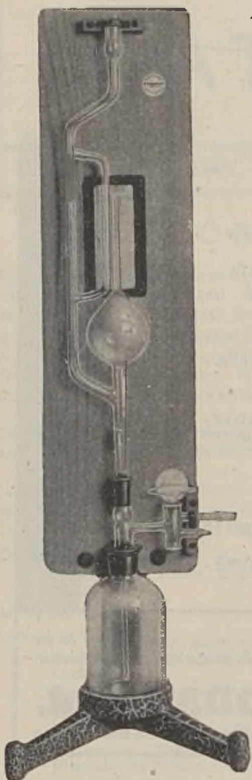
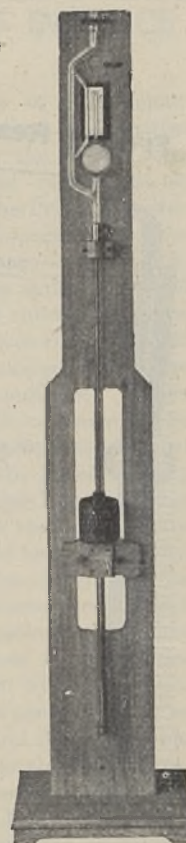
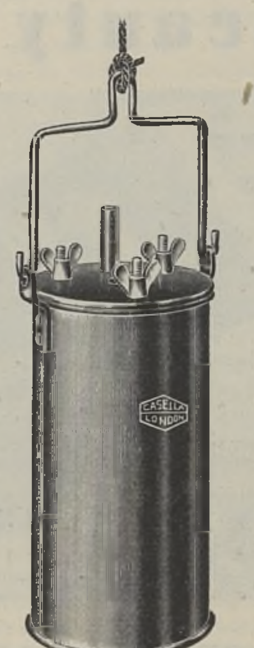
"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

Vol. 158, No. 4019 SATURDAY, NOVEMBER 9, 1946 ONE SHILLING & SIXPENCE






CASELLA
LONDON

NATURE

No. 4019 SATURDAY, NOVEMBER 9, 1946 Vol. 158

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ST. MARTIN'S STREET, LONDON, W.C.2.
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Telephone: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

RE-ORGANISATION OF DEFENCE IN BRITAIN

THE changes in the machinery of government announced in the White Paper on the Central Organisation for Defence have on the whole been well received. The plan outlined represents an adaptation of war-time practice. The Prime Minister remains chairman of the Defence Committee, and the Chiefs of Staff Committee will remain autonomous, with the responsibility for preparing appreciations of strategy and military plans and for submitting them direct to the Defence Committee, while the joint staff system will be retained and developed under the direction of the Chiefs of Staff Committee. While, however, the Service Ministers will continue to be responsible to Parliament for the administration of their Services in accordance with the general policy approved by the Cabinet and within the resources allotted to them, they will no longer themselves be in the Cabinet. They will be replaced there by a new Minister—the Minister of Defence—who will be deputy chairman of the Defence Committee and will carry the responsibility of co-ordination not only of resources between the three Services in accordance with the strategic policy laid down by the Defence Committee, but also the framing of general policy to govern research and development and the correlation of production programmes, as well as the administration of inter-Service organisations such as Combined Operations Headquarters and the Joint Intelligence Bureau, and the settlement of questions of general administration on which a common policy for the three Services is desirable.

While an eventual combined administration of the three Services is not excluded, the Government rightly regards this as an impracticable step at the moment, although it has in mind the possibility of closer links, for example, in the medical services, which at present are provided separately for each Service. While, as Lord Trenchard pointed out, complete fusion of such specialized Services might involve serious administrative difficulties and confusion, there are probably other directions, especially on the scientific side, where something more could be done towards the provision of common services, as, for example, in the field of radar. Moreover, assisted by the Joint War Production Staff, which is to be retained, the new Minister's Production Committee will be responsible for studying all, and especially the wider, aspects of our war potential, and there will thus be a considered attempt made to relate the size of peace-time stocks of equipment to the rate at which production can develop in emergency.

These proposals are largely in line with what Lord Hankey has advocated in his recent books, and with the proposals for constitutional reform outlined in the recommendations of a group of Conservatives in a book published under that title ("Some Proposals for Constitutional Reform, being the Recommendations of a Group of Conservatives." Eyre and Spottiswoode, Ltd. London, 1946. 7*s.* 6*d.*). Moreover, they are a step towards adopting the proposals of the Haldane Report, as Lord Samuel was quick to point out in the House of Lords debate on October 16. Lord Samuel said further that it was understood that other groups of Departments were in process of formation, and that just as Mr. Alexander was to bring the defence services together, ministries dealing with economic planning were being co-ordinated by Mr. Morrison, those dealing with social services by Mr. Greenwood, and those dealing with external affairs by Mr. Bevin. Lord Addison agreed with Lord Samuel that at long last some notice was being taken of the recommendations of the Haldane Committee, and this particular proposal of the White Paper calls for close study to see that it avoids the danger of creating a bottleneck above the three Service Ministries and the Ministry of Supply. Co-ordinating ministers without a portfolio, as both Sir John Anderson and Prof. K. C. Wheare have pointed out in recent lectures on the machinery of government, are likely to find themselves with little real authority ; but it seems clear from the White Paper itself that the new Minister is in no danger of finding himself in that position.

Of special interest to the man of science are the observations in the White Paper on research and development, and on the great progress made in the direct association of scientific workers with the work of the Service and other departments. Recognizing that any future development of our central organisation for defence would be incomplete if it did not provide throughout for the closest possible integration of scientific and military men, the Government has now established a new Committee on Defence Research Policy which will be responsible, not only for securing such integration of thought at all levels, but also for seeing that, in planning defence research, account is taken of the scientific effort of the country in other fields in order that our resources may be efficiently and economically used. This Committee will consist of those responsible, both from the operational and scientific angle, for research and development in the Service Departments and the Ministry of Supply, and its chairman, according to the White Paper, will be a man of science of high standing, appointed for a period of years, who will exercise his functions under the authority of the Minister of Defence. The announcement on October 29 that Sir Henry Tizard had been appointed to this responsible post will give widespread satisfaction.

This development was warmly welcomed in the House of Lords debate, particularly by Lord Swinton, who stressed the value of putting the scientific man at the heart of operational planning and associating him with a problem from the start ; by Lord Samuel, who pointed out that science is now a fifth factor no less important in the long run than the three Services themselves or the Supply Ministry, because the achievements and developments of science determine the whole course of military operations ; and also by Lord Addison. Although Lord Hankey in his own speech did not mention this point, the appointment of such a Committee has long been urged by him, notably in his Lees Knowles Lecture last year, and the idea is implicit in his eleventh Haldane Memorial Lecture "The Machinery of Government" delivered in 1942, and also in the paper on the Cabinet Secretariat, put together twenty years earlier and published for the first time in "Diplomacy by Conference" (1946).

From this point of view, the proposal should also be considered in relation to the broader structure of research as set forth in the White Paper on Scientific Research and Development in 1944. The functions of the new Committee will in part overlap with those of the Scientific Advisory Committee of the War Cabinet set forth therein, and they will presumably include the functions of the Office of Scientific Advisers to the Ministry of Production abolished last year. Meanwhile, it is clear from Lord Addison's statement and that made by Mr. Attlee, and indeed from the White Paper itself, that the Government takes a wide view of the whole subject, and that there is no intention of isolating the new Committee on Defence Research Policy from the main current of scientific activity. The Defence Committee itself is recognized as concerned with plans affecting the whole life of the nation. If the White Paper does less than justice to the importance of home security and civil defence, it is clear that in excluding home security from the functions of the Minister of Defence, the Government has acted wisely. It will, however, be the duty of the Defence Committee to link home security problems to broad defence problems, and the Home Defence Committee has already been reconstituted for the purpose. Furthermore, the Prime Minister stated on October 30 that a complete review of the methods and organisation of civil defence is now in hand.

The success of such integration will doubtless depend largely on the extent to which the functional groupings of other ministries on the lines recommended by the Haldane Report are in fact proceeding, as Lord Addison appeared to admit. That change in constitutional practice may well be even more important than the changes in the organisation of defence ; more particularly as the latter represent, as Lord Hankey agreed, a steady evolution and no drastic break with the past except in the change of title already noted and the question of co-operation with the Dominions on defence on which Lord Hankey, like most other speakers in the House of Lords, centred his criticism.

Lord Addison's reply suggested that no real disturbance of existing practice is intended in the question of collective defence, and it is obvious that both regional arrangements and national arrangements will require to be kept constantly under review while the Atomic Energy Commission is formulating proposals for the control of atomic energy and the United Nations Organisation is working out effective plans for collective defence. Even in the criticism of the section of the White Paper dealing with the organisation for collective defence, there was a very manifest desire to keep both British and Commonwealth arrangements in line with the plans and arrangements that might develop under the United Nations Organisation.

There are, however, two major matters on which there is some room for concern. Criticizing the statement in the historical commentary in the White Paper that failure to equip the British forces on an adequate scale was mainly due to the political and economic circumstances of the decade before 1939, Lord Chatfield said that he could see nothing in the White Paper to ensure that there would be no recurrence of similar political circumstances in ten or twenty years time, and he reiterated his plea that foreign policy should be taken out of political party strife. The absence of provision for consultation with the leaders of the Parliamentary Opposition was a major criticism of Lord Hankey, whose recent book includes a powerful argument for the association of leaders of the Opposition with the work of the Committee of Imperial Defence, particularly in linking foreign policy and defence. Lord Hankey believes that the endowment of the United Nations Organisation with military attributes enhances the importance of this point, and in its proposals for constitutional reform, the group of Conservatives already quoted points out that recent scientific developments have made it all the more essential to maintain the agreement between Government and Opposition to co-operate on vital matters of national defence. For that purpose a standing sub-committee of the Committee of Imperial Defence was proposed, which should include leaders of the Opposition, who should be Privy Councillors; and it was suggested that the sub-committee should produce an annual report on the adequacy of the national and imperial defence organisation in the light of the existing international situation. This proposal is clearly intended to assist in the formation of that enlightened public opinion upon which the efficient functioning of a Parliamentary democracy depends. The flexibility of the new Defence Committee leaves the door open for such developments, and scientific workers should not need to be reminded of the importance of public opinion, as is shown by Lord Hankey in his Lees Knowles Lecture, or of his appeal to them and to other trained minds to attempt to appreciate the position and to assist others to do so also.

Ultimately, however, the effectiveness of the new machinery will depend, as was very clearly recognized in the debate, largely on the men who operate it. This is true at the top and also at the lower levels, where indeed Lord Hankey pleaded for tuning up details of administration to avoid risk of delays. Much will depend on our ability to find continuously the right man for Minister of Defence. We cannot expect that the Prime Minister will always be, as Mr. Churchill was so manifestly, the right man for the chairmanship of the Defence Committee and the mainspring of the war effort. But it will depend also on our ability to find for the chairmanship of the Defence Research Policy Committee and for other important posts the right men, not only of high professional qualifications, but also capable of rising above departmentalism and of co-operation in the fullest sense of the word. The central organisation for defence, in the ultimate resort, is a challenge to the quality of our man-power at all levels—administrative, scientific and technical—no less than to our capacity for statesmanship and political vision and courage.

CHEMISTRY THROUGH THE AGES

Die Entwicklungsgeschichte der Chemie

Eine Studie. Von H. E. Fierz-David. (Wissenschaft und Kultur, Band 2.) Pp. xv + 425 + 33 plates. (Basel: Verlag Birkhäuser, 1945.) 21.50 Schw. francs.

If we include alchemy, chemistry must have a much greater literature than any other branch of science. Chemistry in the broad sense is, moreover, a science with a long history, extending over two thousand years. Any historian of chemistry who aims at describing its development within the limits of a single moderately sized volume must therefore make an arbitrary selection from the vast amount of data available. The most striking feature of the present book is the skill with which Prof. Fierz-David has made this selection, while to anyone with a sense of authorship the balance and construction of the narrative are things to be admired for themselves, quite apart from the substance of the book. The substance, however, matches the structure, and there can be little doubt that "Die Entwicklungsgeschichte der Chemie" will establish itself as one of the most authoritative and readable books in its field. It certainly ought to be translated into English.

Prof. Fierz-David remarks that, from the beginning, there were two quite different ways of regarding substances. One was the unsophisticated view which treated them as real objects forming a basis for an experimental art; the other was alchemy, which looked upon experiment merely as the starting-point for philosophical speculation. It was from the practical art that, in due course, modern chemistry arose, and it might, therefore, seem logical to neglect the history of alchemy. In fact, however, alchemy and early practical chemistry were always so interlocked with one another that to follow such logic would entirely falsify the picture. The same sort of connexion existed between astrology and early astronomy, but astronomy shook itself free of astrology much more rapidly than chemistry ridded itself of the fetters of alchemy. In spite, therefore, of his eagerness to get to the history of chemistry itself, the author finds it necessary to devote about a quarter of the book to a review of the main events and tenets of the alchemical period. This section, while competent in matter and interestingly written, is not up to the standard of the remainder and shows a certain lack of judgment in its use of authorities. Thus, in dealing with Muslim chemistry, Prof. Fierz-David relies mainly on Berthelot—whose unreliability he himself admits earlier—and on von Lippmann, giving little or no mention to the work of Ruska, Stapleton, and others, which has so greatly enlarged and modified our knowledge of this important stage in the development of chemistry.

The account of the transitional period, from Muslim times to Boyle, includes brief but excellent summaries of the work of Agricola and Glauber, and the author is then free to turn to the fruitful century or so that began with Boyle and ended with Lavoisier. Unlike the majority of historians of chemistry, he maintains that the phlogiston theory of Becher and Stahl served chemistry well. It not only gave a reasonable explanation of the main phenomena of combustion as then known, but also allowed an unexpectedly happy correlation of apparently chaotically diverse facts. That phlogiston had no real existence is no more against the phlogiston theory than is the non-existence of the ether a blot on the escutcheon of nineteenth-century physics. They both rendered service in their days.

There will be no difference of opinion about Prof. Fierz-David's point of view that the real beginning of modern chemistry came with Lavoisier's establishment of quantitative analysis by weight. Before that time, when weighing was done at all it was usually of the original materials only—though we must claim an honourable exception in Black, whose name does not appear in the index or, apparently, in the text. By analysing and weighing the end-products as well, Lavoisier effected the crucial metamorphosis, and modern, exact chemistry was born—to grow with amazing rapidity under the stimulus of the new atomic theory of Dalton.

The remaining sections of the book show the author at his best. They are on unconventional lines but are refreshingly alive, being arranged, as it were, vertically instead of horizontally. The benzene theory, for example, is treated as an individual topic, as are such other subjects as stereochemistry, theories of solution, the periodic system, and radioactivity. In each case the story is brought up to the outbreak of the Second World War.

The final portion gives a very satisfactory bird's-eye view of modern applied chemistry, and there are various appendixes, indexes and charts. The book is well illustrated and produced, and its price must be considered very moderate. E. J. HOLMYARD

MICRO-ORGANISMS AND INSECTS

Insect Microbiology

An Account of the Microbes associated with Insects and Ticks with special reference to the Biologic Relationships Involved. By Asst. Prof. Edward A. Steinhaus. Pp. xi+763. (Ithaca, N.Y.: Comstock Publishing Co., Inc., 1946.) 7.75 dollars.

SCIENCE for its exercise requires a medium. In recent years, one after another of the natural sciences in search of such a medium has discovered the insects. Physiologists, chemists, even zoologists are finding among the insects a rich harvest waiting to be gathered. Microbiology, the latest of the biological sciences to demand recognition in its own right, has now entered the field.

In the golden age of bacteriology, as one disease after another fell before the advancing microbe hunters, medical and veterinary bacteriology developed as a craft of its own, the experts of which viewed the uncharted multitudes of non-pathogenic micro-organisms as being little more than a nuisance or at most as having only a negative sort of interest. Farmers, gardeners, brewers, cheese-makers and other industrialists have discovered the importance to them of microbiology, and new specialized areas of the subject have grown up. But it is only in quite recent years that it has been realized how lop-sided the growth of microbiology has become and how far our knowledge of pathogenic fungi, bacteria or protista has outstripped that of the harmless or free-living forms—to the detriment of the science as a whole.

The microbiologist who takes man or the mammalia as his point of reference will find a pretty varied field for his interests. There are the pathogenic viruses, rickettsiæ, bacteria, fungi, spirochætes and protozoa; the harmless denizens of the body surfaces and the intestinal tract; the organisms that play such an essential part in ruminant digestion; the phenomena of immunity. But compared with the microbiology of insects, what a narrow and restricted field it is!

Among the insects there are likewise pathogenic viruses, bacteria, fungi and protozoa. Some of these are responsible for the diseases that are so important in commercial insects: the polyhedral 'grasserie' and 'flacherie' of the silkworm which early attracted the attention of Pasteur, or the bacterial foul broods and the virus of sac brood in the honey bee. Others are important in the destruction of plagues of insects; when an outbreak of insects reaches its peak it commonly gives way before an outbreak of disease. *Coccobacillus acridiorum* will dissipate swarms of locusts; the European spruce sawfly, after threatening destruction in the forests of Eastern Canada, has melted away before a microbial infection; one of the most promising measures for the control of the Japanese beetle in the United States is the inoculation of the soil with the spores of *Bacillus popilliæ*, available commercially as a dry powder; and, on a homely scale, everyone is familiar with the spectacle of house-flies in the autumn dying off before the fungal infection *Empusa muscæ*.

But bacteria also form the staple diet of some insects. Certain ants and termites cultivate fungi in gardens for the nourishment of their colonies. The female 'ambrosia' beetles provide little fungal pellets to feed their young. Then there are the great number of micro-organisms pathogenic to plants and animals which have an insect as alternative host and carrier, undergoing within it such complex life-cycles as the plasmodium in the mosquito or the spirochæte in the tick. The problems of immunity, both cellular and humoral, to the microbes that invade it, likewise exist in the insect; and the subtle problem of the adaptation of the insect to carry pathogenic organisms. There are genetic races of *Culex pipiens* of which some can and others cannot serve as hosts for the plasmodium of bird malaria. There are strains of the leaf-hopper *Cicadulina* which carry a virus of maize, and other genetic strains of the same species which cannot act as carriers because the virus will not pass through the gut wall.

Scores of micro-organisms are harmless inhabitants of the body surface or gut contents of insects. But all degrees of mutual adaptation exist between host and microbe. The digestive enzymes in the cockroach are adapted to work in an acid medium created solely by bacterial fermentation. Fermentation chambers, stocked with cellulose-splitting bacteria, are characteristic of certain beetle larvæ from decaying vegetable matter. Protozoa and bacteria are essential for digestion in the wood-feeding termites; if defaunated they die of starvation. Bacteria may serve as a source of accessory food factors. An *Actinomyces* constantly present in the gut of the blood-sucking bug *Rhodnius* appears to provide some factor, perhaps a vitamin of the B group, that is lacking in blood. Intracellular micro-organisms (yeasts, bacteria and the like) transmitted from one generation to the next and maintained in special organs provide an endogenous source of vitamins for many insects.

Dr. Edward Steinhaus, who has been invited by the University of California to develop the study of the microbial diseases of insects, has produced the first introduction to insect microbiology. His book is described as a study of the biological relationships existing between microbes and insects (including ticks and mites), and covers the rich field outlined above—and much more. He does not include the fundamentals of bacteriology or protozoology but does give some account of the taxonomy of each group dealt with. Bacteria, rickettsiæ, viruses, protozoa, spirochætes, yeasts, fungi are all included. Where knowledge exists it has been brought together here; the facts well marshalled and presented, and supported by copious references (about ninety pages of them). It is indeed a really solid book. In many parts of the subject, it is true, there are formidable accumulations of fact but few generalizations. As the author admits, some sections of the book are little more than annotated lists—sometimes perhaps of organisms the credentials of which are not beyond question. Two hundred and fifty identified species of bacteria have been found associated with insects and ticks. Some are wholly adventitious (such as *Clostridium tetani* in larvæ feeding in the soil), which scarcely earn the space they occupy in these pages. But it is a good book. The author has made it abundantly clear that the insect is a splendid medium for the study of microbiology. V. B. WIGGLESWORTH

A REFERENCE BOOK OF INDUSTRIAL RESEARCH

Industrial Research, 1946

Pp. 738. (London and New York: Todd Publishing Co., Ltd., 1946.) 21*s*. net.

A REFERENCE book on industrial research which provided in one volume not merely relevant information for which at present search has to be made in numerous volumes such as "Who's Who", "Whitaker's Almanac", the "Yearbook of Scientific and Learned Societies", the "Universities Yearbook", and the registers of various professional or technical associations, but also much that has not been brought together in this way, would prove a real boon to the busy executive, research manager or industrial scientific worker concerned with the planning or administration of research. The present volume, however, misses the mark. Covering a wide field, it does so too imperfectly to replace, even for research purposes, such volumes as those mentioned, and it does little to supply the information which is lacking in those reference works and which they could not reasonably be expected to supply. The publishers show no clear conception of either the public for whom the book is intended or the precise purposes the book is designed to serve. Attempting too much, no field is covered thoroughly enough for reference purposes, and the resulting 'hotch-potch' is a bulky volume which cannot justify in its present form a place on the reference shelf of the library or the desk of the industrialist.

There are, however, at least two sections of the book which, suitably expanded, might make future editions a valuable reference work if some of the extraneous sections are eliminated. The directory of organisations interested in research, while rather generously interpreted and at present incomplete even on a narrower interpretation, could form the basis of a useful directory, particularly if some of the information scattered verbosely elsewhere in the volume were condensed into brief annotations in this list. Even more useful is the list of industrial research laboratories and the appended list of university laboratories, which contain information not easily available elsewhere. There is, moreover, in the former list much information concerning research staff which should have been included in the "Who's Who in Industrial Research". The latter section in its present form is singularly useless, and the publishers have missed their opportunity of gathering together the information at present scattered in "Whitaker's Almanac", the annual reports of the Department of Scientific and Industrial Research, the "Universities Yearbook" and various professional registers or directories. If the pamphlet "Notes on Current Scientific Researches in the United Kingdom" issued to delegates of the Royal Society Empire Scientific Conference, revised and brought up to date, were also incorporated in future editions of this book, possibly supplemented by a list of titles of theses on scientific subjects accepted by British universities for higher degrees during the year, the volume could become a valuable desk reference book for the research manager and industrial executive.

For the rest, there is little in the present volume that could usefully be retained in a reference work. The essays that comprise the first section are out of place. Some are reviews of current progress in special fields of the type one would naturally seek in, for example, the Reports on the Progress of Applied Chemistry. Nor are all these reviews new: one is a reprint of an article almost two years old. The relevance of others to the theme of industrial research is by no means evident, and their variety and discursiveness, whatever their individual merits, only emphasize the lack of thought and planning in the compilation of the book as a whole. The inclusion in this section of an article, "Common Hazardous Chemicals", reprinted from *Chemical and Engineering News*, illustrates the point: information on such matters would naturally be sought in Lange's "Handbook of Chemistry" or Hodgman's "Handbook of Chemistry and Physics".

The following section, "Official Directories", is also inadequate and much less informative than either "Whitaker" or the appendixes to the annual reports of the Department of Scientific and Industrial Research. Striking omissions in so omnivorous a volume are references to the Agricultural Research Council or the Medical Research Council—surely sufficiently closely linked with industrial research! The Overseas Section makes no reference to the South African Council for Scientific and Industrial Research or to the East African Industrial Research Board. The Official and Unofficial Statements which occupy the next two sections are unbalanced. There is remarkable disparity in the accounts of the various research associations, and in the absence of any attempt at classification the compilation is a little bizarre. The connexion of some of the organisations with research seems a little far-fetched, and others with much stronger claims to be included find no mention. For the most part it would be more effective to relegate the information in these sections to the Directory of Organisations as already indicated, and while it might be worth while including a fuller account of some, such as the Parliamentary and Scientific Committee or the University Grants Committee, the information should not be duplicated as at present.

The section "Officially Appointed Committees", listing a number of committees, some remotely connected with research, and with summaries of their reports, seems ill-conceived. It is not, and—unless carefully defined in scope—could not be, complete, but the purpose of summarizing the reports is not intelligible. References to the reports would much more appropriately have been relegated to the bibliographic section, and it would no doubt have been appreciated if that had included cross-headings facilitating the identification of the subject-matter and title of the many reports such as the Platt Report, the Hankey Report, the Barlow Report, which in common parlance go by the name of their chairman. Nor is the section on "Books, Periodicals and Films" adequate. In the nature of things, a book list in such a volume must be selective, but it could at least be authoritative and the basis of selection made plain. The present list displays all the worst faults of the whole volume, and the inclusion of so much triviality inevitably robs it of any pretensions to serve the one purpose that justifies the inclusion of such a list in a reference book on industrial research : a guide to sources of reliable and authoritative information which those concerned with the conduct or direction of research whether at the policy-making or executive level might be expected to need.

R. Brightman

A NEW FLORA OF GUATEMALA

Flora of Guatemala (Part IV)

By Paul C. Standley and Julian A. Steyermark. (Fieldiana : Botany, Vol. 24, Part 4.) Pp. v+493. (Chicago : Chicago Natural History Museum, 1946.) 3.50 dollars.

THIS is the first part to be published of a "Flora of Guatemala" which has been in preparation for the past six years at the Herbarium of the Chicago Natural History Museum. The Flora is based upon published records and earlier collections ; in particular, it records new information obtained by the authors during four botanical expeditions of the Chicago Museum which extended to all the twenty-two departments of Guatemala. The authors state in their introduction that the flora of Guatemala, as considered in their work, includes that of British Honduras, which is continuous with that of the departments of Petén and Izabal : "There is no reason to suppose that in British Honduras there exists more than a handful of species that will not be found eventually in Guatemala". The work is thus of great importance for forest officers and students of the vegetation of the British Central American Colony. The only survey hitherto of the flora of British Honduras was Standley and Record's "Forests and Flora of British Honduras" (*Pub. Field Museum*, Bot. Series, 12 ; 1936) in which the systematic list was little more than a 'prodromus' ; while there has been no previous flora of Guatemala.

The authors state in the introduction to this volume, which is Part IV of the Flora, that although almost all the manuscript has been written it has been found impractical to publish it in systematic order because of conditions imposed by the War. "Part I will include an account of the general features of Guatemala vegetation, a résumé of the history of its exploration, and other pertinent matter." Presumably, there will be a key to the plant families.

Part IV contains the accounts of a large number of families, including the important and difficult Moraceæ, Annonaceæ and Lauraceæ. The format follows the usual lines : there are keys (with macroscopic or field characters) to genera and species, ample generic and specific descriptions, relevant synonymy and citations of references, definitions of habitat and altitude, distribution by departments of Guatemala. The distribution of individual species outside the Republic is carefully defined, but only rarely are details given of distribution in British Honduras, except in instances where the species does not occur in Guatemala. Collectors' numbers, with the exception of those of recent type collections, are scarcely ever cited.

Of particular value and interest are the notes on properties, economic uses and vernacular names which follow the descriptions of many of the species. Many common Old World vegetables, fruits and garden favourites are wisely included.

The authors are enthusiasts and keen observers, who have acquired a very wide knowledge of the inhabitants and their customs in relation to the vegetation. The reduction of many species into synonymy and their frequent comments on variability show that they take a broad view of species. For the purposes of a flora of a tropical country this is probably more satisfactory than the provision of unworkable keys which maintain doubtful and critical species by selecting characters from descriptions or single collections.

The "Flora of Guatemala" promises to be the best of the numerous works of this kind with which Dr. Standley's name is associated. Clearly, then, the appearance of the all-important Part I should not be delayed.

N. Y. Sandwith

SCIENCE AND ADULT EDUCATION

Progress in Science

By W. L. Sumner. Pp. viii+176+14 plates. (Oxford : Basil Blackwell.) 8*s*. 6*d*. net.

IF it be true that the ability to think effectively on literary, economic, political and philosophical affairs does not take place until individuals have had experience of life, it is equally certain that there can be no real conception of the function of science in modern life before maturity. Belief in these ideas has, during the last decade, led to an awakened interest in the general education of adults and culminated in that section of the Education Act of 1944 which transformed a hitherto permissive right of local education authorities to provide facilities for adults to educate themselves in their off-duty hours into a mandate.

Among the extended facilities will be the provision of books and, as the Act becomes translated into practice, there will inevitably be a steady and rising demand for texts from the variety of study groups which spring up. If these classes develop as educationists envisage, it is hoped to draw in students from that section of the community which has previously been unattracted by any activity which could be put even under the broad heading of education. One of the obstacles which hinders the formation of such classes to-day is that there are few books suitable enough to be used as texts. The books provided for university extra-mural groups would be beyond most students and the books written for school-children would alienate and be repugnant to them. In this field a rich harvest awaits the enterprising publisher who is sufficiently discriminating to obtain discerning and skilful authors who can fashion their pens to suit their readers. In the realm of science discrimination will be particularly necessary both because of its changeful nature and because the paucity of suitable contemporary books for the untutored offers little guide to would-be authors.

Which brings us to Mr. Sumner's book. During the First World War and since, almost unique opportunities were provided for expounding modern developments in science to large groups in the Armed and Civil Defence Services. Surprisingly, although perhaps unavoidably, these opportunities were not taken by many men of science. Of the few Mr. Sumner was one, and "Progress in Science" is an adaptation of the lectures and demonstrations which he gave to many Service audiences. Wisely he has confined his topics to technical developments during the last few years, and among those dealt with are electrons and their uses, the electron microscope, radar, television, the betatron, atomic energy, jet propulsion, the gas turbine, plastics, chemotherapeutic drugs and plant genetics. In the concluding chapter he discusses present-day researches the applications of which are still somewhat in the embryonic stage, and ranges over a wide selection of recent work.

Of his choice of subjects little more need be said than that it has been done well and with a discriminating awareness of the interests of adults although, since plant genetics is described in some detail, the omission of sections on human and animal genetics is puzzling. Of his manner of presentation it is enough to say that he has never forgotten that he has been writing for those only slightly informed of matters scientific. The importance of this interpretation of science to human society must take its place alongside fundamental researches in such subjects as nuclear physics. It is therefore to be hoped that "Progress in Science" will be the precursor to a long series. T. H. HAWKINS

CURRENT RESEARCHES ON VITAMINS AND HORMONES

Vitamins and Hormones

Advances in Research and Applications, Vol. 3. Edited by Prof. R. S. Harris and Prof. Kenneth V. Thimann. Pp. xv+420. (New York: Academic Press Inc., 1945.) 6.50 dollars.

THE third volume in the series vitamins and hormones amply maintains the standard set by its predecessors. As the editors say in their preface, "The subject matter of successive volumes will integrate more and more until 'Vitamins and Hormones' eventually becomes a complete reference to all active research in the vitamin and hormone field". The authors of the series of chapters are well chosen, and with few exceptions a high standard is maintained in each. Microbiological aspects of vitamins are discussed by Najjar and Barrett, in a chapter on the synthesis of B vitamins by intestinal bacteria, who summarize a subject of much topical interest; an article 120 pages in length (including 456 references) by B. C. J. Knight is an exhaustive review of growth factors in microbiology; amino-acids, purines, pyrimidines and naphthoquinones are discussed as well as the vitamin B complex. The threads of knowledge upon the interrelation of vitamins have been brought together by T. Moore in a suggestive article, and the influence of sulphonamides in experimental diets upon bacterial synthesis of vitamins discussed by Daft and Sebrell.

J. Warkany deals with the important problem of manifestations of prenatal nutritional deficiency.

A suggestive article upon chemotherapeutic research and synthetic œstrogens is contributed by E. C. Dodds. The mechanism of action and metabolism of gonadotropic hormones in the organism is reviewed by Zondek and Sulman—in their words, "what happens in the interval between the administration of the hormone and the time when it takes effect in the organism?" Fifty-five pages are devoted by SubbaRow, Baird Hastings and Elkin to an exhaustive and authoritative account of the chemistry of anti-pernicious anæmia substances of liver which should be read by all interested in this subject; they show the stages in progress towards the isolation of the active factor; less than 1 mgm. from liver is now needed in place of 400 gm.

Finally, in a somewhat more physiological article, Nachmansohn deals with the theory (his own) that acetylcholine is released at the neuronal surface during the passage of an impulse. By the action of acetylcholine the permeability of the membrane to ions is increased and hence a depolarization occurs. This theory is supported with much interesting evidence, though it is naturally also meeting with criticisms.

"Vitamins and Hormones" is a book which should be on the shelves of every library, and the private reader will find it a most useful book of reference. R. A. PETERS

ELECTRICAL CONTACTS IN COMMERCE

Electrical Contacts

A Book of Reference for the Electrical Engineer. By Dr. L. B. Hunt, with the collaboration of E. G. Pickering, Dr. J. C. Chaston, C. A. H. Jahn, E. H. Laister, H. R. Brooker, P. M. G. Thorpe and N. A. Tucker. Pp. 122. (London: Johnson, Matthey and Co., Ltd., 1946.) 10*s.* 6*d.*

THE author states that "The purpose of this book is to place at the disposal of the electrical engineer, in a form suitable for easy reference, information which will help him to make a wise selection of material and form of contact for the majority of applications". Undoubtedly physicists, metallurgists and other technical personnel concerned with contact problems will find the volume equally useful.

In the compass of 122 pages, much of which is taken up with excellent illustrations, it is only possible to treat the complex subject of electrical contacts superficially. Accordingly, Dr. Hunt and his collaborators have limited themselves to considerations of established English practice, and in particular with the products of the firms which they serve and under the ægis of which the book is published.

The problem of electrical contacts is dealt with under three main headings, namely, "Design and Selection of Contacts", "Properties of Contact Materials", and "Contact Engineering". Under the first of these, the influence of electrical and mechanical conditions on contact life and behaviour is discussed. The second describes in reasonable detail the properties of common contact materials, together with recommended applications. "Contact Engineering" deals with various methods of making different types of contacts.

The author has, perhaps wisely, refrained from discussions on the fundamental reasons for the service deterioration of contacts, and the numerous compositions listed serve to emphasize how little is really known of this subject.

There are a number of omissions, and, in particular, it is surprising to find no reference to lubricants for electrical contacts. EDWIN RHODES

JOHN COUCH ADAMS AND THE DISCOVERY OF NEPTUNE*

By Prof. W. M. SMART
University of Glasgow

UNTIL 1781, the planet Saturn represented the outermost boundary of the solar system; on March 13 of that year the planet Uranus was discovered by Sir William Herschel, and by the beginning of 1846 (the year of the discovery of Neptune) five minor planets had been found. In all these instances, the discovery was made at the telescope, in one or two cases purely by accident. The discovery of Neptune was on a far different level of human achievement; the discrepancies between the predicted and observed positions of Uranus since its discovery furnished the means whereby two mathematicians, Adams and Le Verrier, applied their unrivalled skill to deduce independently the position of a new planet the gravitational attraction of which on Uranus, they confidently believed, was responsible for the discrepancies referred to.

When, shortly after 1781, an approximate orbit had been calculated for Uranus, it was suggested by Bode that perhaps the planet had been observed previously as a 'star'; the search of catalogues proved surprisingly successful, for no fewer than nineteen authentic observations of Uranus had been recorded, the earliest in 1690 by Flamsteed (the first Astronomer Royal), who designated it 34 Tauri. In the nomenclature of the time, these pre-discovery observations of Uranus are known as the 'ancient' observations, those after discovery as the 'modern' observations. In the second decade of last century the accurate establishment of the planet's orbit was undertaken by Bouvard, who was soon faced by a peculiar difficulty. If he used the 'ancient' observations alone, he obtained an orbit differing unmistakably from the orbit derived from the 'modern' observations alone, these covering nearly forty years. In this dilemma he rejected the 'ancient' observations entirely, on the plea that they carried very much greater observational errors than the 'modern' observations, and his tables of Uranus, published in 1821, were based entirely on the latter. But soon Uranus was seen to be falling behind its predicted position; by 1832 the error in longitude was ½′, and in 1837 Airy (the Astronomer Royal) reported that the errors were "increasing with fearful rapidity"; the anomalous behaviour of the planet had now become the most puzzling problem in contemporary astronomy.

Several suggestions were offered to account for the phenomenon; the law of gravitation might not be exactly according to the inverse square of the distance (a suggestion regarded by Airy as possible even so late as 1844); the existence of a resisting medium—an ever-popular hypothesis—was put forward; perhaps the errors in the positions of Uranus were due to a massive satellite (how this could have escaped observation was not stated); perhaps about the time of discovery in 1781 Uranus had been hit by a comet, this suggestion being made, of course, to explain the difference in the orbits derived separately from the 'ancient' and 'modern' observations; and finally it was hazarded that the discrepancies—or, technically, the perturbations—resulted from the attraction of an undiscovered planet far beyond the bounds of Uranus. Airy himself had no doubts about the last hypothesis, for he wrote: "If [the anomalous behaviour of Uranus] be the effect of any unseen body it will be very nearly impossible ever to find out its place". Fortunately, Adams and Le Verrier had a clearer perception of the problem than Airy, and they were little daunted by the difficulty and magnitude of the task to which in due course they applied their incomparable mathematical skill. From the beginning they were supremely confident of the existence of an unknown planet and of the power of analysis to ensure its optical discovery.

When Adams was still an undergraduate at St. John's College, Cambridge, he and a companion, Drew, were discussing their futures. When Drew asked him what he proposed to do, Adams replied deliberately: "You see, Uranus is a long way out of his course. I mean to find out why. *I think I know.*" Drew said afterwards that this reply gave him a queer feeling, as if a young prophet were speaking. Adams was born on June 5, 1819, the eldest of the seven children of a Cornish farmer. In 1836 his mother inherited a small property, and it seems almost certain that but for this 'windfall' the family economy—always exiguous—would never have stood the strain of a university education for the future astronomer. In January 1843, Adams was Senior Wrangler, and within a few months he had won the First Smith's Prize and had been elected to a College fellowship. Earlier, on July 3, 1841, Adams wrote his celebrated memorandum—now preserved in St. John's College library—in which he expressed his determination to start operations, as soon as he had taken his degree, on the mathematical discovery of a trans-Uranian planet.

The problem to which Adams devoted his energies during 1843–46 was one of considerable complexity. On the hypothesis of an unseen planet, the orbital elements of Uranus as deduced by Bouvard must be somewhat erroneous, for the observed positions of Uranus which he used must be affected by perturbations of which he was unaware; the corrections to Bouvard's orbital elements of Uranus constituted the first group of the unknowns in the mathematical formulation of the problem; to these must be added the mass of the hypothetical planet and the elements of its orbit. Owing to the way in which the mean distance of the new planet entered into the equations of condition it was necessary, if the problem were to be made practicable, to assume some value for this mean distance.

Adams, and afterwards Le Verrier, started with the value suggested by Bode's Rule as applied to the known planets. Before the end of 1843, Adams—he was then only twenty-four—had arrived at a preliminary solution which convinced him that the hypothesis of an unknown planet was adequate to explain the anomalous behaviour of Uranus. He then proceeded to introduce some necessary refinements into his mathematical investigations. By September 1845 he had made such progress that he was advised by Challis—then Plumian professor and director of the Cambridge Observatory—to place his results before Airy. Accordingly, when on his way to Cornwall for a holiday in September, Adams, armed with an introduction from Challis, called at the Royal Observatory, Greenwich, only to discover that Airy was in France. On his return from Cornwall, Adams again called on Airy (October 21, 1845); Airy was out at the time, but Adams left his card and a message to say that he would call in about an hour; he did so,

* Summary of addresses to the Royal Astronomical Society on October 8 on the occasion of the centenary celebrations of the discovery of Neptune.

but was informed that Airy was at dinner. Adams had perforce to depart, leaving, however, for the Astronomer Royal a "short statement" of the results of his researches, which, as we now know, were adequate to ensure the optical discovery of the planet at that time. Airy wrote to Adams fifteen days later putting his famous question as to whether Adams's theory could also explain the discrepancies between the values of the radius vector, as computed on Bouvard's theory, and the values which Airy had derived from observation. Adams did not bother to reply; he was not prepared to regard the question as other than trivial (although at the time he was only twenty-six, he was a master of planetary theory), and further he was disappointed that his efforts to make personal contact with Airy had proved fruitless. Adams's "short statement" remained in Airy's pocket for eight months, and probably would never have seen the light of day if events in France had not rescued it from oblivion.

In November 1845, Le Verrier read his first memoir on Uranus; this can be described simply as "Bouvard" amended and brought up to date; there was no mention of a hypothetical planet. In June 1846, Le Verrier read his second memoir, in which, after discussing the reasons for the necessity to assume the existence of an extraneous planet, he announced the position of a hypothetical body as deduced from his mathematical investigation; the mass and the elements of the orbit were not stated. The position obtained by Le Verrier was within a degree of the position found by Adams.

Towards the end of June 1846, Airy put the same query about the radius vector to Le Verrier as he had put to Adams eight months earlier. Le Verrier replied without delay, assuring the Astronomer Royal that his theory accounted automatically for the errors in the radius vector; further, he applied to Airy for assistance in the search for the planet, promising to send him at once fuller details of his work. This request for practical aid and the offer of more precise information passed unheeded; nor did Airy inform Le Verrier that mathematical investigations of a similar character had been in progress at Cambridge for nearly three years previously. A day before Le Verrier's letter reached Airy, the latter announced to the Board of Visitors of the Royal Observatory the almost identical results—as regards the longitude of the new planet—obtained by Adams and Le Verrier, and on July 9, realizing that the situation was indeed becoming "desperate"—as he described it—he wrote to Challis, the director of the Cambridge Observatory, asking him to undertake the search for the new planet with the Northumberland Telescope, at that time one of the biggest instruments in the world. Challis agreed, and the search began on July 29. In the absence of a stellar chart of that part of the sky in which the planet was believed to be situated, Challis had perforce to undertake a laborious programme of observations, determining the positions of all the stars within the suspected zone. Up to the end of September, when the news of the telescopic discovery of Neptune at Berlin reached Cambridge, Challis had made altogether 3,150 observations of stars and, as it transpired afterwards, had actually observed the planet on four occasions.

On August 31, 1846, Le Verrier's third paper was presented to the Academy at Paris; in this paper he gave the mass and the orbital elements of the planet and also stated that the planet should show a disk of about 3″ in diameter, which observations in due course confirmed almost exactly. Two days later Adams wrote to the Astronomer Royal giving him the results of a new solution of the problem, and, remembering Airy's former query about the radius vector, he indicated how reasonably well his theory fitted in numerically with the established errors of radius vector. There can be no doubt that, at this time, Adams was entirely ignorant that Le Verrier was hard on his heels; it is also certain that Le Verrier had no inkling of Adams's investigations.

On September 18, Le Verrier wrote to Galle, the assistant at the Berlin Observatory, requesting the latter to undertake the search for the planet; the letter was received on September 23, and Galle decided to start operations at once. A young student-observer, d'Arrest, suggested that the first thing to do would be to find out if Bremiker's star-chart (Hora XXI)—which included the zone in which the planet might be expected to be found—had been finished. A search in the director's house proved successful. There they found the edition of the relevant chart which had been engraved at the beginning of 1846 and which was being held back from distribution until another chart could keep it company in the post. Galle took charge of the telescope and described the configurations and magnitudes of the stars in the field of view, with d'Arrest checking Galle's observations on the chart. Soon Galle described the position of an eighth-magnitude star; d'Arrest immediately exclaimed: "That star is *not* on the chart". Subsequent observations confirmed its planetary character; the hypothetical planet had become a reality.

Naturally, there was great enthusiasm in France; Arago (director of Paris Observatory), referring to Le Verrier's achievement, declared that the discovery of the new planet "would remain one of the most magnificent discoveries of astronomical theory, one of the glories of the French Academy and one of the noblest titles of his country to the gratitude and admiration of posterity".

Into this atmosphere of rejoicing came immediately the first rude shock in the form of a letter from Sir John Herschel to the *Athenæum*, making the first public reference to Adams and to his investigations; Herschel's knowledge of these was limited to the information briefly given by Airy at the meeting of the Board of Visitors three months previously. A second shock was provided by Challis's announcement that he had been engaged at Cambridge in the search for the hypothetical planet since the end of July, and that since its optical discovery at Berlin a scrutiny of his observations had revealed the fact that he had actually observed it on four occasions. Except for a comparison of his observations on July 30 and August 12, Challis made no attempt to discuss the fruits of his toil, despite the sense of urgency which Airy's importunity and his own knowledge of Le Verrier's June paper would have seemed imperative to one who had even a modicum of faith in the results of mathematical analysis. Comparing his observations on August 12 with those on July 30, Challis noted that the first thirty-nine stars on the former date agreed with the observations on July 30; if he had gone on to star number forty-nine he would have seen that this star was absent from the records of July 30; this star was the planet. On September 29, before the news of the discovery at Berlin reached Cambridge, Challis, impressed with Le Verrier's insistence that the planet would show an unmistakable disk, noted against a star: "It seems to have a disc" ; this again was the planet. The fourth observation had been made on August 4.

As might have been expected, consternation reigned in Paris at what appeared to be an impudent claim to priority of discovery made on behalf of Adams. No wonder that Arago announced pontifically that Adams had "no right to figure in the history of the new planet, neither by a detailed citation, nor even by the slightest allusion". The defence of Le Verrier was promptly undertaken by Airy who, in a letter to the former, declared : "You are to be recognized beyond doubt as the real predictor of the planet's place". A little later he wrote : "No one will dispute the completeness of your investigations and the fairness of your *moral* convictions as to the accuracy and certainty of the results. With these things, the produce not only of a mathematical but also of a philosophical mind we have nothing which we can put in competition. My acknowledgment of this will never be wanting." It is to be remembered that Airy's knowledge of Le Verrier's work was confined to the three abstracts printed in *Comptes Rendus*, for the full mathematical investigation was published only towards the end of 1846. Later, Airy's opinion was less dogmatic. Writing to Biot in June 1847 he says : "I assure you that I have a very high opinion of Mr. Adams and that upon the whole I think his mathematical investigations superior to M. Le Verrier's. However, both are so admirable that it is difficult to say."

In the weeks following the discovery of Neptune, the French press was exceedingly bitter in its attacks on Airy, Challis and Herschel. English men of science were dumbfounded at the revelations of Airy's and Challis's shares in the transaction. Considering the latter first, we have his own word that he had very little faith in the outcome of theoretical investigations for detecting a new planet ; he seemed to undertake the laborious series of observations merely because Airy was firm on the matter ; and when he had embarked on the observational programme it never occurred to him to discuss his observations as they proceeded—except for the instance recorded earlier, and the comparison in this case was merely a test of the adequacy of the two separate observational methods he had adopted. Challis comes out of the Neptune episode as a sceptic and procrastinator, perhaps not earning, however, the almost brutal judgment passed on him by the historian of the Royal Astronomical Society.

It was Airy, however, on whom the greatest weight of criticism fell. His long silence as to Adams's investigations, his alleged 'snubbing' of Adams, but above all his fulsome praise of Le Verrier without any accompanying reference to Adams were the main points of accusation. Le Verrier, indeed, deserved every eulogy from whatever quarter it came ; but the apparently pointed neglect of a young Cambridge graduate by the acknowledged head of British astronomy was something that no fair-minded person could understand. After reading the private papers of Adams and the contemporary literature, I am convinced that criticism of Airy was on some points unfair and unjustifiable ; but I am equally convinced that his treatment of Adams in general was unbecoming to the leading astronomer of his generation. In any event some kind of action was called for. At the famous meeting of the Royal Astronomical Society on November 13, 1846, Airy read his "Account of some Circumstances Historically connected with the Discovery of the Planet exterior to Uranus" ; he was followed by Challis, who described his observations at Cambridge, and finally by Adams, who outlined his theoretical investigations. In his "Account", Airy claimed to know the history of the whole business ; but it is significant that of Adams he scarcely knew anything. In asking Adams for permission to insert in his "Account" such correspondence as had passed between them (this was Airy's second letter to Adams, the first being that containing the radius vector query) he addressed him as "The Rev. W. J. Adams" ! Moreover, until then Airy, on his own confession, had met Adams only twice ; on the first occasion he had forgotten where ; on the second, in company with Hansen, on St. John's Bridge on July 2, 1846 ; each interview lasted no more than a couple of minutes. It seems extraordinary that on the second occasion—Le Verrier's second paper was by then known to both—two of the world's most eminent astronomers should meet the young Johnian without making some reference to his share in disentangling the most baffling problem in contemporary astronomy. Airy's "Account" contained several extraordinary passages, full of the liveliest eulogies of Le Verrier, but almost destitute of the deserved recognition of Adams's achievements. At the conclusion of his "Account", which in some measure must be reckoned a defence of his own conduct, Airy made one remarkable statement (its significance seems to have been overlooked by all previous commentators) to the effect that if Adams and Le Verrier had not adopted Bode's rule of distances they would never have arrived at the elements of the orbit. It is legitimate to ask if Airy really understood the problem of inverse perturbations so confidently and successfully tackled by Adams and Le Verrier, for unless some value of the semi-major axis, a, of the unknown planet is assumed, the problem becomes intractable owing to the complicated way a enters into the expression of the disturbing function. It was obvious to Adams and Le Verrier who, it must be remembered, were supremely confident of the existence of an exterior planet, that a 'trial and error method' was the only one to be adopted. They both soon found that the value of a must be considerably reduced—in other words that Neptune provided an exception to Bode's rule. If the rule had never been heard of, they must of necessity have adopted *some* value for a and proceeded on the lines of their respective investigations.

Challis had a most unenviable task at the meeting. A few days before, he had written to Airy : "I am in difficulties about this report [for the meeting] and should be glad to see some means of getting out of it". His 'report' was a confession of scepticism and procrastination. Adams's share in the proceedings took the form of a masterly account of his own investigations, concluding with a generous tribute to Le Verrier. It should be stated that he never took any part in the controversy that raged so long around his name, nor did he ever utter a harsh word about those to whom an inexperienced youth might have expected to look for guidance, advice and encouragement.

Perhaps the greatest slight to which Adams was subjected was the award of the Copley Medal of the Royal Society to Le Verrier on November 30, 1846. In this award the discovery was attributed to Le Verrier alone without any reference to Adams, despite the fact that those responsible for the award must have known about the proceedings at the Royal Astronomical Society meeting more than a fortnight before. The Royal Society was evidently of Arago's opinion that Adams had no right to figure in the history of the discovery of Neptune in any way. The Society, however, made amends by awarding to Adams the Copley Medal in 1848. The Royal Astronomical Society was saved by its by-laws from perpetrating a similar injustice. One medal and only one could be awarded; it was proposed, however, to waive the by-law *pro tem.* with the obvious intention of honouring both Le Verrier and Adams. This proposal in council was defeated. A resolution to award the Medal to Le Verrier alone was carried by 10 votes to 5, but as the by-laws stipulated a 3 to 1 majority the proposal was inoperative. Thus, there was no award by the leading astronomical society in the world for the most spectacular discovery in the history of astronomy.

Honours were immediately—and deservedly—showered on Le Verrier from all quarters. Recognition of Adams's achievements was much more tardy. It is worthy of mention that on the occasion of Queen Victoria's visit to Cambridge in the summer of 1847 the Vice-Chancellor was informed that "Her Majesty had commanded the honour of knighthood to be offered to Mr. Adams"; but Adams, against the advice of Prof. Adam Sedgewick, whom he consulted, modestly prayed to be allowed to decline the honour. About the same time he also declined the chair of natural philosophy at St. Andrews.

A subsidiary controversy—intimately connected, however, with the French claim on behalf of Le Verrier for the undivided credit of discovery—raged around the name to be given to the planet. It is usually stated that the name of Neptune (with a trident as the astronomical sign) was at first mutually agreed upon by Le Verrier and the Bureau of Longitudes. M. Danjon, director of the Paris Observatory, has recently informed me that there is no record in the Bureau confirming this; the name was certainly suggested by Le Verrier himself a few days after the discovery of the planet. But a little later, Le Verrier persuaded Arago to accept the discoverer's privilege of naming the new planet. Arago immediately announced that he had decided to name the new planet "Le Verrier", adding that in consequence there must be a wholesale renaming of the planets hitherto discovered (Uranus and five minor planets) in accordance with this new principle of attaching the discoverer's name to the planet discovered by him; for example, the name "Uranus" must now be changed to "Herschel". Both he and Le Verrier vowed that the new planet would never be referred to by them except by the name of "Le Verrier". At this time Le Verrier's complete mathematical investigations were presented to the Academy with the title "Researches on the Motion of the Planet *Herschel* (formerly *Uranus*)"; in the body of this large memoir the planet is referred to as Uranus, and Le Verrier explained in the preface that owing to the advanced state of printing it was impossible to effect the change throughout. This clumsy device of associating the new planet with Le Verrier alone met, quite naturally, with the unanimous disapproval of astronomers in other countries; it is perhaps worthy of mention that the Royal Astronomical Society Club—a festive body not usually prone to the discussion of serious subjects—was quite prepared to accept any mythological name proposed by Le Verrier. Soon the French astronomers were constrained to fall into line, and the name of Neptune passed eventually into established nomenclature.

The question as to whether Adams or Le Verrier should be accorded priority of discovery agitated scientific circles for several months. There could be no doubt as to the relevant events and their sequence. But could Adams's communications to Airy and Challis be regarded as 'publication', for no one disputed the fact that Le Verrier was the first to get into print? The fact that Adams was engaged in investigations of a trans-Uranian planet was known to various reputable astronomers in Britain and was the subject of general comment in Cambridge; it is true, of course, that Airy and Challis were alone familiar, at some time or other, with the main features of Adams's investigation and in possession of such information as to lead to the detection of Neptune in October 1845. The doctrine of priority was stated unequivocally by Biot in terms of "the common and imprescriptible law without which no scientific title could be assured that a discovery belongs to him who proclaims and publishes it to all". It is to Airy's credit that he explicitly denied the existence of such a law. Scientific workers in the past had adopted various expedients to ensure their titles to a discovery—the anagrams of Galileo and Huygens relating to the peculiar appearance of Saturn and to the rings of the planet are well-known instances. In later times the device of the 'sealed packet' became almost universal; Faraday, Wheatstone and Brewster adopted this expedient, which was even more popular with the Paris Academy of Sciences for, in 1846, no fewer than ninety were deposited and recorded in *Comptes Rendus*. There was thus some reason for the claim on behalf of Adams, for was not Airy the custodian of the young astronomer's results, and was he not responsible (in the last resort) for jogging the apathetic Challis to activity? The impartial verdict of the illustrious Struve may be quoted: "It cannot be denied that Mr. Adams has been the first theoretical discoverer of Neptune, though not so fortunate as to effect a direct result of his indications". In this centenary year there is no need for us to try to settle this vexed—and interesting—question of priority; rather do we hail Adams and Le Verrier as the co-equal sharers of one of the greatest triumphs of science.

But the element of dramatic surprise had not yet been exhausted. Using Challis's observations at Cambridge, Adams proceeded to calculate the elements of the new planet's orbit, as accurately as such observations permitted; the results proved to be in excellent agreement with results derived afterwards from more abundant observational material. It is interesting to note that Airy had little faith in such attempts. Writing to Adams near the beginning of 1847, he says: "I cannot conceive that you can obtain from the observations made at the now expiring appearance of the new planet any determination of its actual distance from the sun sufficiently accurate to be of the smallest service to you". In this opinion he showed a sad lack of appreciation of the possibilities of determining the orbital elements and, what was of the greatest importance, of using these for the search of 'ancient' observations, as was so successfully done in the case of Uranus. The surprising result of Adams's and other calculations was the comparatively small value of the semi-major axis of Neptune's orbit: this was thirty astronomical units as against about thirty-five used in Adams's and Le Verrier's solutions; no wonder that Peirce of Harvard was led to declare that Neptune was *not* the planet resulting from mathematical analysis and that its discovery must be accounted a happy accident. The arguments in refutation of such a suggestion are somewhat technical, and we must be satisfied on the present occasion with the mere statement that Neptune is indeed the fruit of Adams's and Le Verrier's genius.

Adams, now armed with satisfactory orbital elements, himself examined old catalogues in an attempt to discover 'ancient' observations of the planet, but his efforts were unsuccessful. However, Walker at Harvard and Petersen at Altona discovered an old observation of Neptune made by Lalande on May 10, 1795; this observation was marked 'doubtful', and it seemed bad luck that, out of so many thousand observations of stars, the only one that mattered in this connexion should be reckoned by Lalande to be unworthy of confidence. Subsequent reference to Lalande's manuscripts revealed the interesting fact that Lalande had observed the 'star' —as he believed it to be—on May 8, as well as on May 10; as the observations on the two nights were discordant he discarded the first and included only the second in his catalogue, labelling this as 'doubtful'. Instead of one unsatisfactory position of the planet, astronomers were now provided with two satisfactory positions, and these contributed very substantially to the accurate determination of the planet's orbit.

The subsequent careers of Le Verrier and Adams may be briefly indicated. For the former, a professorship of celestial mechanics was specially created in Paris; later he became director of the Paris Observatory. Le Verrier received the Gold Medal of the Royal Astronomical Society on two occasions in recognition of his masterly investigations in planetary theory.

Adams occupied the chair of mathematics at St. Andrews for a year, returning to Cambridge in 1859 as Lowndean professor; in 1861 he succeeded Challis as director of the Cambridge Observatory, where he resided until his death in 1892. He was president of the Royal Astronomical Society during 1851–53 (perhaps the most youthful occupant of the chair in the history of the Society) and again during 1874–76. In 1881 he was offered by Gladstone, then Prime Minister, the post of Astronomer Royal in succession to Airy, but this he declined. Adams's contributions to celestial mechanics were outstanding —perhaps no one has ever possessed such a thorough grasp of this most intricate subject, in which he was the acknowledged master.

LORD KEYNES: THE NEW THEORY OF MONEY

By J. R. N. STONE
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THE sudden death of John Maynard Keynes on the morning of Easter Sunday, 1946, deprived the world of the greatest economist of these times and Britain of one of her noblest sons. This article concentrates entirely on his principal contributions to economic science and leaves untouched the many other fields in each of which his achievements would seem to most men a fitting life-work.

Keynes' approach to economic problems was characterized by two separate features which are not frequently found together. On one hand, he was deeply interested in practical problems, and it was in their light that he viewed the propositions of pure economics. He can surely have had no equal in his broad grasp and understanding of contemporary economic events, and in this sense was an outstanding observer although he did not himself contribute largely to measurement and calculation. On the other hand, he saw practical problems through the eyes of a theorist well acquainted with contemporary and historical writings. He constantly compared his experience with existing theory and aimed at its correction and generalization where the comparison showed it to be deficient. He wrote of his endeavours in the preface to his greatest work, "The General Theory of Employment, Interest and Money" (1936), that they were "an attempt by an economist to bring to an issue the deep divergencies of opinion between fellow economists which have for the time being almost destroyed the practical influence of economic theory and will, until they are resolved, continue to do so". The attempt was successful; on the subjects of which he treated there is now, as is well known, a measure of agreement among economists which was unknown at the time he wrote, and which is directly attributable to his teaching. His ideas created an intellectual ferment wherever economics was seriously studied, and like all such basic contributions to a science are now well on the way to becoming the new orthodoxy. In his work at the Treasury in recent years, he and the younger men whom he influenced carried the new ideas on to the plane of affairs, and the changed official outlook, to which, for example, the White Paper on employment policy is a testimony, shows how conspicuous his success was in this field.

Keynes' most sustained contribution to economics lay in the field of what used to be called the theory of money but which has been transformed into a wider and more connected subject through his labours. He directed attention away from the purely monetary aspect of this subject towards an analysis of all the factors determining the level of aggregate demand for goods and services. In analysing effective demand he laid stress on the distinction between consumption expenditure and expenditure on additions to wealth or capital formation, or, in his terminology, investment. The concept of expenditure has to do with spending on goods and services; in addition, there is needed a concept of outlay which has to do with the disposal of income and may be divided into consumption outlay and saving. Now while the outlay and expenditure on consumption goods and services go hand-in-hand, a decision to save on the part of one individual does not automatically carry with it a desire to use that saving for investment purposes, since investment expenditure is in general undertaken by a set of individuals and businesses different from those undertaking the saving. From the definitions employed it follows that total saving is identically equal to total investment; but Keynes showed that under conditions where there is a tendency to excess saving, that is, where the amount which the community wishes to save at the full employment level of income exceeds the amount which is wanted for investment purposes in the same circumstances, an equilibrium level of saving and investment might be brought about by a reduction in income and therefore in saving, rather than by any factor in the situation tending automatically to raise investment demands to the level of full employment saving. He further argued that the former mode of adjustment would be the normal one in modern economic societies, and that an equilibrium situation could exist and might be expected at a level of income well below that which would accompany the full employment of resources.

The position can be seen in outline by a simple example. Suppose a constant rate of investment to be given independently of income. Saving (identically equal to income minus consumption outlay as above) is taken, in accordance with Keynes' 'psychological law', to be an increasing function of income. If we consider the graph of investment and of saving against income, we shall find a point at which the upward sloping saving–income line cuts the horizontal line representing the investment–income relationship. The point of intersection gives the realized level of income (identically equal to output in this simplified case), which in turn determines the level of employment. The equilibrium level of income is thus dependent on the behaviouristic responses of the community, which fix the point of intersection of the investment–income and saving–income relationships. This example is over-simplified and static, but illustrates the starting point of Keynesian analysis.

In Keynes' system saving is taken as a simple increasing function of income. Investment he regarded as dependent mainly on the anticipated yield of new assets on one hand and the rate of interest on the other. The rate of interest he analysed in terms of the supply of, and demand for, money. Thus money plays an important part in his system of equations and justifies the statement made above that this branch of economic analysis may be regarded as a development of the older theory of money.

These ideas can readily be developed in a symbolic form. It would not be appropriate here to attempt to set out a realistic model on Keynesian lines, but a simplified scheme which introduces dynamic elements may be helpful to those accustomed to the language of mathematics rather than economics. This example is representative of the kind of development of Keynesian analysis to be found in the works of the econometric school, but its relation to what has been said above will be obvious.

Let X_1 be consumption expenditure (identically equal to consumption outlay), X_2 be investment, X_3 be income and X_4 be saving, for a whole economic system, and let E be a unit delaying operator so that $E^n x_t = x_{t-n}$. The 'psychological law' in its dynamic form is represented by a 'propensity to consume' relationship which in its simplest form may be written

$$x_1 = aEx_3,$$

where the x_i are now the deviations from means of the X_i. Since $x_4 = x_3 - x_1$, the saving-income relationship is

$$x_4 = (1 - aE)x_3 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In this example we suppose that investment is unaffected by interest rates, and that expectations as to the yield of additions to the capital stock are based on total sales ($\equiv x_1 + x_2 = x_3$) in the previous period and the rate at which they were changing. On this hypothesis the investment–income relationship may be written

$$x_2 = (bE + cE^2)x_3 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Finally, the system is closed by the identity saving $\equiv$ investment, that is,

$$x_4 \equiv x_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If we write these three equations in homogeneous form and let $[\alpha E]$ be the matrix of operator polynomials, then $|\alpha E| x_i = 0$ is the generating function of the system. The movement over time of the system, if undisturbed by outside influences, is dependent on the coefficients of the powers of E in this expression, which in the present example can easily be seen to be, for successive powers, 1, $-(a+b)$ and $-c$. Thus, given the existence of the time lags, the question of whether the system is explosive, oscillatory or stable depends on the behaviouristic coefficients a, b and c.

Starting from a simple case like this, allowance can be made for complicating factors by changing the number of variables and the number and form of the relationships, and by allowing for the fact that to some extent each equation is incomplete in the sense that only the principal determining variables can be included. In all cases the relationships either will be derived from the set of definitions adopted, or they will involve coefficients which summarize the average response of some part of the economy; and these may be either technological in the narrow sense or in a wider sense behaviouristic in that they sum up human responses. The problem in this field, as in others, is to see in the apparent confusion of actual experience the strategic variables and to relate them in the most succinct and fruitful way. The difficulty of doing this is especially great in economics, where the facts are complex and the available observations far from complete. Nevertheless, a scientific theory derives its principal interest from being able to represent experience; and the necessary knowledge to formulate such a theory in economics can be obtained only by combining, as Keynes did, the study of statistical material with a detailed knowledge of what takes place in actual economic life.

What, it may be asked, was new in all this? How did Keynes' theories differ from the many theories of the trade cycle that had already made their appearance? The gist of the answer to this question may perhaps be seen from the following considerations. First he aimed at what, mathematically speaking, was a complete explanation of the phenomena studied and did not concentrate, as many previous writers had done, on one particular phase of the trade cycle. Secondly, he linked together the real and the monetary aspects of the problem and found a place in his theories for confidence, expectations and similar psychological reactions, thus avoiding an explanation restricted to any one of these categories. Thirdly, he linked together the factors responsible for short-period changes with those operating to determine the average levels of the variables over longer periods, and showed that these average levels are also dependent on the quantitative responses of the system. The importance of this finding is that there is nothing in the mechanism of change in economic systems as we know them to make the equilibrium level an optimum level; in other words, the norm of a system in terms of employment may be any fraction of capacity, and there is nothing tending to bring the system automatically to a full use of capacity. It was the necessity of accepting this conclusion that led to the reluctance of so many of Keynes' contemporaries to acclaim the new ideas when they first appeared. Finally, prescription followed diagnosis, and the practical means of avoiding under-employment, especially through the weapons of fiscal policy, stand out clearly as an integral part of his system of ideas.

Although he did not himself specialize in the careful measurements which form the basis of so much applied and statistical economics, he rated such work highly and encouraged it to the utmost. He was always interested in the development of applied economics and played a leading part in the founding of the new research Department of Applied Economics at Cambridge.

It is of interest to note the part that the mathematical method played in Keynes' work. Since he read mathematics at Cambridge, it might be supposed that he would have employed it in his published work more than he actually did. He was, in fact, sceptical of mathematical economics, feeling perhaps, as Marshall did, that the mathematics involved was trivial, a view which nowadays can scarcely be sustained, and also that the complexities of the real economic world were not, at least in the present state of knowledge, to be ensnared in the mathematical net. His published comments on econometrics showed, however, that he paid it the compliment of serious, if not always comprehending, criticism. In private he was far more sympathetic, though a little impatient of the tentative character of this new treatment of economics.

Keynes did not regard economics as a subject of great cultural significance, but rather as a mundane matter which would have to be got right before human energies could be released from their present wearisome preoccupation with getting and spending. It is in achieving this goal largely by means of working out and applying his ideas that much of the energies of the present generation of economists will be absorbed.

BIOSYNTHESIS OF THE BELLADONNA ALKALOIDS

By Dr. W. O. JAMES
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THE origin of the tropane (and other) alkaloids in the plants that produce them has not been the object of much interest in the past. This seems to have been due to the sterility of the teleological approach to which they were subjected. They have been variously dismissed as reserve products of singular ineffectiveness, as flotsam thrown up on the beach of metabolism, and even as that final resort of the guesser hard up for a guess, a mechanism of detoxication. They are, nevertheless, very interesting substances for phytochemical investigation on account of their great variety, their relation to the proteins and the soluble nitrogen compounds, their specificity and the mystery of their coming and going. They are rendered especially suitable for investigation at the present time by the wealth of knowledge concerning their organic chemistry, and by the relative ease of their manipulation when compared with the other complex nitrogen compounds in the plant. The study of alkaloid metabolism may be expected to yield much information valuable to the wider study of the plant's nitrogen metabolism in general.

The necessities of war-time have acted as a stimulus in this field also; and a renewed attack upon its problems has become noticeable in Great Britain, in the U.S.S.R. and in the United States. In Britain, the Solanaceæ have been the favourite objects of study, particularly the *Atropa–Datura–Hyoscyamus* group, which is responsible for the tropane alkaloids[1]. The alkaloid content of young *Atropa belladonna* shoots collected from English sources in 1940 varied from 0·13 to 1·18 per cent of the dry weight. *A. belladonna* grows in discontinuous pockets over the chalk and limestone exposures from the south coast to the Scottish border, and tends to establish local races, which are botanically distinguishable from one another. They retain at least some of their distinctive features when transplanted to an agricultural site, or when raised from the seed of self-pollinations. A characteristic alkaloid content does not seem to be one of these permanent features; and there is so much variation between different parts of the plant and of the same part at different ages that any such constant would be difficult to establish.

The embryos and endosperms of the resting seeds of *Atropa* and *Datura* are without alkaloids. Alkaloids appear at an extremely early stage of germination, and are first formed in the meristem of the radicle. They can be detected by suitable methods when the radicles are 3 mm. long. The young epicotyledonary bud and the leaf rudiments as they form behave similarly and are soon possessed of demonstrable quantities. A series of analyses performed at weekly intervals throughout the life-history of the basal leaves of *A. belladonna* showed a high initial proportion (0·74 per cent dry weight), which fell steadily to 0·09 per cent when the leaves were yellowing. While the leaves were actively growing, the absolute amount of alkaloid per leaf increased to a maximum of 1·37 mgm. (as *l*-hyoscyamine). As soon as growth was complete the absolute amount of alkaloid in the leaf began to diminish and was only 0·32 mgm. at yellowing. Similar results were obtained with colchicine in autumn crocus leaves and appear to be general. They are compatible with the supposition that alkaloids are synthesized in the young and actively growing tissues and are broken down during senescence. Unfortunately, the position is complicated by translocation. It seems to be generally held at the present time that transport of alkaloids (nicotine and the tropane alkaloids particularly) through the phloem occurs scarcely or not at all. The entire absence of alkaloids from the sieve tubes has been repeatedly confirmed; and detached leaves have been shown to lose alkaloids at a fairly advanced stage of starvation. So soon as autolysis sets in, the loss is rapid and complete, and it is evident that the leaf possesses the necessary equipment for alkaloid degradation. The invasion of preformed alkaloids into the leaf by the agency of the transpiration stream is a highly probable event. It is the most obvious explanation of the fact, now well attested by numerous independent workers, that *Atropa* and related plants, grafted upon tomato stocks, contain no more than traces of alkaloids in their leaves. Conversely, tomato scions do contain alkaloids when grafted upon appropriate stocks. It is not a complete explanation, however, because detached belladonna leaves can be induced, as mentioned in more detail below, to increase their alkaloid content. At present, therefore, it remains possible that the leaf alkaloids normally have a dual origin: by synthesis *in situ* and by transport from the root.

The rapid appearance of abundant alkaloids in actively growing tissues occurs in other parts of the plant also. Primary root meristems contrast strongly with the older tissues behind them; and lateral meristems behave in a similar fashion. Young cortical and pith cells and secondary meristems such as phellogen also show a rapidly accumulating content. The general picture is of a synthesis running parallel with that of the proteins; the ontogenetic conditions that favour the one favouring also the other. The parallel is not quite complete, and detached belladonna leaves, incapable of protein formation, may still be able to synthesize their alkaloids. In this respect the obvious parallel is with the acid amides arising by secondary synthesis from the simpler soluble nitrogen compounds.

The quantity of alkaloid produced is to some extent under control through cultural methods, especially the appropriate use of fertilizers. Alkaloids are formed 'in competition' with other demands upon the nitrogen and carbohydrate stocks of the plant. There is an evident tendency to the establishment of limit values, and perhaps of variable, though not simple, equilibria between alkaloids and other nitrogen sinks, such as the proteins. The simplest and most reliable method of increasing the yield of alkaloid is to arrange for good vegetative growth of the plant. This implies a porous and calcareous soil, optimal spacing (about 30 in. × 30 in. for belladonna) and good general fertilization with perhaps an excess of nitrogen and lime. Under such conditions the yield of alkaloid increases *pari passu* with the general increase of plant material. To increase the percentage alkaloid, that is, to divert nitrogen and carbon from other metabolic paths into the alkaloid one is a more difficult and less certain undertaking. The only method at present holding out a prospect of success is unbalanced nitrogen manuring. Attempts in Great Britain both on the scale of pot cultures and field plots have shown significant but rather small increases of alkaloid per cent dry weight. A rather interesting feature is that additions of ammonium sulphate, so heavy as to stunt root growth, have caused increases in the percentage of alkaloids present. On other soils no increase has been recorded; the critical difference seeming to be deficiency of lime and absence of clay. The belief that liming in itself tends to raise the alkaloid percentage lacks experimental confirmation at present. A still more elusive, but highly interesting problem lies in the effect of the other major mineral nutrients, potassium and phosphorus. Results repeatedly show slight reduction of alkaloid percentage due to potassium, and slight increase due to phosphorus, particularly in the roots. The effect generally fails to reach a probability-level of 0·02 (19 to 1 odds) in any one experiment, but the summation difference between lack of potassium and lack of phosphorus may be highly significant. In view of the well-known effect of potassium in promoting protein synthesis, the apparent retardation of alkaloid formation affords an interesting suggestion of competition between the two processes for available nitrogen. The alkaloid is nevertheless a very unsuccessful competitor. In young belladonna leaves about 95 per cent of the total nitrogen is in the proteins and 0·3–0·9 per cent in the alkaloids.

It may be assumed that alkaloid synthesis begins with some fraction of the soluble nitrogen which constitutes 4–5 per cent of the total nitrogen. The amino-acids have long been regarded as the starting point of the synthesis and have commonly been assumed to arise by degradation of the proteins. The alkaloids are thus considered to result from protein breakdown followed by secondary synthesis. Such an origin for the belladonna alkaloids is indicated by experiments with detached leaves kept upon distilled water in the dark. No change occurs in the alkaloid content during the first two or three days; but at the stage where the leaves become noticeably yellow, and there is a rapid breakdown of proteins, the amount of alkaloid per leaf may increase. The increase is soon followed by a rapid loss of alkaloid as autolysis sets in. The increase is not very great, is evanescent and may be difficult to observe.

Whether the alkaloids are to be regarded as always derived from proteins depends on whether amino-acids can be formed first, or are the products of protein hydrolysis only. The fact mentioned above that alkaloids commonly arise in the *loci* of active growth, where protein breakdown is at a minimum, speaks rather for a primary origin. It has further been found that detached belladonna leaves fed with ammonium sulphate plus sucrose in the dark increase their amount of alkaloid per leaf more vigorously than leaves kept on water or sucrose solution only. Similar leaves showed no protein accumulation during such a period, and an intermediate formation of protein seems unlikely. In short, the alkaloid synthesis associated with protein degradation appears to be due to a somewhat greater persistence enabling it to take temporary advantage of the relatively high amino-acid concentration after the mechanism of protein synthesis has broken down. Amino-acids of either secondary or primary formation are potential alkaloid precursors.

It is improbable that all amino-acids are equally suitable for the role, and speculation in the past has favoured proline and ornithine as possible forerunners of the tropane alkaloids. Oxidation of ornithine by an α-amino oxidase yielding α-keto-δ-aminovalerianic acid is a not unlikely reaction, and the same product is obtained from proline by ring opening under the influence of a known variety of the enzyme. In this way the two amino-acids might be geared to a single synthesis.

Direct investigation by means of leaf-feeding experiments leads to the conclusion that *l*(+)arginine is the alkaloid precursor formed by belladonna. Young detached leaves fed with *l*(+)arginine have been shown repeatedly to increase their alkaloid content per leaf. The increases are small but statistically significant. Older leaves lose the capacity. In parallel experiments other amino-acids tested, glycine, *dl*-alanine, *l*(+)valine, *l*(−)leucine, *l*(+)glutamic acid, *l*(−)histidine, and *l*(−)proline have given negative results. On the other hand, *l*(+)ornithine gives rise to increased alkaloid contents, apparently in excess even of those obtained with arginine. The sharp distinction between *l*(−)proline and *l*(+)ornithine is striking and appears to rule out the joint oxidation hypothesis mentioned above.

In feeding experiments with arginine, especially if uptake is vigorous, leaves may develop signs characteristic of ammonia poisoning. The same mishap may occur during feeding with ammonium sulphate and can to some extent be mitigated by the presence of sucrose. It is not observed with the other amino-acids investigated, so is unlikely to depend on the α-amino group common to all of them. Its occurrence with arginine suggests the presence of arginase which hydrolyses arginine to ornithine and urea. The last might be further hydrolysed by urease to release the ammonia. Both enzymes have therefore been sought for and shown to exist in belladonna. The first may well be of significance in alkaloid formation, since it brings about the conversion of arginine to ornithine, which is not preformed in plant proteins or known from any other plant source. As well as in belladonna leaves, arginase has been found in the roots, in scions grafted on tomato stocks, in *Datura stramonium* and other solanaceous plants.

There are thus solid grounds for presuming that the nitrogen of the tropane alkaloids is derived from the δ-amino group provided by the arginine-ornithine group of amino-acids, and that the α-amino nitrogen of the other acids and the ring nitrogen of proline are not utilizable in the synthesis.

[1] Oxford Medicinal Plants Scheme, Annual Reports 1941-2-3-4-5.

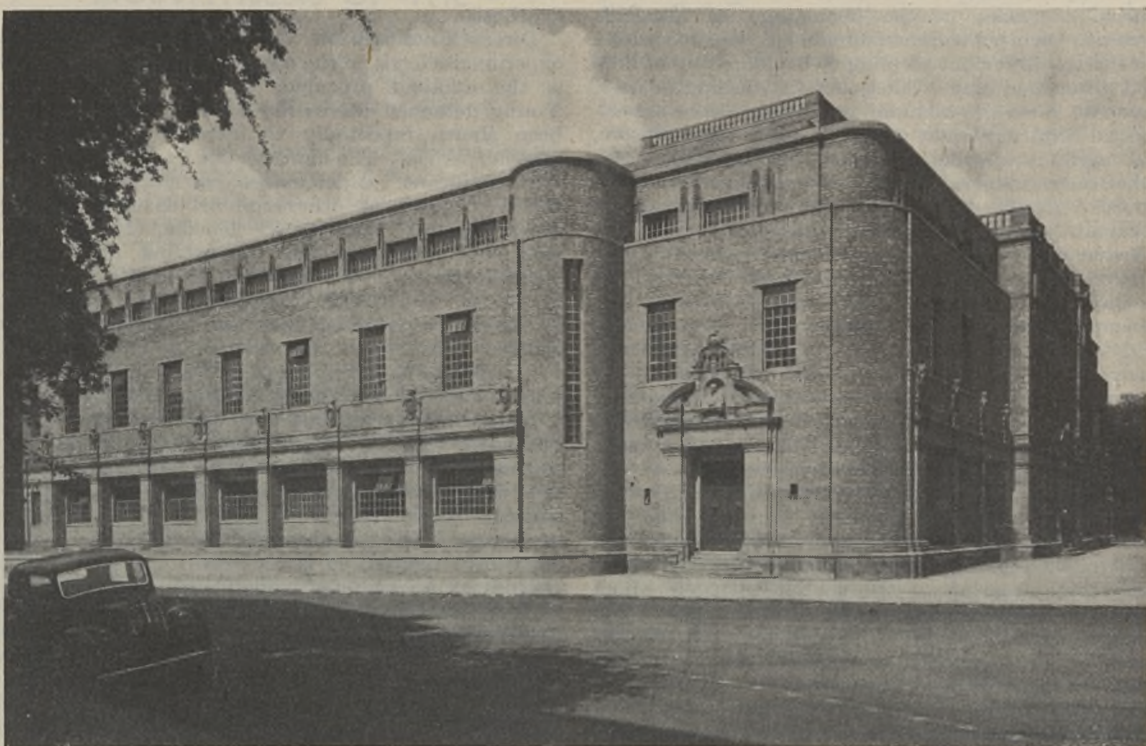
THE NEW BODLEIAN LIBRARY AT OXFORD

By Dr. A. S. RUSSELL

On October 24 the King, in presence of the Queen, Lord Halifax, Chancellor of the University of Oxford, Sir Giles Gilbert Scott, architect of the building, and a distinguished Oxford gathering, opened the new Library which has been erected at the corner of Broad Street and the Parks Road. The cost has been about £660,000, much of which was generously given to the University by the Rockefeller Trustees. Work on the building started in December 1936, and in the summer of 1937 the foundation-stone was laid by Queen Mary. The building was finished in 1940, and, but for the War, would have been formally opened in June of that year.

The New Library, as it is to be called, is a square stone block with frontages 41 ft. in height surrounding a central mass which rises 78 ft. above the street-level. The main problem for the architect and his helpers was how to get accommodation for five million books on a small site near the old Bodleian Library in the heart of the University area, where buildings of many periods are all low. Twelve years ago the University rejected the suggestion that the new building should stand by itself outside of the busy area. In consequence, a plan like that of the Cambridge Library, with book-stacks naturally lighted around open courts, and with a high central tower, was not feasible. The plan adopted was something like that of the new Library of Columbia University or of the annexe to the Library of Congress at Washington. In the centre is the main book-stack, starting many feet below ground-level and rising only to a height of 78 ft. It has eleven decks, each a little more than 7 ft. in height, of which three are below the ground and extend under the whole site. Six of the eight decks above the ground are entirely surrounded by the three floors of the outer range of rooms, and consequently, like the basement, are dependent on electric power for their lighting and ventilation. The topmost two decks of the stack rise above the rest of the building and so can be naturally lighted. The decks are fitted throughout with ranges of steel stack interrupted by gangways and having passages of about 2 ft. 6 in. wide between each range. There are many lifts and internal staircases to allow of communication between the decks. Throughout the stack there is plenum and extract ventilation, and the whole building is heated by water coming from a thermal storage plant in the basement.

Surrounding this great stack are the outer rooms, the frontages of which rise in three stories only. As room for many library needs are already adequately met in Bodley's Library, the Radcliffe Reading Room, the Radcliffe Science Library and the departmental University libraries elsewhere, the New



The New Bodleian Library

Library rooms will be used mainly for special purposes. There are rooms for photography and for the reading of microfilms. There are a map room, a catalogue room, a bindery, a reading room able to accommodate eighty readers, and many rooms for research workers. The New Library, although its main purpose is to house millions of books, will help towards making them more accessible, especially for senior members of the University and those engaged in co-operative research.

Oxford differs from Cambridge in that books from its University library may not be taken out of it. Access to the stack, which will be granted to all serious readers wishing to have it, is thus of importance. A good deal of attention, also, has been paid to getting books from the stack quickly to readers in various parts of the old Library. A tunnel under the intervening street connects the basements of the old and the new Library, and a mechanical conveyor is at work there. This enables books to be taken to and fro from all floors on both buildings. A book starting from the stack, for example, descends to the basement, goes through the tunnel under the street and ascends to the old Library, where it is automatically discharged at the correct floor-level. There are ingenious devices so that messages can be sent quickly almost anywhere in the area, and the systems of ventilation and of air-conditioning ensure that the central heating will not damage, even over periods of years, the books that are housed there.

There can be no expansion on this site. It is not anticipated, however, that the new building will be full for another two hundred years at the present rate of intake of books. It is interesting to note how books can accumulate. In 1822, Bodley's Library had a modest total of 160,000 volumes. In 1888 this had risen to 440,000, and in 1915 to 1,000,000. Every year this growth—benign or otherwise as it may be viewed—has increasingly overflowed into neighbouring buildings and basements, and produced the attendant inconveniences of lack of access and delay. It has had one good effect. It has compelled the central library to be less hostile to the setting up of departmental libraries with open shelves. At one time the Radcliffe Science Library in the area of the Laboratories, with its open shelves, had to buy books, copies of which Bodley's Library received gratis and hid inaccessibly away. Since 1927, however, the science books in the old Library go straight to the Radcliffe Science Library, where the conditions for access are unsurpassed. Despite the setting up of such departmental libraries on various sites, the space available for books in the main Library would have completely vanished by 1940.

Not everybody likes the outside of the Library. It fits in with its neighbours moderately only, but its solid unpretentiousness grows on one with time. Dignified efficiency and an almost complete absence of ornament or architectural effects are what impress the visitor most in the interior. It is 'utility' raised almost to the point of genius. It is a civilized place for working in. It is the antithesis of some parts of the old Library, the characteristic of which was a funereal gloom, where no candle, lamp or even electric light was allowed for risk of fire. Sir Thomas Bodley, it is not generally known, was a lover and collector, in his day, of scientific instruments, and his ghost may well view the magnificent addition to the Library which he founded, where applied science has been summoned to bring books and readers comfortably together, not with consternation but with delight.

OBITUARY

Dr. Charles S. Myers, C.B.E., F.R.S.

When the complete history of the last forty years of development of experimental and applied psychology in Britain is written, it will become clear that an enormous amount of this development was due directly to the enthusiasm, foresight, scientific knowledge and organising skill of Dr. C. S. Myers. For some time there was no certainty that psychology would claim him for life. Literature, music, philosophy, archæology all attracted and held him, as well as natural science. It was, however, as a student of natural science that he gained an exhibition at Gonville and Caius College in 1891, and later a scholarship. He had a distinguished student career at Cambridge, where his interests turned chiefly in the direction of biological studies, and from physiology and anatomy he went on, through the influence of Rivers and Haddon, to experimental psychology and anthropology.

Myers left Cambridge in 1895 and decided to take a medical qualification, looking forward, however, not to medical practice but to a life of research. As it turned out, he was offered, and accepted, a place in Haddon's expedition to the Torres Straits, and this was a crucial decision. He joined Rivers in an experimental study of the special senses and reaction-times of the natives of that area, and himself carried out his pioneer research into some of the characteristics of primitive music. Henceforward, psychology became the chief concern of his working life.

Back again in Cambridge in 1902, Myers began to assist Rivers in the teaching of experimental psychology in three rooms of a dilapidated building which were vacated by the pathologists. Students increased in number, and within a year psychology moved to a cottage which belonged to the University Press. Myers was still, justifiably, dissatisfied. He was working part of his time as professor of psychology at King's College, London, part of his time at Cambridge, and was engaged upon his famous "Text Book of Experimental Psychology". It was a busy life, but Myers still found time to agitate, organise, plan ceaselessly and in the face of frequent disappointments, for an adequate base in Cambridge for the subject that was nearest to his heart. In 1911, two years after he had given up his work in London, the first real steps were taken, and in 1912 the Cambridge Laboratory of Experimental Psychology, provided to an extent that few people ever fully realized by the splendid gifts of himself and his friends, became a permanent memorial to his energy and drive.

Before the new Laboratory could get into full swing, the First World War broke out. Myers surmounted all the difficulties that were put in his way and went overseas. He became eventually consultant psychologist to the British Armies in France. Here his very great organising and administrative skill for the first time got something like an adequate scope, though it was not until the Second World War that the work he then did came to full flower. More and more now his interests were turning to applied fields. He wanted to go on using psychology in the interests of medicine, industry, education and the Fighting Services. He was restless and even unhappy in academic life. In 1922 he severed his official connexion with Cambridge, and became the founder and director of the National Institute of Industrial Psychology.

Part of the story of the next twenty years Myers has himself told in his "Ten Years of Industrial Psychology"; but it is a small part even of the period covered. Only those who knew him very well indeed know what boundless energy, what ceaseless planning, what jealous regard went into the building and development of the Institute. It was an effort in the public service, actuated by very fine ideals and carried out with astonishing courage and great disregard for personal comfort. Some day, perhaps, its worth to the nation will be fully recognized. Certainly that day has not yet come.

Of Myers as a man and of his genuine scientific power it is not very easy to write. The most charming hospitality which he and his wife accorded his students in the early Cambridge days remains a cherished memory to all of us who knew it. He was not a very fluent speaker, and only those who were able to discuss quietly with him the problems, practical and theoretical, of his young science, knew how sure was his scientific grasp, how wide his knowledge, and how honest and unprejudiced his mind.

Many honours came to him, which he carried lightly. He was the first to be elected a fellow of the Royal Society for specifically psychological work. He was awarded a C.B.E., had honorary doctorates from the Universities of Manchester, Calcutta and Pennsylvania and held an honorary fellowship at Gonville and Caius College, Cambridge. He was widely known and esteemed in other countries, was president of the International Congress of Psychology in 1922, and twice president of the Psychology Section of the British Association. He was largely responsible for the founding and fortunes of the British Psychological Society, and one of the early and most successful editors of its journal.

What Myers could have achieved if he could have schooled himself to a single-minded pursuit either of scientific investigation on one hand or to a complete immersion in practical affairs on the other, it is possible only to guess. He certainly had rare qualities, deliberate to be sure, of width and accuracy of knowledge, of devotion to exact method, and of imagination which could have led to very outstanding personal achievement in psychology, or anthropology, or medicine. He had also the grasp, the energy, the capacity to inspire personal loyalty and a good deal, at least, of the impartiality which go to make the absolutely first-rate organiser. He never quite squared these two interests. The second robbed him of the leisure for the first, and the first always left him a little dissatisfied with the second. In fact, I believe, having sized up the probable consequences, he chose to devote his working life to the service of man, and from the path along which this decision led him he did not swerve. F. C. Bartlett

NEWS and VIEWS

Nobel Prize for Physiology and Medicine: Dr. H. J. Muller

In any treatise on modern genetics, H. J. Muller figures as the man who discovered the action of X-rays on chromosomes and genes. It is this association which at once comes to the mind of the biologist on learning of the award to him of the Nobel Prize for Physiology and Medicine for 1946. Yet this spectacular and in a way crowning achievement of his scientific career, when seen in the perspective of his whole work, is only one step along a road which was planned with brilliant foresight and imagination, and followed with critical and untiring accuracy. In 1927, when Muller at the Genetical Congress in Berlin first produced definite proof that X-rays cause mutations, similar attempts, although without clear success, had already been made by a number of workers, and actually in the following year Stadler and others announced positive results of independent X-ray experiments with plants. Thus it was not the bare discovery of the metagenic action of X-rays which revolutionized genetics, but the manner in which Muller's previous work had paved the way for the use of it, and the genius with which he exploited it. First, in co-operation with T. H. Morgan in Columbia, later in the University of Texas, he had with great ingenuity used the fruitfly *Drosophila* to develop strains and methods, such as the *ClB* strain and balanced lethals, which formed and still form the basis for accurate tests of mutability. These methods, which already had borne fruit in studies of spontaneous mutability and its dependence on temperature, carried out by Muller alone and in co-operation with Altenburg, could now be put into the service of the new powerful agency for producing mutations. With their aid, progress in the new field was amazingly rapid. During the twenty years since its beginning, radiation genetics has proved a means of approach to a great number of fundamental problems of genetics: types of mutation, chromosome mechanics, gene action, position effect, size of gene, nature of mutation, to name only a few of them; and a very large share of the subsequent work has been due to Muller himself, or has at least been inspired or guided by him.

Muller's outstanding share in mutation and radiation genetics is apt to make us overlook that he has left his impress on almost every branch of genetics. In his early days he took a prominent part in the development of the theory of crossing-over, and from the beginning, when he studied multiple and modifying factors, to his recent papers on "Reversibility in Evolution" and "The Role of Isolation and Temperature in Evolution" he has been a powerful advocate of the neo-Darwinian theory. Although his main work has been carried out with *Drosophila*, he has always been quick to realize possibilities inherent in other material. It is probably not widely known that it was Muller who in 1925 inaugurated the study of identical twins reared apart, which later on has been taken up so successfully by Newman and his school.

It may be asked wherein the benefit of his work to medicine is to be found. There appear to be two reasons for this. The first, more superficial one, is the help which radiation therapy has derived from a knowledge of the nuclear phenomena on which its results are based, and also of the dangers to the germ cells inherent in all work with high-energy radiation. The second points to the much larger benefits which medicine, especially preventive medicine, and eugenics are likely to derive in the future from an application of genetical knowledge and theory to problems of human health ; in so far as modern genetics is inextricably bound up with the work of H. J. Muller, his will be a very large share in this hoped-for gain to human welfare and happiness.

University College of the West Indies

THE Secretary of State for the Colonies has decided, after consideration of the report of the West Indies Committee of the Commission on Higher Education in the Colonies, to adopt the Committee's recommendation that a West Indian University College should be established in Jamaica. In the first instance the College will be given the status of a university college and will prepare its students for the degrees of the University of London. It is hoped that this formative period will not be prolonged beyond the minimum time necessary to establish the reputation of the College as a centre of teaching and research. He has further decided, in agreement with the University of London, which sent two delegations to the West Indies to investigate the problem on the spot, that the temporary medical school which the Committee recommended in anticipation of a permanent Medical Faculty of the College, should also be established in Jamaica as an integral part of the College. The further measures required to establish the College and temporary medical school are already under discussion between the Colonial Office and the academic bodies and Colonial Governments concerned.

Dr. T. W. J. Taylor, C.B.E.

THE appointment of Dr. T. W. J. Taylor as principal-designate of the new University College of the West Indies deprives Oxford of a versatile chemist and a man of an almost unique range of experience. Elected scholar of Brasenose College from the City of London School in 1913, his undergraduate career was interrupted by active service with the Essex Regiment (Gallipoli and France) during 1914–19. Returning to Oxford in the latter year, he got a 'first' in chemistry in June 1920 and was elected to a fellowship at Brasenose. For the ensuing twenty years he tutored the Brasenose chemists and served as a demonstrator in organic chemistry at the Dyson-Perrins Laboratory. Most of his published researches are concerned with stereochemistry, and his work on oximes is well known. With Dr. (now Prof.) Wilson Baker he undertook with notable success the task of revising Sidgwick's "Organic Chemistry of Nitrogen": he also edited the second volume of the English revision of "Richter". He found time to visit the United States and Canada as Rhodes Travelling Fellow in 1931, and characteristically employed a sabbatical leave in 1938 as member of an expedition to the Galapagos Islands, where he studied the plant pigments of the endemic flora.

In January 1940, Dr. Taylor joined the Royal Engineers and served as technical officer on the General Staff at G.H.Q., Middle East, from July 1940 until October 1942. After a short period at G.H.Q., Home Forces, he was released from the Army to go to Washington in January 1943 as secretary (and later director) of the British Commonwealth Scientific Office, where he played a key part in the broadening of that organisation which led to its present title of "British Commonwealth Scientific Office". In March 1944, Dr. Taylor relinquished his Washington appointment to become scientific adviser to the Supreme Allied Commander, South-East Asia ; for this work, which terminated with his return to Oxford in October 1945, he was awarded the C.B.E. Dr. Taylor's wide chemical interests are associated with many outside the subject : to a well-informed enthusiasm for botany, ornithology and music may be added a passion for travel that has taken him to every continent but Australasia. His adventurous spirit and zest for many branches of knowledge augur well for the future of his important task in the Caribbean area.

Botany at Sydney : Prof. N. A. Burges

DR. N. A. Burges, University demonstrator and fellow of Emmanuel College, Cambridge, has been appointed to the chair of botany in the University of Sydney, in succession to Prof. Eric Ashby. Born in Australia, he graduated at Sydney in 1931, after which he began researches in mycology. In 1934 he went to Cambridge as a research student with an Australian scholarship and carried out investigations in plant pathology. He soon showed himself to be a man of exceptional ability. He took an active part in the life of Emmanuel College and was prominent in athletics. He graduated Ph.D. in 1937 and was awarded a senior 1851 Exhibition. In the following year he was elected a research fellow of his College. Early in the War he joined the R.A.F.V.R. and was attached to the signals branch of Bomber Command, retiring in 1945 with the rank of wing-commander. On returning to Cambridge he was made a University demonstrator, and in addition to continuing his researches, especially on soil fungi and mycorrhiza, greatly assisted in restoring the Botany School to its peace-time activities. Dr. Burges has wide botanical interests both in the field and in the laboratory, for which he will have ample scope at Sydney. He certainly will be an inspiration to his students. His Cambridge colleagues, though personally regretting his departure, are confident that he will maintain the prestige already associated with the Sydney Department of Botany. Both the University and his native country are to be congratulated on his return.

Botany at Hull : Prof. R. D'O. Good

MR. R. D'O. GOOD, head of the Department of Botany at University College, Hull, since 1928, has been appointed to the newly created chair of botany. After serving in the Army during the First World War, Dr. Good went to Downing College, Cambridge, and took botany in Part 2 of the Natural Sciences Tripos in 1922. He was for a time an assistant in the Department of Botany at the British Museum, and while there he began the phytogeographical investigations for which he is widely known. Studies of the distribution of the Magnolieæ, the Stylidiaceæ, *Empetrum* and *Coriaria*, and a valuable summary of discontinuous generic distribution in the Angiosperms were followed by "A Theory of Plant Geography" (1931). This important analysis of the factors determining plant distribution continues after fifteen years to provide a basis for the discussion of phytogeographical principles. More recently Prof. Good has been making a detailed botanical survey of his native county, Dorset, and the publication of a small paper on the distribution of the primrose in Dorset gives cause to expect that the work, when completed, will set a new and far higher standard for county floras. All botanists will wish Prof. Good happiness and success in his new appointment.

Physiology at Sheffield: Dr. D. H. Smyth

Dr. D. H. Smyth, senior lecturer in physiology at University College, London, has been appointed to succeed Prof. G. A. Clark in the chair of physiology at the University of Sheffield. Dr. Smyth was educated at the Royal Belfast Academical Institution and at the Queen's University, Belfast, in the Faculties of Medicine and Science, where he had a brilliant career. He has held various studentships and appointments, mainly in connexion with his subject of physiology, and has gathered wide experience as a teacher during his stay of three years at Belfast and nine years at University College, London. At the latter place he held for three years the important post of tutor to medical students, and sub-dean of the Faculty of Medical Sciences. Dr. Smyth also worked under Prof. H. Rein, at the University of Göttingen, during 1936–37. His interests in research work have been in two main directions, the first on the physiology of respiration and the reflex control of respiration from the carotid sinus, and the second on the metabolism of tissues such as the brain, heart-muscle, etc. He also carried out confidential work for the Ministry of Supply during the War. Dr. Smyth has always taken a keen interest in the general problem of medical education, and in that difficult and topical one, the selection of students for entry to the medical curriculum.

British Institution of Radio Engineers: Twenty-first Anniversary

The twenty-first anniversary of the formation of the British Institution of Radio Engineers was celebrated by a dinner at the Savoy Hotel on October 31 under the presidency of Viscount Mountbatten of Burma. The guests included several eminent men of science and engineers from the universities, the Services and Government departments. Lord Mountbatten was introduced to the assembly by Mr. Leslie McMichael, the immediate past-president, who explained that the new president had received all the education and training in wireless technology and application provided by the Royal Navy, and that in all these courses he had attained high honours and distinctions.

At the beginning of his presidential address, Lord Mountbatten announced that H.M. the King had intimated his readiness to become a patron of the Institution. He then went on to describe the manner in which, during the War, scientific men in every field had applied their knowledge and skill to the solution of practical problems and so had contributed to a very notable extent in bringing about victory. Great stimulus had been given to all forms of radio and electronic research, and much of the resulting experience is now being devoted to inventions for peace-time purposes. Lord Mountbatten gave a very imaginative and highly stimulating forecast of what might be the future of radio communication, radar, and other forms of radiation; and, looking further ahead, visualized the possibility of the electronic calculating machine, such as ENIAC (described in *Nature* of October 12), evolving into a device which might perform functions comparable with those at present undertaken by the semi-automatic portions of the human brain. Now that the memory machine and electronic brain are upon us, it seemed that we are really facing a new revolution, not an industrial one, but a revolution of the mind; and the responsibilities facing the scientific man to-day are formidable and serious. Following this address, the toast of the Institution was proposed by Sir Robert Robinson, president of the Royal Society.

Neighbourhood Planning in Education

The Bureau of Current Affairs, acting on behalf of the Carnegie United Kingdom Trust, has recently issued a pamphlet (No. 13) entitled "Education for What?" written by Mr. John Mackay-Mure (London: Bureau of Current Affairs). The pamphlet deals with one of the most important sociological problems of the present time. Asking his readers to "think again", the writer puts to them the questions: What is the object of education, and what is the best way of fulfilling that object? Then he comes to closer quarters with his purpose. Can any child's education be complete by the age of fourteen or fifteen? Is education simply a matter of schooling? Are our schools sufficiently integrated with home life? What place can be found for education in neighbourhood planning? And so we arrive eventually at the climax of the meaning and purpose of the pamphlet. Every teacher in a socially degraded neighbourhood knows too well that the school is daily fighting a losing battle with the home and the streets. There is only one way out—the way of neighbourhood planning. Planners both in Britain and in the United States have taken the neighbourhood as the social unit of their planning, the neighbourhood being defined in terms of the population that would serve a school for children between the ages of seven and eleven, thus making the junior school fundamental. This is a step towards an object which is difficult but not unattainable, an "educative community of whole men and whole women". Such is a brief outline of this significant pamphlet, the keynote of which is "educative community". The only fault we have to find with it is that the illustrations are not a successful effort at popularization.

Indian Association for the Cultivation of Science

The annual report of the Indian Association for the Cultivation of Science, Calcutta, for the year 1945 includes the report of the Committee of Management, with a list of papers published in the *Proceedings* of the Association and in the *Indian Journal of Physics*, the accounts of the Association for the year ended December 31, 1945, and budget estimates for 1946. An appended report on the scientific work of the Association by Prof. K. Banerjee refers to the continued detailed study of extra reflexion of X-rays from crystals of phloroglucinol dihydrate, benzil, *o*- and *p*-dinitrobenzene and pyrene. The intensities of the reflexion due to spatial derangement waves in general fall off very rapidly, showing that the wave-lengths of the derangement waves responsible for these extra reflexions are long. With benzil the intensities of the continuous lines due to planar derangement waves fall off gradually and much more slowly than diffuse spots. X-ray studies on jute fibres showed that methylene blue and Congo red cause no structural change in the cellulose, but complete delignification with chlorine dioxide over a long period causes partial dishevelling of the cellulose fibres, though no further change in diffraction pattern resulted on dyeing. Mercerized jute, dyed or undyed, also gives the typical mercerized cellulose pattern.

X-ray investigations on the structure of boric acid glasses containing sodium bromide, potassium bromide and potassium sulphate have continued, and all the lines in the Debye–Scherrer photographs were identified as due to the dissolved salt. The effect of various concentrations of gold and platinum dissolved in boric anhydride and borax glasses was also investigated, and other studies relating to the electrical and magnetic properties of single crystals of molybdenite indicate that along the basal plane the conductivity is wholly electronic above 90° C. Raman spectra studies have demonstrated the formation of associated molecules of ethylene dibromide and aliphatic ketones in the solid state. The spectra of di-*n*-propyl ketone shows no appreciable fluorescence at room temperature; but an intense fluorescence band at 4880–5100 A. has been observed in the solid state at − 170° C. The absorption and fluorescence spectra of anthracene have also been studied from the temperature of liquid oxygen to 100° C. Many of these investigations carried out under the auspices of the Association have been reported as "Letters to the Editors" in *Nature*.

Amateur Astronomy in Czechoslovakia

ZIENEK KOPAL has an article on this subject in *Sky and Telescope* of July, in which he discusses the development of amateur astronomy in Czechoslovakia since its beginnings in the second half of the nineteenth century. A large portion of the article is devoted to a survey of the careers of Josef and Jan Fric who, late in the last century, were among the first in Central Europe to photograph celestial objects systematically. The Ondrejov Observatory, on a hill about 1,700 ft. above sea-level and thirty miles south-east of Praha, was erected by Josef Fric as a memorial to his younger brother Jan, who died in 1897. It is interesting to know that one dome of the Observatory houses an 8-in. refractor, the lens of which was made nearly a century ago by the then unknown amateur optician, Alvan Clark. The Rev. W. R. Dawes, the well-known British amateur astronomer, purchased the lens from Clark, and after his death it was purchased by Prof. Safarik and eventually reached Praha. After the death of Safarik it came into the possession of the Fric brothers and was later mounted at Ondrejov. In 1917, the increase of astronomers in the country justified the founding of an astronomical society in Praha, and in 1928 the Czechoslovak Astronomical Society erected its own Observatory at Petrin Hill overlooking Praha. At present the membership numbers more than 2,400, and as there are only about eleven million Czechoslovaks living in Central Europe, this is probably the highest percentage of amateur astronomers in any country in the world. The article describes the activities of the Society at length, and forms very useful reading for those who are interested in the work of the amateur astronomer.

Academy of Sciences of the U.S.S.R.: Design for New Buildings

ACCORDING to the *Soviet News*, work began immediately after the War on the new headquarters in Moscow of the Academy of Sciences of the U.S.S.R. The designs were executed by the Russian architect Alexey Shchusev. A single building will house the Academy's general council, all its administrative offices, a central library for 6,000,000 volumes, and ten institutes studying the humanities. It will be erected on the right bank of the Moscow River, opposite Gorky Park and next to the Crimea Bridge. The site has an area of more than 200,000 square yards, and the main façade will be 300 yards in length. The design provides for a central building with a tower at each end, and two side blocks with semicircular entrances. The seven-storied central building, 132 ft. high, will stand upon a five-floor basement, from which a broad staircase leads down to the river. In the centre there will be an eight-columned portico 80 ft. high, supporting four pairs of Corinthian columns surmounted by a hexagonal dome. To the left of the portico will rise a 260-ft. pierced tower. The main façade will be faced with natural stone. The building will stand in a large park in which eventually the Museum of the History of the Earth and the Museum of the History of Life will be built.

British Archæology in Greece

THOUGH the British School of Archæology in Greece was necessarily closed during the German-Italian occupation, it was possible to publish during the war years two of its Annuals, representing the studies of former students. Volume 40, for 1940–45, now issued (London: Macmillan and Co., Ltd. 2 gns.), contains obituaries of former students who lost their lives in the War; studies of miniature panathenaic vases by Prof. J. D. Beazley, of some provincial black-ware workshops by Mrs. A. D. Ure, and of inscriptions from Beroea by J. M. R. Cormack; an archæological survey of the classical antiquities of Chios by D. W. S. Hunt; and a full publication by Sir John Myres of excavations in Cyprus undertaken for the Cyprus Museum, including a sanctuary site at Lefkóniko, settlement sites at Enkomi, Lampousa, and Larnaca, and a rich bronze-age cemetery at Lapithos; with notes on the 'black stone' on the site of the famous temple at Paphos (which may be the actual cult-object), on the dates and origins of Cyprioti sculpture, and on the 'rising from the sea' of Aphrodite, a remarkable natural incident, resulting from the collision of incoming and reflected waves in certain winds on a steep beach, immediately in front of the Paphian Temple.

With the restoration of more normal conditions in Greece, the British School has resumed some of its former activities. The buildings and library in Athens are unharmed; the Palace site and hostel at Knossos very little damaged; but excavation is suspended until the end of 1947, through the disorganisation of the Greek Department of Antiquities.

Verticillium Disease of the Mushroom

A USEFUL pamphlet entitled "Verticillium on Mushrooms" has recently appeared from the Midlands Group Publications (Yaxley, Peterborough, 55 pp., 1946. 5*s*. net). Fred C. Atkins, honorary secretary of the Mushroom Growers' Association, reviews the history of the disease, its symptoms and control. *Verticillium Malthousei* is the causal fungus; it may be soil-borne, or carried by flies. The best method of control appears to be fumigation of mushroom houses by formalin vapour generated by mixing potassium permanganate and 40 per cent formaldehyde. An appendix contains extracts from "Control of Mushroom Diseases and Weed Fungi" by W. S. Beach (Bull. 351, Pa. Agric. Exp. Sta., 1937). Infection by *Verticillium* is favoured by high relative humidity, and an additional measure of control lies in spraying a diseased area of the bed, after removal of the good mushrooms, with Bordeaux mixture. A further appendix is a reprint of the original paper by

W. M. Ware, which describes *V. Malthousei* as a new species (*Ann. Bot.*, 47, No. 188; Oct. 1933). This gives cultural details, thermal reactions, the results of inoculation tests, and outlines methods for the examination of diseased mushrooms for the disease. There are six excellent photographs, and the pamphlet is further enriched by a coloured plate prepared by McG. Bulloch. This shows symptoms of the soil-borne and insect-borne phases of the disease.

Commonwealth Fund Fellowships

COMMONWEALTH FUND fellowships are being awarded in 1947. These fellowships, established by the Commonwealth Fund of New York in 1918, are confined to British subjects and are tenable in the United States. Three kinds of fellowships are awarded: (1) Ordinary fellowships; (2) Service fellowships, for candidates who hold British Government appointments overseas; (3) Home Civil Service fellowships, for candidates holding appointments in the Home Civil Service. None of these fellowships is open to women. There is no fixed stipend, but the emolument attached to each fellowship, which is estimated at a minimum of approximately 3,500 dollars for twelve months, is calculated to cover the full expenses of residence, study and travel in the United States during the year. All applications must be submitted on the prescribed form, and must be approved by the authorities of the college or university of which the candidate is, or has been, a member. They must reach the Secretary to the Committee, Richard H. Simpson, Commonwealth Fund Fellowships, 35 Portman Square, London, W.1, by February 1, 1947.

Ministry of Agriculture Post-graduate Scholarships

THE Ministry of Agriculture has awarded the following post-graduate research and training scholarships in agricultural economics, agricultural engineering and husbandry, tenable for periods up to three years, in the first instance at the institutions shown: *Agricultural Economics:* A. W. Ashby, School of Agriculture, Cambridge; R. D. Hewlett, Department of Agriculture and Horticulture, University of Reading; O. T. W. Price (not yet determined); Miss M. A. Wilson, School of Rural Economy, Oxford. *Agricultural Engineering:* J. A. Gibb (not yet determined). *Husbandry:* G. E. Barnsley, Norfolk Agricultural Station, Sprowston; A. Mitchell, School of Agriculture, Cambridge; D. E. Tribe, Rowett Research Institute, Aberdeen.

Royal Society of Edinburgh

THE following have been elected officers of the Royal Society of Edinburgh: *President*, Sir W. Wright Smith; *Vice-Presidents*, Prof. R. J. D. Graham, Lord Cooper, Prof. J. W. Heslop Harrison, Prof. W. M. H. Greaves, Lieut.-Colonel W. F. Harvey, Prof. J. P. Kendall; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. E. T. Copson and Prof. A. Holmes; *Treasurer*, Sir E. Maclagan Wedderburn; *Curator*, Dr. J. E. Mackenzie; *Councillors*, Prof. T. Alty, Mr. J. Morrison Caie, Sir Robert Muir, Lord Birnam, Prof. E. P. Cathcart, Prof. Alexander Gray, Dr. J. Russell Greig, Dr. W. A. Harwood, Prof. C. M. Yonge, Prof. A. D. Hobson, Dr. W. O. Kermack, Dr. John Weir.

The Dr. W. S. Bruce Memorial Prize (1946) has been awarded by the Joint Committee of the Royal Physical Society, the Royal Scottish Geographical Society and the Royal Society of Edinburgh to Lieut.-Colonel P. D. Baird for his valuable survey and geological work with Mr. J. M. Wordie in North-West Greenland and Baffin Island in 1934, and with Mr. T. H. Manning's British Canadian Arctic Expedition in 1936–37; during 1938–39 he went back again with his friend Bray and reached Iglooik near Fury and Hecla Strait that summer. Bray was unfortunately drowned, but Baird carried on by himself and travelled extensively over northern Baffin Island, mapping as he went, and made a first entry into Bylot Island. Recently, he has been in charge of the 'Musk-Ox Operation' in Arctic Canada.

Announcements

DR. HAROLD JEFFREYS, reader in geophysics in the University of Cambridge, has been elected to the Plumian professorship of astronomy and experimental philosophy at Cambridge, vacant since the death of Sir Arthur Eddington.

DR. H. ZANSTRA has been appointed director of the Astronomical Institute of the University of Amsterdam, in succession to Prof. A. Pannekoek, who has retired.

DR. HOWARD REID CRAIG has been appointed director of the New York Academy of Medicine in succession to Dr. Herbert B. Wilcox, who has resigned. Dr. Craig was born in 1894, and since 1921 has been associated with Babies' Hospital, New York; he has served on the Advisory Council of the Child Welfare Bureau of the U.S. Department of Health.

THE trustees of the Miners' Welfare National Scholarship Scheme invite applications for a limited number of university scholarships for award in 1947. There are, in addition, a limited number of exhibitions available for award to the most meritorious of the unsuccessful candidates for scholarships. Candidates must be either workers in or about coal mines in Great Britain, or sons and daughters of such workers, and should not normally be less than seventeen years of age on January 25, 1947. Forms of application can be obtained from the Secretary, Miners' Welfare National Scholarship Scheme, Ashley Court, Ashtead, Surrey. Applicants for forms must state whether they apply as workers in or about mines or as children of such workers. Completed forms must be returned by January 25, 1947.

MESSRS. EASIBIND LTD., Pilot House, Mallow Street, London, E.C.1, have sent for examination an example of the covers they supply for filing or binding periodicals. The covers are made to fit specific journals, and that for *Nature* holds twenty-six issues. Each issue is kept in place by a stiff wire the ends of which run in slots in two metal frames at the back edge of the binder; and the issues are held together by two stouter wires passing outside the first and last issues and inserted in holes in the same frames. The binder is easy and convenient to use whether full or only partially full.

ERRATUM. Dr. P. J. G. Mann and Dr. J. H. Quastel write: "The equation, relating to the decomposition of manganese dioxide by hydroxylamine, mentioned in our article on 'Manganese Metabolism in Soil' (*Nature*, August 3, p. 154) was by an oversight incorrectly stated. The equation should read:

$$2MnO_2 + 2NH_2OH = 2MnO + N_2O + 3H_2O.$$

IMPERIAL AGRICULTURAL BUREAUX

POSTS OF DIRECTOR IN THE IMPERIAL AGRICULTURAL BUREAUX OF ANIMAL BREEDING AND GENETICS, AND OF FORESTRY

1. These two bureaux are part of the group of centres of information under the control of the Executive Council of the Imperial Agricultural Bureaux. These are respectively located at and work closely with the Institute of Animal Genetics, University of Edinburgh and the Imperial Forestry Institute, Oxford. The Consultant Director of the Institute has general supervisory charge of a Bureau, but the Director is the Chief Executive Officer of a Bureau and as such is directly responsible to the Executive Council.

2. The work of a Bureau is to collect, collate and make available to scientific research workers information in the particular subject of that bureau and allied subjects.

3. Applications are invited for these posts. The salary grade is £840–£30–£1,200–£50–£1,300, though exceptionally an officer might start higher than the bottom of the scale. The salary is inclusive. There are no bonuses or extras, except travelling and subsistence allowance on the recognized scale when travelling. The appointment and subsequent increment dates count from the date of joining the Bureau. The appointment can be terminated at three months notice on either side.

If the officer appointed is not already a member of the Federated Superannuation System for Universities, he is required to become a member. Under this scheme an insurance policy at the officer's selection is taken out, the premium being equivalent to 15 per cent of salary of which one-third is recoverable by deduction from salary, the remaining two-thirds being contributed by the Executive Council. Arrangements are made for additional policies as salary rises. Annual leave and sick leave are allowed according to regulations.

4. Applicants should give among other particulars, Name, Address, Date and country of Birth, present employment and salary, proficiency in languages, education (school, university and degrees), experience (including scientific and administrative experience and experience in different countries), publications. In addition the names of three persons should be given to whom reference can be made on qualifications and work.

5. Applications should reach the Secretary at the latest by March 1, 1947, and the appointments will be made as soon as possible afterwards, probably early in May. Further information can be obtained from the Secretary.

The Secretary, Imperial Agricultural Bureaux, 2, Queen Anne's Gate Buildings, London, S.W.1.

CIVIL SERVICE COMMISSION

The Civil Service Commissioners announce that a special competition will be held for appointments as Assistant Examiner in the Patent Office under the Board of Trade. Approximately 200 vacancies will be filled by competitive interviews spread over a period of two or three years. Vacancies will be available for mathematicians, physicists, chemists, electrical engineers, mechanical engineers and persons with general scientific qualifications.

Candidates must have passed an examination qualifying for a University degree or its equivalent or hold other qualifications specified in the regulations.

Candidates must have been born on or after August 2, 1910, and have attained the age of 20 on January 1 of the year in which they compete. Allowance will be made for service in H.M. Forces prior to September 3, 1939, and for service as Established Civil Servant commencing before age 25, the latter allowance being subject to a maximum of two years.

The salary scale is £250 a year, rising to £400 a year (men), £350 a year (women), plus consolidation additions varying from £78 a year (men) and £63 a year (women) at the minimum of the scale to £90 a year and £72 a year for men and women respectively at the maximum. Commencing salary will vary according to age. Subject to efficiency there is advancement after five years service to Examiner, £450 to £750 (men) and £375 to £650 (women). There are prospects of promotion to higher grades.

Candidates who have served or are serving in H.M. Forces must send in their application forms in time to reach the Civil Service Commission not later than February 1, 1947. All other candidates must send them in by December 1, 1946.

Copies of the Regulations and Forms of Application may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1, or from the Chief Officer, Civil Service Commission, at the following addresses, quoting No. 1664. India: 10 Underhill Lane, Delhi; Egypt: 8 Sharia Tolumbat, Garden City, Cairo; Italy: c/o G.H.Q., C.M.F.; Germany: c/o 2nd Echelon, G.H.Q., B.A.O.R.

IMPERIAL AGRICULTURAL BUREAUX

POSTS IN THE IMPERIAL AGRICULTURAL BUREAUX OF SOIL SCIENCE, OF DAIRY SCIENCE, OF HORTICULTURE AND PLANTATION CROPS, AND OF PASTURES AND FORAGE CROPS (INCLUDING FIELD CROPS)

1. These four bureaux are part of the group of centres of information under the control of the Executive Council of the Imperial Agricultural Bureaux. These are respectively located at and work closely with the Rothamsted Experimental Station, Harpenden, Herts; the National Institute for Research in Dairying, Shinfield, Reading; the East Malling Research Station, East Malling, Kent; and the Welsh Plant Breeding Station, Penglais, Aberystwyth. The Director is the Chief Executive Officer of a Bureau and as such is directly responsible to the Executive Council. The posts advertised are directly under the Director and the incumbent would be expected to take entire charge in the absence of the Director.

2. The work of a Bureau is to collect, collate and make available to scientific research workers information in the particular subject of that Bureau and allied subjects.

3. Applications are invited for the posts in the grade of £600–£25–£800 (bar)–£25–£900, though exceptionally an officer might start higher than the bottom of the scale. The salary is inclusive. There are no bonuses or extras, except travelling and subsistence allowance on the recognized scale when travelling. The appointment and subsequent increment dates count from the date of joining a Bureau. The appointment can be terminated at three months' notice on either side.

If the officer appointed is not already a member of the Federated Superannuation System for Universities, he is required to become a member. Under this scheme an insurance policy at the officer's selection is taken out, the premium being equivalent to 15 per cent of salary of which one-third is recoverable by deduction from salary, the remaining two-thirds being contributed by the Executive Council. Arrangements are made for additional policies as salary rises. Annual leave and sick leave are allowed according to regulations.

4. Applicants should give, among other particulars, name, address, date and country of birth, present employment and salary, proficiency in languages, education (school, university and degrees), experience (including scientific and administrative experience and experience in different countries), publications. In addition the names of three persons should be given to whom reference can be made on qualifications and work.

5. Applications should reach the Secretary at the latest by March 1, 1947, and the appointment will be made as soon as possible afterwards, probably early in May. Further information can be obtained from the Secretary.

The Secretary, Imperial Agricultural Bureaux, 2, Queen Anne's Gate Buildings, London, S.W.1.

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

Chemist required by the above Association on or before January 1, 1947, for fundamental researches in conjunction with a small team of Marine Biologists at Millport, Isle of Cumbrae, on anti-fouling composition for marine use. University degree essential. Some research experience, a good understanding of physico-chemical principles, and a fair knowledge of organic chemistry are desirable qualifications. Special knowledge of paints useful, but not essential. The post will be in either the Scientific Officer or Senior Scientific Officer grade, age range 25–35. Salary according to age, qualifications and experience.

Written applications only, giving curriculum vitae, to be sent to the Personnel Officer, B.I.S.R.A., 11, Park Lane, London, W.1, to arrive not later than Saturday, November 23.

UNIVERSITY OF CAPE TOWN

SENIOR LECTURER IN PHYSIOLOGY

Applications are invited for the post of senior lecturer in the Department of Physiology. The salary scale is £675 × £25–£775 per annum. The lecturer will be required to teach in practical classes of human and experimental physiology, and to take part in the routine lecturing of the department. He will also be expected to do research work. He must have scientific qualifications in Physiology. A medical qualification would be a recommendation. Applications from serving personnel and ex-volunteers will receive special consideration and applicants are advised to give details of their military and other national service.

Write quoting G.83 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 completed by December 12, 1946.

STOKES STUDENTSHIP

The Master and Fellows of Pembroke College, Cambridge, announce that the Stokes Studentship is about to become vacant.

Candidates for the Studentship should send their applications together with a birth certificate, a certificate as to personal character, and, if possible, seven copies of (1) a brief statement of their educational history, (2) a list of their published works, and (3) any testimonials (not exceeding four in number) which they may desire to submit to the Master of Pembroke College, Cambridge, on or before December 31, 1946, marked on the outside "Stokes Studentship."

One set of copies of their published works should also be sent, and it should be stated what line of research is intended to be pursued.

The conditions under which the Studentship will be awarded are as follows:

1. The Studentship will be awarded without distinction of sex.
2. Preference will be given to graduates of the University of Cambridge.
3. Candidates must not be less than twenty-three or more than thirty years of age on January 1, 1947, and a preference will be given to those between the ages of 23 and 26.
4. Candidates for the Studentship must have shown capacity for research in Mathematical or Experimental Physics or in subjects cognate thereto, such as Physical Chemistry or the study of Physical Laws in relation to Living Matter.
5. The student appointed will be expected to devote himself to research in Cambridge unless he is permitted for special reasons and for a limited time to conduct his researches elsewhere.
6. With the approval of the Head of the Department to which he is attached the student will be allowed to do a strictly limited amount of teaching, but will not be permitted to undertake other work.
7. Normally the tenure in the first instance will be for a period of three years with a possibility of renewal for a further period not exceeding five years.
8. The value of the Studentship has been normally £400–£450 a year, and the Board of Managers will be prepared to recommend the election of more than one student on similar terms if suitable applicants are forthcoming.
9. The student appointed, if a man, will be required to become a member of Pembroke College.

SCIENTIFIC CIVIL SERVICE

The Civil Service Commissioners invite applications for appointment as Principal Scientific Officer in the Radar Research and Development Establishment of the Ministry of Supply at Malvern, Worcs.

Candidates should be British subjects, born on or before August 1, 1915 and not more than 50 years of age on October 1, 1946. They should possess qualifications in physical chemistry, equivalent to an Honours degree, and have good research experience in this field and a sound knowledge of electrochemistry. They should be capable of conducting and directing research and development work on electric batteries. Some industrial experience is necessary and a knowledge of primary cells would be an advantage.

The appointment is permanent with Superannuation benefits under the Federated Superannuation System for Universities and is graded as Principal Scientific Officer on the Provincial scales £750 × £30–£1,020, plus a consolidation addition ranging from £90 at the minimum to £105 at the maximum (men) and £660 × £30–£880 plus a consolidation addition ranging from £79 at the minimum to £84 at the maximum (women).

Forms of application are obtainable from the Secretary, Civil Service Commission, 6, Burlington Gardens, London, W.1, quoting No. 1671, to whom completed applications must be returned not later than November 21, 1946.

SCIENTIFIC CIVIL SERVICE

The Civil Service Commissioners invite applications for appointment as Senior Principal Scientific Officer at the Atomic Energy Research Establishment of the Ministry of Supply.

Candidates should be British subjects, born on or before August 1, 1915, and not more than 50 years of age on October 1, 1946. They must have a First or Second Class Honours Degree in Chemistry and have a knowledge of metallurgical ideas and processes. Experience of research in the field of refractories or ceramics will be an advantage.

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 of £1,100 × £50–£1,300, plus a consolidation addition of £120.

Forms of application are obtainable from the Secretary, Civil Service Commission, 6, Burlington Gardens, London, W.1, quoting No. 1670, to whom completed applications must be returned not later than November 21, 1946.

THE BRITISH PLASTICS FEDERATION

47–48 PICCADILLY, LONDON, W.1

BOWEN PRIZE FUND

The Council of the British Plastics Federation, as administrators of the Bowen (Cables and Plastics) Prize Fund, offer three prizes, to the value of £50 each, for award in June, 1947. The prizes will be awarded for original scientific contributions in Chemistry, Physics, Engineering or Chemical Engineering of post-graduate standard, and having a bearing on the plastics industry. Two of the prizes will be open for competition only for employees, of not less than twelve months' service, of member firms of the British Plastics Federation. One prize will be open to anyone domiciled in Great Britain. The Council reserves to itself the right to restrict the number of prizes awarded if contributions should not be deemed to be of sufficiently high standard.

Contributions, which must *not* bear the name of the author, should be enclosed in a sealed envelope and forwarded with a covering letter giving the following information: Name and address of author; name of his employers and length of time he has been employed by them, with a letter from a responsible official representing his employers, giving permission for the author to submit his contribution.

Authors of contribution for the open prize, if not employed by an industrial undertaking, should state their occupation. If authors of contributions for the open prize are employed by member firms of the Federation, they should also submit a letter from their employers giving them permission to submit the contribution.

Contribution should be sent to the General Manager, The British Plastics Federation, 47–48 Piccadilly, London, W.1, so as to reach him not later than first post on Saturday, March 29, 1947.

It is the desire of the Council of the Federation that all suitable contributions submitted for these prizes shall be published, but it reserves the right to determine, in conjunction with competitors, the method and place of publication.

Additional copies of this advertisement can be had on application to the Federation.

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

Applications are invited for post of Principal Research Officer in the National Bureau for Personnel Research, Pretoria, to undertake personnel research in industry.

Applicants must have research degree in psychology, and had extensive experience of personnel selection and the investigation of psychological problems in industry. A knowledge of personnel management will be a recommendation.

Salary scale: £900 × £40—£1,100 p.a., plus cost of living allowance. The starting salary will be decided according to successful applicant's qualifications and experience.

Applications, giving full details of age, marital status, qualifications, experience and date when duty may be assumed, together with a recent medical certificate of health and the names of three referees, must reach the Scientific Liaison Officer, South Africa House, Trafalgar Square, London, W.C.2, by November 30, 1946.

UNIVERSITY OF CEYLON

Applications are invited for the following posts in the University of Ceylon:

Chair of Botany;
Chair or Lectureship in Geography
Chair of Physiology.

The salary of the Professor of Physiology will be between £1,500 and £2,000 per annum, according to qualifications, plus rent allowance. Those of the other posts will be on University's rupee scales plus overseas allowance of not more than one-third of the salary, plus rent allowance. If the full overseas allowance is paid, the sterling equivalent, at current rates, of a married professor's salary and allowances would be about £1,500 to £1,900; and in the case of a married lecturer it would be about £900 to £1,250.

Applications, in triplicate, should be addressed before December 10, 1946 to the Secretary, Inter-University Council, 8, Park Street, London, W.1, from whom further particulars may be obtained.

UNIVERSITY OF GLASGOW

LECTURESHIP IN BOTANY

Applications are invited for appointment as a Lecturer in Botany, with special qualifications in Mycology. The Lectureship will be in Grade IIb, the salary range of which is £400–£600, plus family allowance and superannuation. The commencing salary will be fixed according to qualifications and experience. Applications (three copies) should be lodged with the undersigned not later than November 30, 1946.

ROBT. T. HUTCHESON,
Secretary of University Court.

ASSOCIATION OF ANAESTHETISTS OF GREAT BRITAIN AND IRELAND

RESEARCH FELLOWSHIP

A candidate will shortly be appointed by the Council of the Association to a Research Fellowship in anaesthesia, analgesia and allied subjects. The annual value of the Fellowship will be £650 with an allowance for expenses, and will be for one year in the first instance, with a possibility of extension. Candidates should be of British birth and hold a medical qualification registered in this country or a British university degree (not necessarily medical).

Applications, giving a statement of the proposed research and accompanied by a recommendation from a member of the staff of the applicant's Medical School or University, should be sent to the Honorary Secretary, Association of Anaesthetists, 45, Lincoln's Inn Fields, London, W.C.2, before November 30, 1946.

LOUGHBOROUGH COLLEGE

PRINCIPAL: DR. H. SCHOFIELD, C.B.E.

DEPARTMENT OF PURE AND APPLIED SCIENCE

CHEMICAL ENGINEERING SECTION

HEAD OF DEPARTMENT: C. WHITWORTH, PH.D., M.SC., F.R.I.C., M.INST.F.

Required for this newly formed Section a full-time Lecturer in Chemical Engineering. Candidates should be Corporate Members of the Institution of Chemical Engineers.

The successful candidate will be expected to take up his duties as soon as possible. Subject to approval by the Ministry of Education the salary is that of a Senior Assistant on the Burnham Scale, i.e., £600–£25–£750 per annum.

Further particulars and form of application may be obtained from the Registrar, Loughborough College, Loughborough, Leicestershire, to whom they should be returned by November 30, 1946.

This is a second advertisement. Candidates who have already applied need not re-apply.

LOUGHBOROUGH COLLEGE

PRINCIPAL: DR. H. SCHOFIELD, C.B.E.

DEPARTMENT OF PURE AND APPLIED SCIENCE

HEAD OF DEPARTMENT: C. WHITWORTH, PH.D., M.SC., F.R.I.C., M.INST.F.

Required 1 or 2 Lecturers to teach Physics or Chemistry, with some Applied Mathematics, or Mathematics, to students up to general B.Sc. standard. Ability to teach some Metallurgy would be appreciated. Salary according to the Burnham Scale for Technical Colleges.

Further particulars and application forms (which should be returned as soon as possible), from the Registrar, Loughborough College, Loughborough.

DUNDEE TECHNICAL COLLEGE

MECHANICAL ENGINEERING DEPARTMENT

The Governors of the Dundee Institute of Art and Technology invite applications for the Full Time Post of Lecturer. Candidates should be qualified to degree standard with industrial experience, particularly in Engineering Drawing and Design.

The salary for the post, which is superannuable, is on a scale £450–£15–£685 with placing for exceptional qualifications and experience.

Statement of particulars and form of application may be had from Mr. George H. Thomson, Clerk and Treasurer, Bell Street, Dundee.

B.E.C.C. SOCIETY INCORPORATED

N.Z. BRANCH

Applications are invited for the position of Director of Cancer Research in the Medical School of the University of Otago, Dunedin (New Zealand). Salary £1,000–£1,200, according to qualifications and experience. Further particulars may be obtained from the General Secretary, B.E.C.C. Society, 11, Grosvenor Crescent, Hyde Park Corner, London, S.W.1.

Applications should be forwarded by airmail to reach the Chairman, Cancer Research Committee, Medical School, Dunedin, before December 31, 1946.

UNIVERSITY OF OTAGO

DUNEDIN, NEW ZEALAND

Applications are invited for the following positions:

Senior Lecturers, salary £750 (N.Z.) p.a. rising to £825 (N.Z.) p.a. in Physics and Mathematical Physics.

Lecturers, salary £600 (N.Z.) p.a. rising to £700 (N.Z.) p.a. in Philosophy and Zoology.

Assistant Lecturers, salary £400 (N.Z.) p.a. rising to £500 (N.Z.) p.a. in History, Physics, and Mathematics.

Full particulars and application forms may be obtained on application to the High Commissioner for New Zealand, 415, Strand, London, W.C.2, England.

GUY'S HOSPITAL MEDICAL SCHOOL

(UNIVERSITY OF LONDON)

Chemistry Department. The above department requires at once a Technician, commencing at a salary of £255 rising by annual increments of £15 to £345; a superannuation scheme is in operation. A knowledge of Chemistry to Intermediate standard and of laboratory technique is essential. *Or* a Junior Technician, not under 21 years of age. Salary according to age and experience, minimum £3 5s. per week, with the possibility of promotion to the higher grade. A sound knowledge of Chemistry or of laboratory technique is essential.

Applications for these posts with the names of two referees (testimonials not required) should be sent to Professor C. S. Gibson, F.R.S., Chemistry Department, Guy's Hospital Medical School, London Bridge, S.E.1.

LONDON (ROYAL FREE HOSPITAL) SCHOOL OF MEDICINE FOR WOMEN

(UNIVERSITY OF LONDON)

8 HUNTER STREET, BRUNSWICK SQUARE, W.C.1

Two Laboratory Technicians required in the Physiology Department: one Grade B, at a salary of £300 p.a., rising by annual increments of £15 to £345 p.a., with superannuation benefits, and one Grade C, salary according to age, minimum age 16, at £1 15s. per week.

Applications, giving particulars of age, qualifications, experience, etc., to be sent to the Warden & Secretary as soon as possible.

UNIVERSITY OF THE WITWATERSRAND

Applications are invited for a Second Lecturer in Physiotherapy. Candidates must be qualified as Teachers of Massage. Salary £400 × 25 — £650, but higher initial salary may be paid on ground of special qualifications and experience. Cost of living allowance £46. Allowance for travelling expenses. Further particulars may be obtained from the Secretary of the Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

MIDDLESEX HOSPITAL MEDICAL SCHOOL, W.1

Biochemist required for a research appointment in the Courtauld Institute, to investigate enzymes and tissue metabolism in relation to cancer. Applicants should be university graduates possessing research experience in biochemistry. Salary £600 per annum.

Also Research Assistant, preferably one having some training in the above field, and in chemical analysis. Salary £300 per annum.

Applications, addressed to the Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1, should be received not later than November 30.

THE GLASGOW VETERINARY COLLEGE INCORPORATED

Applications are invited for the following posts, namely: (1) Lecturer in Biology; (2) Lecturer in Physiology or Biochemistry; (3) Lecturer in Histology and Embryology. Applications, stating age, qualifications and experience, and giving the names of two persons to whom reference may be made, should be lodged not later than November 23, 1946, with the undersigned, from whom further particulars may be obtained.

JAMES AUSTIN,
Secretary.

County Buildings,
149 Ingram Street, Glasgow, C.1.

RHODES UNIVERSITY COLLEGE

GRAHAMSTOWN, SOUTH AFRICA

Applications are invited for 1947 for the posts of: Lecturer in Physics (reference A.326); Lecturer in Mathematics (reference A.327); Salary scale: men £450 × £25—£600, Women £350 × £25—£500. Write, quoting appropriate reference number, 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 by November 19, 1946.

KING'S COLLEGE OF HOUSEHOLD & SOCIAL SCIENCE

(UNIVERSITY OF LONDON)

CAMPDEN HILL ROAD, LONDON, W.8

Applications are invited for Appointment as Assistant Lecturer and Demonstrator in Physiology, to date from January, 1947. Initial salary £350 (plus £25 increase for cost of living) per annum. The appointment is open to men and women equally.

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

(*Continued on pages* clxvi *and* clxvii)

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

LETTERS TO THE EDITORS

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

A Fruit-setting Hormone from Apple Seeds

In the apple, fruit size and shape are known to be closely correlated with the number and position of the fertile seeds, an observation which suggests that the developing seed may be the source of a hormone which initiates and controls the growth of the fruit. Experimental evidence supporting this has recently been obtained for the apple variety Crawley Beauty, from the young seeds of which it has been found possible to prepare extracts which are active in stimulating the development of unfertilized tomato ovaries.

Active extracts can be obtained from both fresh and dried material by the simple expedient of boiling the seeds in water (25 ml. per gm. dry wt.) in an open beaker for 15 minutes, which serves not only to extract the hormone and concentrate the extract, but also at the same time inactivates oxidizing enzymes. After separation from the plant material, the resulting liquor is cooled at 5° C. for 24 hours, filtered, and the filtrate tested directly by placing one drop on the ovary of an emasculated tomato flower. Alternatively, the active principle can be removed from the filtrate by shaking with ether, evaporating to dryness, and taking up the residue with water or lanolin. If the extract is active, the tomato ovaries show visible swelling within four or five days, and eventually develop into seedless fruits of excellent size and quality.

Using the above extraction procedure, active extracts were prepared from seeds taken from young fruits collected at various stages from three to ten weeks after petal fall, but no fructigenic activity could be detected in seeds taken from fruits which were older than this. This disappearance of activity corresponded closely with the cessation of the rapid growth of the seed, the disappearance of an unidentified compound (believed to be a glucoside) from the seed, and the occurrence of the so-called 'June drop', which in this variety occurs in the latter half of July. Further work is in progress to establish more precisely the relationship between these phenomena and to investigate the role of this hormone in the processes of fruit-set and development of the apple and other tree fruits.

Leonard C. Luckwill
Long Ashton Research Station,
University of Bristol.
Oct. 5.

Underground Spread of Potato Virus X

Although potato virus X is the most widely distributed of the potato viruses, there is considerable uncertainty about its method of transmission. No insect has been found to act as a vector, and the only way in which it is known to spread is by contact between healthy and infected plants. This was first demonstrated by Loughnane and Murphy[1,2], who concluded that it resulted solely from leaf contact, and that there was no danger of spread occurring below ground. Experiments at Rothamsted have confirmed that spread occurs only when plants are in contact, and that leaf contact alone is sufficient; but the results also suggest that root contact is equally important.

In potatoes, the rate of spread is slow; in no year during the course of these experiments have more than 1 in 10 of the healthy plants in contact with infected ones become infected. In field experiments it has been noticed that tubers from plants adjacent to infected ones were sometimes infected even when the haulms had not reacted when tested for virus X at the end of the season. One explanation for this would be that infection occurred through foliage late in the season, and that the virus passed to the tubers without becoming systemically established in the haulms. It seemed, however, equally probable that spread was occurring underground, and glasshouse experiments were made to test this possibility.

Various experiments have been carried out in which healthy and infected potato tubers were planted in the same pots, in half of which screens of 'Cellophane' were erected to prevent foliage contact. There was too little spread for any definite conclusions to be reached, but again there was a suggestion of spread without leaf contact. In one experiment, for example, there was no sign of spread from tests made from the haulms at the end of the season in either the screened or unscreened pots, but subsequent tests on the harvested tubers showed that spread had occurred in one of the screened pots.

Tomato is much more susceptible than potato to infection by virus X, and spread is much more rapid. Parallel experiments with this plant have shown that spread occurs equally well whether there is root contact only, or both root and leaf contact between infected and healthy plants. The virus strain used produced a bright yellow interveinal mottle in the tomato. Plants were set out in pairs in large pots, individual 'Cellophane' screens were erected in half the pots, and the plants were allowed to grow to 5–6 in. in height before one of them was inoculated with the virus. Tests made eight weeks later showed that 7–9 of the uninoculated plants in the unscreened pots had become infected, and 5–9 in the screened pots.

In an experiment with a different type of screen which provided a continuous barrier between the infected and healthy plants in 9 of the 18 pots, spread of virus occurred to all 9 of the uninoculated plants (root contact only) and to 7–9 of the unscreened pots. All the control tomato plants in the same glasshouse, not in contact with infected plants, remained healthy. There is no evidence to show whether the underground spread is caused by mechanical transfer of virus between roots in contact or by some other mechanism.

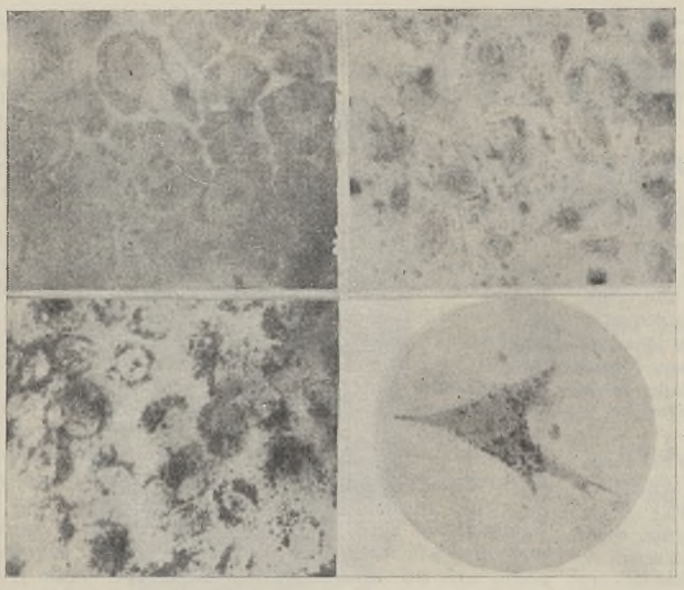
F. M. Roberts
Rothamsted Experimental Station,
Harpenden, Herts.

[1] Loughnane, J. B., and Murphy, P. A., *Nature*, 141, 120 (1938).
[2] Loughnane, J. B., and Murphy, P. A., *Sci. Proc. Roy. Dublin Soc.*, n.s., 22, 1 (1938).

Ultra-Violet Absorption in Living and Dead Cells

An ultra-violet microscope having an achromatic objective designed by Brumberg and Gershgorin[1] (with an aperture of 0·5) has been used for photographing living tissue cultures. The latter were grown by the hanging drop method on a quartz cover-glass. The source of light used was a high-pressure quartz

A B C D



A, LIVING CANCER CELLS IN TISSUE CULTURE; *B*, THE SAME CELLS DEAD IN HYPOTONIC RINGER SOLUTION; *C*, LIVING CANCER CELLS; AND *D*, A LIVING MOUSE FIBROBLAST WITH NEUTRAL RED GRANULES. THE PHOTOGRAPHS WERE TAKEN WITH AN ACHROMATIC REFLECTING OBJECTIVE (APERTURE 0·5) IN ULTRA-VIOLET LIGHT λ 254–275 Mμ

mercury lamp. All radiation except that of wave-lengths 254–275 $\mu\mu$ were prevented from reaching the object by means of filters (bromine and chlorine vapours and Corning's Red Purple Corex A, No. 986 Glass). Focusing was performed under conditions of visible light (usually in a dark field) which completely prevented the ultra-violet rays from reaching the cells previous to their being photographed. The time of exposure was 20 sec.

Photographs of the living cells of mouse mammary carcinoma cultures, as well as of mouse or chicken fibroblasts, revealed a picture widely different from that described by Caspersson[2] both for fixed histological preparations and for living cells. In our experiments the nuclei of living cells entirely failed to absorb any ultra-violet rays within the region 254–275 $\mu\mu$ (*A*). The nucleoli alone revealed moderate absorption. Cancer cell cytoplasm was likewise found to absorb ultra-violet rays moderately.

With the view of checking their state of vitality, some of the cultures were immersed, previous to their being photographed, in a solution of vital stain, namely, neutral red, in Ringer's mixture. The granules of the stain which intensely absorbed ultra-violet rays in the cytoplasm formed a clear demarcation around the nucleus which, however, with the exception of the nucleoli, failed to reveal any ultra-violet absorption (*C* and *D*). Whereas the cytoplasm of non-stained cancer cells absorbed ultra-violet rays, the cytoplasm of vitally stained cells lost its capacity for absorption, which was centred in the granules.

Ultra-violet radiation of the culture on the microscope stage for two minutes (without the use of filters) was found to effect typical changes. The nucleus developed the capacity for ultra-violet absorption, the nuclear membrane became clearly outlined, and the nucleoli developed more intense absorption. As a result the cell nuclei revealed the same picture as that described in Caspersson's investigations. So far we have failed to obtain more detailed photographs of nuclear structure owing to the aperture of the objective not being sufficiently large. When radiation wave-length 313 $\mu\mu$ was used (the filter being a solution in water of potassium chromate and 'Corax' glass) no ultra-violet absorption was observed. Together with a change of ultra-violet absorption occurring in the nuclei, they became smaller in size, their diameter being reduced by a quarter or a third. Cancer cell cytoplasm lost its capacity for absorption, owing to which fact its fatty-lipoid inclusions were clearly outlined. In the experiments conducted with neutral red stain the granules of the latter were found to disappear at the onset of the injury.

Similar changes in ultra-violet absorption were observed when the cells were dying in a strong hypotonic solution, (*B*), or due to mechanical factors. Photographs taken in succession revealed the gradual course of these processes; details are given elsewhere[3].

In Caspersson's investigations the cells of the nuclei which were to be examined *in vivo* were apparently found to absorb ultra-violet rays owing to the fact that, since he was using a monochromatic objective, Caspersson was obliged to take a few preliminary photographs in ultra-violet light with the view of getting the object in focus, and the cells were damaged and killed in the process.

Apparently desoxyribonucleic acid is contained in the nuclei of living cells in a somewhat different state, in which it does not absorb ultra-violet rays of wave-length about 260 $\mu\mu$. Absorption develops in connexion with the injury and death of the cells.

E. M. BRUMBERG
L. TH. LARIONOW

Luminescence Laboratory
of the State Optical Institute,
and Cancer Research Laboratory
of the Central Roentgenological,
Radiological and Cancer Institute,
Leningrad.

[1] Brumberg, E., *Nature*, 152, 357 (1943).
[2] Caspersson, T., *Skand. Arch. Physiol.*, Suppl. No. 8 (1936).
[3] Larionow, L., and Brumberg, E., *C.R. Acad. Sci. U.R.S.S.*, in the press.

Quantitative Microchemical and Histochemical Analysis of Elements by X-rays

A METHOD of X-ray absorption analysis has been developed which permits the quantitative determination of elements with low atomic numbers in extremely small quantities of a biological tissue. It is based upon the measurement of the absorption of monochromatic X-ray radiation, within a very small area of an object, for example, a microscopic section of a tissue. The measuring procedure, either ionometrically or photographic-photometrically, is repeated in a series of wave-lengths lying on each side of a long-wave X-ray absorption edge of the element sought for. From these experimental data the quantity of the element in question can be calculated. Localization of the area in the specimen to be analysed is secured by taking monochromatic X-ray radiomicrographs. The method permits of the determination in a tissue of elements of atomic number above 6. Thus with the exception of hydrogen, all elements of biological interest can be determined. Analysis may be made upon a volume of tissue corresponding to that of a mammalian cell. In analyses of calcium and phosphorus in biological material, quantities of 10^{-10}–10^{-11} gm. have been determined by the method with an error of 10 per cent.

A complete theoretical investigation of the method of analysis, a description of the construction of the experimental apparatus and an account of the analytical technique and the experimental results obtained will shortly be published in a supplement to *Acta Radiologica* (Stockholm).

A. ENGSTRÖM

Department of Cell Research,
Karolinska Institutet,
Stockholm.
Oct. 4.

Role of Ultra-filtration in the Formation of Aqueous Humor

IN a previous communication[1], I reported that sodium enters the aqueous humor predominantly by secretion. This implies either : (i) that practically no ultra-filtration at all takes place from the vessels of the iris and ciliary body ; or (ii) that the amount of sodium entering the aqueous by secretion greatly exceeds the amount entering by ultra-filtration, even if ultra-filtration still supplies a considerable part of the fluid volume of the aqueous.

If alternative (i) were true, the old question of the relative importance of ultra-filtration and secretion in aqueous humor formation would be solved. If alternative (ii) were true, the problem would still be unsolved. The present work was undertaken to test alternative (ii).

If the secretion is to supply almost all the sodium and the ultra-filtrate a considerable part of all the fluid, their respective sodium contents obviously must be markedly different. But as sodium is the absolutely dominant cation of the aqueous, a marked difference in osmotic pressure would necessarily accompany any large difference in sodium content. If alternative (ii) were true, then the secretion would have a higher osmotic pressure than the ultra-filtrate. The aqueous, being a mixture of the two, would have an intermediate osmotic pressure, and this would depend on the proportions of the mixture. Thus, by reducing the amount of ultra-filtrate, one could change the osmotic pressure of the aqueous towards that of the secretion and, as the secretion is hypertonic, towards higher values of osmotic pressure.

The amount of ultra-filtrate (if any) in the aqueous of one eye was reduced by clamping the homolateral common carotid artery in rabbits. This greatly reduced the filtering pressure and thereby the rate of ultra-filtration. The osmotic pressure difference between the two aqueous humors was determined by the Hill–Baldes thermo-electric method 1·5–2 hours after carotid closure. The mean difference between the side with closed carotid and the control side was $-0 \cdot 5 \pm 1 \cdot 1$ mgm. sodium chloride per 100 ml. (29 experiments on 22 animals, 3–9 determinations of osmotic pressure on each sample). Thus, the blood pressure reduction cannot have augmented the osmotic pressure by more than at most $-0 \cdot 5 + 3 \times 1 \cdot 1 = 2 \cdot 8$ mgm. sodium chloride per 100 ml. or about 3·2/1,000 of the total osmotic pressure. This change is so small that ultra-filtration cannot play any considerable part in the formation of aqueous humor.

A full account of the experiments contained in this and the previous communication will appear in *Acta Physiologica Scandinavica*. A series of papers dealing with the pressure relations after unilateral carotid closure is in the press in *Acta Ophthalmologica*.

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Role of the Earthworm Nephridium in Water Balance

OSMOTIC and volume regulation have been studied in the earthworm *Lumbricus terrestris* by many investigators, but no very convincing evidence has been presented regarding the part played by the nephridia. Overton[1] observed an initial loss of weight on handling the worm, and attributed this to the expulsion of fluid through the nephridiopores ; but Adolf[2] failed to confirm this and concluded that there was "no evidence that the nephridia are at all concerned in the water exchange of earthworms". Since then, Maluf[3] has confirmed Overton's observation and has brought indirect evidence to suggest that the urine is hypotonic to the body fluids. Still more recently, Bahl[4], working on *Pheretima*, collected urine by draining from forty to fifty worms in a glass vessel, and showed that the fluid obtained in this way was hypotonic to the cœlomic fluid.

The purpose of this communication is to state that it has recently been found possible to collect urine directly from a single nephridiopore, by inserting a fine pipette, in sufficient quantity for vapour pressure determination by the Hill–Baldes method. Previous to the experiment, the worm (*L. terrestris*) is kept for some days in tap water, and during the process of collection, which takes two to three hours, it is pinned down in a moist chamber. Since the orifice of the pipette is readily blocked with mucus, etc., only a limited proportion of attempts are successful, but results have been obtained as follows, osmotic pressure being expressed in terms of the equivalent concentration of sodium chloride per cent.

Experiment	Cœlomic fluid	Urine
1	not recorded	0·10 0·12
2	0·41	0·06 0·05
3	0·65	0·19 0·14
4	0·52	0·08

These results, although thus limited, are sufficiently clear-cut to indicate that the urine is strongly hypotonic to the cœlomic fluid, which implies that the nephridia have an active role in water balance.

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Chromosome Number of *Rorippa (Nasturtium) sylvestris*

THE only published count of the chromosome number of *Rorippa sylvestris* (L.) Besser (= *Nasturtium sylvestre* (L.)R.Br.) appears to be that of Manton[1], who found $2n = 32$. In a search for the other parent species which, with *Nasturtium officinale*, has given rise to the allotetraploid species *N. uniseriatum*[2], I studied a specimen of *R. sylvestris* obtained from the Newry canal at Newry (border of Co. Down and Co. Armagh, N. Ireland) and found this plant to have a chromosome number of $n = 24$ and $2n = 48$. Similarly, specimens of *R. sylvestris* from Horton-in-Ribblesdale (Yorkshire) and from the Botanic Gardens at Cambridge and Kew (the plant was growing as a weed in both gardens) were all found to have a chromosome number of $n = 24$. There thus seems no doubt that British specimens of *R. sylvestris* have a chromosome number of $2n = 48$ and not $2n = 32$ as reported by Manton.

Prof. Manton obtained her specimen of *R. sylvestris* as seeds labelled *Nasturtium lippizense* from the Munich Botanic Gardens. There is a single sheet of the plant of which the chromosome number was counted by Manton in the University of Manchester Herbarium. Unfortunately, it has no fruits, and the separate fruits which have also been preserved are not adequate for determining whether Manton's plant really was *R. sylvestris*. Also *N. lippizense* is listed as a distinct species in the Kew Index, and is not a synonym for *N. sylvestre*. It is thus possible that Manton's count does not refer to *R. sylvestris*, but to the European species *N. lippizense*.

Both the cuttings of the single plant from Newry and the clone of *R. sylvestris* growing in the Cambridge Botanic Gardens produced no seeds by natural pollination. A high set of good seeds was, however, obtained by bud pollination or by crossing the Newry and Cambridge plants. It thus seems that *R. sylvestris* is self-incompatible. This is rather unexpected in a hexaploid species, the basic chromosome number in the genus *Rorippa* being 8.

My thanks are due to Mr. C. A. Cheetham, Mr. H. Gilbert Carter and Mr. N. Y. Sandwith for specimens, and to Mr. V. Chapman for making the cytological preparations.

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Amniotic Inoculation of Chick Embryos

THE respiratory tract of the developing chick embryo is susceptible to infection with various bacteria and the viruses of influenza, psittacosis, herpes and certain other infections of man and animals. This infection of the respiratory system is secured most readily by an inoculation of the virus directly into the amniotic cavity. Various techniques have been devised for this purpose, by Goodpasture, Hirst and others, but the most popular is probably that of Burnet[1]. By this method, virus is inoculated under direct vision into the amniotic cavity, which seems preferable to methods where the inoculation is made 'blind'.

In the course of studies on the reaction of the respiratory system to amniotic inoculation of influenza virus (to be published), it was discovered that Burnet's method could be simplified. The method that I have used seems to be such an obvious modification of Burnet's technique that doubtless other workers have come to use a similar method, but I have not seen any references to the use of such a procedure. I have decided to publish this note as there seems to be an impression that amniotic inoculation is difficult; but this need not be so, and the technique deserves wider application in experimental work.

Eggs of 13–14 days are candled, and the site of the densest area of the embryo marked with a pencilled cross. An equilateral triangle, with sides about 1 cm., is then drilled in the shell with a rotating disk, operated by a foot or electrically-driven dental drill. The shell in this area is then lightly dabbed with methylated spirit, and when this has dried, the triangle is gently levered off with a mounted dissecting needle sterilized by flaming. The shell membrane is now exposed, and should be undamaged. A drop of sterile saline is then placed on the shell membrane and a small opening made with a dissecting needle. The drop is coaxed to run under the shell membrane to separate it from the underlying vascular, easily damaged, chorio-allantois. A pair of delicate forceps, without teeth, is then used to tear away gently the triangular area of shell membrane. This can easily be done without damaging the chorio-allantois, especially as it is usually found that by this time it has dropped down some little distance. A heated dissecting needle is now used to make a small 'nick' in the chorio-allantois. The heated needle will make a short tear, and at the same time seal any opened vessels, thus minimizing bleeding.

A pair of sterile fine curved forceps is now passed through the tear in the chorio-allantois. The forceps are then opened and the underlying amnion grasped and pulled through the tear. The inoculation is then made into the amniotic cavity through a delicate short-bevelled needle attached to a 1 c.c. syringe held in the other hand. On completion, the amnion slips back into place. Sometimes, especially in older embryos, the embryo can easily be seen under the chorio-allantois as soon as the shell membrane is reflected. If so, it is not necessary to cut the chorio-allantois, as the inoculation can be made simply by passing the needle through the chorio-allantois and amnion into the amniotic cavity.

The triangle in the shell is then ringed round with a mixture of molten 'Vaseline' (with a little added hard paraffin) applied by a pasteur pipette. A sterile coverslip is quickly flamed and applied to the 'wall' of 'Vaseline'. Before placing in the incubator, the egg should be held level with the eye, to make certain that there is no gap in the 'Vaseline' ring. The embryo should be observed daily, and if still alive vigorous movements will be seen.

The only important modification in this method is that I do not find it necessary to 'drop' the chorio-allantois artificially by applying suction to a hole in the air-sac end of the egg.

Various authors who have used amniotic inoculation speak of a mortality-rate in the embryo, from the effects of the inoculation *per se*, of 30–40 per cent. I have not yet inoculated sufficient embryos to give a definite figure, but I have on a number of occasions inoculated a batch of up to six with sterile broth, and found most to survive in a healthy state for many days, suggesting a lower rate of mortality.

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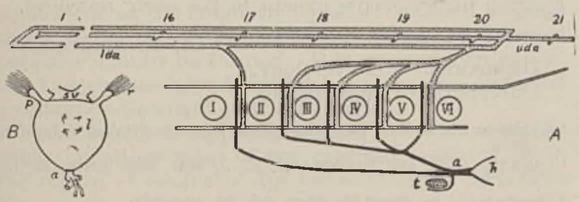
A Living Bony Fish which Differs Substantially from all Living and Fossil Osteichthyes

In 1883, Gill and Ryder[1] stated that *Eurypharynx* (order Lyomeri) has *six* branchial clefts and *five* holobranchs, a feature found in some Selachians but never in Osteichthyes. However, the nature of this extra cleft and gill was uncertain, and the very fact of their presence was considered doubtful. Through the kindness of Dr. Å. V. Tåning, of the Marine Laboratory, in Charlottenlund Slot, I received a number of specimens of *Eurypharynx*. All the *Eurypharynx* which I have examined invariably have *six* branchial clefts and *five* holobranchs.

Eurypharynx has true bones with cells. The dorsal end of the hyomandibula articulates with the auditory capsule laterally to the head vein (characters of Osteichthyes). But in contrast with Osteichthyes, there are no opercular bones and there is no secondary upper jaw (premaxilla and maxilla). The dorsal element of the mandibular arch consists of two bones, the quadrate articulating directly with the ventral end of the hyomandibula, and another bone acting as the upper jaw. The latter bone is closely united with the suspensorium, its posterior end being attached to the inner side of the quadrate; it lies medially to the m. adductor mandibulæ. Thus, this bone corresponds apparently to the pterygoid and the palatine.

The hyoid arch consists of a single element, the hyomandibula; there is no symplectic and no trace of the ventral hyoid elements.



(*A*) Diagram of the branchial region of the arterial system of *Eurypharynx*, left side, slightly from above
Afferent arteries black; efferent arteries dotted. I–VI, branchial clefts; 1–20, segments of the body (segments 2–15 not shown in the figure); *a*, ventral aorta; *h*, bulbus aortæ; *lda*, lateral dorsal aorta (paired); *t*, thyroid; *uda*, unpaired dorsal aorta
(*B*) Pericardium of *Eurypharynx* with the pectoral fins attached to it. Ventral view, diagrammatic
a, ventral aorta; *l*, ligaments attaching the ventral muscle of the body to the pericardium; *p*, lobes of the pectoral fins; *r*, fin rays; *sv*, sinus venosus

Cephalic nerves. The hyoid branch of the facial nerve does not extend behind the foremost branchial cleft. The glossopharyngeal nerve runs into the septum dividing this cleft from the second one. Branches of the n. vagus pass behind the second, third, fourth, fifth and sixth branchial clefts. Thus, the foremost cleft corresponds to the first branchial cleft and the posterior branchial cleft is an extra one, homologous to that found in some Selachians.

Vascular system. The ventral aorta is short. It divides vertically into three short trunks from which issue six pairs of afferent arteries. The most ventral pair supplies with blood the thyroid gland and the ventral muscle of the body; the next five pairs are the branchial afferent arteries.

The efferent branchial arteries are united above and below the branchial clefts by lateral commissural vessels forming vascular loops round the second, third, fourth and fifth branchial clefts. In this respect *Eurypharynx* recalls Selachians rather than Osteichthyes.

Beside the lateral dorsal aortæ, which unite anteriorly forming the circulus cephalicus, an anterior unpaired dorsal aorta extends from the hind end of the branchial region to the cranium; it runs between the left and right lateral dorsal aortæ, and gives off twenty pairs of inter-segmental arteries. Such a structure is not found in Osteichthyes; it recalls rather the condition of *Myxine* and Selachian embryos[2].

The branchial clefts of *Eurypharynx* are surrounded by muscular sphincters.

The pericardium of *Eurypharynx* is very thick and has an unusual relation to the pectoral fins. These fins are small with lobate basal parts. The basal parts extend inwards and forwards, pass through the septum dividing the cœlom of the body from the heart and unite firmly with the posterior ventral edge of the pericardium. The elastic fibrillæ of the pericardial wall pass right into the lobes of the fins. In supporting the pectorals the pericardium acts as the shoulder girdle. The pectoral fins are small, but functional, for their muscles are well developed; thus the movements of these fins probably affect the working of the heart. The relations between the pericardium and the pectorals of *Eurypharynx* appear to be unique among fishes.

Only some of the features of *Eurypharynx* are mentioned here, but even these brief characteristics show that it disagrees most substantially with other bony fishes (Osteichthyes).

There seems no reason to consider these unusual features as merely modifications due to unusual surroundings and habits. The Lyomeri live in the same milieu as many other deep-sea fishes, feed upon similar food, and struggle against the same enemies. They are large fishes (some up to 6 ft. long), and are widely distributed over the deep parts of the seas. Two families of Lyomeri are known: Eurypharyngidæ and Saccopharyngidæ, the latter with several species. Thus one can scarcely consider profound differences between Lyomeri and other Osteichthyes as mere secondary adaptations having no phylogenetic importance. The problems mentioned will be dealt with fully elsewhere.

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Ecdysis and Growth in Crustacea

The restriction of increase of size to the immediate post-ecdysal period is a feature of growth peculiar to Arthropods. The rapidity of the increment suggests that it is due merely to inflation of the body with fluid[1,2,3], while true growth, that is, the addition of new protoplasm and cell division, is probably continuous as in other groups. There remains the question : Does the post-ecdysal inflation affect the cavities of the body, the tissues, or both ?

The phenomenon has been studied histologically on *Asellus aquaticus*, the habit of moulting of which in two stages enables fixation of individuals when the posterior half of the body has already undergone ecdysis and the subsequent increase in size, whereas the anterior half is still in the pre-ecdysal stage. From longitudinal, particularly frontal, sections, the pre- and post-ecdysal histology of the metamerically homologous body-segments may be compared synoptically, after identical technical treatment. Some twenty preparations were studied at various stages of the 'intramoult' period.

In addition to general observation, the following data were compared in the pre- and post-ecdysal regions : (1) number of cells per unit extent of the epidermis ; (2) dimensions of corresponding structures, from total body width and depth to particular cells and their nuclei ; and (3) relative size of the hæmolymph, and other, cavities. Representative results are shown in the accompanying table.

	No. 1		No. 2	
	Pre-ecdysal	Post-ecdysal	Pre-ecdysal	Post-ecdysal
No. of cells per 40 unit extent of epidermis	9·7 (10)	7·8 (8)	8·0 (10)	7·3 (8)
Thickness of epidermis	4·4 (11)	7·7 (10)	8·6 (5)	11·9 (5)
Thickness of sarcoplasm of main muscles of limb-base	10·7 (14)	11·8 (14)	14·7 (6)	16·2 (6)
Total thickness of these muscles	41·4 (9)	82·0 (5)	—	—
Max. diam. of nuclei of epidermal cells	—	—	3·5 (42)	3·8 (34)
Max. diam. of nuclei of muscles	4·6 (15)	4·5 (24)	3·9 (15)	4·3 (16)
Max. diam. of nuclei of cells of hind-gut	15·4 (11)	13·2 (8)	19·0 (16)	16·1 (14)
Max. diam. of nuclei of cells of digestive diverticula	—	—	17·7 (12)	17·5 (11)

The figures, in units (mm. × 3[illegible]0), are averages. the number of observations being shown in brackets.

There was no evidence of mitosis during ecdysis. The number of cells per unit extent of the epidermis actually decreased (see table), and the classical view of a simple inflation with fluid is no doubt correct. Under optimum conditions there was an approximation to the two-fold increase in total volume required by the Brooks–Przibram law[4].

The inflation affects not only the hæmolymph and all cavities, including intercellular spaces, but also the cells and tissues themselves (for example, epidermis and muscle). This is shown also by a marked decrease in the density of staining of the tissues, and by an evidently wider spacing of the muscle fibres and increased vacuolation of the cytoplasm. There was no measurable increase in cell-size in the hind gut, the digestive diverticula and the ovary, which extend through both pre- and post-ecdysal regions, though the cavities of the two former organs increased. There appeared to be no significant increase in size of the nuclei of any tissues ; unfortunately the nuclei of those tissues (epidermis and muscle) which showed a clear cellular enlargement are not large enough (10 μ) for accurate measurement, even with the oil immersion objective. The smaller size of rectal nuclei in the posterior half of the body may be an intrinsic local difference.

Towards the onset of ecdysis, the epidermal cells become filled with ovoid inclusions which may be material resorbed from the inner layers of the old exoskeleton[1]. Their staining reaction, with Heidenhain's Azan, seems to change from blue to red with the progress of resorption. This is probably a genuine change, and not an effect of slight variations in technique, since the pre-ecdysal tissue (muscle in particular) is usually bluer than the post-ecdysal, under identical treatment. The inclusions disappear rapidly after ecdysis, and it seems probable that their solution may assist the post-ecdysal inflation by increasing the osmotic pressure within the body.

In the pre-ecdysal anterior half of the body, after the ecdysis of the posterior half, water would tend to flow into the space formed, by resorption, underneath the old exoskeleton; but this is prevented by light adhesion of the latter, around its free posterior margin, to the new exoskeleton forming below.

In ecdysis, any available rough surface is used to anchor the dactyl-claws of the walking legs and facilitate withdrawal from the exoskeleton, but the animal emerges successfully on a smooth glass substratum. The barb-like orientation of the free ends of most of the setæ towards the distal ends of the limbs and of the abdominal plate ensures that the tissues can move only in a proximal direction relative to the exoskeleton. By unco-ordinated muscular activity the various parts are thus in turn drawn a little farther from the exuvia. The total diminution in volume of the soft parts during the process of withdrawal is very considerable ; in old or pathological individuals the post-ecdysal increase is not always sufficient to restore the volume, and 'degrowth' may be said to occur. The soft parts are remarkably plastic, the broad flat abdominal plate passing quickly and easily through the round narrow 'waist' and then rapidly recovering its normal shape. The new exoskeleton hardens within 1–3 hours. Ecdysis rarely occurs except in the early morning.

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Geomagnetic Control of Region F_2 of the Ionosphere

IN a recent communication in *Nature*, Sir Edward Appleton[1] has brought forward unmistakable evidence of geomagnetic control of the distribution of ionization in the F_2 layer. In particular, he has shown from an examination of the world data that, "for noon equinox conditions, there is a belt of low values of f_{F_2} circling the earth and centred roughly on the magnetic equator". The geomagnetic control raises the important question of the nature of the source of the control. Since magnetic disturbances and auroras are also subject to similar control, one can envisage, in common with the probable origins of these geophysical phenomena, two possible sources :

(1) It may be imagined that part at least of the F_2 ionization is produced by bombardment of the upper atmosphere by charged particles (after the Birkeland–Störmer hypothesis of auroras and magnetic disturbances). Further, since the points of precipitation of these particles are controlled by the terrestrial magnetic field, the geomagnetic control of F_2 layer ionization is understood. This, however, raises the old difficulty of the speeds of such particles; in order to reach low latitudes they must possess velocities approaching that of light. Such energetic particles are too penetrating to ionize atmospheric gases in the F_2 region.

(2) The above difficulty is avoided if one makes the plausible assumption that the charged particles are of terrestrial origin (after the ultra-violet light theory[2] of auroras and magnetic storms). In the region high above the F_2 layer where the fringe of the atmosphere might be supposed to begin, the collisional frequency is very small and the electrons and ions produced by solar ultra-violet rays have very long free paths. They are thus free to spiral round the magnetic lines of force and, at the same time, are roughly guided along them, because, when formed by photon absorption, they will in general have velocity components along the lines of force. Now, at the magnetic equator the lines of force rise highest and slope north and south. The ions and electrons formed in the high atmosphere in the belt along the magnetic equator are therefore guided north and south and, when they come down to the lower levels, contribute to the ionization density of Region F_2. The densities on either side of the magnetic equator are thus increased by this 'distilling' process which operates throughout the daylight hours.

It should be mentioned at this point that the 'ultra-violet light theory' fails to explain the auroral phenomena, because, as was pointed out by Chapman[3], the lines of force which enter the terrestrial atmosphere near the auroral belt rise to 30,000–40,000 km. at the magnetic equator. At such heights, there being no atmosphere, the necessary charged particles cannot be formed. But, as is shown below, the theory can be adapted to explain the observed geomagnetic control of the F_2 region.

From Fig. 2 of Appleton's note, it is seen that the peaks on either sides of the magnetic equator lie in the region of magnetic dip value of about 28°. The geomagnetic lines of force which enter the earth's atmosphere in this region (dip value 19°–34°) at 400 km. level rise to heights of 600–1,200 km. over the magnetic equator. It therefore follows that if, (1) there are atmospheric particles in sufficient numbers at such heights, and (2) these particles are ionized by solar ultra-violet rays, then the ions and electrons so formed will be guided to the regions of the observed peaks of Appleton's curve. Now, direct evidence on these two points is furnished by the sunlit auroras[4]. The fact that these auroras are observed at heights of 600–1,100 km. is evidence that there are sufficient atmospheric particles at such heights. The proof of ionization by solar radiation is furnished by their spectrum, in which the first negative bands, due to N_2^+, are greatly enhanced.

In the illustrative example, the 400-km. level has been taken as the level of entry of charged particles into the atmosphere. This is because at about this level the collisional frequency begins to be sufficiently high to prevent the particles from freely following the magnetic lines of force. Assuming the atmospheric density in Region F_2 (250-km.) level to be 10^{10}/c.c., the collisional frequency of electrons 10^3/sec. and a rising temperature of 4° K./km. above (all as indicated by radio observations[5,6]), the densities at the 400-km. and the 600-km. levels are found to be of the orders of 3×10^8 and 2×10^7/c.c. and the collisional frequencies 30 and 2 per sec. respectively. For a temperature of 2,000° K. the mean velocities are 3×10^7 cm./sec. for an electron and $1 \cdot 3 \times 10^5$ cm./sec. for an ion. The radius of gyration at the 600-km. level is 7 cm. for an electron and $1 \cdot 6 \times 10^3$ cm. for an ion.

It is to be noted that in the high atmosphere where collisions are few and far between, the lengths of the free paths, as first pointed out by Jones[7], are strongly dependent on their directions. In an upward direction this length may be many times that in a downward direction.

In conclusion, attention may be directed to the fact that, according to observations of Rayleigh and Spencer Jones[8], the seasonal variations of the intensity of night sky radiation are related to geomagnetic latitude. Since, as I have shown[9], the nocturnal Region F is to be identified with the luminescent layer of the night sky, the geomagnetic control of the intensity of night sky radiation can also be understood.

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Nuclear Magnetic Resonance and Spin Lattice Equilibrium

By measuring the absorption of radio-frequency energy by a substance in a magnetic field due to nuclear magnetic resonance[1,2], an estimate can be made of the order of magnitude of the time required for the establishment of thermal equilibrium between the spin system and the lattice. The absorption coefficient is proportional to the difference between the population of the magnetic energy states. The effect of the radio-frequency field is to tend to equalize the population of the states, so that in a strong radio-frequency field the absorption coefficient is less than in a weak field. This tendency to equalize the population of the states is opposed by the effect of the spin-lattice coupling, which tends to restore thermal equilibrium with the lattice. By finding the magnitude of radio-frequency field required to produce an appreciable reduction in the absorption coefficient, the relaxation time for transfer of energy from the spin system to the lattice can be calculated.

Measurements have been made by observing the damping of a resonant circuit due to the nuclear absorption by a method similar to that employed by Purcell, Torrey and Pound[2]. The specimen was placed inside the coil of a tuned circuit situated in a transverse magnetic field which was modulated at 750 c./sec. Radio-frequency power from a crystal oscillator was fed through the tuned circuit to an amplifier followed by a detector and tuned audio amplifier. When the mean value of the magnetic field was adjusted to a value near resonance, the radio-frequency power reaching the detector was modulated at 750 cycles by the variation in the loss in the tuned circuit due to the nuclear absorption. The signal to noise ratio was increased by the application of positive feedback to the tuned circuit. Measurements have been made at a frequency of 2 Mc./sec. and also at 16 Mc./sec. The signal voltage due to absorption by protons in water at 16 Mc./sec. was of the order of a hundred times the noise voltage. An estimate can be made of the width of the resonance line by finding the change in signal amplitude with variation of the amplitude of modulation of the magnetic field.

Measurable absorptions have been observed so far only with substances containing protons or fluorine nuclei. Observations have been made at room temperatures and liquid air temperatures. In all the substances investigated, the results seem to indicate that the resonance line is stronger and sharper in the liquid than in the solid state; for example, with paraffin wax in the molten state, the width of the resonance appears to be about 2 kilocycles, but, on solidification, it increases to about 40 kilocycles, and the absorption coefficient drops correspondingly. From the change in absorption coefficient with input power, a relaxation time of the order of a second is derived for the liquid. In the solid state the relaxation time seems to be shorter. Most proton-containing liquids such as water, methyl and ethyl alcohol, acetone and benzene appear to have a relaxation time of about a second; but in glycerol it is shorter. Observations on ice have so far failed to indicate any measurable absorption, and it seems possible that this may be due to a greatly increased broadening of the line in the solid which makes the absorption coefficient too small to detect. A search has been made for absorption in heavy water, but so far no result has been obtained; the absorption coefficient is at least ten times smaller than in ordinary water. This may be due to a broadening of the resonance by interaction between the nuclear quadrupole electric moment and the internal electric field in the liquid. In fluorine compounds a strong sharp resonance has been found with a substituted liquid hydrocarbon (φ dimethyl cyclohexane, C_8F_{16}) and a weak broad resonance in calcium fluoride. A search for resonance absorption by other nuclei has so far given negative results.

Experiments have been made to find whether there is any change of relaxation time with temperature apart from the change on solidification. In the region between room temperature and liquid air temperature, there appears to be no considerable change.

Further measurements are in progress at liquid hydrogen and helium temperatures.

B. V. Rollin

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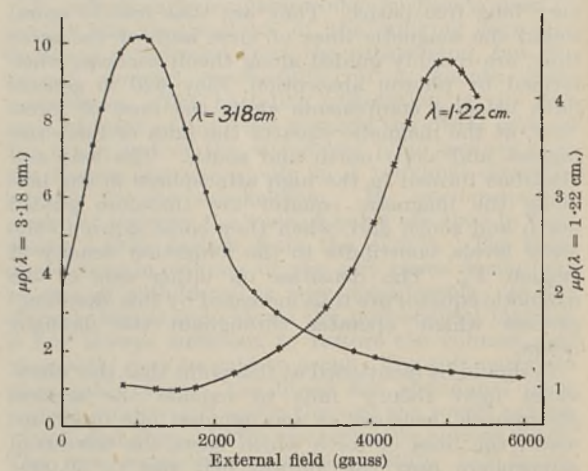
Oct. 14.

[1] Gorter, *Physica*, 3, 995 (1936).
[2] Purcell, Torrey and Pound, *Phys. Rev.*, 69, 37 (1946).

Anomalous High-frequency Resistance of Ferromagnetic Metals

The energy lost by a high-frequency current flowing in a conductor is dependent on the product of the electrical resistivity ρ and the magnetic permeability μ of the conductor, and this fact has been used by several investigators[1,2,3] to determine the effective permeability of ferromagnetic metals at high frequencies.

In attempting to measure the permeability of ferromagnetic metals at wave-lengths of about 1–3 cm., it has been found that a new phenomenon appears. Normally when a magnetic field of greater than a few gauss is applied to a ferromagnetic metal, the differential permeability decreases steadily to 1 as the field is increased. At these high frequencies, however, it appears that there is a large increase in the product μ × ρ at a certain magnetic field which depends on the frequency, as shown in the accompanying figure.



The experiment was performed as follows. A thin film (about 0·025 mm. thick) of the ferromagnetic metal was prepared by electroplating one side of a brass disk which formed one end of a cylindrical resonator, excited in the H_0 mode at a wave-length of 1·22 cm. A similar arrangement was used at 3·18 cm. except that the resonator was excited in the H_1 mode. A steady magnetic field H was applied with the lines of force parallel to the surface of the disk and the Q (circuit magnification) of the resonator measured for different values of the field H. From these measurements the change of the product μρ with magnetic field H may be determined. The values of μρ for nickel are plotted as ordinates in the figure against the magnetic field H. The 3 cm. curve shows, as expected, that as H increases to large values, μρ decreases to a constant value and the ordinate scale on the left of the figure, which refers to the 3-cm. measurement, gives the ratio of μρ to the value extrapolated to $H = \infty$.

The magnetic field available was not sufficient to enable an extrapolation of the 1 cm. curve to be made, and in this case, μρ at $H = 0$ is set equal to 1. This scale is shown on the right of the figure. Although it is difficult to determine the scale of the μρ values accurately, errors in this measurement will not change the shape of the curve, and the scales given in the figure are certainly of the right order of magnitude.

It will be seen that, superposed on the expected decrease of μ with magnetic field, there is a variation of $\mu\rho$, which has the appearance of a broad resonance curve, the value of H for which $\mu\rho$ is a maximum being dependent on the wave-length.

The results so far obtained are given in the accompanying table. No effect was found with silver-plated nickel.

Metal	λ (cm.)	H for $\mu\rho$ max. (gauss)	μ_H	H^1	$H\lambda \times 10^{-3}$	$H^1\lambda \times 10^{-3}$
Ni	1·22	5,000	2·3	7,150	6·1	8·7
,,	1·43	3,800	2·6	5,900	5·4	8·4
,,	3·18	1,030	7·3	3,180	3·3	10
Fe	1·22	2,800	8·6	9,900	3·4	12
,,	3·18	500	42	7,350	1·6	23
Co	3·18	510	26	4,760	1·6	15

Until more experimental work has been done, it would be premature to attempt a theoretical interpretation of these results, but the following points may be of interest. It is clear that the effect will depend on the magnetic field inside the metal which is acting on the magnetic dipoles. The demagnetizing field is fortunately negligible in the case of a thin film with magnetic field parallel to the surface, and a crude approximation to the internal field H^1 may be obtained by using the Lorentz expression

$$H + \frac{4}{3}\pi I = H\left(1 + \frac{\mu_H - 1}{3}\right),$$

where I is the intensity of the magnetization and μ_H the permeability at the field H. The values of H^1 are given in column 5 and of $H^1\lambda$ in column 7 of the table. A comparison of columns 6 and 7 shows that $H^1\lambda$ is less dependent on wave-length and material than $H\lambda$, but it increases with μ_H, particularly for large values of μ_H. The main uncertainty in this calculation lies in the use of the Lorentz field, which is unlikely to be correct when μ_H is large.

It is also of interest that the values of $H^1\lambda$ are of the order of magnitude of

$$\frac{2\pi \times mc}{e} = \frac{hc}{2\mu_B} = 10{\cdot}7 \times 10^3 \text{ gauss/cm.},$$

which is given by the relation $2\mu_B \times H = h\nu$, where μ_B is a Bohr magneton. This suggests that resonant absorption by the magnetic dipoles (which may, of course, be multiples of μ_B) is taking place, leading to a loss of energy from the field.

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Oct. 15.

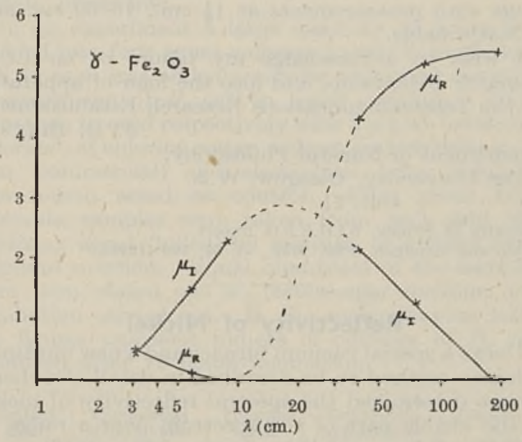
[1] A review of previous work is given by Allanson, *J. Inst. Elect. Eng.*, Pt. 3, 92, 247 (1945).

[2] Simon, *Nature*, 157, 735 (1946).

[3] Hoag and Jones, *Phys. Rev.*, 42, 571 (1932).

Magnetic Dispersion of Iron Oxides at Centimetre Wave-lengths

The electromagnetic properties of ferroso-ferric oxide and gamma-ferric oxide have been measured at wave-lengths of 9, 6 and 3 cm. The oxides in powder form were mixed in various proportions with a low-loss, non-magnetic binder, paraffin wax. Moulded specimens of the mixtures were inserted in a slotted transmission line (coaxial line at 9 cm. and 6 cm.: H_{10} rectangular wave-guide at 3 cm.) fitted with a movable crystal detector probe, and measurements were made of the input impedances of the specimens when terminated in a short-circuit, and in an open-circuit (obtained experimentally by terminating in a short-circuited quarter wave-length line). The input impedance was derived from the voltage standing wave ratio n and the position of the voltage minimum. n was obtained indirectly from the relation $n^2 = 1 + \text{cosec}^2\,\beta x$, where β is the phase velocity in the measuring line, and x the distance between points at which the high-frequency voltage is $\sqrt{2}$ of its value at the minimum. In this way all measurements were carried out with crystal currents of less than 1·2 microamp., a range in which they were accurately proportional to the square of the high-frequency voltage.



The characteristic impedance z_0 (relative to that of the measuring line) and the propagation coefficient γ of a sample, thickness d, are obtained from the relative short-circuit and open-circuit impedances z_{sc}, z_{oc} by the relationships:

$$z_0 = \sqrt{z_{sc}\, z_{oc}}; \quad \tanh \gamma d = \sqrt{\frac{z_{sc}}{z_{oc}}}.$$

z_0 and γ are related to ε and μ, the complex permittivity and permeability of the material, by

$$z_0 = \sqrt{\mu/\varepsilon}; \quad \gamma = \frac{2\pi i}{\lambda}\sqrt{\mu\varepsilon}$$

for the coaxial transmission line, and by

$$z_0 = \mu\sqrt{\frac{1 - (\lambda/\lambda_c)^2}{\varepsilon\mu - (\lambda/\lambda_c)^2}}; \quad \gamma = \frac{2\pi i}{\lambda}\sqrt{\varepsilon\mu - (\lambda/\lambda_c)^2}$$

in the case of the H_{10} wave-guide, where λ is the free-space wave-length, λ_c the cut-off wave-length of the guide.

From measurements on mixtures up to 50 per cent concentration, at the three wave-lengths, it is found that the complex permeability μ varies with v, the proportion by volume of the oxide, in accordance with the theoretical Clausius–Mosotti relation,

$$\frac{\mu - 1}{\mu + 2} = v\,\frac{\mu_a - 1}{\mu_a + 2},$$

where μ_a $(= |\mu_a| \exp(-i\mu'_a))$ is the complex permeability of the oxide (extrapolated to 100 per cent concentration). The derived magnetic properties of the two oxides are listed below.

	Fe_3O_4			γFe_2O_3		
λ in cm.	8·93	5·97	3·085	8·93	5·97	3·085
$\|\mu_a\|$	2·53	1·72	1·08	2·30	1·49	0·65
μ'_a	66°	66·7°	63°	90°	86°	40·5°

In the figure, the real and imaginary components of μ_a for γFe_2O_3 are plotted, together with Hüttig's measurements[1] on the solid oxide for wave-lengths from 39 to 174 cm.

Both oxides show a rapid decrease of $|\mu|$ with wave-length, and this is accompanied by a large magnetic absorption. The similarity of behaviour of the two oxides is almost certainly due to similarity of crystal structure, as suggested by Welo and Baudisch[2] from their work with static magnetic fields.

The measurements are being extended to solid samples of the two oxides, and to other ferromagnetic compounds, and it is hoped to widen the wave-length range with measurements at $1\frac{1}{4}$ cm., 15–60 cm. and in static fields.

I wish to acknowledge my tenure of an I.C.I. Research Fellowship, and also the loan of apparatus by the Telecommunications Research Establishment.

J. B. Birks

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Oct. 11.

[1] Ministry of Supply, S.I.G.E.S.O. Report.
Welo and Baudisch, *Phil. Mag.*, vi, 50, 399 (1925).

Reflectivity of Nickel

Using a special vacuum furnace and a new multiple-reflexion method to be described in detail elsewhere, I have determined the spectral reflectivity of nickel in the visible part of the spectrum over a range of 400° C. A beam of light from a 100-watt filament lamp was reflected four times at a nickel mirror, and compared with a standard beam from the same source, the intensity of the standard being reduced by means of a rotating sector until a match was obtained between the two for any given wave-length.

It was found that no discontinuity occurred at the Curie point. Following a theory of Gerlach's[1] and an investigation on the emissivity of nickel in the infra-red by Löwe[2], this was only to be expected: such a discontinuity does not occur for wave-lengths less than 4·5 μ.

The temperature coefficient of reflectivity was found to be positive and varied from $0{\cdot}85 \times 10^{-4}$ in the red to $1{\cdot}6 \times 10^{-4}$ in the blue. This is in good agreement with Reid's[3] value of $6{\cdot}6 \times 10^{-5}$ for 0·8 μ, and 0 at 2·15 μ. It is well known that in the infra-red the temperature coefficient of reflectivity is negative for all metals. In fact, for wave-lengths greater than 10 μ, this coefficient is determined by the temperature coefficient of the electrical conductivity, the relation between reflectivity and conductivity σ being

$$R = 1 - 2\sqrt{\frac{\nu}{\sigma}}.$$

It is evident that for a certain wave-length the reflectivity coefficient must be zero. Attention was first directed to this phenomenon by Price[4], but no explanation was advanced.

It is also known that the above equation breaks down as the visible part of the spectrum is approached from the infra-red, and Mott and Jones[5] and Seitz[6] believe that a surface layer of very great resistivity is responsible. The above findings throw some light on this hypothesis. If a surface layer caused the reduction in reflectivity which is found, then it might also be expected that the absolute value of the temperature coefficient would be reduced, since work on thin films has shown repeatedly that, as the film under test is made thinner, its conductivity and the temperature coefficient of the latter are reduced. Yet this does not explain the appearance of a *positive* temperature coefficient. In a few isolated cases very thin films (other than bismuth) have shown a positive temperature coefficient of conductivity. These results have generally been dismissed as due to a faulty technique in the preparation of the films, etc. Such objections, however, cannot be raised in connexion with solid metal mirrors the thickness of which is 0·2 in. In the case of reflectivity, two factors enter the picture: first the absorption coefficient ($n\,k$) and secondly, the dielectric constant (ε), where n is the ordinary refractive index, and k the extinction coefficient. Then, by Maxwell's equations

$$n\,k = \frac{\sigma}{\nu} \text{ and } n^2 - k^2 = \varepsilon,$$

ν being the frequency of light. The explanation advanced for the positive temperature coefficient of reflectivity is that, as the wave-length of light is reduced, the effect of the bound electrons becomes more marked, and thus the dielectric constant more prominent. To account for the positive temperature coefficient of reflectivity it is assumed that the part of the temperature coefficient of reflectivity to which the dielectric portions contribute is positive: this is a fair assumption since the dielectric constant of metals is often negative; if this constant is to have a meaning similar to that for insulators, its temperature coefficient also must be negative. Hence $\frac{-d(-\varepsilon)}{dT}$ is positive. Where the positive temperature coefficient of reflectivity (as conditioned by the dielectric) is equal to the negative coefficient (resulting from the free electrons or the conductivity), the point is obtained at which the temperature coefficient of reflectivity as determined by intensity measurements is zero.

To test the above hypothesis it is necessary to perform catoptric measurements so as to obtain the temperature variation of ε. A new sensitive method has been devised to this end, and experiments are in progress further to elucidate this problem of reflexion.

The above investigation was carried out for the Pyrometry Sub-Committee of the British Iron and Steel Research Association, which has kindly given permission for this communication to be published.

Robert Weil

South-West Essex Technical College,
London, E.17. Oct. 9.

[1] Gerlach, *Ann. Phys.*, 25, 209 (1936).
[2] Löwe, *Ann. Phys.*, 25, 212 (1936).
[3] Reid, *Phys. Rev.*, 60, 161 (1941).
[4] Price, *J. Iron and Steel Inst.*, Paper No. 7 (1943). *Nature*, 157, 765 (1946).
[5] Mott and Jones "Properties of Metals and Alloys", Chap. 3, p. 120.
[6] Seitz, "Modern Theory of Solids" (McGraw-Hill Book Co.), Chap. 17, p. 642.

The Ethoxyfluorsilanes

Two compounds of this series, $(C_2H_5O)_2SiF_2$ and $(C_2H_5O)_3SiF$, were recently described by Peppard, Brown and Johnson[1]. I wish to point out that I had previously prepared and characterized[2] the three compounds $(C_2H_5O)SiF_3$, $(C_2H_5O)_2SiF_2$ and $(C_2H_5O)_3SiF$. The publication of this work has been prevented by war conditions; but a paper is now in preparation.

The monoethoxy compound is a colourless gas, boiling at about − 7°. It is unstable at room temperature, disproportionating rapidly into SiF_4 and $(C_2H_5O)_2SiF_2$. The disproportionation proceeds to about one third of completion, at which point an equilibrium is set up. However, the compound can easily be purified by high-vacuum distillation at low temperature and pressure. The solid melts at − 122°. The diethoxy compound is also unstable by disproportionation ; even when distilled in high vacuum at temperatures in the neighbourhood of − 30°, it disproportionates about one eighth of the total into SiF_4 and one eighth into $(C_2H_5O)_3SiF$ at each distillation. Peppard, Brown and Johnson probably failed to note this compound as unstable, because of the circumstance that they distilled it only once with a long column ; had they repeated the distillation, they would have observed the disproportionation. The triethoxy compound is the most stable of the three, having no tendency to disproportionate even at temperatures near its boiling point. The boiling point is 134·6°, by extrapolation from the vapour pressure curve. This agrees reasonably well with the American authors' figure of 133°–133·5°.

The monoethoxy compound was prepared by fluorinating $(C_2H_5O)SiCl_3$ with SbF_3, and the other two by fluorinating $(C_2H_5O)_3SiCl$ with SbF_3. Reaction is vigorous and no catalyst is needed. Disproportionation occurs during the fluorination (whence the possibility of preparing $(C_2H_5O)_2SiF_2$ from $(C_2H_5O)_3SiCl$), and a mixture of all three fluoro-compounds is formed when either of the chloro-compounds is fluorinated.

In attempting to prepare the three chloro-compounds by Friedel and Crafts' method, the mono- and tri-ethoxy compounds were easily obtained pure and stable to distillation, but the diethoxy compound disproportionated, and the whole fraction eventually resolved itself, on repeated distillation, into the mono- and tri-ethoxy derivatives.

This work was carried out at the Imperial College of Science and Technology, under the direction of Dr. H. J. Emeléus.

H. G. Heal

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Seebach, Zurich 11. Oct. 5.

[1] *J. Amer. Chem. Soc.*, 68, 76 (1946).
Ph.D. Thesis, University of London, 1942.

Bactericidal Power of Electrolytic Hypochlorite

It has been long observed that hypochlorite liquor, freshly prepared by electrolysis of brine using carbon electrodes, possesses characteristic oxidizing properties distinct from chlorine water or from sodium hypochlorite prepared by the passage of chlorine into caustic soda solution. Masterman[1] made an extensive survey of the possible differences, and, using tetramethyl base, showed that electrolytic hypochlorite produced quite a different range of dyestuff colours from either of the other two chlorine agents. He suggested that this might be due to the presence of ozone in the electrolysed solution, since a similar colour reaction is given by that substance.

Experimental work carried out in this laboratory in 1938 on the oxidation of aniline confirmed Masterman's differential findings, but no evidence of the presence of ozone could be demonstrated.

Electrolytic hypochlorite is a buffered solution containing free hypochlorous acid and sodium hypochlorite. Degradation of hypochlorous acid produces hydrochloric acid which liberates further hypochlorous acid. It is possible that this labile hypochlorous acid is responsible for the enhanced oxidizing powers. It is significant that commercial hypochlorite is stabilized by alkalinization to *p*H 10, whereby free hypochlorous acid is neutralized.

Chlorine water, on the other hand, is still a solution of the gas (since the bulk of it may be removed by aspiration), and its oxidizing action probably occurs after chlorination of the reducing agent. A further suggestion that the electrolytic solution contains amounts of chlorites should also be borne in mind.

That there is a marked difference in the oxidation potential of the three substances may readily be demonstrated by their behaviour as bactericides to certain organisms.

In an experiment a large quantity of water was divided into four equal volumes in sterile containers, and to each was added a similar measured quantity of suspension of *B. coli* in water medium. These were then treated respectively with 2 p.p.m. 'available chlorine', of chlorine water, sodium hypochlorite solution (commercial) and electrolytic brine solution. The fourth acted as control. After given time intervals, samples were taken from each and the oxidizing agent 'killed' by addition of sodium thiosulphate solution. Equal quantities of the samples were then plated out on lactose-agar medium and incubation carried out. In the accompanying table the figures represent indices of colonies of *B. coli* produced after 72 hours incubation.

Contact time	Commercial hypochlorite	Chlorine water	Electrolytic hypochlorite	Control
0 min.	10	10	10	10
3 "	7	7	7	10
6 "	5	5	2	10
15 "	3	4	0·5	10
30 "	1	2	nil	10

It will be seen that, for equal quantities of oxidizing agent as measured by arsenite-iodine titration, electrolytic hypochlorite has definitely a more rapid bactericidal effect. These tests have been carried out with a number of different organisms using varying concentrations, with or without ammonia being present. In every case it is observed that the electrolytic hypochlorite has a more rapid bactericidal effect.

R. F. Milton
J. L. Hoskins

23–24 Welbeck Way,
London, W.1. Oct. 1.

[1] Masterman, A. T., *Analyst*, 64, 492 (1939).

Physiology in Horse-racing

Deeming the scientific world interested in all things, and competent to contribute useful help, I make no apology for introducing the subject of horse-racing and the riding of races therein.

Horse-racing is not a particular hobby of mine, but I have been much struck on a visit to Ascot races by the fact that, whereas in sprints up to a mile all jockeys try to keep among the prominent horses throughout the race, relying on extra speed at the end to win, in long-distance races there seems to be almost competition to be last at the beginning in order to be first at the finish. I cannot believe that this is based on the Biblical adage, but that in the minds of the very shrewd people whose business it is to do these things, it is thought to show advantages.

Now there are one or two fundamental considerations that seem to be forgotten, and one is that whoever covers the distance in the shortest time will win, though they may finish at a pace slower than any other horse running. Surely, therefore, a horse, like anything else having a limited amount of energy to expend, should go fast downhill and ease himself uphill. This apparently simple expedient is taboo I notice, anyhow at Ascot, where horses are pulled violently to prevent undue speed on the downhill, but must go fast uphill towards the finish.

I acknowledge the advantage of being paced from an aeronautical point of view, but provided you are not first, not much advantage accrues from being last as compared with second. There is also the fact that on any form of circuit, whatever its size, if you run parallel to another horse and can at no time get on the rails, you will have to go (allowing 4-ft. separation) 26 ft. farther. To be on the rails, therefore, is a definite advantage.

A race between a great French horse and a great English horse which I witnessed at Ascot will illustrate my point. The distance was two and a half miles. The French horse was instantly put among the leaders, using the downhill to get there easily, and lay third for most of the race. The English horse was pulled back at the beginning so as to be last, and for most of the race was at least 100 yards behind the Frenchman. Not until about seven furlongs from home, when the going was uphill, was he asked to close the gap. Nobly he did it, but when abreast of the Frenchman, the Frenchman was able easily to shoot ahead and win.

These tactics struck me as scientifically unsound. Were the tactics reversed a different result might have occurred, for I contend, and here I want corroboration or rebuttal, that the English horse was asked to exert more energy in that race than the Frenchman.

Dynamically and physiologically there is mechanical error here, that shows itself in tactics, that has crept into racing and wants exposing, and I should indeed like the views thereon of readers of *Nature*.

Tod Sloane with his forward seat revolutionized riding by jockeys, and he was scientifically right. It would indeed be very enjoyable if *Nature* could expose other fallacies in at present accepted turf procedure.

BRABAZON OF TARA

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Oct. 17.

I KNOW nothing about the technique of horse-racing, and there may be subtle reasons, or prosaic ones such as not desiring to break the horses' legs, why jockeys should not let their horses go too fast downhill. If, however, they were human and not equine runners, I should certainly say go faster downhill and slower uphill; at a guess, but I have not tried to work it out, I should say let them exert total energy at the same rate throughout the race. They would require less energy to run at the same rate downhill and more energy to run at the same rate uphill; so at a constant rate of energy expenditure they should go faster downhill and slower up.

For running on the flat the results of all physiological experiments allowed one to predict (and I did so predict a good many years ago) that the best times would be done by running at a uniform speed throughout a race. The energy spent in running a given distance increases as some power of the speed, so that you gain less during the time you go slow than you lose during the time you go fast. Running downhill is exactly like running with a following wind: the hill provides some of the energy to overcome air-resistance, the following wind reduces the air resistance. If I were advising human runners on a circular track on a windy day I should say run fast when the wind is behind and slow when the wind is ahead.

I wrote a paper on "The Air Resistance to a Runner"[1]; Best and Partridge wrote one on "The Equation of Motion of a Runner Exerting a Maximum Effort"[2]. Both these papers have a bearing on the same problem. Another paper on the same topic is that by Sargent on "The Relation between Oxygen Requirement and Speed in Running"[3].

Winning races is not always the same thing as doing the best time: there is tactics as well as strategy about it. Certainly, however, for doing the best time and getting the utmost out of oneself over a given distance, these rules apply. I see no reason why they should not apply to horses as well as men. Perhaps Lord Brabazon would like to repeat on horses (if the R.S.P.C.A. would let him) the experiments which Best, Partridge, Sargent and I made on men!

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Oct. 21.

[1] *Proc. Roy. Soc.*, B, **102**, 380 (1928).
[2] *Proc. Roy. Soc.*, B, **103**, 218 (1928).
[3] *Proc. Roy. Soc.*, B, **100**, 10 (1926).

Soil Perfusion Apparatus

IN view of Audus's communication[1], which describes a modification of my original design of perfusion pump, it is perhaps relevant to note that I simplified the apparatus myself more than two years ago. The simplified apparatus was, as Audus's, actuated by unidirectional air flow and was used for months in experiments that demanded a control of composition of the inflowing gas. It also incorporated the idea of using air-flow through a capillary to regulate an air-pressure difference. This modified design is described in an addendum to some forthcoming papers by Dr. Quastel and myself[2].

Those who contemplate using the perfusion technique may, however, be interested to learn that an entirely new design, far simpler than either Audus's modification or my own, has now been reached. It has been in constant use in this laboratory for eight months; it is completely self-regulating, is worked by unidirectional air (or gas) flow and represents what I believe to be the limit of simplicity in apparatus of this sort. The apparatus[3] was demonstrated at a meeting in Manchester of the Society of Public Analysts on October 19. The design has much to recommend it to bacteriologists, in that a small-scale version of it can be sterilized complete in an autoclave.

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[1] *Nature*, **158**, 419 (1946).
[2] *Biochem. J.*, in the press.
[3] *J. Agric. Sci.*, in the press.

A MICROCHROMATOGRAPHIC METHOD FOR THE DETECTION AND APPROXIMATE DETERMINATION OF THE DIFFERENT PENICILLINS IN A MIXTURE

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MARTIN and co-workers[1] extended their technique of partition chromatography of the amino-acids to the micro-scale by using filter paper instead of silica gel as the support for the stationary phase (water). We have found that the modified partition chromatogram for penicillin using buffer as the stationary phase[2] can also be adapted to the micro-scale by the same change in support. Colour reactions are not readily applicable to locate the positions of the invisible developed zones, so that a micro-biological procedure has been used both to identify and to determine approximately the types and amounts of penicillins resolved on the buffered paper strip. The procedure is as follows.

Filter paper (Whatman No. 1 or 4) is soaked in approximately 30 per cent potassium phosphate buffer of *p*H 6–7 according to requirements (the *p*H is measured on the solution after dilution to 1 per cent). Excess buffer is removed by pressing between sheets of blotting paper, and the impregnated paper is allowed to dry in air. It is then cut into strips 1·8 cm. by 33 cm. Uniform width is essential. The strips are kept in a damp atmosphere for one hour immediately before use.

The sample in the form of a salt is dissolved in phosphate buffer (similar to that applied to the paper) to form a solution containing 1,000–30,000 units per ml. (by *B. subtilis* assay). Insoluble phosphates are removed. Alternatively, similar concentrations of the free penicillins in solvent solution can be used, but only the qualitative aspect of this modification has been explored.

A 1-microlitre spot of the test solution is placed centrally near one end of each of the test strips, which in sets of six replicates are then submitted to chromatographic development in a gas-tight apparatus as described in ref. 1. It is preferable to have a separate reservoir for supplying solvent to each strip. Arrangements are made to provide an atmosphere of water vapour and solvent in the apparatus, and the strips are exposed to this atmosphere for about two hours before development is commenced. The apparatus must be kept at 0–5° C. throughout the experiment.

The extent of development obtained is related to the type and throughput of solvent, which is normally 10 ml. of water-saturated ether per strip. Other water-immiscible solvents can also be used. After 20–24 hr., when the reservoirs are exhausted of solvent, the disposition and approximate amount of each invisible penicillin zone is determined by the following biological technique.

Uniform sheets of medium (about 2 mm. thick and 35 cm. square) are prepared by pouring molten agar at 70° C. pre-inoculated with *B. subtilis* (as in the cup-assay for penicillin) into sterile plate glass trays. After each agar sheet has been cooled to approximately 5° C. the six replicate test strips and one strip carrying a set of undeveloped standard spots of graded concentration (see below) are pressed on the surface of the agar at equal intervals. The standard spots are prepared by delivering, at 5 cm. intervals down a buffered strip, a set of six 1-microlitre spots pipetted from a set of serial dilutions of sodium penicillin II in buffer solution (for example, 30, 10, 3·3, 1·1, 0·37 and 0·12 units per microlitre). After allowing the 'penicillin activity' to diffuse out from the paper into the agar during 3–4 hr. at 0–5° C. the plates are incubated at 37–38° C. overnight.

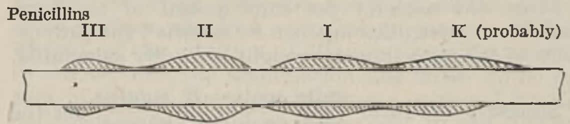

Fig. 1

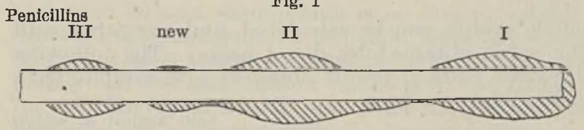

Fig. 2

×, POINT AT WHICH PENICILLIN SOLUTION WAS APPLIED; AREA OF INHIBITED GROWTH IS SHADED

The standard spots, which have not been chromatographically developed, give a series of circular inhibition zones, whereas each developed test strip shows a number of elliptical zones (as in Fig. 1) indicating the distance which each resolved penicillin zone has travelled down the paper.

The identity of the zones for penicillins I, II and III was established by comparison with the results obtained from artificial mixtures of these penicillins. The results were closely parallel to those obtained on macro-columns.

It was established in accordance with chromatographic theory that the ratio of the distances travelled on a given strip by a given pair of penicillins was constant regardless of the total degree of development. The position of the penicillin II zone can be easily established. Hence, using the position of this zone as a basis for comparison, this ratio was determined for other zones, and the figure was regarded as a convenient characteristic for identification. Only penicillins I, II and III are available for direct comparison. At least four other zones of activity have been observed and characterized by this ratio. Whether they are identical or not with penicillins reported by other workers on macro-columns can at present only be inferred.

A typical analysis is shown in Fig. 1.

Quantitative. Sets of serial dilutions of sodium penicillin-II were repeatedly compared after development on the chromatographic strips with the same solutions as undeveloped standards. For the developed zones it was found that maximum width of zone is equal to $a' + b'$ log (units in zone), where a' and b' are constants for a particular biological plate.

For the undeveloped solutions a similar relation holds, namely, diameter of zone equal to $a + b$ log (units in zone), as in the ordinary cup assay.

For the same biological plate, b' was found empirically to be about 1·2 times b, but no means of relating a to a' was found. Hence the activity of the developed zones in absolute *B. subtilis* units could not be determined. To evaluate relative proportions, b was calculated from the undeveloped standards and multiplied by 1·2 to give an estimate of b'. If it is now assumed that $a' = 0$ the expression

$$\log (\text{units in zone}) = \frac{\text{maximum width}}{b'}$$

gives values for the activities of the zones in units which are arbitrary, but proportional to *B. subtilis* units. The percentage composition in these units is then calculated.

The standard error of these proportions for one sample replicated on six strips is of the order of ± 15 per cent. Even less than 0·1 per cent of any penicillin in a mixture can readily be detected, but the accuracy of estimation at the lower values is rather less.

From the activity per unit weight of the pure individual penicillins against *B. subtilis*[3], the proportions of the penicillins by weight is readily calculated.

Similarly the ratio $\frac{\text{units against } B.\ subtilis}{\text{units against } S.\ aureus}$ for the whole sample can be calculated, and compared with the value obtained by direct assay. The following are some pairs of results obtained with samples from different sources.

	Values of $\frac{\text{units against } B.\ subtilis}{\text{units against } S.\ aureus}$		
Calc. from results of microchromatographic analysis	0·69	0·71	0·98
Direct assay	0·65	0·71	0·983

The method has proved of value in a number of directions; for example, for establishing whether a purified penicillin is free from traces of other penicillins; or as a guide when carrying out macro-chromatograms, etc. The delicacy of the test is well illustrated by the discovery of a small amount of what is almost certainly a new penicillin in samples of varying origin. This penicillin was detected in the sample shown in Fig. 1, when chromatographic development was made at a lower *p*H. As a result (Fig. 2), the two upper zones became further separated, revealing a small zone due to the new penicillin.

A full report will be published shortly.

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[3] Schmidt, W. H., Ward, G. E., and Coghill, R. D., *J. Bact.*, **49**, 411 (1945).

ACTION OF PENICILLIN IN PREVENTING THE ASSIMILATION OF GLUTAMIC ACID BY *STAPHYLOCOCCUS AUREUS*

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CERTAIN bacteria possess the ability to assimilate glutamic acid and to concentrate this amino-acid in the free state within the internal environment[1]. Glutamic acid cannot pass through the bacterial cell-wall by free diffusion as the migration requires energy which can be supplied by exergonic metabolism such as the fermentation of glucose by the organism. At equilibrium the concentration of glutamic acid in the internal environment is markedly greater than that holding in the external environment. Since a survey of a large number of bacterial species has shown that this capacity to assimilate and concentrate glutamic acid is restricted to Gram-positive organisms[2], it was decided to investigate the action on the assimilatory process of various chemotherapeutic agents which

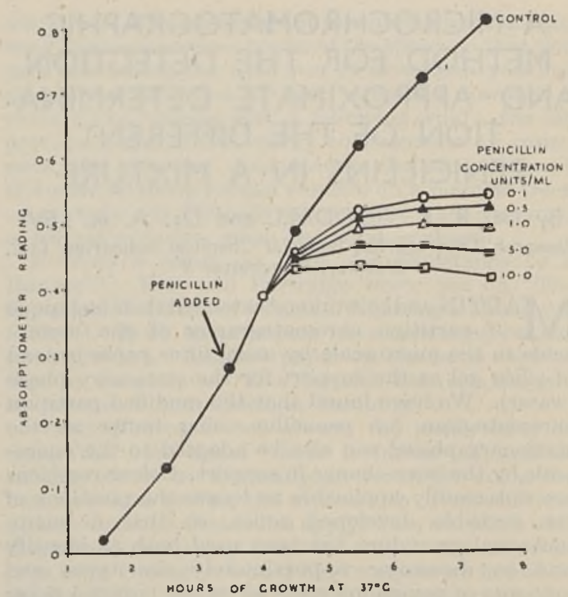

Fig. 1. EFFECT OF ADDITION OF PENICILLIN TO GROWING CULTURES OF *Staphylococcus aureus*.
Medium: salt mixture + 0·1% 'Marmite' + 1·0% glucose. Penicillin concentrations in Oxford units per ml. medium

are known to differentiate between Gram-positive and Gram-negative bacteria.

Penicillin is primarily effective against Gram-positive bacteria. Chain and Duthie[3] found that whereas penicillin has no effect on the respiration of resting cells, its addition to growing cultures of *Staph. aureus* gives rise to an inhibition of respiration which progressively increases until eventually the oxygen-uptake ceases altogether. The addition of penicillin during the lag or the logarithmic phases of growth is followed by a period during which the cells increase in size without undergoing normal division —not more than one division taking place before growth ceases—after which both total and viable count of the cells decrease with time and general lysis takes place after some hours[3]. Hirsch[4] obtained similar results and showed that, after the addition of penicillin to growing cultures of *Staph. aureus*, the oxygen consumption of the culture increases normally for a time and then, after a stationary period, decreases. He suggested that the action of penicillin is to produce a degenerative change which results in the production of a sterile generation of cells. Both sets of workers showed that the same effects are produced by a wide range of penicillin concentrations.

Fig. 1 shows the effect of the addition of various concentrations of penicillin to growing cultures of *Staph. aureus*; the ordinates give the readings of the absorptiometer scale by which the increase of turbidity consequent upon cell-growth is measured. Within the range of concentrations tested (0·1–10·0 Oxford units/ml.) the addition of penicillin to the growing culture is followed by increasing turbidity for 1–2 hr. Viable counts show that approximately one division per cell occurs during the period immediately following the addition of penicillin, after which there is a steady loss of viability over a period of several hours.

The strain of *Staph. aureus* used for this work is one which effects a high concentration of glutamic acid in the internal environment, and studies were first made on the internal environment of the cells

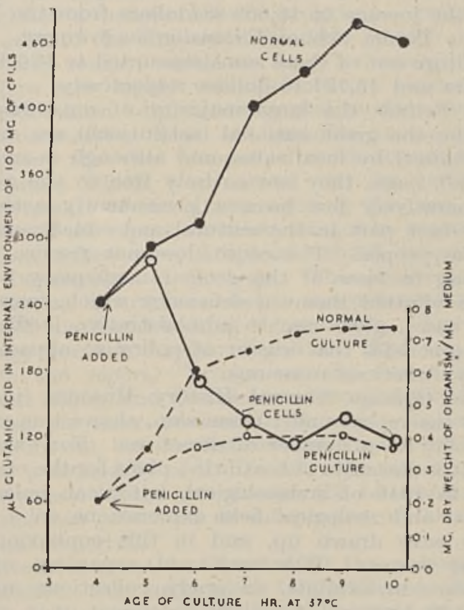

Fig. 2. EFFECT OF ADDITION OF PENICILLIN TO GROWING CULTURES OF *Staphylococcus aureus* ON THE ACCUMULATION OF FREE GLUTAMIC ACID IN THE INTERNAL ENVIRONMENT OF THE CELLS

Full line, internal concentration of glutamic acid; broken line, turbidity of culture as indication of growth

during normal growth and during growth after the addition of five units penicillin per ml. medium (Fig. 2). The medium used for these investigations consisted of casein-digest containing 1 per cent glucose and 0·1 per cent 'Marmite' and was consequently rich in glutamic acid. During normal growth in this medium the internal concentration of free glutamic acid rises steadily throughout the growth period as previously reported for streptococci[1]. After the addition of penicillin to the growing culture, the internal concentration of glutamic acid rises normally for the first hour, after which it falls rapidly and reaches a steady level at approximately the same time as the turbidity ceases to increase. The curves of these changes (Fig. 2) suggest that assimilation of glutamic acid by the cells ceases shortly after the addition of penicillin.

Since the concentration of glutamic acid attained inside the cell is dependent upon, though much higher than, the external concentration, it is possible to study the assimilation if cells are grown in a medium containing minimal glutamic acid and are then incubated in buffer solution containing both glucose and a high concentration of glutamic acid[1]. A suitably 'deficient' medium for the growth of *Staph. aureus* consists of nutrient salt solution containing 0·1 per cent 'Marmite' and 1·0 per cent glucose. The effect of penicillin on glutamic acid assimilation has been studied by growing the organism in this medium and adding penicillin to the growing culture (Fig. 1). At intervals after the addition of penicillin, the organism has been harvested on the centrifuge, its internal glutamic acid content assayed and the suspension then incubated at 37° C. in a suitable salt solution containing 0·5 per cent glucose and 200 μl. glutamic acid per ml. After 1 hr. (when equilibrium has been reached) the cells were centrifuged down, washed once in water, and the internal glutamic acid content again determined. The increase in the internal concentration can then be taken as a measure of the glutamic acid assimilated under these conditions. Table 1 shows the amount of glutamic acid assimilated by 100 mgm. dry weight of cells harvested under various cultural conditions.

Cells from the normal (penicillin-free) culture take up 560–700 μl. glutamic acid per 100 mgm. under the conditions of test, and this assimilation is unaffected by penicillin up to 200 units per ml. Cells taken from cultures to which penicillin has been added during growth show impaired assimilatory power. Within 30 min. of the addition of 10 units penicillin per ml. to the culture, the assimilation has fallen to 14 per cent of that of the control culture; within 1 hr. the assimilation has fallen to 4 per cent of the control, and after 90 min. assimilation is no longer possible. Smaller concentrations of penicillin have the same effect but take longer to prevent assimilation completely. If the assimilation values given in Table 1 for cells harvested 90–120 min. after the addition of penicillin are compared with the 'growth' curves in Fig. 1 or with the increases in turbidity during the time of harvesting, it can be seen that there is a correlation between impairment of assimilation and cessation of growth.

TABLE 1. EFFECT OF THE PRESENCE OF PENICILLIN DURING GROWTH ON THE ASSIMILATION OF GLUTAMIC ACID BY *Staphylococcus aureus*

Penicillin concentration (Oxford units per ml. medium)	μl. Glutamic acid assimilated/100 mgm. cells. Time of harvesting after penicillin addition: 30 min.	1 hr.	1½ hr.	2 hr.	3 hr.	Increase in turbidity during 1–2 hr. after penicillin addition as % control
0	561*	702	602*	590	614	100
0·1	—	—	—	130	—	54
0·5	—	—	—	113	—	37
1·0	—	—	87	—	nil	22
5·0	—	—	nil	nil	nil	7
10·0	82	31	nil	nil	nil	0

* Also determined in presence 50 units penicillin/ml.—no effect.

TABLE 2. METABOLIC ACTIVITIES OF NORMAL AND 'PENICILLIN-CELLS'
'Penicillin-cells' grown for 90 min. in medium containing 10 units penicillin per ml.

	Normal cells	Penicillin-cells
Respiration, Q_{O_2}	21·5*	19·6*
Glucose oxidation, Q_{O_2}	86·5*	84·5*
Glucose fermentation, $Q^{acid}_{CO_2}$	96*	108*
Lysine assimilation (μl./100 mgm.)	90	96
Glutamic assimilation (μl./100 mgm.)	602	nil
Comparative viable count	452	9

* Also determined in presence 50 units penicillin/ml.—no effect.

The loss of assimilatory power by the cells grown in the presence of penicillin is not affected by washing the cells in water and is not restored by treatment with cysteine. The assimilation of glutamine is impaired to the same extent as that of glutamic acid. Table 2 shows the general metabolic activities of normal cells compared with those of cells harvested from a culture grown for 90 min. in the presence of 10 units penicillin per ml. medium (cells referred to as 'penicillin-cells'). Rates of respiration, oxidation and fermentation of glucose were determined in the usual manner in Warburg manometers using washed suspensions. There is no significant difference between these activities in the two cultures, and the addition of penicillin to the washed suspensions has no effect in any of these tests.

The assimilation of lysine by Gram-positive bacteria appears to be due to diffusion of the charged ion in an electrical field and not to a mechanism such as that involved in glutamic acid assimilation[1]; Table 2 shows that the assimilation of lysine by normal and 'penicillin-cells' is the same, demonstrating that the cell-wall is intact in both cases. No lytic action of the type shown for the action of tyrocidin and detergent substances[5] has been found for penicillin, although lysis of the cultures containing penicillin takes place after several hours[3]. Penicillin is known, so far, to have four effects on *Staph. aureus*: (1) the cells become non-viable[3]; (2) their respiration progressively fails[3,4]; (3) lysis occurs after several hours; and (4) assimilation of glutamic acid is prevented. The results shown in Table 2 indicate that the prevention of assimilation precedes both respiratory failure and lysis of the cells, and would appear to take place simultaneously with loss of viability.

The mechanism whereby glutamic acid is assimilated and concentrated within the internal environment of the Gram-positive cell is not yet understood. Since penicillin has no effect upon this mechanism in normal cells but affects cells during growth in such a way that assimilation is prevented, this suggests that penicillin either combines with or produces a reorganisation of the cell-wall such that the assimilatory mechanism is blocked. In these experiments the cells contain a high concentration of glutamic acid at the time of the addition of penicillin, and it has been shown that the further metabolism of this glutamic acid is the same whether penicillin is added or not. In the normal cell this metabolism is balanced by further assimilation; but in 'penicillin-cells' assimilation is prevented, and consequently the internal concentration of glutamic acid decreases as shown in Fig. 2.

Full details of this work will be published later.

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[2] Taylor, E. S., *J. Gen. Microbiol.*, 1 (in the press, 1947).

[3] Chain, E., and Duthie, E. S., *Lancet*, 248, 652 (1945).

[4] Hirsch, J., *C.R. Ann. Arch. Soc. Turque Sci. Phys. Nat.*, Fasc. 12 (1943–44).

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CHICAGO NATURAL HISTORY MUSEUM

ANNUAL REPORT

THE report for 1945 of the Chicago Natural History Museum, produced in magazine form and well illustrated, is an attractive publication which at once invites attention. Its perusal gives one, in the first place, the impression that here is an institution which is strongly 'public conscious'. In the second place, one is convinced that the Chicago Museum is happily succeeding in a great public service and that Chicago citizens, as a result, are 'museum conscious'. The large number of volunteer workers (who have rendered valuable service both inside and outside the Museum), the large museum membership, and the long lists of donors and other benefactors shown in the report substantiates that conclusion. Further, if the status of a museum within a community can be judged from the financial support it receives, then that of the Chicago Museum stands high. Ideas as to the manner of the financial support proper to museums may differ, but however debatable that point may be, it is of considerable interest that the very active educational and research work taking place in this Museum is made possible by endowments and voluntary public subscriptions alone. In 1945 the Museum's income amounted to 601,796.85 dollars (of which 348,336.53 dollars accrued from endowment funds). In addition, there was the income of 16,609.88 dollars from the N.W. Harris Public School Extension endowment. Expenditure out of these sums amounted to 596,471.89 dollars and 16,727.49 dollars respectively.

In Britain the large majority of museums (excluding the great national institutions) are usually maintained by local rates, and although in most, if not all, cases they are entirely free to the public, comparatively few have a permanently active or important part in the cultural and educational life of the people. The cause does not require much seeking in view of the general inadequacy of the funds allotted them—a deficiency which, except in rare cases, gives rise to administrative inefficiency and precludes that vigour of policy so apparent in many American museums.

The Chicago Natural History Museum, judging from the report under discussion, shows this vigour in policy in a number of directions. For example, with the cessation of hostilities, plans for the resumption in 1946 of archæological, botanical, palæontological and zoological field explorations on a large scale were drawn up, and in this connexion the report states: "The continued expansion of the Museum in exhibits, in study collections and in scientific research is mainly dependent upon such a programme". Again, in co-operation with the University of Chicago and the Northwestern University, a scheme (already in part operation) has been drawn up which will facilitate the greater use of the Museum's collections and the teaching of natural science by the Universities. Towards this, certain reciprocal staff appointments have been made, and there are plans for the further co-ordination of the work of the three institutions in fields of mutual interest. Another interesting connexion with the University of Chicago is the establishment of university classes in museology in the Department of Anthropology of the Museum.

Among the various other schemes carried out by this Museum during 1945 the following are noteworthy: a special series of radio broadcasts within the Museum conducted by means of portable equipment set up in the exhibition halls; lectures, tours and motion picture shows for school children; the presentation of a series of weekly radio broadcasts on "Places and People" in conjunction with the Radio Council of the Chicago Public Schools; and the production of reading matter for children in the form of the "Museum Stories" published weekly, the spring series dealing with brief sketches of young animals, and the autumn series with the Indians of the Chicago region. Under the N. W. Harris Public School Extension Scheme, 498 Chicago schools continued to receive on loan from the Museum portable exhibits, and it is noted that the more than 1,100 available exhibits are in constant use during the ten months of the school year.

Under the heading of "Public Relations", the report describes such special events as temporary exhibitions on a variety of subjects of general interest; the stage presentation of the temple dancers of Bali and Java, and evening lectures on "timely topics". These formed the basis of the Museum's press and radio publicity for the year, and, together with many of its other activities, received "lavish attention" in the Press—some papers publishing half to full pages of pictures. It is interesting to note in this connexion that the *Illustrated London News* has published several pages of some of the Chicago Museum's exhibits. Further useful publicity was given this Museum when the Chicago radion station broadcast a unique feature programme presenting the work of the Museum 'behind-the-scenes'.

In this review, which has been written primarily to show how highly valuable museum services can be under keen administration and modern methods of presentation, it is not possible to note with adequacy the vast amount of work (research and otherwise) which was carried out by individual Departments of the Museum during the year. This section of the report, however, cannot be passed over without reference to a special exhibit prepared in the Department of Geology. This illustrated the production of uranium, and it was arranged with a map of the world bearing the sub-title, "Sources of Energy for the Atomic Bomb". "The map," to quote the report, "brings out the fact that the United States and Canada are favoured among the nations in their possession of major deposits of Uranium ore, but emphasises that they by no means enjoy a monopoly of it. In fact, the rather general distribution of the ore stresses the ultimatum that Science has presented to the peoples of the world: 'Unite or perish'."

Attention must be directed to the photographic production that takes place in the Chicago Natural History Museum: during 1945 there was an output of 19,792 items. These included negatives, prints, enlargements, lantern slides, transparencies and colour films, and were made for the various Museum departments, outside institutions, the Press, book publishers, and for sale to the public.

Compared with the American museum movement, that of Great Britain has still far to travel. The time for large-scale reorganisation and the introduction of new ideas and new methods is long overdue. The slight movement that was being made in this direction before the War was brought to a standstill when hostilities broke out in 1939, and now 1947 is on the horizon. During these seven years many British museums (those which escaped destruction and those that were partly destroyed) have made a valiant effort to overcome their difficulties and to render useful service. These museums are now slowly struggling back to their pre-war aspect. Collections are returning, or have returned, to buildings which before the War were already overcrowded and often unsuitable for the execution of museum services in keeping with modern needs and modern developments. Some museum authorities, looking to the future, have schemes in plan for reconstruction or new buildings, but it does not appear likely that museum accommodation will be built in Britain in the near future. A further factor which stems progressive action is the non-recognition of the educational potentialities of museums in those official quarters which would otherwise be the most helpful. Furthermore, governing authorities themselves far too frequently see nothing more in the museums under their control than repositories for municipal and collectors' treasures. Any extra expenditure on these, therefore, is considered unnecessary. Nevertheless, the claim of the British museums is a strong one, for collectively they house a great wealth of material which, in relation to the education and cultivation of the ordinary people, has, as yet, scarcely been tapped. The improvements looked for, however, may not come without some form of outside impetus—a vigorous central body to press their claims and with powers to prevent the opening of new museums if funds sufficient for their efficient maintenance are not in sight; a greater and more practical interest in their functioning on the part of the national institutions, and the recognition of all other educational institutions, are what British museums need at the present time.

NUTRITIONAL INVESTIGATIONS IN MAURITIUS

It is encouraging to find that even the smaller territories are now taking an interest in nutrition, but they will have to do better work and produce better reports than that surveying investigations in Mauritius during 1942–45, which has recently been issued*.

At first reading, one supposes it is merely a case of careless checking; for example, in Fig. 1 all nutrients and also calories are said to be given in terms of grams (actually they are expressed in a most odd variety of units, calcium being in centigrams and thiamin and riboflavin in hundredths of a milligram); in Appendix 2 the values for "vitamin B_2" are said to be in I.U. (the figures appear to be for riboflavin expressed in milligrams), and no indication at all is given of the units used for nicotinic acid and ascorbic acid. There are also major differences between values given in the appendix and those in other parts of the report, and the general atmosphere of confusion is added to by strange phrases such as, "This is, of course, expectable" and "not to any consequential degree".

On closer examination, however, it is evident that the faults go much deeper. The introduction and the discussion on pages 28–30 of the report deal with the total food supplies available (based on imports, exports and local production), and an attempt is made to relate them to the requirements of the population. The only satisfactory way of doing this is on a 'per head' basis (the method adopted by the United Nations Food and Agriculture Organisation); but the author has preferred to use the long-discredited 'man-value coefficients' based on calories alone. For the requirements of his standard 'man' he uses the original (since modified) *nutrient* recommendations of the U.S. National Research Council for a moderately active male living in a temperate climate and eating an American type of dietary, but he supplies a *calorie* recommendation of his own. He shows no appreciation of the factors which determine requirements or of the interrelationship between different nutrients and between some nutrients and calories.

Table 1 compares "per man-value" daily intakes in different years, and shows considerable fluctuations which are duly 'explained' in the text. But these fluctuations are much greater than can be accounted for by changes in the supply position as detailed in Appendix 1. Only one set of figures relating to the intermediate step (amount of each *food* per man-value) is given, and this tallies neither with the amounts of foods given in Appendix 1 nor with the amounts of nutrients given in Table 1. Either the figures in the appendixes were not, in fact, used for the calculations (though it is stated that they were), or there have been errors in arithmetic; whichever way it may be, it makes it difficult to know how much

* Colony of Mauritius. Final Report on Nutritional Investigations in Mauritius, 1942–45. Pp. iv+89. (Port Louis: Gov. Printer; London: Crown Agents for the Colonies, 1946.) 1 Re.

value to set on the report at all, since the greater part of it is based on these evaluations.

Another part of the report deals with the influence of feeding on malarial infection and the experimental feeding of school-children. The first describes the feeding of dietary supplements to children suffering from malaria, but here again arithmetical anomalies make it impossible to judge the value of the work, since the figures given under the heading "nutrients supplied" are not in agreement with the analytical values given in the text for the foodstuffs used, and show discrepancies even in the comparison of one supplement with another.

The experimental feeding of school-children is not described in sufficient detail for any assessment of its significance; but it appears certain that it was carried out without adequate supervision, since it is stated that "owing to the large variation in amounts given per child in the different schools it was impossible to record actual nutrients supplied". It is suggested, however, that each meal should have supplied about 200–300 calories. As the main item was soup, it is very probable that even this calorie value may not have been reached on all occasions, and (as is recognized) school meals are often a substitute rather than a supplement. In view of this and the fact that the experiment only lasted three months, the failure to obtain spectacular proof of the great value of school meals is not so "extraordinary" as the author thinks. No observations seem to have been made on any changes other than weight, or of the initial nutritional state of test and control groups. Those wishing to embark on school-feeding "experiments" would save themselves (and others) a lot of trouble if they would study Cory Mann's report before they begin.

Other sections deal with laboratory investigations (chiefly analyses of local foodstuffs), and with recommendations for the preparation and use of autolysed yeast and of green Algæ. Here also there are examples of arithmetical discrepancies and arguments based on false premises.

Clearly this report should have been submitted to more critical consideration prior to publication. If recommendations are to be made, and possibly action taken, on such foundations, the end result may be a worse state of malnutrition than at present exists.

M. W. GRANT

NORTHERN POLYTECHNIC JUBILEE (1896–1946)

THE Northern Polytechnic, London, was opened on October 5, 1896, following the approval given by Queen Victoria on August 5, 1892, to the scheme of foundation. It celebrated its jubilee by an exhibition of students' work on October 24 and 25, and by a luncheon attended by the Minister of Education, the Rt. Hon. Ellen Wilkinson, M.P.

Miss Wilkinson, speaking of the Polytechnic, directed attention to the fact that the chairman of the governors, Mr. R. L. Roberts, and his father had been associated with the foundation and development of the Polytechnic since 1892, and that a member of the third generation had, at the last meeting, joined the governing body; this indicated a commendable family association. It was interesting to note the wide vision of the founders, who had included in the scheme not only educational and technical studies, but also cultural and recreative activities. Under the Education Act, 1944, it became a duty for the local education authority to secure the provision of these facilities; the Government would support the development, but was also anxious at the same time to preserve the best of the old voluntary spirit which had contributed much to the Polytechnic. One proof of the vitality of the Polytechnic was that its home had never been big enough. It was to be regretted that before the War greater effort had not been made to put up more capacious buildings. At present the lack of building and shortages of labour and materials were obstacles, and the Polytechnic would for a time have to house as best it could its 1,000 full-time day students, 3,000 part-time students, and 1,000 non-student social members. The provision of social and recreative activities for the latter members was a vital influence which went far beyond the walls of the Polytechnic.

The Northern Polytechnic, Miss Wilkinson remarked, was a pioneer in at least two respects. It had opened the first department for musical instrument technology—and this still appears to be the only one of its kind in the world—and it had inaugurated the first courses in rubber technology. In the case of the course in rubber technology, the Ministry of Education is anticipating a further development in the establishment of a National College of Rubber Technology to provide advanced courses and to serve the rubber industry of Great Britain.

During the War, the Northern Polytechnic, with its existing radio course, was called upon early in October 1939 to train men in radio for the Services, and more than 2,000 Service men and women received instruction to meet the urgent demand for technically trained personnel. The demand continues in this world of rapid industrial and scientific change, and the Polytechnic with its great past and its wonderful traditions is fully conscious of the great opportunities for future service to the locality and to the country.

Mr. R. L. Roberts, chairman of the governors, said in reply that he could look back over almost the whole of the jubilee period, for he was an evening student in 1898, when the Northern Polytechnic provided numerous courses on a large variety of subjects. It is no longer a polytechnic in that sense. It is now a college of technology, as its activities had been concentrated into four main sections: first, architecture, surveying and building; secondly, science and rubber and plastics technology; thirdly, radio and musical instrument technology; and fourthly, domestic science.

In all the courses the governors have pursued a policy of effective contact with industry through influential advisory committees. The close association for more than forty years with the University of London through the 'recognized teachers' is of benefit to both the staff and the students. A similar close contact is maintained with the professional organisations, such as the Royal Institute of British Architects, which has recognized the five years full-time course in architecture at the Polytechnic. The main difficulty in the Polytechnic is still one of accommodation, and the governing body hopes that when the building industry is able to direct its activities to national needs other than housing, an extension will be built worthy of the Polytechnic and capable of meeting its needs for some time. There is one further difficulty, which other similar institutions must feel, namely, staffing. The Burnham

Committee had not accepted the recommendations in the Percy and McNair Reports, nor have the salary scales justified the belief of the Minister that they would make it possible to maintain a high standard of staffing. Shortage of man-power has played only a secondary part ; the fact is that the salary scales are not sufficiently attractive to induce the best teachers to accept employment in colleges such as the Northern Polytechnic, where the standard of education is high. Possibly the Minister might consider seeking further advice on this matter from the Burnham Committee.

Finally, the Ministry of Education, London County Council, Middlesex County Council and City Parochial Foundation were thanked for their generous support of the educational, technical, social and recreative activities of the Polytechnic. The activities of colleges of this standard must undoubtedly expand during the forthcoming years if the industries and commerce of Britain are to attain that degree of efficiency essential in a highly competitive world.

FLATFORD MILL FIELD CENTRE

THE first report of the warden of the pioneer centre at Flatford Mill of the Council for the Promotion of Field Studies shows how much has already been achieved. This centre opened to receive students on May 25, and closed on September 30. During this period 339 students or visiting staff came into residence—118 men, 221 women—or attended daily (29 on approximately twenty occasions). Of the visiting students and staff, 102 stayed for three days or less ; 157 stayed for between three days and a week ; 40 stayed for between a week and a fortnight ; 11 stayed for longer than a fortnight ; and 29 attended daily. 217, coming as members of classes, were eligible for university or other educational authority grants-in-aid ; 122 came independently, that is, about one third were independent scientific workers or artists ineligible, so far as is known, for any official grant-in-aid. It would seem, therefore, that a field centre provides a long-wanted opportunity for the 'independent amateur'. The relative numbers of the various groups of students and staff were as follows : visiting teaching staff, 36 ; university students, 19 ; teachers (attending courses or in other official capacity), 57 ; training college students, 53 ; school students, 53 ; independent students (*a*) "of research status", 62 ; (*b*) "of amateur status", 40 (total 102, of whom 28 were artists—21 in *a*, 7 in *b* status) ; other "interested visitors", 19.

In many cases the students' interests and activities were by no means confined to one particular study, but the following figures will give some indication of the relative divisions into the various field studies undertaken : artists, 36 ; history and archæology, 8 ; geology, 10 ; geography, rural science and social studies, 41 ; geography and biology, 40 ; general biology, 123 ; botany, 37 ; entomology, 11 ; birds, 21.

The work, under the immediate direction of the warden or in most cases when visiting staff were present with his co-operation, has been largely exploratory ; stress has been laid upon methods of tackling field work and outdoor class instruction rather than upon organising detailed research or record-hunting. The difficulties of obtaining essential field apparatus, and perhaps, above all, the multifarious demands upon the warden's time with parts of the premises constantly in the builder's hands, have prevented as close an investigation of the area as might otherwise have been undertaken. In the laboratory the main concern has been with the demonstration of simple techniques and use of apparatus, the recording of field data, and identification. Field work has been pursued in many branches. It is hoped that the centre will re-open towards the end of next March and be able to take an increased number of students.

Further information can be obtained from the Secretary, Council for the Promotion of Field Studies, Mr. F. H. C. Butler, Ravensmead, Keston, Kent.

FORTHCOMING EVENTS

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

Monday, November 11

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Mr. A. Jacob : "Handling Material in Bulk by Weight".

Tuesday, November 12

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. H. T. A. Sharpe : "Economic Telephone Exchange Area Planning".

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. James Gray, F.R.S. : "Locomotory Mechanisms in Vertebrate Animals, 3. Locomotory Mechanism in Typical Tetrapods ; Limbs as Co-ordinated Struts and Levers".*

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. G. F. Wood, Dr. Alfred H. Nissan and Dr. F. H. Garner : "Viscometry of Soap-in-Hydrocarbon Systems".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Prof. Alejandro Lipschutz : "Results of a Recent Expedition to Tierra del Fuego".

Wednesday, November 13

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Manchester), at 2.30 p.m.—Dr. E. S. Grumell and Dr. A. C. Dunningham : "The Distribution of Ash in British Coals and its Bearing on the Economics of Coal Cleaning".

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (at the Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Second Annual General Meeting. Discussion on "The Cultivation of a Thermodynamic Outlook" (to be opened by Sir Charles Darwin, K.B.E., F.R.S.).

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Chemistry Lecture Theatre, The University, Liverpool), at 5 p.m.—Dr. H. W. Thompson, F.R.S. : "Some Applications of Infra-red Measurements".

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5 p.m.—Mr. R. W. Lacey : "Aspects of Cotton's War Effort".

GEOLOGICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. T. Trechmann : "Coastal Uplift and Glacial Problems in East Durham" ; Mr. W. N. Edwards (on behalf of Mr. W. Kühne) will exhibit remains of Early Mesozoic Mammal-like Reptiles from Fissures in the Carboniferous Limestone of Somerset.

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. R. P. Harrison : "The Development of the Gas-Cushion Cable System for the Highest Voltages".

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. D. I. Richards : "The Application of Soil Mechanics to Highway Construction".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—"Decolourisation by Vegetable Carbons". (Mr. L. Wickenden : "The Percofil Process" ; Mr. D. Ramondt : "The Collactivit Process".)

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Bolbec Hall, Newcastle-upon-Tyne 1), at 6.45 p.m.—Mr. P. D. U. Fraser-Smith : "Variable Pitch Propellers".

WOMEN'S ENGINEERING SOCIETY (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—Dr. K. Lonsdale, F.R.S. : "The Engineer and the Crystal".

Thursday, November 14

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Discussion on "Engineering Problems of Future Aircraft".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting. Dr. A. G. Walker : "Geometry and Cosmology".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. J. R. Partington : "History of Alchemy and Early Chemistry, 3".*

Institution of Electrical Engineers, Installations Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. —Mr. W. Fordham Cooper: "Electrical Control of Dangerous Machinery and Processes".

Women's Engineering Society, Manchester Branch (at the Engineers' Club, Albert Square, Manchester 2), at 6.30 p.m.—Mr. J. S. Taylor: "Textile Engineering".

Royal Photographic Society (joint meeting of the Scientific and Technical Group and the Colour Group, at 16 Princes' Gate, London, S.W.7), at 7 p.m.—Dr. H. V. Walters: "Colour and its Reproduction" ("How it Works in Colour Photography", 1).

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Mr. G. G. Simpson: "The Selection of Dyes for covering Wool which has been Exposed to Light".

Pharmaceutical Society, Manchester, Salford and District Branch (joint meeting with the National Association of Women Pharmacists, in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7.45 p.m.—Mr. H. Gartside: "Pharmacy in Germany and Spain".

Wednesday, November 13—Thursday, November 14

Iron and Steel Institute (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Autumn Meeting.

Wednesday, November 13

At 10 a.m. and 2.30 p.m.

Thursday, November 14

At 9.30 a.m. and 2.30 p.m.

Friday, November 15

Chemical Society, St. Andrews and Dundee Section (joint meeting with the St. Andrews University Chemical Society, in the Chemistry Lecture Theatre, United College, St. Andrews), at 5 p.m.—Prof. F. S. Spring: "Applications of the Hofmann Reaction to the Synthesis of Heterocyclic Compounds".

Physical Society (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. O. Klemperer: "Electron Optics and Space Charge in Strip-Cathode Emission Systems"; Dr. W. J. G. Beynon: (a) "The Application of Ionospheric Data to Radio Communication Problems"; (b) "Oblique Radio Transmission in the Ionosphere and the Lorentz Polarization Term"; (c) "Some Observations of the Maximum Frequency of Radio Communication over Distances of 1,000 km. and 2,500 km.".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. J. Gough, F.R.S.: "Research and Development Applied to Bomb Disposal" (Thirty-third Thomas Hawksley Lecture).

Royal Institute of Chemistry (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. J. C. Withers: "The Chemist as Information Officer" (Twenty-ninth Streatfeild Memorial Lecture).

Society of Dyers and Colourists, Manchester Section (joint meeting with the Local Sections of the Royal Institute of Chemistry, the Chemical Society, the Society of Chemical Industry and the Textile Institute, in the Lecture Theatre of the Gas Show Rooms, Town Hall, Manchester), at 6.30 p.m.—Prof. E. L. Hirst, F.R.S., and Dr. J. K. N. Jones: "Gums and Thickening Agents".

Paper Makers' Association (Technical Section), Northern Divison (at the Engineers' Club, Manchester), at 7 p.m.—Mr. W. S. Baskerville: "The Place of Fuel in the National Economy of the Country".

Textile Institute, Midlands Section (at Leicester), at 7 p.m.—"Specific Uses of Wool and Cotton Yarns". Mr. G. Fielden: "Worsted Yarns"; Mr. J. N. Simpson: "Cotton Yarns"; Mr. Alan Bax: "Knitwear Manufacture".

Chemical Society, Glasgow Section (in the Chemistry Lecture Theatre, The University, Glasgow), at 7.15 p.m.—Prof. A. R. Ubbelohde: "Melting and other Phase Changes".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. G. M. Trevelyan, O.M.: "Society in Roman Britain".

APPOINTMENTS VACANT

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

Superintending Pharmacist at the Royal Air Force Medical Equipment Depot, Chessington—The Under-Secretary of State, Air Ministry, S.2(q), Cornwall House, Waterloo Bridge Road, London, S.E.1 (November 14).

Lecturer in Inorganic Chemistry, and a Lecturer in Fuel Technology—The Principal, Heriot-Watt College, Edinburgh (November 15).

Lecturer in the Department of Chemistry (to teach mainly Organic with some Physical Chemistry) at Leeds College of Technology —The Director of Education, Education Offices, Leeds 1 (November 16).

Lecturer in Bacteriology—The Secretary, The University, Edmund Street, Birmingham 3 (November 16).

Lecturer in Organic Chemistry—The Registrar, King's College, Newcastle-upon-Tyne (November 16).

Research Assistants (4) for routine analysis, etc., as members of a team studying plankton ecology in relation to the fisheries—The Head of the Department of Oceanography, University College, Hull (November 16).

Lecturer in the Department of Bacteriology—The Secretary, The University, Edmund Street, Birmingham 3 (November 16).

Principal of the Old Swan Technical Institute—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (November 18).

Senior Scientific Officer (temporary), and an Assistant Experimental Officer (temporary), in the Royal Air Force Acoustics Laboratory—The Under-Secretary of State, Air Ministry, S.2(q), Cornwall House, Waterloo Bridge Road, London, S.E.1 (November 18).

Readership in Geography tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 19).

Lecturer in Electrical Engineering at Cape Technical College, Cape Town—J. A. Ewing and Co. (London), Ltd., Finsbury Court, Finsbury Pavement, London, E.C.2 (November 20).

Principal Scientific Officer in the Radar Research and Development Establishment of the Ministry of Supply at Malvern, Worcs.—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1671 (November 21).

Lecturer (Grade II) and an Assistant Lecturer (Grade III) in the Department of Geography—The Registrar, The University, Liverpool (November 22).

Assistant Lecturer in the Department of Physics—The Registrar, The University, Sheffield (November 23).

Demonstrator in the Department of Botany—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (November 25).

Readership in Mathematical Statistics tenable at Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 26).

Head of the Department of Science and Electro-technics, Head of the Mathematics Department, Senior Lecturers and Lecturers in Science (Physics, Chemistry, Engineering), at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1677 (November 28).

Scientific Officer (engineer or physicist) to take charge of work on Automatic Controls at the National Physical Laboratory—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1661 (November 28).

Principal of the Wandsworth Technical Institute, High Street, London, S.W.18—The Education Officer (T.1), County Hall, London, S.E.1 (November 30).

Lecturer in West African Languages at the School of Oriental and African Studies—The Secretary, University of London, Senate House, London, W.C.1 (November 30).

Lecturer and an Assistant Lecturer in the Department of Inorganic and Physical Chemistry—The Registrar, The University, Leeds 2 (November 30).

Professor of Agriculture—The Registrar, University of Queensland, Brisbane, Qd., Australia (air mail, November 30).

Assistant Examiners in the Patent Office under the Board of Trade—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1664 (December 1).

Chair of Botany, Chair or Lectureship in Geography, and the Chair of Physiology, in the University of Ceylon—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (December 10).

Lecturer in Physics at Makerere College, Kampala, Uganda—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (December 10).

Senior Lecturer in Physiology 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.83 (December 12).

Principalship of the Gordon Memorial College, Khartoum—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (December 13).

Lecturer in Agricultural Chemistry—The Registrar, University of Queensland, Brisbane, Qd., Australia (December 31).

Principal—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (January 1).

Research Assistant in the Pig Husbandry Research Station —The Secretary, Wye College, Wye, Ashford, Kent.

Principal of Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

Lecturers at the Natal University College in Applied Mathematics (in Pietermaritzburg), in Geography (in Durban)—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

Demonstrator in Biology for Department of Anatomy—The Bursar, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1.

Scientific Officer to run locust breeding laboratory with possibility of research, a Technical Assistant in the locust laboratory, and a Technical Secretary—The Director, Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, London, S.W.7.

Junior Technician in an organic chemical research laboratory—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

Graduate Chemist—The Secretary, British Coal Utilisation Research Association, 13 Grosvenor Gardens, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Bernice P. Bishop Museum. Bulletin 183: Songs of Uvea and Futuna. By E. G. Burrows. Pp. 122. Bulletin 185: The Native Culture of the Marianas Islands. By Laura Thompson. Pp. 48 + 3 plates. Bulletin 186: Report of the Director for 1944. By Peter H. Buck (Te Rangi Hiroa). Pp. 44. (Honolulu: Bernice P. Bishop Museum, 1945.) [174

Colony and Protectorate of Kenya. Forest Department Annual Report for the Year 1944. Pp. 14. (Nairobi: Government Printer, 1946.) [234

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

UNIVERSITY OF LONDON

A course of two Lectures on "The Unity of Petrarch's Thought" will be given by Professor Etienne Gilson (Collège de France) at 5.30 p.m. on November 18 and 20, 1946, at King's College (Strand, W.C.2). At the first lecture the Chair will be taken by The Very Rev. the Dean of St. Paul's. Admission Free, Without Ticket.

JAMES HENDERSON,
Academic Registrar

UNIVERSITY OF LONDON

A lecture entitled "Research and the Farmer" will be delivered by Professor J. A. Scott Watson, C.B.E., LL.D., at 5 p.m. on Friday, November 22, 1946, in the Large Chemistry Theatre, Royal College of Science (Imperial Institute Road, South Kensington, S.W.7). The Chair will be taken by Dunstan Skilbeck, Esq., M.A. (Principal of Wye College). Admission Free, Without Ticket.

JAMES HENDERSON,
Academic Registrar.

CHELSEA POLYTECHNIC

MANRESA ROAD, LONDON, S.W.3
DEPARTMENT OF BIOLOGY

Required, full-time Lecturer in Physiology up to B.Sc. standard. Salary will be paid in accordance with the Burnham Scale for Technical Teachers. Full particulars together with application forms may be obtained by sending a stamped addressed foolscap envelope to the Principal of the Polytechnic, to whom applications must be returned not later than November 22.

F. J. HARLOW, M.B.E., Ph.D., B.Sc.,
Principal.

MAKERERE COLLEGE, KAMPALA, UGANDA

Applications are invited for the post of Lecturer in Physics at Makerere College which is being developed as the University College of East Africa. Salary £500–£700 with house and home leave every second year.

Applications, in triplicate, should be addressed before December 10, 1946, to the Secretary, Inter-University Council, 8, Park Street, London, W.1, from whom further particulars may be obtained.

KING'S COLLEGE OF HOUSEHOLD & SOCIAL SCIENCE

(UNIVERSITY OF LONDON)
CAMPDEN HILL ROAD, LONDON, W.8

The College Council invites applications for the appointment of Principal, to take office in October 1947.

Further particulars may be obtained from the Secretary at the above address.

Completed applications should be received on or before January 1, 1947.

THE UNIVERSITY OF SHEFFIELD

Applications are invited for an Assistant Lectureship in the Department of Physics. The appointment will be in the first instance probationary, on an annual basis. Salary £450 per annum in the first year, rising by £25 per annum to £500, with Superannuation provision under the Federated Superannuation Scheme for Universities and family allowance. The successful candidate will be expected to enter upon his duties as early in 1947 as possible. Applications (three copies), including the names and addresses of three referees and, if possible, copies of two testimonials, should be sent to the undersigned (from whom further particulars may be obtained) by November 23, 1946.

A. W. CHAPMAN,
Registrar.

UNIVERSITY OF LEEDS

EXPERIMENTAL PATHOLOGY AND CANCER RESEARCH

Applications are invited, preferably from registered medical practitioners, including those at present serving in H.M. Forces, for the post of Lecturer to work in the Cancer Research Department of the School of Medicine on the effects of X-rays on tissues. The post, in the salary range £550 to £900, has been established in association with the Radiotherapy Department of the Leeds General Infirmary. Exceptionally, if the candidate's experience and qualifications merit it, appointment to the grade of Senior Lecturer, in the salary range of £800 to £1,100, would be considered.

Further particulars may be obtained on request. Applications should reach the Registrar, The University, Leeds, 2, not later than December 11, 1946.

STUDLEY COLLEGE, WARWICKSHIRE

Required in January, Woman Graduate as Lecturer in Chemistry to Agricultural and Horticultural students. Applications before November 30. Further particulars may be obtained from The Principal.

UNIVERSITY OF LONDON

The Senate invite applications for the Readership in Mathematical Statistics tenable at Imperial College of Science and Technology (salary not less than £800). Applications must be received not later than November 26, 1946, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars should be obtained.

UNIVERSITY OF LONDON

The Senate invite applications for the Readership in Geography tenable at Queen Mary College (salary not less than £800). Applications must be received not later than November 19, 1946, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars should be obtained.

UNIVERSITY OF LONDON

The Senate invite applications for the Readership in Geology tenable at Queen Mary College (salary not less than £700). Applications must be received not later than November 19, 1946, by the Academic Registrar, University of London, Senate House, W.C.1 from whom further particulars should be obtained.

UNIVERSITY COLLEGE, SOUTHAMPTON

Applications are invited for the post of Lecturer or Assistant Lecturer in Geography to date from January 1, 1947, or earliest possible date. Further particulars may be obtained from the Registrar, with whom applications should be lodged not later than November 30, 1946.

BEDFORD COLLEGE FOR WOMEN

(UNIVERSITY OF LONDON)
REGENT'S PARK, N.W.1

The Council of Bedford College invites applications for the post of Demonstrator in the Department of Botany, vacant as from January 1, 1947, open to men and women equally. Candidates must hold a Special Degree in Botany or its equivalent. Salary £350 to £400 per annum. Last date for receiving applications November 25. Further particulars from the Secretary.

LECTURER IN EDUCATION

Science Graduate, experience in use of visual techniques essential. Salary according to experience and qualifications, commencing minimum £550. For further information apply to the Registrar, University College, Leicester.

SUDAN GOVERNMENT

Applications are invited for posts as Meteorologists for service in the Sudan.

Applicants must be between 23 and 31 years of age and have professional meteorological experience.

Further details may be obtained from the Sudan Agent, Wellington House, Buckingham Gate, London, S.W.1, marking envelope "Meteorologist".

UNIVERSITY OF BIRMINGHAM

Technician required for Department of Medicine, good general education, and experienced in physiology and biochemistry laboratory work. Salary £5–£7 per week, with prospect of further increments to capable person. Apply: Professor of Medicine, Medical School, Birmingham, 15.

BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION

Young Honours graduate in chemistry required to carry out research on adhesives and emulsions in connection with the sizing for weaving of synthetic yarns. The salary will be dependent upon the qualifications and experience of the successful applicant. Application to be made to the Director, B.C.I.R.A., Shirley Institute, Didsbury, Manchester 20.

BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION

Junior Research Officer (hons. graduate in Physics or Applied Mathematics) required for research on the weaving behaviour of textile yarns in relation to their mechanical and physical properties. Application to be made to the Director, B.C.I.R.A., Shirley Institute, Didsbury, Manchester 20.

University of London. A Lecture entitled "The Study of Antibiosis" will be given in the Meyerstein Lecture Theatre of Westminster Hospital Medical School (Horseferry Road, S.W.1) by Prof. Sir Howard Florey, M.D., Ph.D., F.R.S. (Professor of Pathology, University of Oxford), at 5 p.m. on Wednesday, November 13, 1946. The chair will be taken by Prof. G. Hadfield, M.D., B.S., F.R.C.P. (Professor of Pathology in the University of London). Admission free, without ticket.

JAMES HENDERSON,
Academic Registrar.

Computer required for the research laboratories of a large engineering firm West of London. Previous experience in computing is desirable and ability to type an asset. Salary according to qualifications and experience. Write stating age, qualifications and experience to Box 748, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

Large company with world-wide interests now developing new pest-control products require a qualified engineer (B.Sc.Eng. or A.M.I.Mech.E.) with agricultural experience. Alternatively, an agriculturalist (B.Sc.Agric.) with engineering experience might be suitable. The post is a progressive one with prospects of interesting development work. Write Box ZM.576, Deacons Advertising, 36, Leadenhall Street, E.C.3.

Assistant required for work in Patent Department of long established Radio and Television Manufacturers. Applicant's qualifications must include a good technical knowledge of radio and electronics, preferably a degree or equivalent, a definite aptitude for, and interest in, new inventions and Patent procedure. Salary according to qualifications and experience. Age not above 35 years. Apply, giving necessary particulars, to Box 746, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

Required for Research Department of Roche Products Limited, two experienced typists to type technical/scientific reports; scientific journal abstracting, and to assist in the library. A knowledge of French and German an advantage. Five day week of 40 hours. Canteen; good working conditions, and good prospects. Particulars of education and experience to: Roche Products Limited, Welwyn Garden City, Herts.

Physicist with some general knowledge of manufacturing in various branches of Electrical Engineering, required by large organization. Knowledge of Patent procedure an advantage. Applicants should write giving fullest details of qualifications and previous experience, also stating age and salary required, to Box 747, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

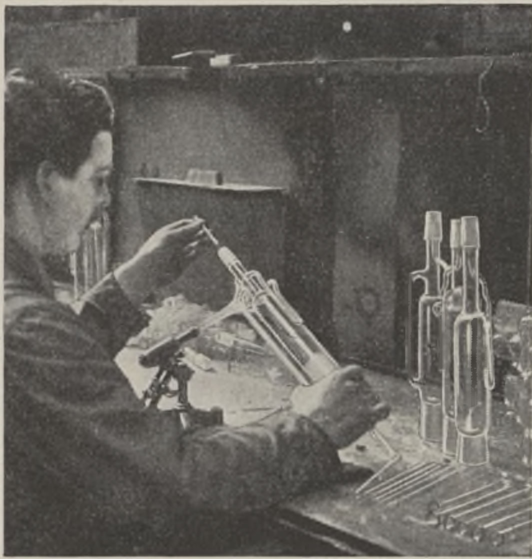
Surveyors, topographic, required with thorough knowledge of all types of field surveying and experience in air survey methods. Applicants must be prepared to travel abroad for limited periods. Initial salary according to qualifications and experience. Apply in writing to Hunting Aerosurveys, Ltd., Elm Lodge, Elstree, Herts.

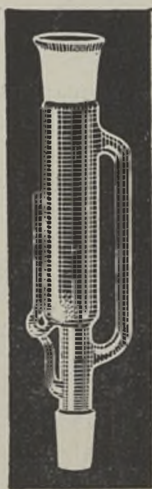
Physicist required. A good general knowledge of Physics, particularly Optics and Electricity, is necessary with practical ability. Experience of electronic devices and/or infra-red technique will be an advantage. Qualifications must include a degree in Physics (or suitable equivalent) and several years' research experience. Salary according to qualifications. Write stating age, qualifications, experience and salary required. Sir Howard Grubb, Parsons & Co., Optical Works, Walker Gate, Newcastle-upon-Tyne, 6.

Electronic Development Engineer required. Practical ability with a good general knowledge of valve circuitry and experience of high gain L.F. amplifiers is desired. Qualifications must include a degree in Physics or Engineering (or suitable equivalent) and several years' research experience. Salary according to qualifications. Write stating age, qualifications, experience and salary required. Sir Howard Grubb, Parsons & Co., Optical Works, Walker Gate, Newcastle-upon-Tyne, 6.

The Royal Meteorological Society proposes to appoint an Executive Secretary early in January, 1947. This officer will be responsible to the Council for the administration of the Society and the production of its publications. Initially the appointment will be for five years at a salary of the order of £500 rising to £600. Honours graduates (British) with scientific training, executive capacity and preferably some meteorological experience who wish to be considered for the post should write to the Honorary Secretaries, 49, Cromwell Road, London, S.W.7. Further particulars will be supplied to suitably qualified candidates.

Imperial Chemical Industries Limited have a vacancy in their Central Agricultural Control Research Station at Jealott's Hill, near Bracknell, for an assistant Statistician. Applications are invited from Mathematicians and Science Graduates with experience of statistics, especially as regards modern Statistical Methods in Biological and Agricultural Research. Salary according to age and experience. Applications should be made to Central Staff Department, Imperial Chemical Industries, Ltd., Black Fan Road, Welwyn Garden City, Herts.





Printed in Great Britain by FISHER, KNIGHT & Co., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & Co., LIMITED, at St. Martin's Street, London, W.C.2, and THE MACMILLAN Co., 60 Fifth Avenue, New York 11, N.Y., U.S.A.—Saturday, November 9, 1946.