, his work on niobium and tantalum is outstanding, as also is his work on the atomic weight of phosphorus. In all three cases he proved that the accepted chemical values were markedly too high, and that when really pure halides, or oxyhalide in the case of phosphorus, were used a close concordance with the mass spectrograph was obtained.

In a few instances, however, errors were discovered in the mass spectrograph values, and chemical revision even with extreme elaboration failed to bring the two sets of data into accord. Such was the case with cadmium and tellurium, which when revised chemically by Hönigschmid paved the way to the discovery of new isotopes of tellurium and a modification of the abundance ratios for cadmium. Another example is that of neodymium, the chemical value of which when revised by Hönigschmid and Wittner was found in agreement with the earlier value of Baxter and Chapin, and nearly 0·8 unit higher than Aston's value, which has now been shown by Mattauch to have been based on an isotopic constitution affected by small errors.

Mention should be made, too, of Hönigschmid's application of precise analytical methods to detect and measure the degree of isotopic separation achieved by evaporation at low pressure, in the pioneer experiments of Brönsted and Hevesy on mercury and on lead chloride and by Hevesy alone on potassium. In those for mercury and potassium the separation was small but definitely detectable. Much later, he tested the isotopic hydrogen chlorides obtained by Clusius and Dickel in their thermal diffusion apparatus, and confirmed beyond doubt that the separation was practically 100 per cent.

During the earlier part of the War, Hönigschmid appears to have continued his atomic weight work for, in 1941, he published papers on zinc, samarium, and yttrium. Later work from his laboratory has not been reported.

Finally, the services rendered to the German Atomic Weight Commission by Hönigschmid, who was chairman during 1920–30, must be noted. The eleven yearly reports and reviews of the progress of research with the annual table of the most trustworthy atomic weight values came mainly from his pen. In 1930, when the Atomic Weight Committee of the International Union of Chemistry came into being, Hönigschmid was the obvious choice for the German representative. Under the chairmanship of Prof. G. P. Baxter, eleven international reports have been issued since then, and although from time to time there has been a change in membership, Otto Hönigschmid and his opposite number, G. P. Baxter, the leaders of the two chief schools of atomic weight research in Europe and America, have invariably been re-elected.

Enough has been said in this notice to indicate the great part played by Otto Hönigschmid in analytical and atomic weight research. It is a matter of general regret that work like his, of a truly international character, should have been abruptly terminated before his energies were exhausted.

R. Whytlaw-Gray

Prof. I. Mościcki

Prof. Ignacy Mościcki, former President of Poland and a distinguished chemist, died on October 2 at Versoix, Geneva, in his seventy-ninth year.

Born at Mierzanow, then in Russia, Mościcki was educated locally and at Riga, but his revolutionary views necessitated his leaving Russia. For five years he stayed in England, spending some time at Finsbury Technical College. Then he went to the University of Fribourg as assistant to Prof. Kuwalski, under whose influence he became interested in the applications of science and made a careful study of the methods for the fixation of nitrogen. He invented new processes that proved successful, and in 1913 he was appointed professor of electrochemistry at Lwów (then in Austria).

After the liberation of Poland, Mościcki became head of the chemical works at Chorzów and Mościce (named in his honour). He succeeded in establishing the Polish chemical industry on a firm basis, and

when Marshal Pilsudski rose to power in 1926, Prof. Mościcki was elected President of the Polish Republic. He was now able to use his influence for the furtherance of the educational and scientific programmes connected with the various Polish universities and cultural bodies. Re-elected President in 1933, he was head of the State when Germany invaded Poland in 1939; within a month Mościcki relinquished office, escaped to Rumania and then succeeded in reaching Switzerland. In view of his earlier sojourn (lasting sixteen years) in that country, he was granted Swiss citizenship, and he was thus able to spend his last years in quiet retirement.

We regret to announce the following deaths:

Prof. E. H. Lamb, formerly professor of civil and mechanical engineering, Queen Mary College, London, on October 12, aged sixty-eight.

Dr. C. S. Myers, C.B.E., F.R.S., honorary scientific adviser to the National Institute of Industrial Psychology, on October 12, aged seventy-three.

NEWS and VIEWS

Radar Observation of the Giacobinid Meteors

Since the general occurrence of transient radio reflexions in the *E* region of the ionosphere, at frequencies exceeding the critical frequencies for normal or abnormal *E* layers, was noticed by Sir Edward Appleton and R. Naismith, in their observations during the International Polar Year, 1932–33, much work has been carried out which has shown that echoes of this type can be associated with visually observed meteors. When high-powered transmitters are used, the number of radio echoes may greatly exceed that of the visible meteors. As a result of experiments in which the directional characteristics of radar sets were utilized to investigate the aspect sensitivity of the transient echoes, Hey and Stewart have shown that the majority of the echoes at five metres wave-length must be of meteoric origin. Assuming that the most favourable aspect for reflexion is perpendicular to the meteor train and hence to the radiant, they were able to show not only that the frequency of occurrence of echoes reached a maximum at the times of the big meteor showers, but also that radiants of the streams could often be deduced and these coincided with known meteor streams. This work has been carried out in close liaison with the Slough Radio Research Station of the Department of Scientific and Industrial Research, where Sir Edward Appleton and R. Naismith have continued their studies of the transient ionospheric echoes at longer wave-lengths. The recent Giacobinid shower provided an excellent opportunity for the various investigators working in this field. J. S. Hey and his team at the Operational Research Group, Ministry of Supply, maintained a continuous watch during October 7–11 with the help of operators loaned from A.A. Command. This revealed a marked rise in meteor activity between 0100–0600 hr. on October 10, which reached a tremendous peak between 0330 and 0430 hr. G.M.T., when the echoes were too numerous to count on the cathode ray tube display. A detailed report must await analysis of the photographic recordings. Even at wave-lengths so short as 1½ metres, a number of these echoes could be detected.

Use of Electrical Power in Great Britain

In his presidential address to the Institution of Electrical Engineers on October 3, Mr. V. Z. de Ferranti analysed the progress which has been made towards the 'all-electric' goal envisaged by his renowned father, in a paper delivered to the same institution thirty-six years ago. The latter took as his basis the 150 million tons of coal a year being used in Great Britain in 1910 and estimated that by raising the efficiency of conversion to 25 per cent the same usefulness could be achieved by the conversion of only 60 million tons into electricity. He visualized the generation of 131,400 million kWh. by means of 25 million kW. of operative plant working at a 60 per cent load factor, this plant to be concentrated in about a hundred stations spread over the country. Of these targets, the efficiency one has been exceeded in individual installations. Notwithstanding the introduction of the Grid scheme, however, progress towards the others has been slow. Thus only 24 million tons of coal a year are converted into electricity, and this is but 12 per cent of the coal now available. The electricity consumption figure is 32,000 kWh., though if recent trends are maintained the 'target' of 131,400 kWh., or about 2,850 kWh. per head of population, should be reached in 1959. It is evident, however, that with the considerably increased rise of energy consumption in one form or another, this would be far from representing the 'all-electric' condition visualized in 1910, and that much still remains to be done in the industrial and domestic fields if unnecessary waste of energy, and its several unsocial consequences, are to be avoided.

Meteors from Comet Giacobini-Zinner

Unfortunately, the bad weather conditions prevented visual observation of this shower throughout a great part of the British Isles; but observations from an aeroplane on the morning of October 10 showed that the meteors were very active—in some cases about 400 a minute. Mr. P. M. Ryves, near Ashford, Kent, observed the shower shortly before 4h. on October 10, when the sky cleared, but the peak was probably passed by that time as only three or four meteors a minute were seen. Several were as bright as Jupiter, but none much brighter was observed.

Atomic Energy Bill

Any misgivings with which scientific men have regarded the Atomic Energy Bill have been due largely to the possible effects of the restrictive clauses on scientific research. Those fears, which found ample reflexion in the debate on the second reading in the House of Commons on October 8 and at the committee stage on October 11, have been largely dispelled by the reasonable and conciliatory attitude of both the Prime Minister and the Minister of Supply. Mr. Attlee, in moving the second reading, directed special attention to Clause 11, which places

restriction on the disclosure of information; and his speech indicated both full appreciation of the difficulty encountered in drafting the Bill so as to obtain the essential security without impeding scientific research, and the intention of the Government to work the restrictive clauses sensibly. Mr. Attlee said that the Government had decided to define in the Bill the information which could not be communicated regarding atomic energy, and provide for excluding information about plant in use for purposes other than atomic energy if the connexion with atomic energy was not disclosed. At the committee stage, Mr. Woodburn, joint Parliamentary Secretary to the Ministry of Supply, moved a new sub-section providing that the Minister should not withhold consent to the communication of information relating to plant in general use for other purposes if he was satisfied that such information did not endanger national security, and in moving this amendment Mr. Woodburn indicated that within this strict limitation the Minister bound himself to exclude all such matters as plant for scientific research or educational work.

Mr. Wilmot, speaking on the second reading, said that the drafting of Clause 11 was the best compromise they could make, and reiterated in committee that he could not improve on the definition of his attitude in the sub-section moved by Mr. Woodburn. He was prepared to free the ordinary laboratory tools of the nuclear physicists by excluding them from the terms of the order under Clause 10, and he undertook as soon as the Bill became law to confer with physicists and other men of science affected with the view of making an order excluding those tools from the categories of plant about which communication was prohibited. Pointing out that the insertion of the words "to his knowledge" brought the words into accord with the Official Secrets Act, Mr. Wilmot emphasized that the clause gave complete freedom for the whole field unless it was associated with atomic energy plant or proposed plant. Basic scientific information was excluded, and while the clause could not be made more restrictive by the Minister, he could gradually loosen the restrictions, and Mr. Wilmot anticipated that there would be more and more exemptions and wider and wider fields outside the clause as it became possible to define more exactly the actual limits of security requirements. Even more than the words of the Prime Minister and the Minister of Supply, the whole spirit of the Government's attitude should be profoundly reassuring to the scientific world. The necessity of securing the utmost freedom for the exchange of scientific knowledge was clearly acknowledged, and also the fact that scientific progress is conditioned by the free flow and interchange of scientific opinion; and when Mr. Richard Law said that whether the Bill was effective for its purpose would depend less on what was in it than on the judgment, energy and good sense with which it was administered, Mr. Wilmot was quick to agree and to assure the House as to the spirit in which the Government intends to use its powers under the Bill.

Mathematics at the Queen's University, Belfast: Dr. H. R. Pitt

Dr. H. R. Pitt, who was elected last year at the age of thirty-one to the chair of mathematics at the Queen's University of Belfast, is recognized as a leader among the younger analysts. He went to Cambridge as a scholar of Peterhouse in 1932. After taking his degree in 1935, he started research on Tauberian theorems under the direction of Prof. G. H. Hardy. Dissertations in which this was the central theme gained him a bye-fellowship at Peterhouse in 1936 and a Smith's Prizé in 1937. Pitt's work was based on ideas introduced into analyses by Norbert Wiener, and the award in 1937 of the Joseph Hodges Choate Memorial Fellowship at Harvard enabled him to continue his studies under the direct influence of Wiener. This period was fruitful, and Pitt wrote further papers independently and in collaboration with Wiener and with Halperin, another member of Wiener's school. On his return from the United States, he became a lecturer at the University of Aberdeen, until his services were claimed during the War by the Air Ministry.

Application of Radio and Radar to Astronomical Research

The Operational Research Group of the Ministry of Supply has recently done much to demonstrate the potentialities of radio and radar equipments as instruments for astronomical research. An anti-aircraft equipment operating on wave-lengths around 5 metres has proved to be particularly suitable for three different investigations of astronomical interest. The receiver has been adapted for automatic recording of the intensity of the sunspot radio noise emissions discovered by Sir Edward Appleton and J. S. Hey (*Nature*, **156**, 534 (1945); **157**, 47 (1946)). The receiver has also been employed for detailed mapping of the distribution and characteristics of radio noise emissions of cosmic origin at 5 metres wave-length by J. S. Hey, S. J. Parsons and J. W. Phillips (*Nature*, **157**, 296 (1946); **158**, 234 (1946)). The complete radar equipment, with modifications originally introduced in 1944 for tracking V2, has been used by J. S. Hey and G. S. Stewart (*Nature*, **158**, 481 (1946)) for radar observation of the streaks or trains of ionization caused by the passage of meteors through the upper atmosphere. In addition to the intrinsic interest which arises in the occurrence of the above phenomena at such wave-lengths, radio and radar methods, although they cannot attain the directional precision of optical instruments, have the advantage that observations can be made in all weathers and at all times of the day.

War-time Training of Radio Personnel

The Radio Section of the Institution of Electrical Engineers held its first meeting for the current session on October 9, when Prof. Willis Jackson delivered his inaugural address as chairman of the Section. The first part of this address dealt with "The War-time Education and Training of Radio Personnel" and described the war effort, hitherto unrecorded, of the universities and technical colleges of Britain in educating and training a large number of persons for specialized radio work in the Services, Government establishments and in industry. In all, some five thousand men passed through university courses, of six terms duration, affording a substantial instruction in radio as a preliminary to their recruitment, training and employment as radio officers in the Forces, as scientific or technical officers in Service radio establishments or in the radio industry; while upwards of 70,000, including a small proportion of girls, completed courses of four months duration in technical colleges leading to their employment as 'radio' or 'wireless' mechanics, the former being con-

COMMONWEALTH OF AUSTRALIA

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

SECTION OF DAIRY RESEARCH

APPOINTMENT No. 1009 OF OFFICER-IN-CHARGE

Applications are invited for appointment to the position of Officer-in-Charge, Dairy Research Section, Melbourne, Australia.

The Officer-in-Charge will be responsible to the Executive Committee of the Council for the direction and administration of the activities of the Section which are in the field of research, both fundamental and applied, on dairy products and their derivatives, with particular reference to their manufacture.

An applicant should have a University degree, with honours, in Science or Agricultural Science, or equivalent qualifications, and have had considerable research experience in the above-mentioned fields of work.

Dependent on qualifications and experience the commencing salary will be determined within the limits of £A1,040–£A1,290 p.a. actual. The above actual salaries include cost-of-living adjustment (at present an additional £A40 p.a.). *Note.* Salary will commence from the date the successful applicant takes up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia; thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid.

Subject to a satisfactory medical examination the appointee will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications, referring to appointment No. 1009, and stating date of birth, nationality, present employment, particulars of qualifications and experience, together with references to published results of scientific work, accompanied by copies of not more than four testimonials should reach the undersigned not later than November 18, 1946.

(Sgd.) LEWIS LEWIS,
Secretary,
Australian Scientific Research Liaison.

Australia House,
Strand,
London, W.C.2.

COMMONWEALTH OF AUSTRALIA

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

DIVISION OF SOILS

APPOINTMENT (No. 932) CHIEF OF DIVISION

Applications are invited for appointment to the position of Chief of the Division of Soils which will become vacant not earlier than January 1, 1947. The headquarters of the Division are at the Waite Agricultural Research Institute of the University of Adelaide, Adelaide, South Australia, Australia.

The Chief will be responsible to the Executive Committee of the Council for the direction and administration of the activities of the Division which are in the field of soil surveys, soil physics and mechanics, soil bacteriology and soil chemistry. The section of soil chemistry is a joint section with the Waite Institute. An important aspect of the administration will be the development of Divisional activities, particularly soil surveys, on a regional basis.

The salary will be £A1,540 p.a. (actual) which includes cost-of-living adjustment (at present an additional £A40 p.a.). *Note*: Salary will commence from the date the successful applicant takes up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia; thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid.

Subject to a satisfactory medical examination, the appointee will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications referring to appointment No. 932 and giving particulars of qualifications and experience, together with references to published results of scientific work, should reach the undersigned not later than November 18, 1946.

(Sgd.) LEWIS LEWIS,
Secretary,
Australian Scientific Research Liaison.

Australia House,
Strand,
London, W.C.2.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the post of Assistant Lecturer in Geology. Salary £400 per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before November 2, 1946.

COMMONWEALTH OF AUSTRALIA

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

DIVISION OF INDUSTRIAL CHEMISTRY

APPOINTMENT No. 1004 OF RESEARCH OFFICER IN THEORETICAL PHYSICS

Applications are invited for appointment to one position of Research Officer, Division of Industrial Chemistry, Melbourne, Australia.

Duties. To carry out theoretical studies primarily concerned with the quantum physics of solids, within the Division's Chemical Physics Section.

Qualifications. University degree in science with mathematics and physics as major subjects, or equivalent qualifications; also previous experience in the application of quantum theory.

Salary. Dependent on qualifications and experience, commencing salary will be determined within the range of Research Officer (Male: £A560–£A640 p.a. actual; Female: £A485–£A565 p.a. actual; four equal increments, first automatic, remainder discretionary). The above actual salaries include cost-of-living adjustment (at present: Male: additional £A40 p.a.; Female: additional £A27 p.a.). *Note.* Salary will commence from the date the successful applicant takes up duty in England, if required to do so, or one fortnight before scheduled date of departure for Australia, whichever is the earlier, and will be paid in sterling until embarkation for Australia; thereafter in Australian currency. Fares (including those of wife and family) to Australia will be paid.

Subject to a satisfactory medical examination the appointee will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications, referring to appointment No. 1004 and stating date of birth, nationality, present employment, particulars of qualifications and experience, accompanied by copies of not more than four testimonials should reach the undersigned not later than November 18, 1946.

(Sgd.) LEWIS LEWIS,
Secretary,
Australian Scientific Research Liaison.

Australia House,
Strand,
London, W.C.2.

SCIENTIFIC CIVIL SERVICE

The Civil Service Commissioners invite applications for the post of Superintending Engineer in the Radar Research and Development Establishment of the Ministry of Supply.

The post carries responsibility for the general supervision of the design work of the Establishment and also for planning small-scale production of experimental equipment. The Superintending Engineer will be in charge of the Drawing Office, Design Staff and Workshops, and will be responsible for ensuring that modern processes and techniques are used in the engineering work of the Establishment.

Candidates should be British subjects, born on or before August 1, 1915, and under 50 years of age on September 1, 1946. Applicants should have a first or second class honours degree in engineering or corporate membership of the Institution of Mechanical or Electrical Engineers. They must be experienced in the efficient management of highly skilled labour.

The appointment is permanent, with superannuation benefits under the Federated Superannuation System for Universities, and is graded as Senior Principal Scientific Officer on the Provincial scale £1,100 × £50 – £1,300, plus a consolidation addition of £120.

Forms of application are obtainable from the Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1656, to whom completed applications must be returned not later than November 14, 1946.

UNIVERSITY OF LONDON

A course of three lectures on Physiology will be given by Prof. Sir Joseph Barcroft, C.B.E., F.R.S. (Agricultural Research Council, Cambridge) in the Physiology Theatre of University College (Gower Street, W.C.1) at 5 p.m. on Thursdays, October 31, November 14 and 28, 1946. Lecture 1. Movements of the Human Foetus. Lecture 2. Recent Work on Placental Transmission. Lecture 3. The Flora of the Alimentary Canal. The Chair at the first lecture will be taken by Prof. C. A. Lovatt Evans, D.Sc., LL.D., F.R.S. (Jodrell Professor of Physiology, University of London). Admission Free, without ticket.

JAMES HENDERSON,
Academic Registrar.

Scientific Assistant (Zoology) immediate vacancy. Bureau literary work. £354 × £18 – £570 inclusive. Knowledge of German desirable.—Imperial Bureau of Animal Health, New Haw, Weybridge.

UNIVERSITY OF LONDON

Heath Clark Lectures.—A course of five lectures, entitled "British Pioneers in Social Medicine from Percival to Simon," will be given by Professor Emeritus Major Greenwood, D.Sc., F.R.C.P., F.R.S., at 5.30 p.m. on October 28, 29, 30 and 31, and November 1, 1946, at the London School of Hygiene and Tropical Medicine (Keppel Street, Gower Street, W.C.1). The chair at the first lecture will be taken by Sir Allen Daley, M.D., F.R.C.P., D.P.H. (Medical Officer of Health, County of London). Admission Free, without ticket.

JAMES HENDERSON,
Academic Registrar.

UNIVERSITY OF LONDON

A course of three lectures in Zoology entitled "Three Incretory Organs" will be given by Professor Bertil Hanström (Zoological Institute, University of Lund) at 5 p.m. on Tuesday, Wednesday and Thursday, October 22, 23 and 24, 1946, at University College (Gower Street, W.C.1). At the first lecture the Chair will be taken by Professor D. M. S. Watson, D.Sc., F.R.S. (Jodrell Professor of Zoology and Comparative Anatomy in the University of London). Admission Free, without ticket.

JAMES HENDERSON,
Academic Registrar.

LEEDS COLLEGE OF TECHNOLOGY

Principal: C. CHEW, M.Sc.Tech., F.R.I.C.

DEPARTMENT OF CHEMISTRY

Applications are invited for the post of full-time Lecturer in the above department, duties to commence in January 1947.

Candidates should possess a good honours degree of a British university, together with teaching and industrial experience. The selected candidate will be required to teach mainly Organic with some Physical Chemistry. Salary according to the Burnham Scale.

Further particulars and form of application, to be returned within three weeks of the appearance of this advertisement, will be forwarded on receipt of a stamped addressed foolscap envelope.

GEORGE GUEST,
Director of Education.

Education Offices,
Leeds, 1.

COVENTRY LOCAL EDUCATION AUTHORITY

TECHNICAL COLLEGE

Principal: J. Wilson, B.Sc., B.Com., M.I.Mech.E.

CHEMISTRY AND METALLURGY DEPARTMENT

Applications are invited for the post of Lecturer in Chemistry. Candidates should have honours degree in Chemistry, A.R.I.C., or equivalent qualifications. Teaching experience and research or industrial experience are desirable. Candidates should be prepared to lecture in some branch of Chemistry, preferably Organic Chemistry, up to A.R.I.C. standard, and to take part of the Inter.B.Sc. work.

Forms of application, obtainable from the undersigned, should be returned within 14 days of publication of this advertisement.

FRANK H. HARROD,
Director of Education.

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

Assistant Technical Secretary required by the Metallurgy Division of the above Association to assist in the organisation and secretarial servicing of technical committees. University Degree or equivalent qualification in Chemistry (Inorganic) or Metallurgy essential. Some industrial experience in the iron and steel industry preferred.

The vacancy is in the Scientific Officer Grade, salary £400–£550 per annum according to age, qualifications and experience. The appointment is superannuated under the F.S.S.U. Written applications only, quoting "Metallurgy Division", stating full curriculum vitae, to the Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, by Saturday, November 9.

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

Foundry Technical Officers required by the above Association to conduct research projects at Sheffield and other steel-making centres. Officers required in both the Senior Scientific Officer and Scientific Officer grades.

Qualifications: University degree in Metallurgy, Physics or Chemistry essential, some steel-foundry experience desirable.

Salaries: Senior Scientific Officers, £600–£800 p.a.; Scientific Officers, £300–£550 p.a., both according to age, qualifications, experience, etc. Appointments are superannuated under the F.S.S.U.

Written applications only, stating full curriculum vitæ to the Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, by November 1, 1946.

UNIVERSITY OF SYDNEY
(NEW ENGLAND UNIVERSITY COLLEGE, ARMIDALE)

Applications are invited for the position of Senior Lecturer in Biology at New England University College, Armidale, New South Wales. The salary scale for Senior Lecturers is £500 per annum (Australian currency) rising by annual increments of £40 to £750 per annum; salaries are subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to qualifications. The successful applicant will be expected to lecture in Zoology and will, until the appointment of a Professor in Biology, control the work in the Department of Biology at the College. The successful applicant will be expected to take up duties as early as possible in 1947. Reasonable travelling expenses will be allowed. Applications close on November 30, 1946, with the Registrar, University of Sydney, Sydney, Australia.

UNIVERSITY OF CAPE TOWN
SENIOR LECTURER IN ZOOLOGY

Applications are invited for a Senior Lectureship in the Department of Zoology. The post is vacant from 1947, salary scale £675 plus £25—£775 per annum, plus a temporary cost of living allowance. Qualifications in comparative physiology and experimental methods are desirable. Applications from candidates who have been on military or other national service will be given special consideration; applicants are advised to give particulars of such service. Write quoting G.412, to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application forms which must be returned, in duplicate, together with copies of testimonials, and the names of three referees, by November 12, 1946.

UNIVERSITY OF CAPE TOWN
SENIOR LECTURER IN PHYSICS

Applications are invited for a Senior Lectureship in Physics. The post is vacant from 1947. Salary scale £675 by 25–£775 per annum plus a temporary cost of living allowance. Applications from candidates who have been on military or other national service will be given special consideration; applicants are advised to give particulars of such service.

Write quoting A.328 to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application forms which must be returned, in duplicate, together with copies of testimonials, and the names of three referees, by November 12, 1946.

CAMBRIDGESHIRE EDUCATION COMMITTEE
CAMBRIDGESHIRE TECHNICAL COLLEGE AND SCHOOL OF ART

Applications are invited for the post of Lecturer in Biology with subsidiary Chemistry. Applicants should possess an Honours Degree. Salary will be in accordance with the Burnham Scale for Assistants in Technical Colleges. Particulars and forms of application may be obtained on receipt of a stamped addressed foolscap envelope from the Chief Education Officer, Shire Hall, Cambridge, to whom completed applications should be returned not later than October 31, 1946.

UNIVERSITY OF MELBOURNE

Applications are invited for the position of Senior Lecturer in charge of the Department of Forestry, Salary £800 per annum plus cost of living adjustment (at present £48) (Australian currency), subject to Provident Fund contribution. Conditions of appointment may be obtained from the Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

Applications with the required particulars should be lodged with the Registrar, University of Melbourne, not later than November 18, 1946.

UNIVERSITY OF READING
FACULTY OF AGRICULTURE AND HORTICULTURE

The Council will shortly appoint two temporary research assistants for work on composts and organic fertilizers. Salary £255 to £470, plus war bonus, according to age and experience. One of the persons appointed must have been trained as a Chemist. Further particulars may be obtained from the Registrar, the University, Reading.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE
(UNIVERSITY OF LONDON)
CAMPDEN HILL ROAD, LONDON, W.8

Applications are invited for appointment as part-time Demonstrator in Biology for the Session 1946-47.

Applications, together with copies of testimonials, should reach the Secretary (from whom further details may be obtained) as soon as possible.

THE UNIVERSITY OF SHEFFIELD
DEPARTMENT OF BIOCHEMISTRY
Professor: H. A. KREBS, M.A., M.D.

There are salaried vacancies for graduates who wish to train in biochemical research under the Head of the Department. The salary will depend on qualifications and experience. Persons interested in these vacancies should communicate, in the first place, with the undersigned, giving particulars of their careers.

A. W. CHAPMAN,
Registrar.

THE UNIVERSITY OF SHEFFIELD

Applications are invited for a post of Senior Lecturer in Organic Chemistry. Further particulars can be obtained from the undersigned to whom applications (four copies) including the names and addresses of referees, and, if desired, copies of testimonials, should be sent by November 16, 1946.

A. W. CHAPMAN,
Registrar.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the post of Professor of Geology and Head of the Department of Geology and Geography. Salary £1,250 per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before November 9, 1946.

The Civil Service Commissioners invite applications for two posts of Principal Scientific Officer for Research and Development work on flutter, aero-elasticity and general airframe vibration at the Royal Aircraft Establishment, South Farnborough, Hants.

The successful candidates should have a first- or second-class honours degree, or the equivalent, in engineering, mathematics or science, and have either research experience supported by original papers, or aircraft design experience related to aero-elastic theory.

One Principal Scientific Officer is required to assist a Superintendent in the general supervision of flutter research and its application to existing aircraft and new designs, and especially to control and to guide experimental vibration work on actual aircraft, both in fight and on the ground. Some experience in flight testing, instrumentation and general engineering is necessary, and some knowledge of aerodynamics is desirable.

The second Principal Scientific Officer is required to specialize in the aerodynamic aspects of flutter. He must be prepared to give technical supervision in the design of a new high-speed flutter wind-tunnel, and to take charge of its operation when completed. For this post extensive experience of wind-tunnel testing, and knowledge of flutter theory and general aerodynamics, are essential.

The salary scale for these appointments is £750×20—£1,020 (men) and £660×30—£880 (women).

The salary will be increased by a consolidation addition (in place of War Bonus) which ranges from £90 at the minimum of the scale to £105 at the maximum for men and from £79 at the minimum of the scale to £84 at the maximum for women.

Candidates must be of British nationality and have been born on or before August 1, 1915, and be under 50 years of age on September 1, 1946. They must possess the stipulated qualifications and experience. The posts carry superannuation benefits under the Federated Superannuation System for Universities.

Forms of application are obtainable from the Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1659, to whom completed applications must be returned not later than November 18, 1946.

Senior Physicist required to take charge of Physics Section, Research Laboratory, Birmingham. Honours Degree, Physics, with at least five years research experience in physical metallurgy. Must have knowledge of modern theory of solids, X-ray crystal analysis, methods of determination of thermal, magnetic and electrical properties of materials and experience in the application of this knowledge to the study of metals and alloys. Evidence of administrative and organising ability advantageous. Apply to Manager, Development and Research Department, The Mond Nickel Co., Ltd., Grosvenor House, Park Lane, London, W.1, stating age, experience, qualifications, salary required, etc. Mark envelope "Confidential S.P."

Laboratory Steward (Grade B) required in the Department of Chemistry, Middlesex Hospital Medical School, London, W.1. Salary according to age and experience. Application should be made in writing and sent to the Medical School Secretary not later than October 31.

The Distillers Co. has vacancies for several Bacteriologists and Biochemists in connection with expansion of research in antibiotics and other fermentation projects. Posts available at all levels from assistants (Inter B.Sc. or equivalent qualifications) to senior research workers capable of directing complex investigations (Ph.D. or equivalent, with several years research experience). Salaries up to £800 p.a. or higher, depending on age, qualifications and experience.

Apply in writing, giving full particulars and salary required, to Controller of Research and Development, Distillers Co., Ltd., 21, St. James' Square, London, S.W.1.

Overseas Employment. Applications are invited for the post of Glass-blower and Steward in the Department of Chemistry, University of Cape Town, South Africa. Salary scale £375 x £25–£500 p.a. plus a temporary cost of living allowance, at present £75 p.a. for a married man and £43 p.a. for a single man. Passage money will be allowed up to an amount not exceeding £75. The appointment will be for a probationary period of three years in the first instance. Membership of the University Teachers Superannuation Fund is compulsory. In addition to his other duties the glass-blower will be required to assist with the supervision of the central store for supplying apparatus and chemicals to departments of the University or with the general work of the laboratories. Applications from candidates who have been on military or other national service will be given special consideration and applicants are advised to give particulars of such service.

Written applications (no interviews) giving the following essential details: (1) Full name, (2) Date of birth, (3) Qualifications and experience, (4) Name and address of present employers, (5) Details of present work should be sent to the Secretary, Overseas Department (Ref. 18885), Ministry of Labour and National Service, Norfolk House, St. James's Square, London, S.W.1. Applications cannot be acknowledged.

The Civil Service Commissioners invite applications for appointment as Forest Entomologist (male) at the Forest Research Station, Alice Holt, Farnham, Surrey, under H.M. Forestry Commission. Candidates must be British subjects born on or before August 1, 1915, and under 50 years of age on August 1, 1946. They should have either an Honours Degree in Natural Science with Entomology or Zoology as principal subjects or, if holders of a Forestry Degree, have specialized in forest entomology.

The duties will include the organization and general control of investigations on insect pests to be undertaken by the entomological staff of the Forestry Commission, and liaison with other workers in the field of forest entomology.

The appointment is permanent with superannuation benefit under Federated Superannuation Scheme for Universities and is graded as Senior Scientific Officer on a scale of £520×£25–£710 plus consolidation addition of £90.

A form of application and further particulars may be obtained from the Secretary, Civil Service Commission, 6 Burlington Gardens, W.1, quoting No. 1657. Completed application forms must be received by November 18, 1946.

PHYSICIST required to take charge of a testing laboratory at the Wool Industries Research Association. Candidates should have a good Honours degree; acquaintance with textile work desirable but not essential; preference will be given to applicants who have had experience in the control of laboratory testing. Duties will include research into the development of new instruments and methods. The appointment will be made in the grade of Scientific Officer according to age and qualifications. Application should be made on a form obtainable from the Association, Torridon, Headingly, Leeds, 6, and returned within one month from the date of appearance of this advertisement.

Chemical Engineer for works in India. Must be thoroughly experienced in the manufacture of pharmaceuticals, tablet making, fine chemicals, etc. The position will also carry that of Factory Manager. Candidates should be of good education and health. Preference given to applicants possessing pharmaceutical qualifications or degree. Must have had practical experience as Chemical Engineer and be able to accept entire responsibility for plant and manufacturing processes. High salary will be paid to first-class man of proved ability. Residence and travelling expenses provided. Apply to Box 727, T. G. Scott & Son, Ltd., 9 Arundel Street, Strand, London, W.C.2, giving full details in confidence, of experience, age and when available. Candidates can be interviewed in London.

(*Continued on page* iv *of Supplement.*)

(*Continued from page* iii *of Supplement.*)

Laboratory Technician with training in pathological and bacteriological technique required for the City Hospital Laboratory, Aberdeen. The basic salary is £215 per annum, rising by annual increments of £10 to £235, with, in addition, a cost of living bonus of £78 per annum for males, and £63 per annum for females. The post is superannuable.

Applications, giving full particulars, with copies of recent testimonials should be sent to Dr. J. Smith, Public Health Laboratories, City Hospital, Aberdeen.

D. B. GUNN,
Town Clerk.

Applications are invited for the post of Technician, Grade B, in the Department of Physiology and Biochemistry, St. Mary's Hospital Medical School, W.2. Previous biochemical experience essential. Applicants must have passed a Technical Certificate examination, or its equivalent. Initial wage £5 15s. per week, rising 2s. 6d. per week every six months. Contributory superannuation scheme.

Applications, stating age, experience, etc., with two references, to be sent to the School Secretary as soon as possible.

Messrs. Arthur Guinness, Son & Co., require Chemist at their Laboratory in Dublin, capable of undertaking important research work and directing laboratory routine. Applicants should be of Ph.D. standard and from 35 to 45 years of age; salary according to qualifications and experience. Prospects excellent. Convenient accommodation available if required.

Apply, giving full particulars, to Chief Chemist, Messrs. Arthur Guinness, Son & Co., The Laboratory, Watling Street, Dublin.

Physical Chemists with research experience are wanted by a chemical firm in the Manchester area. In all cases sound theoretical knowledge and an ability to apply it are essential. Those with experience in ionic equilibria particularly as applied to liquid extraction problems, or in reaction mechanism studies or in phase rule work, are especially invited to apply. The posts will carry salaries of £500 to £750 per annum, according to experience. Applications to Box 729, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Imperial Chemical Industries Limited, Explosives Division, require for research work on fundamental problems connected with explosives and allied industries, several chemists and physicists with good honours degree and preferably some research experience. Successful candidates will be located at the Experimental Station at Ardeer, Stevenston, Ayrshire. Salary offered will depend on qualifications and experience, full particulars of which should be sent in with applications to Staff Manager, Nobel House, Stevenston.

Applications are invited from Metallurgists or Chemists with some knowledge of Metallurgy, for the post of information officer in a research laboratory in the London area; to organise an abstract service and to collect data from research staff for compilation into reports and publicity pamphlets. Salary £500–£850 according to experience. Box 712, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist and Physical or Inorganic Chemist required in modern research laboratory near London for work involving reaction of molten metals and fluxes. Only men with first-class qualifications are required. Salary according to experience. Box 713, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

MICROANALYST required by organic microanalytical laboratory. Candidates should hold an honours degree or A.R.I.C. and should have had experience in standard micro-organic elemental and group determinations. Commencing salary of the order £400–£450 per annum depending on experience. Apply to Technical Director, Genatosan, Ltd., Loughborough, Leics.

Assistant Biochemist—Queen Elizabeth Hospital, Birmingham. Applications, addressed to the undersigned, are invited. Candidates must have had post-graduate training in research; experience in clinical biochemistry is desirable. Commencing salary—£600 per annum.

G. HURFORD,
House Governor.

Scientific Assistant. Vacancy for Science Graduate (Zoology) for bureau literary work. £354 × £18 – £570 inclusive. Good knowledge of German desirable.—Imperial Bureau of Animal Health, Veterinary Laboratory, Ministry of Agriculture, New Haw, Weybridge, Surrey.

Technical Assistant. Vacancy for Arts Graduate for bureau literary work. Knowledge of a Scandinavian language desirable. £204 × 15 – £384 inclusive. Suitable applicant would start at appropriate grade.—Imperial Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey.

Glass Blower required for Research Laboratory, West London. Good all-round knowledge of hard and soft glass technique including lathe work. Wages according to experience. Write stating age, experience and full particulars to Box 724, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Chemist required for factory process control as applied to cathode ray tubes. Knowledge of fluorescent materials and their application desirable, but not essential. Degree standard and several years industrial experience required. West London district. Apply, giving age, full details of education and experience, together with salary required, to Box 725, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Glass Blower required, used to hard and soft glass working for assembly of tubes and electronic devices. West London district. Salary £325 to £350 per annum inclusive. Apply, giving age, fullest details of training and experience, to Box 726, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Assistant (Grade II) required for the Physiology Department. Salary £2 10s. per week, rising by annual increments of 5s. per week to £5. Pension scheme in operation. Apply as soon as possible, with particulars of qualifications and experience, to the Secretary, King's College of Household and Social Science (University of London), Campden Hill Road, London, W.8.

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cerned with radiolocation, and the latter with communication equipment. The magnitude of the latter achievement can be appreciated from the fact that it was spread over only eighty-three colleges, the remaining technical colleges providing other types of war-time training courses.

New Dielectrics in Telecommunications

In the second part of his address, Prof. Willis Jackson referred to some recent developments in the field of dielectrics of particular interest to telecommunication engineers. Up to only a few years ago, the dielectric materials in general use were chemically and structurally very complex ; but there are now available or becoming available, materials suitable for technical application which, though not strictly simple, are sufficiently uniform chemically and structurally for them to be studied scientifically, and which have the great merit that they can be prepared synthetically by controllable processes. These materials can be classified broadly as compounds of carbon, silicon and titanium respectively ; and Prof. Jackson showed with the aid of diagrams the chemical structure of such materials as polythene, polyvinyl chloride, the silicones, and the titanium compounds. In addition to the technical development and improvement of such materials, the scientific side of the subject of dielectrics is attracting much interest and attention ; and a considerable amount of work is also being carried out in an effort to obtain a better understanding of the physical and mechanical properties of the materials. The whole subject is one which merits the close attention of electrical, and particularly telecommunication, engineers and physicists.

University of Birmingham : Opening of Session

The University of Birmingham, like other universities, begins its new session with a very large increase in number of undergraduates, including about 1,400 freshmen, which brings the total of students up to about 2,600 as compared with about 1,700 before the War. Many of the freshmen are ex-service men to whom, at the request of the Government, preference is to be given up to 90 per cent of places available, if necessary. This quota has been reached in civil and mechanical engineering, the former being most popular especially among ex-service men, with the consequence that many applications from schoolboys have had to be refused. In the Faculty of Medicine the competition has as usual been severe, 25 per cent of the places being allocated to women. Many applications have come from overseas, and of these preference has been given to students from British Colonies, Norway and Holland. The greatest difficulty has been to secure lodgings for students, and this has led to the appointment of a lodgings warden. The existing accommodation for teaching has been taxed beyond capacity, and recourse must be had to temporary buildings when such can be obtained and erected. The shortages of labour and materials are preventing the beginning of the great development plan for permanent building for which the money is available—during the past two years £1,000,000 has been promised by industries in the West Midlands. The Vice-Chancellor comments that for the first time the Government has learnt of the value of university graduates, so far as science is concerned, and is willing to pour in money in a way that it has never done before, so that lack of money is not now an obstacle.

University of Sheffield : Appointments

The Council of the University of Sheffield has made the following appointments : Dr. R. S. Illingworth, to the chair in the newly opened Department of Child Health, which is to be a centre for both treatment and research ; Dr. A. R. Kelsall and Dr. J. Pemberton, to be full-time lecturers in medicine ; Mr. R. B. Shepherd, to be assistant lecturer in physics ; Mr. W. Moser, to be assistant lecturer in chemistry ; Mr. J. McKenna, to be assistant lecturer in chemistry (for the session 1946–47) ; Mr. P. Wilkinson, to be assistant lecturer in geology ; Miss V. M. Hawkins, to be assistant lecturer in metallurgy.

The Council received intimation of the following resignations : Dr. Brynmor Jones, lecturer in organic chemistry, on his appointment to the chair of chemistry at University College, Hull ; Dr. I. F. S. Mackay, lecturer in experimental physiology ; Dr. E. Hutchinson, assistant lecturer in chemistry ; Dr. R. Halle, assistant lecturer and research assistant in the Department of Glass Technology.

Forage Resources of Latin America

The Imperial Bureau of Pastures and Forage Crops, Aberystwyth, in association with the Technical Collaboration Branch, Office of Foreign Agricultural Relations, United States Department of Agriculture, has published the first of a series of bulletins dealing with the forage resources of Latin America ("The Forage Resources of Latin America—El Salvador", by James M. Watkins. Bulletin 35. 2*s*. 6*d*.). The economics of many of these South American countries depend almost entirely on animal products from great tracts of natural grassland. The climatic conditions of the various regions, however, are very diverse, ranging from Mexico, through the tropics to the Patagonian grazing lands of Argentina. The nature of these natural forage resources, the species which compose them and the types of management used on them are of interest and possible application in the British African Colonies and Protectorates. In El Salvador most of the best upland is devoted to coffee, which is the primary cash crop of the country, the livestock industry being concentrated chiefly along the coast. Though good pasture management is followed in some districts, the carrying capacity on the whole could be greatly increased by the better utilization of the upland regions suitable for cattle, thus leaving the coastal areas for more profitable crops. Emphasis is laid on the need for more legumes and grass-legume mixtures, *Desmodium rensoni* (barajillo) in particular appearing to be a promising plant, once sound methods have been determined for managing it and producing seed. A more liberal use of lime and fertilizers would lead to considerable improvements, and as one of the major forage problems in El Salvador is the long dry season, profitable returns could also be expected if increased attention were paid to the production of hay and silage.

Agricultural Genetics in Italy

A new journal, *Genetica Agraria*, has been published by the National Institute of Genetics in Rome. It will include research papers upon agriculture and genetics which were previously issued as bulletins by the research stations of Italy. Thus a wider availability and knowledge of the work of these stations can be afforded. The journal is to be issued quarterly at a cost of 300 lire per number or 900 lire per annual volume, exclusive of postage. It will be welcomed as

filling a long-felt want of information regarding agricultural genetics in Italy. Vol. 1, No. 1 contains papers on such subjects as genetics of castor oil plant, genetics of lethargy of seed in and on colour of wheat, Jarovization of the potato and resistance to rust in wheat. The papers are written in Italian, but there is a summary in both Latin and English. An appendix contains abstracts of papers on genetical or plant-breeding subjects. The form and presentation of the journal are to be commended, but it might be thought desirable to obtain the aid of an English reviser for the English summaries; the summaries in the first issue do not represent adequately the Italian papers.

Naval Mining and Degaussing

A CATALOGUE has been issued of the exhibition now being held at the Science Museum, South Kensington, of representative British and German naval mining and degaussing material used during the Second World War. During 1914–18, mines, almost without exception, had to be struck by the target in order to produce an explosion; but in the inter-war period detecting methods were developed which gave the mines greatly increased range of detection. These advances led to the 'ground' mine, laid on the sea-bed, operated either magnetically, electro-chemically or acoustically, or by the small changes of pressure which occur on the sea-bed, on the approach of the target vessel. The antidote to the magnetic mine used extensively by the Germans for the first time in November 1939, was to reduce to a minimum the natural magnetism of ships by a process of 'degaussing'. The exhibition affords a comprehensive insight into the various methods and varied equipment employed, and also contains charts of the British naval mining achievement and of enemy shipping casualties due to British mines in the European war theatre, 1939–45.

Institution of Naval Architects: Awards

THE Council of the Institution of Naval Architects has made the following awards: Sir William White Post-graduate Scholarship in Naval Architecture (£150 a year for two years) to Mr. Thomas Corin, of the Ship Division, National Physical Laboratory; Aluminium Development Association Research Scholarship in the application of light alloys to ship construction (£400 a year for two years) to Mr. E. C. B. Corlett; Elgar Scholarship in Naval Architecture (£175 a year) to Mr. R. L. Townsin, of H.M. Dockyard, Portsmouth, who will proceed to King's College, Newcastle-on-Tyne, for three years; Parsons Scholarship in Marine Engineering (£170 a year) to Mr. W. G. Wade, of H.M. Dockyard, Sheerness, who will proceed to King's College, Newcastle-on-Tyne, for three years.

Meteor Observations in India in 1943–44 at Begumpet, Deccan, India

MOHD. A. R. KHAN has issued a pamphlet with this title which gives details of meteor observations between January 1, 1943, and December 31, 1944, during a total watch of nearly 132 hours. The observations included the usual well-known shower meteors and in addition a number of exceptionally bright meteors, one of which, in May 1944, was of magnitude − 4. It is interesting to know that the total number observed in each year was nearly the same—1,044 in 1943 and 1,005 in 1944. Details of the paths of all the meteors were sent to Prof. C. P. Olivier, Flower Observatory, who arranged to have the paths plotted and radiants deduced, and a number of new radiants were found as a result. An interesting phenomenon was observed on October 2, 1943, between 21h. and 22h. U.T. The sky appeared to be lit up with a peculiar glow, akin to non-polar aurora. No artificial lights were reported in the neighbourhood at the time, and no explanation has been given of the phenomenon.

Comet Jones (1946 *h*)

THIS comet was discovered on August 6 by A. Jones of Timaru, New Zealand. The following orbit and ephemeris have been computed by Cunningham:

Orbit

T	1946, Oct. 27.191 U.T.	
ω	321° 42′	}
Ω	238 07	} 1946.0
i	57 10	}
q	1·1121	

Ephemeris

		α	δ
Oct.	19.0 U.T.	13h. 02.9m.	− 28° 59′
	27	13 41.0	28 25
Nov.	4	14 17.2	27 17
	20	15 22.6	23 46
Dec.	6	16 18.5	19 11
	22	17 06.4	14 02

Its geocentric distances on the first and last dates are 2 and 2·35, and the heliocentric distances on the corresponding dates are 1·12 and 1·42. Its magnitude on the same dates will be about 7 and 9.

Announcements

A MEETING has been arranged by a committee representative of the Society of Authors, Playwrights and Composers, the International P.E.N. Club (English Centre), the National Book League, and the British Association for the Advancement of Science, in memory of H. G. Wells. Lord Beveridge will preside, and tributes will be paid by Prof. G. D. H. Cole, Sir Richard Gregory, Mr. David Low, Mr. Desmond MacCarthy and Mr. J. B. Priestley. The meeting, which is open to the public, will be held in the Royal Institution, Albemarle Street, London, W.1, on October 30, at 3.0 p.m. Applications for tickets should be addressed to the Secretary, Wells Tribute Meeting, c/o The British Association, Burlington House, London, W.1.

DR. PATRICK D. RITCHIE, head of the Department of Chemistry and Biology at the Leeds College of Technology, has been appointed head of the Department of Chemistry at the Central Technical College, Birmingham, in succession to Dr. J. A. Newton Friend. Dr. Ritchie is a graduate of the University of St. Andrews, where he was a student of Prof. Alex. McKenzie. On leaving the University he went to the research staff of Imperial Chemical Industries, Ltd., and he has had teaching and research experience in the University of London. Later he became chief chemist to Messrs. A. Reyrolle and Co., Ltd.

DR. FRED GRUNDY, medical officer of health for Luton, has been appointed chairman of the Executive Committee of the British Social Hygiene Council in succession to the late Dr. Otto May.

THE Leon Gaster Memorial Premium is awarded annually by the Illuminating Engineering Society for the best contribution submitted to and published by the Society during the session. No award was made in 1944. Two awards are being made now, one to Dr. J. N. Aldington for his paper "Bright Light Sources", and one to Mr. G. T. Winch for his paper "Photometry and Colorimetry of Fluorescent and other Electric Discharge Lamps".

LETTERS TO THE EDITORS

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

Rotating Universe ?

ONE of the most mysterious results of the astronomical studies of the universe lies in the fact that all successive degrees of accumulation of matter, such as planets, stars and galaxies, are found in the state of more or less rapid axial rotation. In various cosmogonical theories the rotation of planets has been explained as resulting from the rotation of stars from which they were formed. The rotation of stars themselves (in particular that of *B*-stars) can be presumably reduced to their origin from the rotating gas-masses which form the spiral arms of various galaxies. But what is the origin of galactic rotation ?

If, according to the current theories, we consider the galaxies as the result of gravitational instability of the originally uniform distribution of matter in space, we will find it very difficult to understand why such condensations are in most cases found in the state of rather fast rotation. In fact, on the basis of statistical distribution of angular momentum, we would rather expect such condensations to show no more rotation than the water droplets in a fog formed from oversaturated vapour. Barring the possible explanation of the rotation of galaxies on the basis of the alleged irregular turbulent motion of the masses of the universe, we can ask ourselves whether it is not possible to assume that *all matter in the visible universe is in a state of general rotation around some centre located far beyond the reach of our telescopes* ?

The answer to such, at first sight fantastic, question need not wait until much larger telescopes shall have been built. It can be, in fact, settled by present means of observation. We know that the rotation of the stars of our system around the galactic centre can be proved by the study of the so-called Oort-effect in the radial velocities of comparatively near stars. In fact, due to the phenomenon of differential rotation, the mean radial velocities of stars located along the galactic plane show a double-sine periodicity with nodal axes directed parallel and perpendicular to the line connecting the sun with the centre of rotation. Thus if the realm of galaxies as seen through Mt. Wilson telescope represents only a small part of a much larger system (a 'super-galaxy' in the super-Shapley sense) rotating around a distant centre, careful observations of mean radial velocities of galaxies located in different regions of the sky should reveal similar periodicity.

The existence of this effect would prove general rotation of the universe and indicate the direction towards the rotation centre without, however, giving us its distance. Thus, it seems that the answer to the problem of universal rotation lies within the grasp of modern astronomical technique.

It must be added in conclusion that in the language of the general theory of relativity such a rotating universe can be probably represented by the group of anisotropic solutions of the fundamental equations of cosmology.

G. GAMOW

Department of Physics,
George Washington University,
Washington, D.C.
Sept. 13.

Conditions of Escape of Radio-frequency Energy from the Sun and the Stars

IN several communications in *Nature*[1,2,3,4] and elsewhere, various British, Australian and New Zealand workers have described experiments carried out during the War which prove conclusively that during times of solar disturbance there are large outbursts of radio-frequency energy from the sun. The wave-lengths measured vary from 1·5 metres to 30 metres (10 Mc. to 200 Mc.). On a rough estimate, the intensity of emission appears to be, as Appleton[1] has shown, 10^4 times the value calculated from the black-body formula taking $T = 6{,}000°$ K. If we assume that the radiation proceeds only from the active areas, as appears to be corroborated by the experiments now in progress at the Cavendish Laboratory, Cambridge*, the emissivity of these regions for the range mentioned is increased nearly 10^7–10^8 times the black-body radiation.

There are certain difficulties in the escape of these radiations from the sun to which attention may be directed. It has been found that the quiescent sun has, like the earth, a magnetic field of the order of 50 gauss, but the spots show a field of much higher range, from 100 gauss in the case of tiny spots to 4,000 gauss for the largest ones[5]. If the radio waves are generated anywhere within the outer layers of the sun, then they must follow the physical laws of electromagnetism. According to the magneto-ionic theory of Appleton, an electromagnetic wave of frequency f, generated anywhere on the earth's surface, can escape vertically from the earth only when the frequency of the waves exceeds certain limits, depending upon the maximum electron concentration above. The exact mathematical relations are

$$f_0^2 > \frac{4\pi Ne^2}{m} > 8{\cdot}0 \times 10^7 . N$$

$$f_e(f_e + f_h) > \frac{4\pi Ne^2}{m} > 8{\cdot}0 \times 10^7 . N.$$

Here N is maximum number of electrons per c.c. in the ionosphere, f_0 is frequency of the *o*-wave, f_e is frequency of the two extraordinary waves, f_h the characteristic gyro-frequency of the electrons under the total field H, $f_h = eH/4\pi$ cm. $= 1{\cdot}32\ H$ Mc. These conditions set a lower limit to the frequency of the radiations which can escape from the earth, and their validity has been verified by innumerable experiments.

If we apply these conditions to the sun, and also to the stars, we find at once that severe physical conditions have to be imposed on the emission of radio-waves from these bodies. Taking first the *o*-wave, we should have

$$N < 1{\cdot}25 \times 10^{-8} . f^2$$
$$< 1{\cdot}25 \times 10^6 \text{ for } f = 10 \text{ Mc.}$$
$$< 5 \times 10^8 \text{ for } f = 200 \text{ Mc.}$$

The concentration of electrons in the different layers of the sun has been found by well-tried astrophysical methods[6] to have the mean values of 10^{13} per c.c. for the reversing layer, 4×10^{11} per c.c. for the mean chromosphere, and 4×10^8 per c.c. for the base of the inner corona. It is, therefore, obvious that *o*-radiations of radio-frequency range which we obtain from the sun cannot have their origin either in the reversing layer or the chromosphere, but only in the corona, and that also progressively in the outer layers as the wave-length is increased. But the corona has been shown to be a purely 'electron atmosphere' without any heavier atomic particles, excepting very small concentrations of heavily ionized Fe, Ni and Ca which produce the coronal lines. The mechanism of origin contemplated by Greenstein, Henyey and Keenan[7] which ascribes the radio-waves to recombination between protons and electrons therefore appears to fall to the ground in the case of the sun.

The e-waves. For the *e*-waves, the value of f_h is decisive, and this varies from 66 Mc. for the quiescent sun to roughly 4,000 Mc. for the spot, taking $H = 3{,}000$. These are frequencies of an order which are not contemplated in Appleton's theory, but a little work shows that whatever has been said regarding the *o*-wave also applies to *thut e*-wave which corresponds to the condition $f_e(f_e - f_h) > 8{\cdot}10^7 \times N$ with greater emphasis. In fact, this wave cannot escape unless f_e has very high values, $>$ 66 Mc. The *e*-wave corresponds to the condition $f_e(f_e + f_h) > 8 \times 10^7\ N$.

The possibility of reception of this wave on the earth has generally been ignored by European and American workers, but it has been obtained distinctly on several occasions by Toshniwal[8] at Allahabad, and his findings have been confirmed by Leiv Harang[9]. Recently, Saha and B. K. Banerjee[10] have shown that any radio-wave generated on the earth would be decomposed into three waves as in inverse Zeemann effect, the *p*-component corresponding to the *o*-wave, and the *S*-components to the *e*-waves. If this deduction be accepted, we at once see that for the spots, the *e*-wave of this type has a far greater probability of escape ; for now we should have

$$N < 1{\cdot}25 \times 10^8\ f_e(f_e + f_h)$$
$$< 1{\cdot}25 \times 10^8\ f_e f_h, \text{ taking } f_h \gg f_e$$
$$< 5 \times 10^8 \text{ for } 10 \text{ Mc. waves, and } < 10^{10} \text{ for } 200 \text{ Mc. waves ;}$$

taking $f_h = 4{,}000$ Mc., corresponding to the field-strength of 3,000 gauss. For a quiescent sun, the figures are $N < 8 \times 10^6$ and $1{\cdot}4 \times 10^8$ respectively. Hence the probability of escape of these waves from the quiescent sun continues to be very small, if the wave originates in the deeper layers. For larger spots, the field generally increases and has been known to reach values as high as 4,000 gauss.

From these arguments, it is fair to draw the conclusion that the large spots are just the regions whence the *e*-waves of the frequency range 10–200 Mc. can escape. The value of the fields given above corresponds to the level where the atomic lines originate, but Chapman[11] thinks that fields might increase to even 10,000 gauss in the deeper layers. If this be true, the *e*-waves can originate even from much deeper layers. Further, it is well known that the spot is a region of far lower temperature, and the electron concentration in the spot is much lower than on the general surface of the sun ; this circumstance also helps the escape of the *e*-waves.

If these considerations be on the right line, the radio-waves received on the earth when a big spot is in the centre of the sun's disk should be circularly polarized, and its sense of polarization will be determined by the sign of the field.

These considerations apply equally well to the stars composing the Milky Way region, from which waves in the metre range have been observed[3]. They cannot be emitted from the surface of the hotter stars, but from cooler stars of *G*-, *K*- and *M*-type, and probably the escape of the radiation is facilitated by the development of spots in these stars, analogous to the case of the sun. The difficulties of the dilution factor pointed out by Greenstein *et al.*[7] are therefore eased to a large extent, as, according to Dunham[12], the disk area covered by *K*- and *M*-stars is nearly 10^4 times that of *B*-stars.

M. N. SAHA

University College of Science,
Calcutta.
Aug. 30.

*I am indebted to Dr. J. A. Ratcliffe for showing me these experiments during my recent visit to Cambridge.

[1] Appleton, *Nature*, **156**, 534 (1945).
[2] Hey, Phillips, Parsons, *Nature*, **157**, 297 (1946).
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[9] Harang, *Terr. Mag.*, **41**, 143 (1936).
[10] Saha and Banerjee, *Ind. J. Phys.*, **19**, 159 (1945).
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[12] Dunham, *Proc. Amer. Phil. Soc.*, **81**, 277 (1939).

Condensations in a Non-static Universe

Einstein and Straus[1] have recently considered the influence of the expansion of space on the gravitation fields surrounding the individual stars. The paper has attracted considerable attention, but an interesting new result implicit in their work does not seem to have been noted as yet[2]. The authors consider the cosmological model which, in the usual notation, is

$$ds^2 = -T^2(1 + zr^2/4)^{-2}\,\delta_{ij}\,dx^i dx^j + dt^2, \quad (1)$$

where $T = T(t)$, $z = 1, -1$ or 0.

The pressure vanishes everywhere if

$$2T\ddot{T} + \dot{T}^2 + z = 0 \text{ or } T\ddot{T}^2 + zT = k, \quad (2)$$

k being a constant of integration. A consequence of the pressure being everywhere zero is that the density ρ is given by

$$\rho = 3k/8\pi T^3. \quad (3)$$

Hence

$$(4\pi\rho/3)T^3r^3\,(1 + zr^2/4)^{-3} = m(r), \quad (4)$$

is a function of r only. If r is fixed as r_0, m is also fixed and may be interpreted as the total mass contained within the boundary $r = r_0$. Einstein and Straus have shown that Schwarzschild's external line-element in an isotropic non-static form can be made to go over into the cosmological form (1) at $r = r_0$ by defining the constant k of (2) as

$$k = 2mr_0^{-3}\,(1 + zr_0^2/4)^3, \quad (5)$$

where m is the mass constant in Schwarzschild's solution. What we wish to point out is that (5) is precisely the relation that one gets from (3) and (4). This fact suggests that if the cosmic matter contained within the sphere $r = r_0$ condenses into a spherical body of the same mass m, there is no change in the external field beyond $r = r_0$. For a given cosmological model of type (1) (that is, for a given k) and for a given r_0 there is naturally a unique m.

V. V. Narlikar
K. R. Karmarkar

Benares Hindu University.
Sept. 7.

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[2] Einstein, A., and Straus, E. G., *Rev. Mod. Phys.*, **18**, No. 1 (1946).

An Observed Abnormal Increase in Cosmic-Ray Intensity at Lahore

During the course of an experimental study at Lahore on the directional total intensity of the cosmic radiation, with a triple coincidence counter system, we observed over a short period a very large increase (nearly 200 per cent) in the intensity.

The telescope consists of three internally quenched Geiger–Müller counters, 35 cm. long and 2·5 cm. in diameter, spaced 12·5 cm. from each other. These counters were prepared with copper oxide coated cylinders and filled with 9 cm. argon and 1·5 cm. pressure of ethyl alcohol vapour, all of them having very similar characteristics and with a plateau of 180 V. A stabilized high tension[1] is applied through a resistance of 0·1 megohm to the wires of the counters and the triple coincidence pulses are recorded by a circuit recommended by Johnson[2], which is an improvement on the original Rossi circuit. We can set the telescope at various angles to the zenith and also vary the azimuthal angle by a suitable mounting.

During July 31–August 3, with the telescope set vertically, and the axes of the counters in the magnetic meridian, we were getting an average of 23·8 coincidences per hour, and at an angle of 20° W. an average of 16 per hour. The readings were taken during the daytime between 11 a.m. and 5 p.m. in the Physics Laboratory, under a single roof of a few inches of concrete. This rate of counts was maintained until noon on August 3, but between noon and 1 p.m. and 1 and 2 p.m. with the telescope at 20° W., the counting rate increased to an average of 40 per hour, from a previous value of 16 per hour.

Considering it might be due to some fault in the apparatus or local causes, we checked all the voltages, which we found to be very constant. Then we checked and even changed a few valves, but the high rate was maintained. We then rotated the telescope, bringing it to the vertical position again, and between 2.30 and 4.30 p.m. took counts in this position, which were also much higher, namely, 60 per hour, as against 24 during previous measurements. It is to be noted that in both cases the total counts per hour increased to two and a half times.

On August 4 (Sunday) we took no observations. On August 5 about the same rate of coincidences as originally was restored, and the observations were normal.

The enhanced intensity lasted at least for five hours, probably longer, and checking up all the facts we are inclined to believe that it was a real increase in the intensity of the radiation. We shall be interested to learn if during the same interval the same abnormal increase was observed elsewhere; or whether it was shown only in a particular region of the earth.

Our thanks are due to Prof. J. B. Seth, Dr. P. K. Kichlu and Dr. P. S. Gill for their encouragement in this work.

H. R. Sarna
O. P. Sharma

Physics Department,
Government College,
Lahore.
Aug. 10.

[1] Evans, R. D., *Rev. Sci. Inst.*, **5**, 371 (1934).
[2] Johnson, T. H., *Rev. Sci. Inst.*, **9**, 221 (1938).

Refraction Effects in Electron Diffraction

Observations by Sturkey and Frevel[1] and Hillier and Baker[2] indicate that some rings in electron diffraction patterns from magnesium oxide and cadmium oxide smokes are double, and in one case (the *220* ring) it was suspected that there were five components contributing to the ring contour. Sturkey and Frevel suggested that refraction by the regularly shaped particles gave rise to the two components, although their data were not conclusive. Using the high-resolution system of the R.C.A. type E.M.U. microscope as a diffraction camera, we have attempted to find some feature of the diffraction by oxides of this type attributable to stoichiometric excess of the metallic constituent. We have obtained patterns showing resolution of details of fine structure of the reflexions, from which a complete interpretation of the phenomenon is possible.

Patterns from magnesium oxide and cadmium oxide smokes, both of which occur as regular cubes of about 500 A. cube-edge, show rings to be double, triple, or, in the case of *h00* reflexions, single and sharp. In certain cases when orientation (cube faces normal to beam) was present, tilting of the plane of the specimen produced arc patterns from which information concerning the dependence of the multiplicity on the angle of tilt could be obtained. In patterns to which few individual crystals contributed, it was observed that spots were grouped about the position at which the normal reflexion was to be expected and that often groups of six were observed. Furthermore, the *h00* rings, although single, consisted of groups of two component spots displaced along the ring. Where larger deviations from the stoichiometric ratio existed, the spots were replaced by streaks radiating from the expected position of the reflexion. For example, yellow cadmium oxide gave spot patterns, whereas brown cadmium oxide, containing greater excess of cadmium, gave streaks. These effects are illustrated in enlargements (× 56) of small segments of certain rings (Fig. 1).

The angular deviation δ expected on the basis of refraction due to an inner potential P volts may be shown to be

$$\delta = \frac{P}{2E}\left(\pm\frac{\cos\psi_1}{\cos\varphi_1} \pm \frac{\cos\psi_2}{\cos\varphi_2}\right),$$

where φ_1 and φ_2 are the angles between the beam and the face normals, ψ_1 and ψ_2 are the angles between face normals and the diffraction plane normal, and E is the accelerating voltage of the electron beam.

This reduces to

$$\delta = \frac{P}{2E}\,(\pm\tan\varphi_1 \pm \tan\varphi_2),$$

in the special case where the path of the beam lies in a plane perpendicular to the cube edge (see also ref. 1).

On the basis of this theory, it has been possible to interpret the features of the patterns obtained. The calculated variations in separation and relative intensity of the several components of the arcs with angle of tilt agreed with those observed. Agreement between the observed and calculated values for the angles between the individual streaks of one group and the radius of the ring was also obtained. Calculated inner potentials varying from 12 to 16 volts for the various planes lie in the range expected. Only a variation of inner potential, resulting, we suggest, from the presence of excess metal atoms in

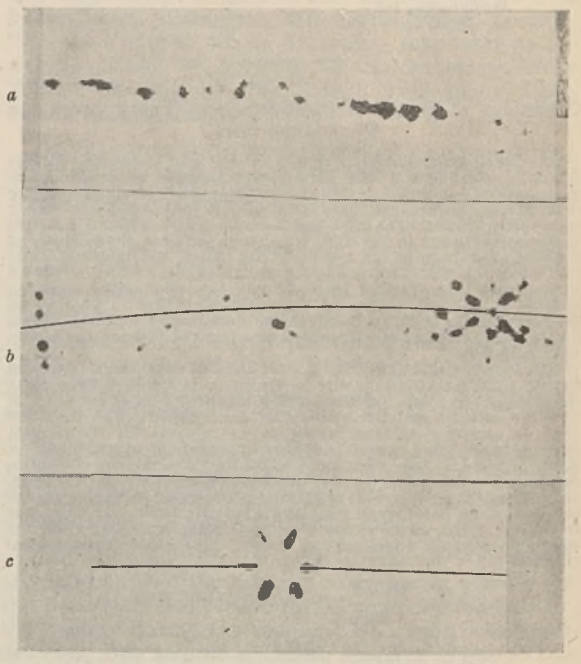

Fig. 1. Examples of groups of reflexions resulting from refraction by cubes of magnesium oxide for (*a*) (200), (*b*) (220) and (*c*) (422) planes. Undisplaced ring positions are indicated by the continuous line in (*b*) and (*c*). Enlargement from original pattern, 56 diameters

Fig. 2. Portion of electron diffraction pattern from cadmium oxide particles, showing different line breadths for *222*, *400*, *420* and *422* reflexions. Enlargement 16 diameters

interstitial sites in the crystal, can explain the elongation of component spots into streaks.

Progressive change from regular cubic to irregular habit was accompanied by the merging of the individual components into one broad ring. For zinc oxide smoke particles, where only the prism faces parallel to the hexagonal axis are well developed in the characteristic long spines, only one pair of streaks is expected from each single-crystal reflexion. Hillier and Baker[3] have observed these streaks for zinc oxide smoke and have interpreted them as low magnification electron-optical images of the individual spines. If this were so the streaks would be radial on the *002* ring and circumferential on the *100*, whereas in the patterns obtained by us, and in those published by Hillier and Baker, the opposite is the case, in accordance with the refraction theory.

For spherical particles, or the similar case of completely irregular shapes, the refraction effect will produce a broadening of the rings of calculated angular half-width $1{\cdot}4\ \frac{P}{2E}$, and width for one tenth intensity $3{\cdot}8\ \frac{P}{2E}$. This broadening is of the same magnitude as that due to finite crystal dimensions for particles of only several hundred angströms diameter for voltages most commonly used, and so must be taken into account in crystal-size determinations. For regularly shaped particles the estimation of particle shape and dimensions on the basis of ring breadth must likewise take into account the selective broadening of the rings by refraction, which may be as large as $\frac{5P}{2E}$ (Fig. 2). Moreover, in this case the relative intensities, as judged by peak intensity values, will be smaller for those rings undergoing refraction-broadening, thus giving rise to apparent intensity anomalies in electron diffraction patterns. Particles having well-developed crystal faces will therefore show deviations in relative intensity of the various reflexions from the X-ray values. In contrast to the explanation offered by Ehrhardt and Lark-Horovitz[4], this is the case with zinc oxide, where the relative intensities of the *110* and *103* rings, in particular, are inverted for material showing hexagonal prism habit.

Details of this work will be published in full at an early date.

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Sept. 3.

[1] Sturkey and Frevel, *Phys. Rev.*, **68**, 56 and 209 (1945).
[2] Hillier and Baker, *Phys. Rev.*, **68**, 98 (1945).
[3] Hillier and Baker, *J. Appl. Phys.*, **17**, 12 (1946).
[4] Ehrhardt and Lark-Horovitz, *Phys. Rev.*, **57**, 603 (1940).

'Container-dent Sensitivity' of Solid Explosives

When explosions result from rough handling of bomb-type ammunition, they generally must be ascribed to accidental fuse action; because, with fuses generally present, alternative explanations appear less reasonable. But during the War there have been some explosions of items of bomb-type ammunition where (with partial detonations) fuses were recovered intact, and other cases where bomb-type ammunition items were exploded without any fuses in them. The impacts which resulted in these explosions were caused by only relatively light bumping, or by the items falling from heights ranging from 4 in. up to 4–5 ft.; and they were too slight to have caused rupture or more than mere dents.

This phenomenon, now called 'container-dent sensitivity', differs essentially from 'bullet sensitivity', or from 'fragment sensitivity', which produce detonations of explosives in thin metal containers when such containers are penetrated by bullets or fragments at high velocities of the order of 2,000 ft./sec. or more (but are only ignited, or are unaffected, at much lower, though still 'penetrative', velocities).

Also, this phenomenon is by no means the same as that involved where an even greater height of fall of a small weight is used to explode a few milligrams of *bare* explosives in conventional 'impact sensitivity' tests. Its existence seems, in fact, not implied by results of usual explosive sensitivity tests; and it appears to have had little or no important mention in the literature of explosives.

Dents on U.S. bomb-type ammunition caused by impacts at least as severe as impacts causing these occasional explosions probably occur by the million; so that explosions from denting impacts are fortunately of extremely low frequency. With U.S. bomb-type ammunition during the War there have been only about twenty incidents probably ascribable to this cause; but they have included particularly bad ones which, by one rough estimate, involved total property losses of many millions of dollars, and thousands of deaths and injuries.

Such occurrences seem more frequent with the more sensitive explosives: but T.N.T. and amatol, as well as R.D.X. explosives, have all been involved. Very thin-walled containers, such as those of depth bombs and torpedo war-heads, appear relatively more susceptible. One may surmise a trivial local ignition is produced by certain unidentified critical conditions of denting, and that burning to partial or complete detonation is peculiarly favoured by confinement afforded by the dented, but unbroken, container.

Adequate understanding of the mechanism of this phenomenon apparently requires further fundamental research, which possibly may result from more widely disseminated knowledge of the existence of 'container-dent sensitivity' and from fuller appreciation of its practical importance.

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An Electronic Method of Tracing the Movements of Beetles in the Field

Recently a new form of Geiger–Müller tube has been developed (by G. A. R. T.) which has been found extremely useful in studying the movements of Elaterid beetles of the genus *Agriotes* Esch. As these beetles are known to fly but rarely in Britain, a study of the extent to which they may move by walking is of considerable interest.

A beetle is taken from the field, and 5 μgm. of radium sulphate, deposited between aluminium foil disks (2 mm. in diameter and weighing in all only 0·5 mgm.), are inserted with resin adhesive beneath the elytra. The beetle is replaced, and its position afterwards found by detecting the radiation from the disk with a Geiger–Müller tube. The tube, which has the advantage of quiet background, stable operation, and high sensitivity, together with its associated power supply, operates a loudspeaker directly, without any valve amplification, and is thus very convenient for field use. When it is passed over the region in which the beetle is thought to lie, periodic ticks increase in frequency to a maximum when the tube is directly overhead. The quantity of radium sulphate used is sufficient to enable localization through four inches of soil, and the beetle's position may thus be ascertained to within a few inches with only the preliminary interference of marking, although it is quite invisible, either at night, or by day under soil, or among the dense stem bases of meadow plants.

It is probable that this robust apparatus will find many applications in ecological field work in the future.

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Statistical Weather Forecasting

In the regression equation

$$P = K_1x_1 + K_2x_2 + \ldots K_nx_n, \quad . \quad (1)$$

characteristic of all equations employed in statistical weather forecasting, including long-range forecasting, let P represent the atmospheric pressure at a station A at time $t = z$, $x_1 \ldots x_n$ representing the pressures at n evenly spaced points on a circle of unit radius at time $t = 0$. This equation serves to predict the value of P for a time z in advance, and the well-known method to obtain the n unknown regression coefficients is to apply the method of least squares:

$$\Sigma(P - K_1x_1 - \ldots - K_nx_n)^2 = \text{min.} \quad (2)$$

in which the summation extends over a long series of previous records.

If the differentials of (2) with respect to the K's are each equated to zero, there emerge n linear equations

$$r_{Aq} = \sum_{s=1}^{n} K_s r_{qs} \ (q = 1, 2 \ldots n). \quad . \quad (3)$$

In (3) r_{Aq} denotes the correlation between P and x_q, and r_{qs} that between x_q and x_s.

The reliability of the predicted P depends upon the closeness with which R_z, the multiple correlation coefficient between P and $x_1 \ldots x_n$, approaches unity; where, according to a well-known theorem of correlation theory,

$$R_z^2 = \sum_{q=1}^{n} K_q \ r_{Aq}. \quad . \quad . \quad . \quad . \quad (4)$$

If the number of 'control stations' n be increased indefinitely, the above equations assume the form

$$r_{(Aq)} = \int_0^{2\pi} K_{(s)} \ r_{(qs)} \ ds, \quad . \quad . \quad . \quad (5)$$

and

$$R_z^2 = \int_0^{2\pi} K_{(q)} \ r_{(Aq)} \ dq. \quad . \quad . \quad . \quad (6)$$

The practical application of these equations was performed as follows. Correlations between the daily pressures at a large number of barometric stations in South Africa were computed for the five-

year period 1936–40, Pretoria serving as station *A*. By drawing a map showing lines of equal correlation, it was possible to determine the value of $r_{(Aq)}$ at all points on a circle of roughly one thousand miles in diameter covering the greater part of the Union of South Africa, and to express $r_{(Aq)}$ analytically in terms of its harmonic components. Similarly, by drawing a series of maps showing lines of equal correlation of *simultaneous* pressures, it was possible to express $r_{(q,s)}$ in terms of a double Fourier series involving the two variables q and s. By substituting the values thus found in (5), one is able to obtain the value of $K(s)$ in terms of its Fourier components, and hence the value of R_z by means of equation (6).

The value actually found for the month of July was

$$R_z = 0{\cdot}916 \pm 0{\cdot}003,$$

and this value represents an accuracy of prediction which compares most favourably with the accuracy obtained by competent meteorologists in drawing prebaratic or prognostic charts.

However, the above value of R_z by no means represents the ultimate possibilities of this method. The maximum value of R_z, which in a previous publication[1] we denoted by M_z, is attained only when all possible controls are included, which implies that pressures at *all* points in the atmosphere measured at *all* times from $t = -\infty$ to 0, should be included in the regression equation. This in turn means that the single integration in (5) and (6) should be replaced by a fourfold integration with respect to space and time to obtain the value of M_z and hence the maximum reliability of prediction.

From the example quoted it will be evident that this method, in which a system of linear equations is transformed into a single integral equation, opens up a very wide field of research, and by the systematic investigation of the value of M_z when z ranges, say, from 6 hours to 6 months, a final verdict may be reached concerning the possibilities and limitations of both medium and long-range weather forecasting.

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[1] Schumann, T. E. W., *Quart. J. Roy. Met. Soc.* (July 1944).

"Turbulent Flow in Alluvium"

Prof. C. M. White, in commenting on Mr. Gerald Lacey's letter on "Turbulent Flow in Alluvium" published in *Nature* of August 3, p. 166, stated, "Mr. Gerald Lacey has discussed the dimensions of rivers flowing in beds of incoherent alluvium . . ."

This is not quite correct. Mr. Lacey's original formulæ of 1930[1]—which remain substantially the same to-day, sixteen years later—were based on a considerable mass of accurately measured data observed in canal channels in which the discharges were maintained nearly constant. Since then, much more data have been collected—in many cases at intervals throughout the year—by specially trained staff, in channels which do not change appreciably from year to year, and are run with almost constant discharges. These data have been statistically analysed and it has been found that the more data that become available, the better the agreement with the Lacey formulæ.

The formulæ presented by Mr. Lacey in his letter are not new, except in their form of presentation, and were inherent in his original formulæ.

What he has done is to substitute

$$f_{SV} = 48\sqrt{SV} \propto (vg)^{1/6}$$

as a sand factor, in place of the earlier

$$f_{VR} = 1{\cdot}155\ V^2/R \propto g.$$

Lacey makes these equal numerically at regime, but they are different dimensionally, due to gravity and kinematic viscosity being omitted for simplicity; because they were designed for use by practical engineers.

All Lacey's formulæ are based on two fundamental relationships

$$\frac{gDS}{V^2} \quad \text{or} \quad \left(\frac{V^*}{V}\right)^2 \quad \text{and} \quad \frac{V^2}{\frac{1}{2}gw} \quad \text{(the Froude number for width),}$$

$$\text{and} \quad \frac{gDS}{V^2} \quad \text{and} \quad \left(\frac{VD}{\nu}\right) \quad \text{(Reynolds' number).}$$

Surely Prof. White does not suggest that "On algebraically combining two such formulæ one could prove anything"!

Next as regards what should be treated as "independent variables": Prof. White has adopted Q, g, Vs—the terminal speed of a typical particle falling through water—and N—the quantity of solids expressed as a fraction of the water flow; and he has selected the area of cross-section at bank-full stage as a dependent variable. He then eliminates N by grouping rivers in which the charges, *as measured*, vary between 1/1,000 and 1/5,000; but he has not stated how such measurements were observed, nor has he yet presented the data of the ten selected rivers on which his formulæ were based.

Experiments carried out by me at Poona[2] showed that the rate of deposition of sand of various grades in turbulent water varies as $(N.Vs)$—that is to say, a heavy charge of silt gives the same rate of deposition as a correspondingly lighter charge of medium sand—so that if the charge—N—varied between 1/1,000 and 1/5,000, either bed movement must have been ignored—as seems probable, because no method of measuring movement of bed sand outside a research station has yet been devised—or else a wide range of charge must have seriously vitiated the results—unless, of course, there was so little movement that charge was an unimportant factor. This is what Lacey assumed for his regime conditions.

There is little difference, therefore, between Lacey's original selection of variables and White's.

		Lacey's original independent variables	White's independent variables
1	Q	Accurately measured practically constant discharges.	Discharge observed at bank-full stage assumed to represent normality.
2	N	Regime charge—the minimum charge associated with a fully active bed.	A range of charge from 1/1,000 to 1/5,000 assumed not to affect results appreciably.
3	f, Vs	f, a sand factor originally linked with V^2/R but later with $\sqrt{SV}$.	Vs, the terminal velocity of what is called a typical particle.

As regards Vs, experience in India shows that the material exposed on the bed of a channel is continually varying, both as regards grade (Vs) and charge(N). That, in fact, changes in N and Vs represent the 'mechanism of adjustment' to meet changing flow conditions. Thus N and Vs are highly dependent variables, the former of which cannot be measured with any degree of accuracy outside a research station and the latter only with difficulty—because samples of bed material have to be taken at the same time as the area of section, discharge and water temperature are observed.

It may be argued that (SV) is an equally poor criterion of independence—on the grounds that S and V are both dependent variables—but S can only alter very slowly, and experience shows that with constant discharge, but varying charge and grade, $V = (Q/a)$ also alters slowly, and that (SV) alters still more slowly. Thus, though S and V depend on rainfall, the material washed into the river, the temperature of the water, and the variations in all of these—which cause 'trading' of material during alternating conditions of scour and accretion—yet (SV) is the best measure of the integrated effects of sand charge and grade on a long-term basis and probably also on a short-term basis; because it is easily measurable and is proportional—after eliminating the effects of discharge—to the overall effects of charge, grade, shape and specific gravity of particles, and water temperature.

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[1] Lacey, G., *Proc. Inst. Civ. Eng.*, 229 (1930).
[2] Inglis, C. C., Ann. Rept. Tech. Central Irrigation and Hydrodynamic Research Station, Poona .India (1941–42).

Prof. C. M. White, in his valuable and constructive comments on my new flow equations[1], has raised certain questions, which, if the subject of alluvial transport is to be further advanced, demand a reply.

The Lindley theorem[2] of 1919, of which my 1930 equations were a natural outcome, asserted that for a given discharge, particle size, and transported load, the dimensions of a channel flowing uniformly in an unlimited medium of its own self-transported alluvium are, ultimately, uniquely determined. The dependent variables are therefore P, R and S, the wetted perimeter, hydraulic mean depth, and water surface slope.

The conditions postulated are ideal and more easily achieved in the laboratory than in the field. On well-established perennial canals, the conditions in respect of discharge, particle size, and transported load are tolerably fulfilled. The engineer, however, by somewhat arbitrarily assigning width, depth and slope, when constructing his canals and making his excavations in the natural soil, presents Nature with the immediate task of modifying the designed depth of water, followed by a further adjustment in depth and slope which is also accompanied by modifications in the width if the soil is friable and permits of this taking place.

The 1939 equations of Prof. White are effectively an application of the Lindley theorem to rivers, and in particular to those rivers in the alluvial plains which by a cycle of erosion and accretion have generated their own cross-sections and established a slope which can correctly be regarded as a dependent, as opposed to the sensibly constant and independent variable of the slope of shingle and boulder torrents, of which the actual size of bed particle exposed at any given time is a dependent variable and a function of the discharge intensity. Rivers in the plains generate their own boundaries and slopes, but, owing to the admixture of fine adhesive particles and 'ageing', the banks and portions of the bed are frequently far from incoherent. As a result, if the gross slope is measured over many miles, this slope is not a simple dependent on the cycle of discharges and the particle size, but is complicated by the addition of other factors leading to loss of energy and an increase in the slope. The poor correlation of Prof. White's slope equation is probably due mainly to this cause.

The dependent variables of P, R and S having been assigned, all other variables, known, or unknown, are independent, and Prof. White's method of dealing with them is highly ingenious and effective. Failing measurement of the transported load, N, we are forced either to treat it as constant, or to adopt a criterion in which both particle size and load are implicit.

Prof. White has directed attention to the impropriety of combining two empirical equations algebraically. With his contention I fully agree, but would submit that when the two equations have each a high correlation, and the merit of extreme simplicity in the powers, the ends may justify the means, and serve to demonstrate the truth of past experience that more than one advance has owed its existence to a leap in the dark, ending happily on firm ground.

The risk, to which Prof. White has referred, that one may derive two empirical equations "which look different but which do in fact state the same thing though containing different errors of field measurement", is one that all unwittingly may run.

The dimensionless number of Prof. White

$$ag^{2/5}/Q^{4/5}$$

is possibly not quite so simple as it appears, and I certainly prefer as an alternative

$$aVs/Q,$$

which can be rewritten

$$Vs/V.$$

When this substitution is made, the two White equations become respectively

$$Vs/V = 2{\cdot}40\ (Vs/g^{2/5}Q^{1/5})^{0{\cdot}78}, \quad . \quad W(1a)$$

and

$$S = 0{\cdot}0120\ (Vs/g^{2/5}Q^{1/5})^{0{\cdot}90}. \quad . \quad W(2)$$

Now, if we demand of our equations that they possess a physical significance, the conclusion is inescapable that, for a constant load N,

$$Vs/V \propto S,$$

and

$$Vs \propto (VS).$$

I conclude that owing to the complex nature of Prof. White's dependent slope variable, and the relatively large errors of field measurement, both in S and Vs, he has inadvertently succeeded in deriving two different equations for the same concept, slope. His terminal velocity of the particle Vs plays the same part as the criterion I have adopted (VS), and I have no doubt that when he examines a more extended and reliable collection of data he will succeed in reconciling his two powers of 0·78 and 0·90 respectively. The arithmetical mean of the two powers is 0·840 and differs very little from my power of 0·833.

I would be the last person in the world to suggest that "bed material is unimportant"; but it is indeed important to note that an equation can be derived in which it is implicit. I would direct the attention of the engineer to the equation

$$S = 2^{1/6}\ (VS)^{5/6}/(g^2Q)^{1/6}, \quad . \quad . \quad (6a)$$

in which (VS) associates particle size with transported load, and is a convenient description of any alluvial channel. To the physicist, I recommend investigation of the new basic equation

$$S = 2V^5/g^2Q. \quad . \quad . \quad . \quad . \quad (6)$$

An expression of this form may ultimately prove to be universal in its application.

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[1] *Nature*, **153**, 166 (1946).
[2] Lindley, E. S., Proc. Punjab Eng. Congress, **7** (1919).

Effect of Environment on the Reactivity of High Polymers

DURING the polymerization of vinyl compounds, in the pure state and in solution, it is frequently observed that the reaction-rate curve is of the 'autocatalytic' type, the velocity increasing as the reaction proceeds. Hitherto this has been attributed to (*a*) non-isothermal character of the reaction, (*b*) to the fact that the catalyst, or its products of dissociation if present, does not immediately react with the monomer. In 1941 Schulz and Blaschke[1] observed a similar increase in the velocity after about 20 per cent polymerization when neither of the above explanations was valid. Similarly, Norrish and Smith[2] found the same phenomenon in solution, the increase in velocity being the more marked the poorer the solvent for the polymer produced. Again, Trommsdorff[3] found that if the viscosity of monomeric methyl methacrylate were increased by the addition of cellulose tripropionate, the velocity of polymerization and also the molecular weight of the polymethacrylate both increased.

The increase in rate might have been due (*a*) to an increase in rate of initiation of polymer chains, (*b*) an increase in the rate of propagation of growth, termination occurring by the mutual interaction of the ends of the active polymer. The effect could be produced either by an increase in viscosity of the solution or by precipitating the polymer out of solution, probably in the act of growing. An increase in (*a*) is not compatible with the observed increase in molecular weight, for normally an increase in (*a*) would lead to a decrease in molecular weight, and it is unlikely that (*b*) would be affected, for it is difficult to see how this rate could increase.

The most probable explanation appeared to be that the rate of termination was cut down. As the liquid became more viscous, the ends of the active polymer would find it more difficult to diffuse into each other's proximity and interact and so terminate growth. In the case of a bad solvent the active polymer would then be so coiled up that again the active ends would not easily gain access to each other. Thus in both cases the rate of polymerization would increase simply owing to a diminution of the speed of reaction responsible for cessation of growth.

Recently a method has been developed[4] for measuring the individual values of all the velocity coefficients in a polymerization reaction, and hence it appeared feasible to see whether in fact the above suggestions would account for the behaviour observed. Using the solvent technique with vinyl acetate and photochemical initiation of the reaction, precisely similar phenomena have been observed. In a good solvent such as ethyl acetate, the reaction is normal and exactly similar to that in the pure monomer: in a bad solvent such as *n*-hexane, the autocatalytic character of the reaction is clearly marked. The accompanying table shows the results obtained in the normal phase of the reaction and after acceleration had set in.

Rate of initiation of chains = $6{\cdot}0 \times 10^{-8}$ mol. lit.$^{-1}$ sec.$^{-1}$. Temp. 25° C.

	Normal	Abnormal*
Overall rate (mol. lit.$^{-1}$ sec.$^{-1}$)	$5{\cdot}0 \times 10^{-6}$	$1{\cdot}1 \times 10^{-4}$
Life-time of active polymer (sec.)	$8{\cdot}1 \times 10^{-2}$	$17{\cdot}0 \times 10^{-2}$
Growth coefficient, k_p (mol.$^{-1}$ lit. sec.$^{-1}$)	$7{\cdot}0 \times 10^{2}$	$6{\cdot}8 \times 10^{2}$
Termination coefficient, k_t (mol.$^{-1}$ lit. sec.$^{-1}$)	$2{\cdot}6 \times 10^{8}$	$5{\cdot}0 \times 10^{8}$

* After 5 per cent of polymer has been formed.

It is of importance to note that the values of k_p and k_t for the pure monomer, namely, $6{\cdot}7 \times 10^2$ and $2{\cdot}5 \times 10^8$, are in excellent agreement with those for the normal phase of the reaction. In the abnormal phase of the reaction, however, only the termination coefficient is affected, thus vindicating the suggestions made previously. The agreement is quantitatively satisfactory, for a two-fold increase in rate would correspond to a four-fold reduction in the termination coefficient, as is approximately observed. Thus the reactivity of growing polymer molecule is affected by the environment in which it is placed, provided that it interacts with another of its kind. Immobility or coiling up as in a bad solvent or in the gas phase cuts down reactivity. On the other hand, when a monomer interacts with the polymer, its high mobility permits it to penetrate to the active spot under all conditions, and environment has no effect. A great many parallel observations on reaction of this kind all fall into quantitative agreement when this new kind of effect is taken into account.

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[1] Schulz and Blaschke, *Z. physik. Chem.*, **50**, 305 (1941).
[2] Norrish and Smith, *Nature*, **150**, 336 (1942).
[3] Trommsdorff, Colloquium on High Polymers, Freiburg, 1944. See B.I.O.S. Report No. 363, Item No. 22.
[4] Burnett and Melville, *Nature*, **156**, 661 (1945).

Alginic Acid Diacetate

BELIEVING that the usual methods of acetylation give degraded products, Wassermann[1] has attempted to acetylate alginic acid with ketene. By this means he succeeded in introducing approximately one acetyl group into each repeating unit of the polymer. Some years ago we studied the action of ketene on alginic acid under various conditions, and although products with a higher acetyl content (20·9 per cent) than Wassermann's were obtained, the method was abandoned in favour of a simpler and more effective procedure[2].

When alginic acid is dried, hydrogen bonding between neighbouring molecules is so severe, and the structure is so compact, that reaction with acetic anhydride is impossible. If, however, the alginic acid is first swollen in water, the hydroxyl groups become available for acetylation and remain available when the water is displaced with glacial acetic acid. Making use of this principle, alginic acid yarn[3] can be acetylated without loss of fibre-form in the following way: the yarn (1·0 gm.) is swollen in water, centrifuged and then immersed in several changes of glacial acetic acid until the residual water is less, preferably very much less, than 30 per cent of the original weight of the yarn. The latter is then transferred to 30–40 c.c. of a mixture having the following composition: benzene 180 gm., acetic anhydride 60 gm. and sulphuric acid (conc.) 1·2–1·5 gm. The reaction is allowed to proceed for 24 hours at 25° C., or for 1 hour at 25°C., followed by 15 minutes at 50°–60° C. Perchloric acid can be used in place of sulphuric acid, and either catalyst can be introduced by swelling the yarn with a 1·0 *N* solution of the acid instead of with water; in this case, acetylation is carried out with a mixture of benzene and acetic anhydride, benzene being present simply to ensure preservation of fibre form.

Yarn acetylated for 17 hours at 25° C. in the above manner gave a 97·3 per cent yield of the di-acetate (acetyl: found, 33·0 per cent; theory, 33·1 per cent). Determinations of the tenacity of the acetylated yarn, its solubility in water, and other properties showed that acetylation had been achieved without any appreciable degree of degradation.

As would be expected, alginic acid di-acetate swells, but does not dissolve, in water, methanol, ethanol, acetone, dioxan and glacial acetic acid at ordinary temperatures. It dissolves at once in aqueous acetone (80 per cent) and, surprisingly enough, in view of the insolubility of calcium alginate, in 0·5 *N* calcium acetate. Similarly, no precipitate could be obtained when solutions of calcium chloride, barium chloride, copper sulphate, lead acetate and ferric chloride were added to a solution of the di-acetate in 0·1 *N* sodium acetate.

The di-acetate undergoes slow hydrolysis on exposure to air at 65 per cent relative humidity and 22·2° C., as is indicated by the following data for yarn acetylated in presence of sulphuric acid:

Time of exposure (days)	Acetyl content (per cent)
0	33·6
20	31·5
40	30·4
100	26·4
220	18·9

Similar results were obtained with yarn acetylated in presence of perchloric acid.

A full account of the preparation and properties of the di-acetate and other esters of alginic acid will be published elsewhere. We are indebted to Alginate Industries, Ltd., and Courtaulds, Ltd., for grants in aid of these investigations.

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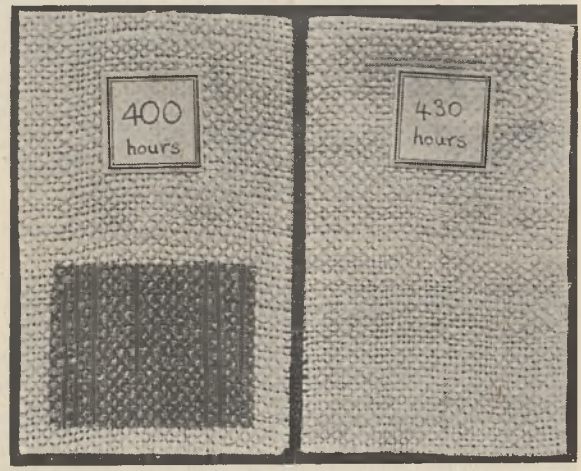
Permanent Bleaching of Ligno-Cellulosic Materials

AT the present time the bleaching of ligno-cellulosic materials such as sisal, jute and manila is, as normally carried out, of only temporary efficacy, for the bleached materials gradually discolour again on exposure to sunlight.

It has now been shown that this discoloration may be prevented and bleaching thereby rendered permanent by subjecting the materials to certain esterification and etherification treatments, particularly acetylation, benzoylation and methylation.

Acetylation has been carried out in a number of ways by means of acetic anhydride in the presence of various acidic and basic catalysts. Benzoylation has been accomplished by treatment with benzoyl chloride in the presence of pyridine at about 100° C. Both these processes have been employed to give complete protection against light discoloration. A marked, though only partial, effect has been obtained on methylation by successive treatments with ethereal diazomethane. Methylation with dimethyl sulphate in the presence of strong alkali has also been found to be partially effective, but in this case the effect is accompanied by considerable damage to the fibre.



In the photograph, untreated jute, of which a limited area was exposed to the light of a carbon arc lamp for 400 hours, is shown on the left. The degree of discoloration is considerable. On the right is a sample of acetylated fabric in which the equivalent area was exposed for an even longer period. In this case no discoloration at all is perceptible.

It is tentatively suggested that the cause of the discoloration is to be found in the reactivity of the phenolic groups of the lignin present in these fibres, which, under the influence of light, tend to polymerize to coloured quinones. By causing the reactive phenolic groups to combine with alkylating or acylating agents, therefore, the discoloration is prevented.

I am indebted to the Sisal Growers' Association for permission to publish this note.

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Effect of Hydrogen Peroxide in the Presence of Copper Sulphate on the Shrinkage of Wool

NILSSEN[1] has reported that chlorine dioxide imparts an unshrinkable finish to wool when applied in a solution from carbon tetrachloride. Experiments have been conducted to examine the effect of oxidation by hydrogen peroxide in the presence of a copper salt on the shrinkage of wool.

The knitted fabric used was made from 60's quality, count of yarn 1/15, circular knit, and the degree of shrinkage through felting was determined by reduction in area during hand milling at about 50° C. in an aqueous solution containing 5 per cent soap and 0·2 per cent sodium carbonate. All measurements were made after the samples had been relaxed by soaking in water for about ten minutes. Samples measuring in each instance about 30 sq. in. in area were immersed in 600 ml. of 0·4 per cent hydrogen peroxide to which 25 ml. of 5 per cent copper sulphate solution had been added and which had been brought to *p*H 4·2 with 5 per cent sodium bicarbonate solution. Lipson[2] has shown that *p*H 4·2 is the value for maximum attack.

The solution was brought to the boil in ten minutes and maintained at the boil for ten minutes. After washing in running water for one hour, the samples were measured and then milled for about fifteen minutes with measured control samples. The percentage reduction in area during milling was 40 per cent and 15 per cent for the control samples and treated samples respectively.

It was found that by soaking the samples before milling, for five minutes, at room temperature (17° C.) in 5 per cent sulphuric acid solution, the shrinkage during milling in the treated samples was reduced further, The reduction in area was 37 per cent and 3·5 per cent for the control samples and treated samples respectively.

Using the apparatus devised by Lipson[3], frictional measurements were undertaken to discover if the treatment affected the directional frictional effect. The values before and after treatment were found to be the same.

Experiments were carried out to determine the effect of the treatment on the extensibility of the fibres, After treatment, fibres were found to be more easily extensible, yet the ability to recover from deformation was not impaired. Thus it appears that the unshrinkable finish is produced by means which differ from those suggested for the majority of other anti-shrink reagents, namely, reduction of directional frictional effect or reduction of extensibility of the fibre.

It is intended to publish a detailed account of this work in the *Journal of the Royal Society of New South Wales*. The interest shown and constructive criticism provided by Mr. M. R. Freney, officer in charge, Australian Wool Realization Commission Testing House, is gratefully acknowledged. Thanks are also due to Mrs. P. Harris for valuable assistance with the frictional measurements and to Dr. F. P. Dwyer for help in preparation of this communication.

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Man's Reaction to Mosquito Bites

IT is widely known that different individuals give very different reactions to the bites of insects, and also that repeated exposure may alter the reactions of one individual (Boycott[1], Hecht[2]), but surprisingly little work has been done on this subject. The availability of a group of human volunteer subjects for medical research made it possible to investigate the effect of the bites of various species on individuals who could be kept under observation for long periods.

In the first series of experiments, the yellow fever mosquito *Aedes ægypti* was used, and only subjects who had never travelled outside Britain, and who were, therefore, unlikely to have been previously bitten by this species, were exposed. Twenty-five volunteers all gave a similar reaction. When bitten by *A. ægypti* for the first time there was no immediate cutaneous response, other than a tiny red spot about 1 mm. in diameter at the site of the bite, and no itching was observed. After a variable period, however, usually between twenty and twenty-four hours, a marked delayed reaction occurred. A red patch about 3 cm. in diameter surrounded the bite, and the central 1 cm. was seen to form a definite weal. This condition was observed over several days, the itching and other symptoms waxing and waning several times.

The volunteers were bitten by *A. ægypti* on several occasions for about a month, and at the end of that period the reaction was markedly different. An immediate reaction had developed—as soon as the mosquito had fed, a weal developed at the site of the bite, an area of erythema appeared surrounding the weal, and the skin itched. Within two hours all these symptoms disappeared completely, but after twenty to twenty-four hours the same delayed reaction noticed on the occasion of the earlier exposures appeared.

After a further period of exposure there was another modification. The immediate reaction persisted unchanged, but the delayed reaction got gradually less severe and eventually disappeared. This meant that the bites were less troublesome to the victim.

The volunteers never got beyond this stage, but in other individuals who have been repeatedly exposed to thousands of bites from *A. ægypti* I have observed that the immediate reaction also disappears.

Man's reaction to the bites of this species may then be tabulated as follows: each stage is reached after further exposure.

	Immediate reaction	Delayed reaction
Stage I	−	+
,, II	+	+
,, III	+	−
,, IV	−	−

I suggest that these two reactions are quite distinct and are probably caused by different antigens in the saliva of the mosquito.

Other experiments have been carried out with *Anopheles maculipennis atroparvus*. Most men when first bitten gave the stage I reaction, and it seems likely that the minority who gave stage II (three out of twenty-five volunteers) had had previous exposure to the mosquito. After exposure, the immediate reaction was developed, and in some cases stage III was reached. I have not yet produced stage IV experimentally, but have observed it in individuals known to have been exposed to this mosquito for several years.

The sensitization and immunity in these delayed and immediate reactions seems to be specific. Thus one man may simultaneously give a stage I reaction to *Anopheles* and a stage II reaction to *Aedes*.

Other species of biting insects appear to give results which fit into the same scheme, with minor modifications. Most human beings appear to give very similar results when subjected to the same degree of exposure, though special cases of hypersensitivity and severe allergy also occur.

The whole problem is under further investigation.

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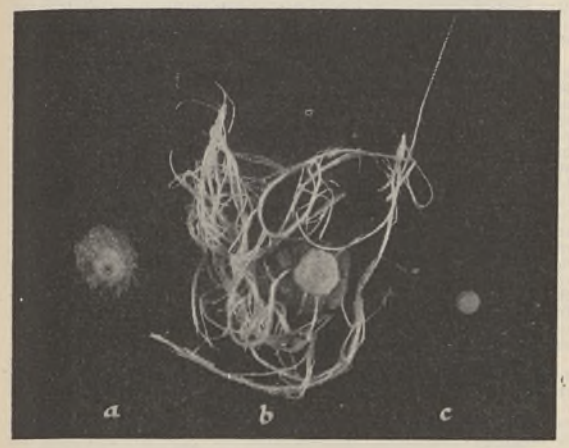
Penicillin as a Plant Hormone

In the course of investigations on the effects of some antibiotics on plant tissues *in vitro*, it was discovered that commercial penicillin sodium (Squibb) has a potent effect on the growth of excised fragments of sunflower stem tissue cultured on White's sucrose mineral agar. A concentration of 500 units per c.c. of this substance caused great proliferation of the cambial tissue without production of visible roots



Effect of commercial penicillin sodium on the growth of sunflower stem fragments *in vitro*: (*a*) 500 units per c.c.; (*b*) 5 units per c.c.; (*c*) no penicillin. (Photograph by J. A. Carlile.)

(Fig. *a*). 5 units per c.c. also caused proliferation of cambial tissue accompanied by an abundant production of roots (Fig. *b*). Stem tissue cultured in the absence of the antibiotic showed neither proliferation nor root production (Fig. *c*). As cambial proliferation and production of roots are both induced in sunflower stem tissue by indole acetic acid, fragments of stem tissue were also cultured in the presence of pure penicillins. The reactions of such stem fragments to different concentrations of these substances as well as to commercial penicillin and indole acetic acid are given in the accompanying table.

Response of fragments of sunflower stem tissue cultured for four weeks in the presence of penicillin or indole acetic acid

Substance	Concentration 10^{-5}	10^{-7}	10^{-9}
Indole acetic acid	*CP* 0/10*	*CP* 10/10	7/10
Commercial penicillin	*CP* 10/10	1/10	0/10
Penicillin *X*	5/10	7/9	0/10
Penicillin *F*	0/10	0/10	9/10
Penicillin *G*	9/10	6/10	10/10
Penicillin *K*	0/10	0/10	0/10
Control, on plain sucrose agar	0/10		

* The fractions refer to the number of stem fragments in each group which produced roots. *CP* = cambial proliferation.

The effect of commercial penicillin on these stem fragments can be attributed with a fair degree of certainty to indole acetic acid, which is known to be produced by *Penicillium notatum* (O. Wintersteiner, personal communication). According to this assay, it appears that indole acetic acid was present in the penicillin in a concentration of about 1 per cent. The root-forming capacity of penicillins *G* and *X* almost certainly resided in these substances themselves. Penicillin *K* had no effect on the growth of the stem fragments. The results obtained with penicillin *F* are doubtful. None of these substances seemed to have any inhibiting effect on the growth of these plant tissues. Streptomycin, which was tested at the same time, also had no inhibiting effects and was without influence on root formation.

Pure penicillins were kindly made available by the following organisations: penicillins *G* and *K*, Squibb Institute, New Brunswick, N.J.; penicillin *X*, Food and Drug Administration, Washington, D.C.; and penicillin *F*, Upjohn Co., Kalamazoo, Mich.

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Oxidation of Tryptophane by Homogenized *a*+ *a*+ and *aa* *Ephestia* Tissue

It has been shown previously that in the flour moth, *Ephestia Kühniella*, the gene *a* in homozygous condition causes lack of kyrurenin and consequently a deficiency in the eye pigments depending on the presence of kyrurenin'. Since kyrurenin is derived from tryptophane by oxidation, it is assumed that the oxidation of tryptophane to kyrurenin is inhibited in *aa* animals. This is confirmed by the fact that an increased amount of tryptophane is found in the proteins of *aa* animals[2,3].

It had been suggested that in *aa* tissues the enzymes necessary for the formation of kyrurenin from tryptophane may be missing or less active than in *a*+*a*+ tissues. The experiments described below were done in order to test this possibility. A number of full-grown *Ephestia* larvæ from closely inbred *a*+*a*+ and *aa* strains were weighed and ground up in a mortar in Ringer solution isotonic for *Ephestia*[4], buffered by an *m*/50 phosphate buffer at *p*H 6·8. The average net weight for a single larva was found to be 32·6 ± 5·4 mgm. in *a*+*a*+ and 22·4 ± 5·6 mgm. in *aa*.

The brei resulting from grinding the larvæ in a mortar was homogenized in a homogenizer (Potter and Elvehjem[5]) driven by a motor. Aliquots of 1 c.c. of the resulting suspension, corresponding to 46·7–110·2 mgm. net weight of larval material, were pipetted into the vessels of a Fenn type respirometer, and the oxygen uptake for one hour at 25·5° C. measured. In the experimental vessels Ringer solution containing 0·05 and 0·2 per cent tryptophane was used. The results of these measurements are given in the accompanying table.

Oxygen consumption of homogenized *a*+*a*+ and *aa* larvæ (mm.³/gm./hr. ± standard error)

	a+*a*+	*aa*
Control	110·7 ± 2·6	102·5 ± 2·0
0·05% tryptophane	132·5 ± 4·7	123·8 ± 5·7
0·2% tryptophane	162·4 ± 5·7	161·8 ± 5·5

The data indicate a somewhat higher oxygen consumption in *a*+*a*+ than in *aa* in the controls. This difference is probably significant ($t = 2{\cdot}50$, $N = 37$, $P < 0{\cdot}02$). This may be connected with the higher viability and speed of development characteristic for *a*+*a*+ *Ephestia*[6].

Addition of tryptophane caused an increase in respiration both in *a*+*a*+ and in *aa* material. The increase is significant at the 1 per cent level both at 0·05 per cent tryptophane, as compared with the controls, and at 0·2 per cent tryptophane, as compared with 0·05 per cent tryptophane. This indicates that in the range of concentrations investigated, the increase in oxygen consumption was limited by the amount of tryptophane present.

No significant differences between *a*+*a*+ and *aa* material were found with 0·05 and 0·2 per cent tryptophane. This indicates that *aa* material is as able as *a*+*a*+ material to oxidize tryptophane.

In the experimental vessels, both in *a*+*a*+ and in *aa* a dark precipitate developed during the experiments. This precipitate was either absent or very weak in the controls. It was insoluble in water, alcohol, ether and acetone, soluble with difficulty in acidified alcohol and weak alkali, but easily soluble in concentrated formic acid. This solubility behaviour is characteristic of ommochromes, the insect pigments formed from kyrurenin[7,8].

These results indicate that *aa* material is as well able to oxidize tryptophane as *a*+*a*+. It is suggested, furthermore, that *aa* material is able to transform it into kyrurenin, the precursor of the ommochrome pigments. If the oxidation of tryptophane to kyrurenin is dependent on an enzyme analogous to the tryptophane pyrrholase catalysing the same reaction in mammals[9], the results seem to suggest that this enzyme is present and active in *aa* as well as in *a*+*a*+ cells.

The situation in *aa* *Ephestia* would therefore be that tryptophane is present and that the enzyme necessary for its oxidation to kyrurenin is also present. A similar condition has been found for body-colour mutants in *Drosophila*, where changes in the amount of melanin formed were not accompanied by a concomitant change in either tyrosinase or tyrosine present[10,11]. It seems justifiable to conclude that in cases of this type the action of the enzyme on the substrate is inhibited.

I am indebted to Dr. David R. Goddard, of the University of Rochester, for valuable aid and advice.

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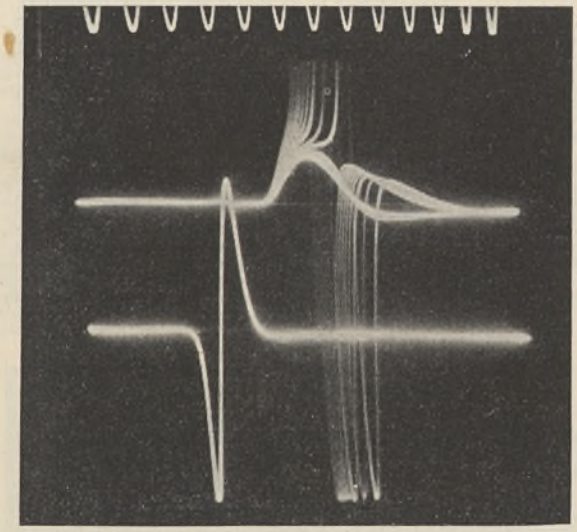
A Preparation for the Physiological Study of the Unit Synapse

Present concepts of synaptic activity are based on direct recording of electrical signs in a small number of preparations. The closest approximations to analysis of the unit synapse have been made with the artificial synapse formed by two isolated giant axons in contact (ephapse of Arvanitaki[1]) and the isolated neuromuscular junction[2]. Several true synapses among invertebrates offer promise as favourable material for recording from the single synapse, for example, the preparations of Pumphrey and Rawdon-Smith[3] from the cockroach and of Prosser[4] from the crayfish abdominal ganglion. The present communication directs attention to the possibilities of another preparation, from the stellate ganglion of a cephalopod, which appears to offer unique advantages.

Young[5] has described the remarkable giant synapse in this ganglion in squid. Thick terminal branches of a single preganglionic fibre (second order giant fibre) from the brain make contact with about ten third order giant fibres which originate in the ganglion and are



POTENTIALS FROM STELLATE GANGLION OF *Loligo pealii*. PREGANGLIONIC NERVE IS STIMULATED AT 30 PER SECOND. LOWER TRACE OF DOUBLE BEAM OSCILLOGRAPH PICKED UP AT JUNCTION OF PREGANGLIONIC NERVE WITH GANGLION, UPPER TRACE FROM ORIGIN OF POSTGANGLIONIC NERVE. MULTIPLE EXPOSURE OF SUPERIMPOSED STIMULUS-TRIGGERED SWEEPS. ONSET OF FATIGUE SHOWING ALL OR NONE SPIKES AND FALLING LOCAL RESPONSE. TIME = 0·5 M.SEC.

distributed, one in each postganglionic stellar nerve, to the mantle musculature. At the region of contact the presynaptic fibre and postsynaptic fibre, each 25–100 μ in diameter, lie side by side for 800 μ, making connexions through small holes in their sheaths, by many short collaterals. Cell bodies or dendrites are not involved.

In *Loligo pealii* a preparation is easily isolated consisting of preganglionic nerve (mantle connective with fin nerve removed), stellate ganglion and the last stellar nerve. Single shocks at low intensity delivered to the preganglionic nerve excite a single giant fibre therein and, after a delay in the ganglion of about 1·2 m.sec. (23° C.), the giant fibres in the stellar nerves. This delay does not include any significant conduction time in fine tapering terminals. Transmission is all or none and one to one; the synapse can follow upwards of four hundred impulses per second for short periods. Increasing shock intensity brings in many smaller preganglionic fibres (including presumably Young's accessory second order giant), some lagging scarcely at all behind the presynaptic giant, but does not alter transmission noticeably. Antidromic impulses are not transmitted from postsynaptic to presynaptic fibre. Transmission is easily blocked by fatigue and for long periods can be kept at any desired level by maintained stimulation of the prefibre at controlled frequency. Thus a certain preparation, once fatigued, could be kept in a non-transmitting state by stimulation at 30 per sec. while dropping the frequency to 25 per sec. permitted transmission. Untransmitted impulses continue to exert an effect, maintaining fatigue of the junction, apparently by acting on the postsynaptic unit.

The preparation permits recording not only of single presynaptic and postsynaptic fibres but also of unit synaptic potentials (local activity of the unit synapse, the non-propagated, graded response corresponding to end-plate potential in muscle). A large electrode (0·2 mm. platinum wire) on the ganglion may pick up several of the ten or so junctions, but they are activated by the same presynaptic fibre, are well synchronized and rarely behave independently. Micro-electrode recording gives the same picture as large electrodes in situations studied so far. The synaptic potential detectable with macro-electrodes may be more than 300 μV., rise to its peak in about 0·6 m.sec. and fall to a third in less than 1 m.sec. In fatigue the local response may suffer no change in latency but falls greatly in height, the propagated spike arising later and later, often apparently from the falling phase of local response (cf. Hodgkin[6]). By graded stimulation directly on the ganglion the synaptic potential may be graded. Its absolute refractory period is about 1 m.sec. and is followed by a relatively refractory period in which at first very small potentials are elicited, later increasingly large ones. Facilitation has been recorded in the fatigued preparation when the first stimulus of a pair elicits only local response whereas the second, if it follows within a critical interval during the relatively refractory period of local response, may result in a propagated impulse.

The general properties of the preparation are strikingly similar to those of the ephapse of Arvanitaki[1] and, with respect to the local response, those of the peripheral nerve fibre[6].

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Adrenal Cortical Hormone and Pigmentation

THE association between the adrenal glands and pathological pigmentation is well established, and it has been suggested that these glands may also control the physiological process[1,2,3]. The influence of sodium chloride on melanin formation *in vitro* has been demonstrated[4], and it follows that if physiological pigmentation is controlled by this mechanism, then deeply pigmented animals should have a low chloride concentration. To confirm this the concentration of chloride in the blood of agouti and black mice has been investigated, using a cross between the *CBA* (Strong) and *C*57 (Little) strains which segregates for these colours.

Much difficulty has been experienced in obtaining reliable estimations from the small quantities of serum available. Even by draining the inferior vena cava it has not been found possible to guarantee more than 0·2 c.c. of serum, and all estimations have been made on this quantity. The method used has been that of Schales and Schales[5], but with only 0·2 c.c. of serum the end-point is not certain. To eliminate errors from this source, a photometric apparatus has been constructed, the electrical circuit being taken directly from that described by Needham[6]. Illumination is by a 40-watt pearl bulb housed in a light-tight tin, in which are two ¼-in. holes opposite to and at the height of the centres of the selenium cells. No lenses are used, but two movable screens with ⅛-in. holes are placed immediately in front of the selenium cells, to act as baffles. The whole is enclosed in a light-tight box, of which the ends can be opened. The apparatus is completed by a microburette mounted on a movable arm so arranged that the nozzle can either be brought to a position immediately in front of one of the selenium cells when the end of the box is open, or removed to such a position that the box may be closed. Galvanometer readings are made only with the box closed.

Estimations are made on protein-free filtrates, prepared by adding to 0·2 c.c. serum, 11 c.c. water and 0·5 c.c. of each of the Folin-Wu reagents. 10 c.c. of the filtrate are placed in an optical cell, with 0·06 c.c. indicator. The cell is placed immediately beneath the microburette between a movable screen and the selenium cell. The resistance is varied so that more current is fed to the galvanometer from this selenium cell than from the other, the difference being accurately adjusted to one degree on the galvanometer scale. Titration is carried out until sufficient colour is developed in the optical cell to balance the circuit and return the galvanometer needle to zero. This is regarded as the end-point. It is, of course, arbitrary, but gives constant results within the limits examined, that is, 100–150 milli-equivalents per litre of chloride. The calculation is made as in the original method, with the necessary adjustment for the quantity of serum used. In this way it has been found possible to estimate known solutions of sodium chloride, using only 0·2 c.c., with an error of 1 per cent.

The mean value for agouti mice is 121 milliequivalents per litre, and for black 124·5. Estimation of the significance of the difference between these means gives $P = 0{\cdot}1$ for $n = 29$[7]. Therefore, instead of the anticipated low concentration of chloride in black as compared with agouti mice, there is a small rise in this concentration, the difference, however, not being significant. There is thus no evidence of any difference in adrenal cortical function between agouti and black mice, as judged by the concentration of chloride in serum. As these results are considered accurate to within 1 per cent, and a difference of very much more than 1 per cent in the chloride concentration is necessary to affect melanin formation[3], it can definitely be stated that if physiological pigmentation in the mouse is controlled by the adrenal glands, the action is not through the chloride balance hormone of the cortex.

I have pleasure in acknowledging my indebtedness to Mr. A. L. Bacharach for the nucleus of the mouse colony, and to Mr. D. C. Price for much valuable advice and help with the electrical part of the apparatus. The work has been carried out with the aid of a grant from the Leverhulme Research Fellowships.

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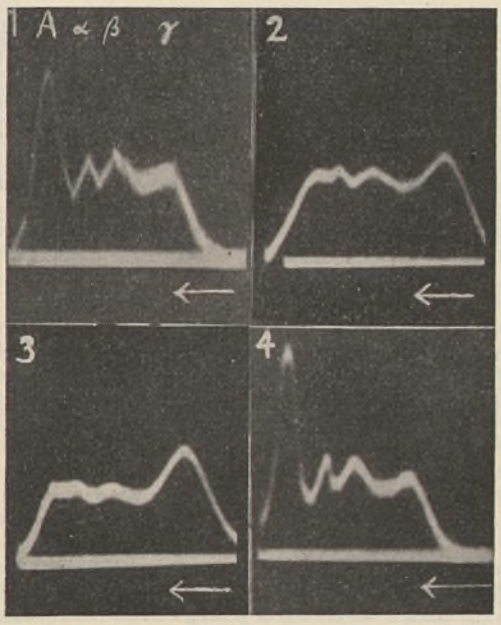
Action of Pepsin on Serum Proteins as Measured by Electrophoresis

SINCE the beginning of this year, we have had the first apparatus for electrophoresis (Tiselius-Philpott-Svensson), which has been wholly built in Switzerland (Strübin and Co., Basle). Our main object is to study the physio-pathological alterations in the blood proteins during disease. In addition, we aimed at studying problems of general biological interest.

Thus we endeavoured to illustrate the action of pepsin (Fairchild) on serum proteins by taking electrophoretic patterns of the remaining proteins at different stages of the digestion. In order to measure the undigested remainder of the serum proteins we used the nephelometric method, as developed by Krijgsman[1]. In this method the protein concentration is proportional to the turbidity which is produced with sulphosalicylic acid in a strongly acid solution. There is no accurate proportion between digested protein and the increase of the degradation products. Therefore a method measuring the last-named products would not be exact in our case. As buffer system we used veronal/sodium – sodium/acetate/hydrochloric acid (Michaelis), mostly used for electrophoresis. During the peptic digestion the *p*H was kept at 5·1, the temperature at 37° C., and the pepsin-protein ratio was 1 : 9. In order to stop the reaction, the *p*H was brought to 7·9 and the solution dialysed against buffer solution of an ionic strength of



0·1 for four days at 2° C. By this method the protein solution remains perfectly clear, a fact which, of course, is all-important when distinct patterns are wanted. Electrophoresis was carried out at 2° C., with a potential gradient of 3·74 volts per cm. for 8,520 sec. All the patterns show 'descending boundaries', and the migration takes place from the right side to the left. The basic line has been reduced according to Wiedemann's method[2].

Pattern	Total protein (gm. %)	Electrophoretic concentrations (gm. per cent) Albumin	α	β	γ γ_1	γ γ_2	Albumin / Globulin
1	6·5	2·21	0·88	1·21	0·40	1·90	0·54
2	3·9	0·89	0·62	0·81	0·39	1·19	0·29
3	2·9	0·54	0·41	0·50	0·30	1·15	0·23
4	6·1	2·19	0·86	1·12	0·38	1·55	0·55

The accompanying table shows that peptic digestion primarily attacks the albumin, whereas the various globulin fractions are degraded in a much less degree. Our method of repeated electrophoresis gives a good illustration of the kinetics of proteolytic action. Thus electrophoresis can serve as control of the various factors (that is, pepsin-protein ratio, *p*H-value, temperature and time) that govern the purification of antitoxic sera by means of enzyme digestion. Further studies will show whether antibodies contained in the γ-fraction have an inactivating effect (compare Sevag[3]) on pepsin, or if they are simply degraded more slowly under otherwise optimal conditions (Pope[4]), Abderhalden[5].

Pattern 4, which was produced after dialysis of the serum in a small bag of parchment paper and eliminating the precipitated proteins after 48 hours by centrifuging, shows some decrease of the β- and γ-globulins, whereas the more lyophylic albumin and α-globulin remain almost unchanged. It forms thus a good contrast with the action of pepsin on the same serum proteins, in which the albumin globulin ratio is lowered.

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Sulphonamides and the Thyroid Gland

IT has been known since 1941 that sulphonamides influence the thyroid gland. MacKenzie, MacKenzie and MacCollum[1] note that rats on a purified diet containing 1–2 per cent of sulphanilylguanidine show hypertrophy of the thyroid gland. The action is not influenced by yeast, *p*-aminobenzoic acid, or excess of iodine. Somewhat later[2], sulphadiazine, sulphathiazole, sulphapyridine and sulphanilamide were found to produce a similar effect. Basal metabolism is lowered by any sulphonamide, and sulphanilamide is the least active one. Taurog, Chaikoff and Franklin[3] showed that sulphonamides and similar products inhibit the formation of diiodotyrosine and thyroxin by living tissue slices of thyroid *in vitro*, in presence of radioactive inorganic iodine.

Hitherto the connexion has not been seen between the action of sulphonamides on the thyroid gland and their bacteriostatic power *in vivo*. In a theory I have put forward[4], I suggested that the bacteriostatic action of sulphonamides is increased by the association of a goitrogenic molecule with their own molecule. Experiments carried out jointly with Dr. Antonio Oriol and Dr. Antonio Esteve confirmed this point of view.

A goitrogenic compound, such as methylthiouracil, alone has no bacteriostatic power in mice; on the other hand, a mere equimolecular mixture of methylthiouracil and sulphanilamide has, on mice infected by pneumococci, the same protecting power as sulphathiazole. When the proportion of methylthiouracil is decreased, the protecting power falls proportionally.

Increase of bacteriostatic power by the addition of a goitrogenic compound to a sulphonamide can be made evident by separate applications of the two compounds. Thus, if the methylthiouracil is given to infected mice 8 hours after giving them the sulphanilamide, still 60 per cent of the animals are protected, whereas sulphanilamide alone protects only 20 per cent.

Another series of experiments was carried out with thyroidectomized mice. As soon as the animals recover from the post-operatory effects, they react against medication by sulphathiazole in exactly the same way as against sulphanilamide. Sulphathiazole or sulphanilamide equally protect 33 per cent of the thyroidectomized mice. Hence there will be no increase in the bacteriostatic power of sulphonamides when the thyroid gland is missing.

Several theories have been proposed to explain the action of sulphonamides and similar compounds on the thyroid gland. Astwood[5], the discoverer of the goitrogenic compounds, says that the aromatic amines, by their resemblance with tyrosine, interfere with thyroxin formation, by taking the iodine necessary for it. This explanation can be applied only to definite cases, especially to the case of *p*-aminobenzoic acid, which behaves as a goitrogenic compound after several months of massive doses. The immediate action of other goitrogenic compounds, made very clear by the investigations of Nogales, Tarrida and Castello[6], cannot be explained by that long process of substitution of the hormone.

Györgyi *et al.*[7] impute the goitrogenic power of sulphonamides and of *p*-aminobenzoic acid to their anti-oxidizing properties. As according to our experiments the goitrogenic character is closely connected in sulphonamides with the bacteriostatic one, anti-oxidizing properties would decrease it. Further, it is known that sulphonamides act better in presence of oxidizers such as azochloramide (Daquin's liquor or perhydrol); and it is known, on the other hand, that the anti-sulphonamidic power of *p*-aminobenzoic acid and similar compounds is based on their anti-oxidizing properties[4]. The weak bacteriostatic power of sulphanilyl-thiourea is well explained by the anti-oxidizing properties of thiourea.

Taurog *et al.*[3] believe that an inhibition of mineral iodine absorption explains the goitrogenic action of sulphonamides. However, those authors' experiments demonstrate that the power of inhibiting the synthesis of the hormone has nothing to do with the bacteriostatic properties. Thus metanilamide inhibits the hormone synthesis more than sulphanilamide, and *meta*-aminobenzoic acid as much as *para*-aminobenzoic acid. As, on the other hand, that theory does not explain the immediate decrease of basal metabolism after the administration of goitrogenic compounds[8], we have to consider the mechanism of the inhibition of the hormone synthesis as a quite independent one of the mechanisms of goitrogenic and bacteriostatic actions.

In our opinion sulphonamides act on the enzymatic system necessary for the formation of the thyroid hormone and also on that for the growth of bacteria. This effect, as I have already shown[4], is followed when the sulphonamide contains a goitrogenic element in its molecule, by direct action on thyroxin wherever it happens to be. That action, which consists, according to Roblin[8], in a transformation of organic iodine into mineral iodine, is accompanied, in the case of thiouracils and aminothiazoles, by the formation of disulphides, and in the case of aminopyridines and aminopyrimidines, by the formation of the corresponding dipyridyles or dipyrimidyles. As regards the *in vitro* activity of sulphonamides, it is known that the differences of bacteriostatic power between sulphonamides are weaker than *in vivo*. Roblin's theory of the influence of physical properties can be applied in that case.

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Browsing of *Patella*

THE food of *Patella vulgata*, so far as we know at present, consists mainly of small Algæ including diatoms[1] which it scrapes from the rocks by means of its radula, but it will also eat larger plants[2]. Orton[3] included a note on *Patella* eating food-paths in green Algæ on piers. Moore and Sproston[4] noted that the growth of Algæ was limited by the browsing of limpets, and Moore[5] has estimated their food requirements from observations on individuals clearing an algal felt. The importance of this browsing habit in connexion with foreshore ecology does not, however, appear to have been sufficiently realized. The following experiment illustrates this importance in striking fashion.

In connexion with work[6] on the rate of growth of *Patella* an area 5 m. by 5 m. at Port St. Mary, Isle of Man, was cleared completely of limpets in January 1946. The situation was on flat limestone rock somewhat below mean sea-level. There was no growth of Algæ on the cleared square or on the surrounding rock, except in a few small pools and crevices. Most of the area was covered with a dense population of *Balanus balanoides*, and the limpets were scattered fairly evenly over the rock but were rather less abundant among the barnacles. The total population of *Patella vulgata* in the square was 2,184 individuals, of which the majority ranged between 16 mm. and 30 mm. in shell-length.

In April it was seen that various species of Algæ were commencing to establish themselves in the cleared area. These grew until, in June, they had formed a fairly thick felt covering most of the square. The most important constituent of the felt was *Enteromorpha compressa*, with some *Porphyra umbilicalis* and *Ulva linza*. A number of plants of *Fucus vesiculosus* were scattered among the felt. At the same time about a hundred limpets had migrated into the square from the outside and prevented the algal felt from covering its outer edges. It was distinctly noticeable that there was no growth of Algæ on the rock outside the square, though this was in every way similar except for the presence of limpets. The shells of the limpets themselves, however, were covered with Algæ. In July the algal felt was decreasing in extent as more limpets moved into the area and started to browse upon it. The plants of *Fucus vesiculosus*, however, were growing strongly, and by August 6 were well established, apparently having been protected during their early stages by the felt of *Enteromorpha*, which by that date had largely disappeared. The population of *Patella vulgata* in the square was then 324 individuals which had moved in from the surrounding rock, and in addition 499 of the present year's spat.

Confirmation of the growth of Algæ in the absence of limpets comes from Eslick. In 1937 he cleared an area 2 m. by 2½ m. at Port St. Mary of its *Patella* population[7]. The tidal-level was about the same. He informs me that during the following year he observed this area and found it entirely covered with a strong growth of *Fucus vesiculosus*. In this case the area was sharply outlined, indicating that there had been little movement by the limpets on the surrounding rock. The difference would appear to be due to the fact that the surface of the rock is very much rougher in the location where Eslick worked than at the site of the 1946 experiment, and that this factor limits the movements of *Patella*.

The conclusion to be drawn is that *Patella vulgata*, by browsing over the rocks, removes the Algæ which settle before they can become established, much as goats prevent the growth of trees. In the case of *Fucus*, once it reaches a certain size it is not eaten by the limpets. It is not too much to suppose that in the absence of *Patella* the whole of the foreshore where it is suitable for their settlement would be thickly covered with Algæ.

Experiments are continuing on a larger scale.

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Gene Recombination in *Escherichia coli*

Analysis of mixed cultures of nutritional mutants has revealed the presence of new types which strongly suggest the occurrence of a sexual process in the bacterium, *Escherichia coli*.

The mutants consist of strains which differ from their parent wild type, strain *K*-12, in lacking the ability to synthesize growth-factors. As a result of these deficiencies they will only grow in media supplemented with their specific nutritional requirements. In these mutants single nutritional requirements are established at single mutational steps under the influence of *X*-ray or ultra-violet[1,2]. By successive treatments, strains with several requirements have been obtained.

In the recombination studies here reported, two triple mutants have been used: *Y*-10, requiring threonine, leucine and thiamin, and *Y*-24, requiring biotin, phenylalanine and cystine. These strains were grown in mixed culture in 'Bacto' yeast-beef broth. When fully grown, the cells were washed with sterile water and inoculated heavily into synthetic agar medium, to which various supplements had been added to allow the growth of colonies of various nutritional types. This procedure readily allows the detection of very small numbers of cell types different from the parental forms.

The only new types found in 'pure' cultures of the individual mutants were occasional forms which had reverted for a single factor, giving strains which required only two of the original three substances. In mixed cultures, however, a variety of types has been found. These include wild-type strains with no growth-factor deficiencies and single mutant types requiring only thiamin or phenylalanine. In addition, double requirement types have been obtained, including strains deficient in the syntheses of biotin and leucine, biotin and threonine, and biotin and thiamin respectively. The wild-type strains have been studied most intensively, and several independent lines of evidence have indicated their stability and homogeneity.

In other experiments, using the triple mutants mentioned, except that one was resistant to the coli phage *T1* (obtained by the procedure of Luria and Delbrück[3]), nutritionally wild-type strains were found both in sensitive and in resistant categories. Similarly, recombinations between biochemical requirements and phage resistance have frequently been found.

These types can most reasonably be interpreted as instances of the assortment of genes in new combinations. In order that various genes may have the opportunity to recombine, a cell fusion would be required. The only apparent alternative to this interpretation would be the occurrence in the medium of transforming factors capable of inducing the mutation of genes, bilaterally, both to and from the wild condition. Attempts at the induction of transformations in single cultures by the use of sterile filtrates have been unsuccessful.

The fusion presumably occurs only rarely, since in the cultures investigated only one cell in a million can be classified as a recombination type. The hypothetical zygote has not been detected cytologically.

These experiments imply the occurrence of a sexual process in the bacterium *Escherichia coli*; they will be reported in more detail elsewhere.

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Assay of Toxic Effect of 'Gammexane' on Man and Animals

The widespread use of the two new insecticides D.D.T. and 'Gammexane' (gamma isomer of benzene hexachloride) has led to considerable interest being taken in their possible toxic effect upon man and animals. In the case of D.D.T., a considerable literature is already available on this aspect, and both acute and chronic toxicity has been discussed by various authors. With regard to 'Gammexane', Cameron[1] has given some notes on its acute toxicity, and Slade[2] has reported the toxicity of the four benzene hexachloride isomers to rats, but little or no information is available as to the possibility either of chronic poisoning or of a cumulative effect.

The following experiments show that the possibility of any toxic effects from residues of 'Gammexane' dust on foodstuffs is extremely remote. The additions daily of 10, 20 and 30 mgm. per kgm. bodyweight of pure 'Gammexane' in powder form to the diet of rats showed no effect whatsoever over a period of twenty-seven days. A longer experiment with much heavier dosages was carried out with benzene hexachloride containing 13 per cent of the gamma isomer. As most 'Gammexane' formulations are based on benzene hexachloride of this composition, the possibility of the other isomers having cumulative or chronic effects would also be demonstrated. The median lethal dose of this substance to rats is 1,250 mgm. per kgm. body-weight, and doses of 500 mgm. per kgm. body-weight were fed daily, mixed with the normal diet. The five rats treated were half-grown at the beginning of the test, and during the period of the experiment, namely, 57 days, their growth-rate was the same as that of untreated littermates. Appetites remained good, the daily ration being readily eaten, and no toxic symptoms of any kind were noted. At the end of the period the animals were killed and all organs found to be normal.

A similar experiment was carried out with pure D.D.T. powder, but a daily dose of 500 mgm. per kgm. body-weight gave rise to nervous symptoms within two days. A dose of 350 mgm. per kgm. body-weight was tolerated, but nervous symptoms occasionally appeared. Rats were kept under experiment for 48 days with this daily dose, but the growth-rate was less than in the control animals. No abnormalities were found in the internal organs.

These doses are much larger than generally reported in the literature, for example, Smith and Stohlman[3], but it should be noted that pure D.D.T. powder was used and not the commercial product, and that no oil was used to incorporate it in the diet.

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Active Aurora of September 28, 1946

The aurora visible at Cambridge on the night of Saturday, September 28, showed considerable activity from 9 to 10 p.m. (B.S.T.). When most disturbed, there was a definite change of colour with increasing altitude, the lower portion being bright green, gradually changing to reddish from about altitude 30° up to and beyond the Pole.

The main structure was composed of several long triangular streamers in the red region, sharply terminated at their upper extremities, with broad bases gradually merging into the greenish lower portion.

A special feature was a long more rectilinear luminous streak, almost vertical, and extending from near *γ Ursæ majoris* to *ε Ursæ minoris*. This lasted for about ten seconds, and was decidedly not a meteor, although these were being looked for as forerunners of the expected stream from the Giacobini–Zinner Comet.

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CONRAD GESNER AND JOHANN JACOB SCHEUCHZER

ON September 7 there was celebrated the two hundredth anniversary of the founding of the Zurich Society of Natural Sciences. The Swiss Society of Natural Sciences held its 126th annual meeting at the same time, and the attendance of delegates from scientific societies in some thirty other countries conferred upon the Congress an international significance.

After addresses by the president, Prof. P. Niggli, professor of mineralogy and petrography in the University of Zurich, and by several of the foreign delegates, Prof. Hans Fischer, professor of pharmacology, delivered an address on the lives and works of two distinguished sons of Zurich, Conrad Gesner and Jacob Scheuchzer, each of whom occupied the position of town physician and greatly advanced the science of his time. The current issue of the Swiss scientific journal *Atlantis* contains not only some extracts from the correspondence of Gesner and Scheuchzer with their English friends but also a number of the remarkable illustrations which adorn Scheuchzer's principal work, "Physica Sacra".

Conrad Gesner (1516–65) was the pioneer of humanism in Zurich at the time of the great movements of the Renaissance and Reformation. That he was a man of immense industry is shown by his "Bibliotheca Universalis", published in 1545, a catalogue of all the writings in Hebrew, Greek and Latin which had appeared prior to that date. This great task completed, Gesner next set himself to describe, in systematic and scientific fashion, every known animal and plant. His "Historia Animalium", the first volume of which was issued in 1551, forms part of the basis of modern zoology, and contains a number of wood-cuts by Albrecht Dürer. The botanical part of this wide scheme of research, "Historia Plantarum", was incomplete when Gesner died. He was widely known for his writings, not merely in science but also in medicine, and he was held in high esteem as a physician.

Gesner's death from plague at the age of fifty-nine was indeed a great loss to science and medicine alike. Among the friends who mourned him was John Caius of Cambridge, who had written, at Gesner's request, his monograph on British dogs, "De Canibus Britannicis", and there were many others, since Gesner's house in Zurich was a meeting-place for scholars from all quarters.

A century later there was born another notable pioneer who became town physician of Zurich, Johann Jacob Scheuchzer (1672–1733). Scheuchzer lived at a time when the progress of science was greatly retarded by the rigid orthodoxy of the Church. Nevertheless, he was the first to describe, in a comprehensive and scientific fashion, the physical geography of the Swiss Alps, and he made many original observations on the meteorology, geology, botany and zoology of Switzerland. Those numerous observations, the results of many journeys in all parts of the country, led to the publication of his "Naturgeschichte des Schweitzerlandes" (1706–08) and "Herbarium Diluvianum" (1709), but his greatest work is contained in the four folio volumes entitled "Physica Sacra" (1731–35). They form a sort of commentary on the Old Testament such as could not fail to be accepted by the most bigoted churchmen of the day, without any sacrifice of scientific accuracy. Of outstanding interest are Scheuchzer's descriptions of fossil plants and animals and of *Homo diluvii testis* (the skull of a 'Rhinelander' man), the relics of an earlier flora and fauna which, he said, had been preserved beneath the waters of the Flood. The engravings which adorn this work are of great artistic merit. In medicine, Scheuchzer was less distinguished than Gesner, although in science he was a worthy follower—one of the leading pioneers in the wide field of natural philosophy.

DOUGLAS GUTHRIE

DENTAL CONDITION OF FIVE-YEAR-OLD ELEMENTARY SCHOOL CHILDREN

By DR. HELEN COUMOULOS
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A FIELD survey of the dental condition of more than 4,500 five-year-old elementary school children in various parts of England and of a few in Wales was undertaken during the years 1943–45. In the course of the survey the surface structure, the incidence and extent of caries, the 'healing' or arrest of the carious process and other conditions were carefully recorded on suitable charts. The standards used were those devised in 1927 by M. Mellanby[1].

The main results of this investigation are presented in the accompanying table, in the hope that they may be of interest to other workers and may serve as a basis for comparative study with future surveys of a similar nature. It must be emphasized, however, that when making such comparisons it is essential that the same standards should be used. Detailed analyses of some of the data obtained are in the press, and others will be published in the near future.

THE DECIDUOUS TEETH OF FIVE-YEAR-OLD ELEMENTARY SCHOOL CHILDREN 1943 TO 1945

Districts	Number of children inspected	Hypoplasia		Caries	
		Percentage of teeth with *M*-hypoplasia	Percentage of teeth with 'text-book' or *G*-hypoplasia*	Percentage of teeth carious	Percentage of carious teeth in which disease 'healed'
Urban					
London 1943	1870	66·8	2·5	30·1	11·7
London 1945	691	59·1	2·8	26·5	21·5
Sheffield 1944	507	74·9	4·0	30·5	10·6
Cambridge 1944	531	67·0	1·8	28·2	10·1
Caernarvon 1943	41	78·9	1·3	45·3	5·3
Total Urban	3640	66·9	2·6	29·4	12·9
Rural					
Cambridgeshire 1943	298	70·2	1·7	32·4	8·1
Oxfordshire 1944	353	63·6	3·1	28·4	12·5
Caernarvonshire 1943	29	71·0	1·3	38·2	12·6
Total Rural	680	66·7	2·3	30·6	10·6
High fluorine					
Maldon 1943	60	39·9	0·9	10·4	22·9
Maldon and district 1945	139	45·4	0·6	11·2	19·2
Grand total	4519	65·6	2·5	28·7	12·6

* Including a few teeth unclassified but with defects nearer to the *G*- than the *M*-type hypoplasia.

Hypoplasia of all grades was found in 68·1 per cent of the teeth, 65·6 per cent having *M*-hypoplasia and *only* 2·5 per cent having the gross or 'text-book' form. Caries was present to a greater or less extent in 28·7 per cent of the teeth. The figures varied considerably in the different districts, but in general the higher the incidence of *M*-hypoplasia the greater the percentage of carious teeth, a fact which bears out the evidence given originally by M. Mellanby[1] to show that the worse the structure of a tooth, that is to say the greater its degree of *M*-hypoplasia, the greater its liability to be attacked by caries.

By far the best structure, the least incidence of caries and the greatest amount of 'healing' or arrest of the disease was found in Maldon. It has been inferred[2] that the comparative freedom from caries of the teeth in that district is due to the high concentration of fluorine (approximately 5 p.p.m.) in the drinking water. This may be a fact, but if so the function of the fluorine is not yet known. In this investigation, as in that of King[3], the very low incidence of caries is definitely associated with a small amount of *M*-hypoplasia.

Two studies of five-year-old children attending London schools in 1943 [4] and 1945 [5] are of particular interest. The first was intended for comparison with a similar study made fourteen years before and showed that the dental condition in 1943 was much better from every point of view than that found in 1929. The 1945 survey showed that the improvement observed in 1943 had not only been maintained, but also exceeded. The structure of the teeth was better than in 1943, and the caries incidence was lower and the amount of arrest of the disease higher even than was expected from the improved structure, suggesting that some powerful beneficial influence had been at work during the post-eruptive as well as the developmental period.

A probable reason for this continued improvement in dental condition is indicated when the trend of the diet in Great Britain is considered. It is common knowledge that during recent years, and especially during the War, much attention has been paid to human nutrition in Great Britain. The increased consumption of the so-called protective foods, especially milk and cod-liver oil, by pregnant and nursing women and by infants, the war-time rationing of certain foods, the inclusion of vitamins D and A in margarine and the addition of calcium carbonate to flour, have helped to raise the dietary standard of some classes of the community and to make it more constant throughout the country. Incidentally, the diet has been enhanced in the main by those factors which have been shown by M. Mellanby and her colleagues[1,6] to be largely responsible for good tooth calcification and for the prevention or delay of the initiation and spread of caries after eruption of the teeth. It seems reasonable, therefore, to attribute the better dental condition of five-year-old London children in recent years to the improvement in the calcifying properties of the diet. The 1945 group, having received the dietary supplements mentioned above for longer periods than their predecessors of 1943, appeared to have benefited to an even greater extent, as is evident from the figures given in the table.

When the findings in this investigation are considered as a whole, in conjunction with the evidence that is available from animal experiments and other investigations on children, it would appear that the key to dental health lies in the ingestion and utilization by the body of a balanced diet rich in calcifying properties, especially vitamin D. It is not claimed that by these measures the elimination of dental caries would be attained, but it is felt that the prevalence of the disease would be considerably reduced.

Acknowledgments will be made when the full data are published.

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[4] Mellanby, M., and Coumoulos, H., *Brit. Med. J.*, **1**, 837 (1944).
[5] Coumoulos, H., and Mellanby, M., *Brit. Med. J.* (1946) (in the press).
[6] Mellanby, M., and Pattison, C. L., *Brit. Dent. J.*, **47**, 1045 (1926); *Brit. Med. J.*, **2**, 1079 (1928); *ibid.*, **1**, 507 (1932); Mellanby, M., Pattison, C. L., and Proud, J. W., *Brit. Med. J.*, **2**, 354 (1924).

LIMITS OF EFFECTIVE HUMAN POWER

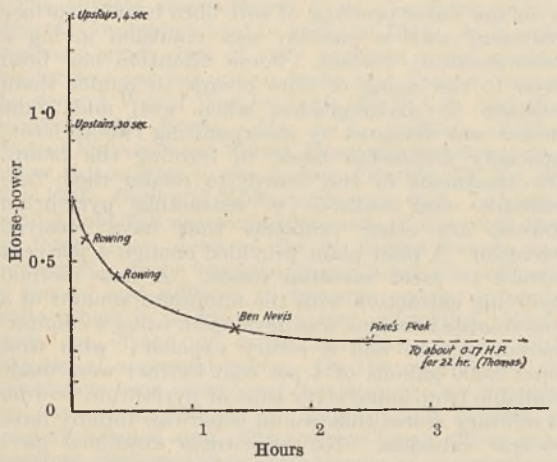
By P. J. H. UNNA

J. S. HALDANE and Yandell Henderson[1] have shown that heavy workers can maintain 0·13 effective horse-power on various tasks throughout an ordinary working day, and it has been pointed out[2] that this figure corresponds to the output when walking uphill at the moderately fast rate of 1,500 ft./hr., if gross weight, that is, with clothes and rucksack, is taken at 180 lb. The present purpose is to assemble corresponding figures for record power, according to the duration of the work. In general, they will be based on racing speeds uphill, for they afford an easy means of measurement of power. So does a cycle ergometer, but the recorded measurements scarcely apply, as they do not seem to have been made on specially selected athletes, though some suitable ones by rowing ergometer are available.

For quite short spells, the figures for running upstairs, given in Cathcart's table[3], will suffice. They work out at 1·32 h.p. for 4 sec., and 0·94 for 30 sec.; but his 0·44 h.p. for 3¾ min. has been kept up for a much longer time.

No further uphill figures for spells of less than an hour have been found. Thus the so-called guides' race at the Grasmere games was down as well as up, and the summit times do not seem to have been recorded; while the ascent of Glamaig from Sligachan Hotel in Skye by a Gurkha brought to Britain by Lord (then Mr. Martin) Conway[4] at the end of last century also fails for lack of essential data. The rise was just 2,500 ft., and the up and down times were 37 min. and 18 min.; but the course includes more than a mile of almost level ground to the foot of the hill. All that one can say is that his effective output of power in the steep part was probably in accordance with other records. One must therefore fall back on Yandell Henderson and Haggard's figures[5] for rowing, 0·45 h.p. for a 4-mile race in 22 min., and 0·57 h.p. for 1½ miles in, say, 7½ min.

As to rather longer spells, the annual race from Fort William up Ben Nevis, and back again, also fails, not only because the summit times are not ascertainable, but also because two miles each way of level road were included. But one Ben Nevis race[6], on October 1, 1901, when the summit observatory was still operating, and which started at Achintee where the pony track begins to rise, and which ended at the top, showed remarkable endurance. The best times for the climb of 4,300 ft. were 1 hr. 8 min. 19 sec.



and 1 hr. 18 min. 44 sec., both made by observatory porters. So the winner's rate of ascent was 3,775 ft./hr., which would give an effective output of 0·27 h.p., even if his unrecorded weight is taken as only 10 stone gross.

Next in order of height, we have the ascent of Pike's Peak[7] from Manitou, a rise of 7,485 ft., by Mr. Robinson, the resident manager at the Summit House, in 2 hr. 31 min., or at 2,975 ft./hr. He weighed 156 lb., so his effective horse-power was 0·235. But for the fact that he was normally living at 14,000 ft., and was climbing below that level, this performance would not indicate his full power nearer sea-level.

Lastly, there is Mr. Eustace Thomas's walk[8] of May 29, 1920, in the Lake District, which included all the principal tops except those near Coniston. It was a switchback walk, undertaken at just over fifty years of age, and for which he trained on a vegetarian diet. It included ascents totalling 23,400 ft., and measured 58½ miles. He covered the ground in 21·9 hr., and then, after resting for 2¼ hr., he went on, and completed 30,000 ft. of climbing within 30 hr. After going for 16½ hr., he descended 2,400 ft. from Clough Head to Threlkeld at 6,450 ft./hr.; and then, after an hour's rest, climbed the 2,600 ft. up Saddleback at 2,400 ft./hr. His stripped weight was 171 lb., or, say, 175 lb. gross, giving an output of 0·21 h.p. But, so far as ascertainable from the recorded times, his uphill speed was, in general, rather less. Taking this and the effect of the hour's rest into account, it would be fairer to place his output at about 0·17 h.p.

When the various figures for power are plotted against duration, they lie on a smooth curve. If they were based on world records, like those for running, which, of course, does not result in any measurable effective power, the curve could be taken as indicating the highest outputs of which human beings are capable. But hill climbing is not suitable for organisation as a competitive sport, and, in any event, the figures used here may be far from comprehensive. So, while a curve based on the best possible performances would probably be similar in shape, it might lie at a rather higher level.

[1] *Nature*, **118**, 308 (1926).
[2] *Nature*, **118**, 481 (1926).
[3] Brit. Assoc. Rep., 1922, p. 167.
[4] Scottish Mountaineering Club, Skye Guide, p. 111.
[5] *Nature*, **118**, 308 (1926), and *Amer. J. Phys.*, **38**, 431 (1909).
[6] *Scotsman*, Oct. 2, 1901.
[7] *Phil. Trans.*, B, **203**, 192 (1913).
[8] *J. of Fell and Rock Climbing Club*, **4**, 202.

THE SMITHSONIAN INSTITUTION: REPORTS FOR 1944 AND 1945

THE report of the Secretary of the Smithsonian Institution and the financial report of the Executive Committee of the Board of Regents for the year ended June 30, 1944, contains, as usual, reports on the United States National Museum, the National Gallery of Art, the National Collection of Fine Arts and the Freer Gallery of Art, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park and the Astrophysical Observatory as well as on the Library and publications. The report refers to the abandonment of its normal peace-time research and exploration programme except for those projects planned to promote better cultural relations with other American republics or bearing on the war effort.

Among such war services mentioned in the report on the National Museum are the preparation by Dr. R. Kellogg, at the request of the National Research Council, of text, keys and distribution maps and illustrations of monkeys known to be susceptible to infection by malarial parasites; this information was required to aid in studies of malaria in man. Information relative to the distribution and identification of mammals involved in the transmission of diseases was also supplied, and nearly two hundred officers assigned to malaria survey or control units or similar activities received instructions or other help from personnel of the Division. Information on the disease-bearing insects of specific foreign areas was also supplied to the Division of Medical Intelligence of the Surgeon General's Office.

Use of the Library during the year was outstanding. In the Museum Library alone, some 520 requests for information were received from war agencies, many of which required a considerable amount of research to answer. The Library's large collection of duplicates was drawn upon by other departments of the Government, and through the Library of Congress the Smithsonian Library is co-operating with the American Library Association in the collection of material for aid to libraries in war areas, and has already contributed more than 20,000 periodicals from its own stock of duplicates.

The corresponding report for the year ended June 30, 1945, again refers to the suspension of a large part of the Institution's normal activities in research, exploration and publication, so that the staff could devote itself to aiding the work of the Armed Forces. The Institution's most useful war-time function has probably been the provision of technical information requested by the Army, Navy and war agencies. More than two thousand such requests were received during the first two years of war. Another war-time service was in the improvement of cultural relations with the other American republics, and the monumental Handbook of South American Indians made satisfactory progress under the guidance of Dr. J. H. Steward. Volumes 1 and 2 were in proof and Volumes 3 and 4 were sent to the printer towards the close of the year. The third part of a "Check List of the Coleopterous Insects of Mexico, Central America, the West Indies and South America", by Dr. R. E. Blackwelder, was published.

During the year many of the evacuated collections were returned to the Institution, the transfer being made without damage, in spite of many of the specimens being fragile and difficult to pack and to

handle. The series of publications started early in the War to present authentic information on the peoples, geography, history and other features of war areas, entitled "War Background Studies", was completed during the year.

Among the outstanding publications of the year were C. G. Abbot's "Weather Predetermined by Solar Variation" in the Smithsonian Miscellaneous Collections; "Summary of the Collections of Amphibians made in Mexico under the Walter Rathbone Bacon Travelling Scholarship" by E. H. Taylor and H. M. Smith; and "Review of the Spider Monkeys" by R. Kellogg and E. A. Goldman in the *Proceedings of the National Museum*, and "Houses and House Use of the Sierra Tarascans" by R. L. Beals, P. Carrasco and T. McCorkle, the first publication of the Institute of Social Anthropology.

Accessions to the Library totalled 4,844, bringing the total holdings to 918,460. A considerable number of valuable old works, some dating from the seventeenth and eighteenth centuries, were acquired by purchase during the year. The regular sending of consignments to the liberated countries of scientific publications had not been resumed by the International Exchange Service, and accumulations for France, Italy and Belgium were forwarded to the Office of War Information, and those for Sweden, Palestine and Egypt through the United States dispatch agent in New York.

INDUSTRIAL DEVELOPMENT IN EAST AFRICA

THE second annual report of the East African Industrial Research Board deals with activities for the year ending December 31, 1944, and stresses the need for competent survey of the industrial opportunities of the country and for planning for their orderly and rapid realization. The Board is concerned that its present war-time improvisations should be developed into a strong peace-time organisation, staffed with specialists in industrial science, economics and technology. Industrial research must now be judged by its contributions to the establishment of permanent competitive industry, and this means concentration on a smaller number of problems.

During 1944, the Industrial Management Board completed the installation at Nairobi of the old oil-pressing equipment removed from Merca in Somalia, and when production of cotton-seed oil started, the Industrial Research Board was called upon to assist in establishing processes and controlling products. Investigations were also started to assist in the improvement of locally produced soap, while a process has been developed for the preparation of motor fuel and other petroleum products by a method based on vapour-phase cracking of the vegetable oils contained in seeds. The seeds are heated to about 500°–550° C., when the oils are vaporized and partly cracked, the vapours passing to a cracking tube at 500°–650° C. at a pressure of about 100 lb. per sq. in. Fuel oils are recovered from the issuing gases by condensation and refined by conventional methods, a yield of about 26 gallons of motor spirit being obtained on the small plant per ton of cotton seed.

Investigations were also carried out to determine the physical constants of fibre board manufactured at Thika factory, Kenya, including expansion and expansion under changes of relative humidity, as well as on the water-proofing of soft fibre boards, surface treatment with a paraffin wax emulsion giving a water-resistant surface. Some attention has been given to the sizing of fibre boards to render them resistant to disintegration when wet, and some success was obtained by incorporating rubber latex, especially *Euphorbia* latex, in forming the board. The treatment of the boards to render them fire-resistant, and methods of extracting pyrethrum flowers, are other problems that have received attention. A pilot plant provided enough 4 per cent extract to meet essential needs. A new method involving extraction with the minimum amount of a non-volatile kerosene was developed, using a counter-current system and a rotary expeller; with this, some 2,500 gallons of 4 per cent extract were made available from some sixty tons of pyrethrum powder in military stores that would otherwise rapidly have become valueless. No substitutes examined gave promise of replacing pyrethrum by other insecticides not in similar demand for war purposes.

Vegetable fuels, the fire-proofing of fabrics and other materials, the protection of timber from insect damage, phosphatic fertilizers and ceramics are among other subjects engaging the attention of the Board, the latter having become the most important single item in the Board's research programme. Striking results have been obtained in making roofing tiles by incorporating certain vegetable fibres in the bodies used.

Included in this report are the reports of the Uganda Industrial Committee and of the Tanganyika Industrial Committee. The former committee functions both as a local agent and liaison for the East African Industrial Research Board, and as the body responsible to the Uganda Government for various industrial operations and undertakings. The hand-spinning and weaving centre at Kampala was continued until the latter part of the year, and construction of a pottery to provide essential articles to meet local demand was completed in February 1944, including a Chinese-type kiln. Under the Tanganyika Industrial Committee, a successor to the East African Substitutes Committee, research was carried out at Totaquina factory on the effect of fineness of grinding on efficiency of extraction, the course of the process of extraction of the alkaloids from the aqueous phase by oil, and the possibility of increasing the efficiency of extraction by adding amyl alcohol to the diesolene. At the Hone factory, experimental work on the production of different types of abrasive articles continued, and the first successful high-speed abrasive wheel to be made in East Africa was produced during the year.

AERIAL RECONNAISSANCE IN FORESTRY

THE aeroplane has been used to assist in forest fire protection for some years, and its use was brought to a high standard of efficiency in Canada before the First World War. It had also been more or less tentatively used by the Forest Department in India as an aid to describing the growing stock of forest areas for which working plans were under preparation. In the minds of many forest officers of experience, having regard to the considerable expense involved, the possibilities of its practical use were not regarded with any great enthusiasm.

The subject was referred to at the Sixth Sylvicultural Conference held in India in 1945. As is well known, a great deal of very accurate aerial photography was carried out in India and Burma during the Second World War by both the R.A.F. and the American Air Force. Mr. A. L. Griffith, of the Central Sylvicultural Forest Research Institute, discusses this matter in the *Indian Forester* (72, No. 5, May 1946. Civil and Military Gazette, Ltd., Lahore), stating that full use should be made of the work the air forces have done so far as Indian forests are concerned. As he remarks, many areas are difficult to get to and difficult to traverse on the ground, while others in addition are very unhealthy. Such areas are often not worth the time, labour and expense of a ground party. On the other hand, it has always been considered that accurate air surveys are expensive, difficult to organise and require a specially trained staff. The average forest officer has, therefore, hesitated to propose the use of an aeroplane for the purpose.

Mr. Griffith had occasion to make a fairly extensive tour of the Thar Desert of Sind. This is the south-western part of the Great Indian Desert and is some 10,000 square miles in area. It is bounded in the west by the Nara River, in the south by the Rann of Cutch, and in the north and east by other parts of the desert. It was desired to obtain information on the subject of the desert scrub growth in connexion with the Development of Sind plans. Some two hundred miles were travelled by camel, and the party saw a fair amount of the westerly edge of the area from Naukot in the south to Chhor in the north, penetrating some 30–40 miles into the desert. It was necessary to see the more southerly and easterly parts of the area, mainly towards Nagar Parkar on the edge of the Rann of Cutch, from which the general sand drift starts. This was done in a chartered Gipsy Moth aeroplane. Mr. Griffith found that he could take perfectly serviceable air photographs with an ordinary camera, though he had never tried to take an air photograph before. The experience gained and photographs have shown the value of this type of reconnaissance to the forest officer, alike for working plan purposes, erosion schemes, reconnaissance of new forest areas, and so forth.

PROPERTIES OF THE EARTH'S CRUSTAL LAYERS

BENO GUTENBERG has examined this problem in the light of a suggestion made by Zoeppritz in 1912 that changes with distance in amplitudes of observed seismic waves may give the required information. Three hundred earthquakes in southern California and several earthquakes recorded at Huancayo, Peru, and originating within 2,000 km. of this place have been used (*Amer. J. Sci.*, 243, A, Daly Volume, 1945, pp. 285–312).

Gutenberg finds that the Mohorovičić discontinuity is at a depth of about 35–40 km. in the coastal areas of southern California, but deeper under mountain ranges. The velocity of *Pn* below it is close to 8·0 km./sec. At first, the velocities of both *P* and *S* increase with depth, probably at a rate similar to that in the upper layers, but the rate of increase falls off rapidly with increasing depth, resulting in a rapid decrease of the amplitudes of *Pn* and *Sn* with distance beyond $\Delta = 200$ km. Amplitudes of *Pn* and similarly of *Sn* in intermediate shocks without appreciable surface waves on records of shocks originating at various depths within a radius of about 2,000 km. from Huancayo, Peru, and recorded at the station there, confirm the previous results of Gutenberg and Richter (1939) concerning the relationship between the epicentral distances at which the amplitudes of *Pn* are very small, and the focal depth of the shocks.

These findings can be explained on the assumption that at a depth of about 80 km. the melting point of the material is reached. Immediately above that critical depth, the effect of temperature on the bulk modulus and on the coefficient of rigidity may approach or even surpass the effect of pressure. At the critical depth itself, there may be a slight sudden decrease of the wave velocity. Experimental data (Birch *et al.*, "Handbook of Physical Constants", *Geol. Soc. Amer. Spec. Papers*, No. 36 (1942), pp. 15, 28 and 59) are insufficient to decide which decrease is larger at the melting point, that of the elastic constants or that of the density. At greater depth, the effect of the temperature on the bulk modulus and the coefficient of rigidity becomes more and more insignificant. Whereas above the critical depth, a minimum stress of the order of 10^9 dynes/cm.^{2} (the strength) is required to start plastic flow, below this depth the strength is much smaller, and the plastic flow is controlled mainly by the plasticity of the material.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Sunday, October 20—Friday, October 25

BRITISH MYCOLOGICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1).—Jubilee Meeting.

Wednesday, October 23

At 10 a.m.—Fiftieth Annual Meeting; at 11 a.m.—Dr. J. Ramsbottom: "Mycology Then and Now" (Presidential Address); at 2 p.m.—"Medical Mycology: Mould Products".

Thursday, October 24

At 10 a.m.—"Seed-borne Fungi"; at 2 p.m.—"Mycorrhiza; Soil Fungi".

Friday, October 25

At 10 a.m.—"Growth Factor Requirements of Fungi"; at 2 p.m.—"Taxonomy".

Monday, October 21

CHEMICAL SOCIETY (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY, and the BUREAU OF ABSTRACTS, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Dr. G. Malcolm Dyson: "A New Notation for Organic Chemistry".

Tuesday, October 22

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. R. E. Peierls: "Fundamental Particles".

Wednesday, October 23

RESEARCH DEFENCE SOCIETY (at Manson House, Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 3.15 p.m.—Annual General Meeting. Prof. N. Hamilton Fairley: "War-time Research in Malaria and other Tropical Diseases of Military Significance" (Fifteenth Stephen Paget Memorial Lecture).

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at Faraday Building, 9th Floor, South Block, Knightrider Street, London, E.C.4), at 5 p.m.—Mr. J. Eccles: "Buildings for Telecommunications—Some Views and Suggestions".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. H. F. Pritchard: "The Problems of Blind Landing".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM AND DISTRICT GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham 2), at 6.30 p.m.—Mr. A. S. Wharton: "Market Research".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Sweet Confectionery" (Mr. D. W. Grover: "The Keeping Properties of Confectionery as Influenced by its Water-Vapour Pressure"; Mr. H. F. Bamford and Mr. H. M. Mason: "Estimation of the Fineness of Grinding of Chocolate").

BRITISH ASSOCIATION OF CHEMISTS, LONDON SECTION (at Gas Industry House, 1 Grosvenor Place, London S.W.1), at 7 p.m.—Mr. D. Matheson: "Fire and Explosion, 2, Methods of Minimising the Results of Explosion".

Thursday, October 24

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

CHEMICAL SOCIETY (joint meeting with the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. A. R. Todd, F.R.S.: "A Synthetic Approach to the Nucleotides".

LEEDS METALLURGICAL SOCIETY (in the Chemistry Lecture Theatre, The University, Leeds), at 7 p.m.—Mr. R. H. Bomback: "Photography and Metallurgy".*

ROYAL INSTITUTE OF CHEMISTRY, TEES-SIDE SECTION (in the Main Hall, William Newton School, Junction Road, Norton-on-Tees), at 7.15 p.m.—Sir Jack Drummond, F.R.S.: "Experiences at the Ministry of Food during the War".

CHEMICAL SOCIETY (joint meeting with the MANCHESTER UNIVERSITY CHEMICAL SOCIETY and the LOCAL SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Department, The University, Manchester), at 7.30 p.m.—Prof. Wilson Baker, F.R.S.: "The Chemistry of Penicillin".

Friday, October 25

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Discussion on "Health Problems in Germany" (to be opened by Brigadier Tom Kennedy).

CHEMICAL SOCIETY (joint meeting with the ALCHEMISTS' CLUB and the ANDERSONIAN CHEMICAL SOCIETY, at the Royal Technical College, Glasgow), at 3.45 p.m.—Prof. R. A. Morton: "Evidence Concerning the Mode of Action of Vitamins".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "The Burton-on-Trent Explosion".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. J. Matthews: Inaugural Address as Chairman.

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY, at Marischal College, Aberdeen).—Prof. G. D. Preston: "Microscopy with Electrons and X-Rays".

Saturday, October 26

ROYAL INSTITUTE OF CHEMISTRY (in the Letters Lecture Theatre, The University, Reading), at 2.30 p.m.—"Water Supplies" (Prof. H. L. Hawkins, F.R.S.: "The Geology of Water Supplies"; Mr. W. Gordon Carey: "The Chemistry and Bacteriology of Water Supplies").*

APPOINTMENTS VACANT

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

PROGRESS AND MATERIALS SUPERINTENDENT at the Board's Chiswick Works—The Chief Staff and Welfare Officer (E.R./E. 260), London Passenger Transport Board, 55 Broadway, London, S.W.1 (October 26).

LECTURER IN PHARMACOLOGY—The Secretary and Registrar, The University, Bristol (October 26).

LECTURER IN PHYSICS, and a LECTURER IN STRUCTURAL ENGINEERING, at the South-West Essex Technical College and School of Art—The Chief Education Officer, County Offices, Chelmsford (October 26).

ASSISTANT LECTURER IN TEXTILE CHEMISTRY, and an ASSISTANT LECTURER IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (October 28).

HEAD OF THE DEPARTMENT OF INDUSTRIAL ADMINISTRATION—The Registrar, Birmingham Central Technical College, Suffolk Street, Birmingham 1 (October 31).

AGRICULTURAL ECONOMIST, an ASSISTANT AGRICULTURAL ECONOMIST, and an ASSISTANT LECTURER IN AGRICULTURAL ECONOMICS—The Registrar, University College of Wales, Aberystwyth (October 31).

SENIOR LECTURER IN STRUCTURAL ENGINEERING, a LECTURER IN MECHANICAL ENGINEERING, and a SENIOR LECTURER IN MECHANICAL ENGINEERING, at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 31).

LABORATORY STEWARD (Grade B) IN THE DEPARTMENT OF CHEMISTRY—The Medical School Secretary, Middlesex Hospital, London, W.1 (October 31).

SPEECH THERAPIST—The County Medical Officer, County Offices, Lincoln (October 31).

DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1 (November 2).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, University College, Singleton Park, Swansea (November 2).

UNIVERSITY LECTURERS AND UNIVERSITY DEMONSTRATORS IN ENGINEERING—The Secretary of the Appointments Committee, Engineering Laboratory, Cambridge (November 4).

ASSISTANT TECHNICAL SECRETARY (University Degree or equivalent qualification in Chemistry (inorganic) or Metallurgy essential) by the Metallurgy Division—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed "Metallurgy Division" (November 9).

LECTURER IN BACTERIOLOGY—The Registrar, The University, Manchester 13 (November 9).

PROFESSOR OF GEOLOGY AND HEAD OF THE DEPARTMENT OF GEOLOGY AND GEOGRAPHY—The Registrar, University College, Singleton Park, Swansea (November 9).

ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Leeds 2 (November 9).

PROBATIONARY ASSISTANT LECTURER IN PHYSICS—The Registrar, University College of North Wales, Bangor (November 9).

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF ANATOMY, and an ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Secretary, King's College, Strand, London, W.C.2 (November 9).

SENIOR LECTURER IN PHYSICS in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting A.328 (November 12).

SENIOR LECTURER IN ZOOLOGY in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting G.412 (November 12).

METEOROLOGICAL OFFICER CADETS (20) in the Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (November 15).

SENIOR LECTURER IN PHYSICS, a LECTURER IN GEOGRAPHY, a LECTURER IN PHILOSOPHY, and a LECTURER IN ECONOMICS, at the Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (November 15).

TEACHER OF COMMERCE in the County Technical Secondary School for Boys—The Principal, Canterbury Technical Institute, Longport Street, Canterbury (November 16).

SENIOR LECTURER IN ORGANIC CHEMISTRY—The Registrar, The University, Sheffield (November 16).

FOREST ENTOMOLOGIST (Male) at the Forest Research Station, Alice Holt, Farnham, Surrey, under H.M. Forestry Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1657 (November 18).

PHYSICIST FOR RESEARCH ON THE PROCESSES OF COMBUSTION, and an ENGINEER FOR VIBRATION INVESTIGATIONS, at the National Gas Turbine Establishment—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1658 (November 18).

PRINCIPAL SCIENTIFIC OFFICERS (2) for research and development work on Flutter, Aero-elasticity and General Airframe Vibration, at the Royal Aircraft Establishment, South Farnborough—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1659 (November 18).

SENIOR LECTURER IN BIOLOGY at the New England University College, Armidale, N.S.W., Australia—The Registrar, The University, Sydney, N.S.W., Australia (November 30).

DIRECTOR OF THE RUBBER RESEARCH INSTITUTE OF MALAYA—The Acting Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S.W.7 (December 10).

CHAIR OF VETERINARY SCIENCE, and the HUGHES CHAIR OF VETERINARY PATHOLOGY AND BACTERIOLOGY—The Registrar, The University, Sydney, N.S.W., Australia (December 31).

HEAD OF THE ENGINEERING AND SCIENCE DEPARTMENT—The Principal, County Technical College, Worksop, Notts.

AREA SUPERVISOR to supervise the work of the National Milk Testing and Advisory Scheme in North Staffordshire and to take charge of the Newcastle Area Laboratory—The Advisory Bacteriologist, Provincial Laboratory, Bank House, Newport, Shropshire.

SENIOR MUSEUM ASSISTANT—The Secretary, Department of Zoology, University Museum, Oxford.

LABORATORY STEWARD and LECTURE ASSISTANT IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Hull.

LABORATORY TECHNICIAN with training in pathological and bacteriological technique for the City Hospital Laboratory—Dr. J. Smith, Public Health Laboratories, City Hospital, Aberdeen.

ASSISTANT BIOCHEMIST—The House Governor, Queen Elizabeth Hospital, Birmingham.

TECHNICAL ASSISTANT (graduate, preferably in physics or electrical engineering) to help with abstracting, answering technical inquiries, and classifying technical literature—The Secretary, British Scientific Instrument Research Association, 26 Russell Square, London, W.C.1.

TECHNICAL ASSISTANT FOR PHYSICS DEPARTMENT—The Professor of Physics, The University, Manchester 13, quoting FAV.

LIBRARIAN for special technical library—The Information Manager, Production Engineering Research Association, Frederick Street, Loughborough, Leics.

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REPORTS and other PUBLICATIONS

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