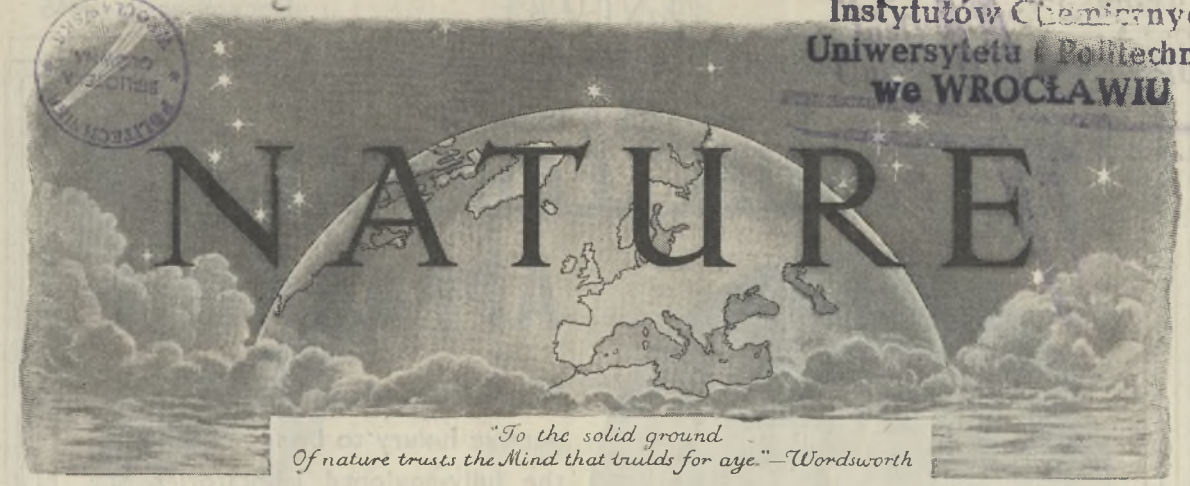

Vol. 156, No. 3971 SATURDAY, DECEMBER 8, 1945 One Shilling & Sixpence

NATURE

No. 3971 SATURDAY, DECEMBER 8, 1945 Vol. 156

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MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

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

TECHNOLOGY AND ADMINISTRATION

MEMBERS of the present Government have already made several statements of their appreciation of the importance of both scientific and industrial research, and affirmed that the Government is no less determined than its predecessor to encourage and support its prosecution within industry, by the universities and by the Departments of State. That research is an essential factor in industrial efficiency is a lesson well learnt since the Balfour Committee published its series of reports in the decade after the First World War. The need for a great expansion in the nation's research effort is now unchallenged : the questions at issue are rather how best to utilize our available resources of men and material, and to provide the most effective means for expansion.

Research, however, is not the sole factor in industrial efficiency that calls for the fuller and wider use of trained minds. Mr. Herbert Morrison, Lord President of the Council, rightly remarked on November 6, in addressing a conference of industrial research associations, that scientific and technical help will be required on the administrative and production side as well as in research, in order that effective use may be made of the new processes and products which may come from research. This has been followed up by the appointment by the president of the Board of Trade of a committee under the chairmanship of Sir Clive Baillieu, president of the Federation of British Industries, to frame proposals for the formation of a British Institute of Management, to which the Government would contribute financial assistance.

The importance of management has been stressed in many recent reports on scientific and industrial research, such as those coming from the Parliamentary and Scientific Committee, the Association of Scientific Workers, the London Chamber of Commerce and other bodies, and is a main theme of two important reports which have just appeared.

The first of these, "University Education and Business", comes from a committee, under the chairmanship of Sir Will Spens, appointed by the Cambridge University Appointments Board*. This report was the outcome of an inquiry initiated in 1937 to consider how adequately the University of Cambridge was equipping students who intended to use the business world, and whether employers were using as well as possible men trained by the University. Admittedly it is based only on samples, for of three hundred firms to which a letter of inquiry was addressed, only one hundred and fourteen replied ; while, of some seventeen hundred Cambridge graduates known to be in business, only three hundred and twenty-six replied to a similar but differently worded letter. Members of the Committee also collected certain important facts and solicited the opinions of those having special knowledge. Moreover, the inquiry must be recognized as a definite attempt by the Cambridge University Appointments Board to fulfil

* University Education and Business. Pp. viii+78. (London : Cambridge University Press, 1945.) 2*s*. 6*d*. net.

functions laid down by Dr. C. P. Snow as necessary for university appointments boards, and by the Hankey Committee for the Appointments Department of the Ministry of Labour and National Service. The Committee has clearly done an admirable piece of work, and the report offers a prototype for inquiries which might be undertaken systematically by other university authorities.

The report opens with the frank recognition of the far-reaching social changes which are taking place in the national life of Britain, and in particular the implications of our changed outlook on education. Educational changes are likely to increase the number of really able men who succeed in obtaining university education at the public expense, so that in the future the number of such men who have not been to a university will be considerably fewer. The process of selection by ability is taking place at all ages and educational levels, and will greatly affect the industrial population. The 'working parties' appointed by Sir Stafford Cripps will not need to probe deeply into the measures required to increase the efficiency of the industries they are investigating to discover the great importance of recruiting the right type of industrial leader. This question is as important from the point of view of eliminating social and industrial friction as of industrial advance. Industry needs minds competent both to appraise the human factors in a situation and quick to appreciate the possibilities of technical innovation. Its leading positions more and more must be filled by men whose minds by habit and training are strategic rather than tactical, who are accustomed to verify ideas and opinions by a study of facts and results, and to take long-term rather than short-term views of costs and advantages.

Apart from this, the gradual raising of the educational standard and cultural outlook of industrial and clerical workers in itself will accentuate the demand for a higher standard of industrial leaders. Business will require an adequate supply of the ablest minds, and since these will in the future be drawn for the most part from the universities, it is important that university education should be such as to fit them for their part, as technicians, as managers or as directors. In regard to one university, the report confirms the widely held opinion that the intellectual level of men entering business is, on the whole, not so high as that of men entering certain other occupations. Only about one third of the men who left Cambridge in 1937 and 1938 went into commerce or industry on the administrative or scientific side ; and although only one half of this number of men took up administrative or research posts outside business, this sixth included two thirds of all the Cambridge men who gained first-class honours in those years. Judged by this definition, those entering business included less than one fifth of the 'best brains'. Over the two years, only the Forces had a lower percentage than business, excluding its scientific side, among their entry.

The report considers in detail some of the factors affecting the recruitment of university men for business and their employment when recruited, and in this the opinions of both employers and graduates were very helpful. The latter were more critical, but the former were for the most part very full and carefully thought out, sometimes the result of conferences of executives. Both sets of replies showed clearly that the university man has an important part to play in the business world, and endorse the two fundamental assumptions which underlie the report : first, industry, in its widest sense, plays a most important part in the social life of a modern community ; and secondly, business provides an opportunity for the highest form of social service for many of the ablest people in the country.

The report rightly points out that university residence as such is not necessarily an advantage in business ; it is only an advantage to the man who is able to assimilate what is offered at the university and to benefit from it. Some undergraduates would undoubtedly make better use of their time at the university if their minds were more mature and had been fortified by some experience of practical life. University education, the Committee suggests, is probably of most use to those who are sufficiently mature to have a sense of values, but not so mature as to find difficulty in appreciating new values ; and what the Committee has to say on this question of the type of university man wanted in business has a profound bearing on the absorption into industry and commerce of men and women released from the Forces whose attainments and character qualify them for employment which would lead to administrative and executive posts.

The observations of the Cambridge Committee appear to be more fundamental than those to be found in the report on Training for Business Administration made by the committee appointed by the Minister of Labour and National Service last February under Sir Frank Newsom-Smith as chairman to consider the latter problem and to make recommendations for suitable courses of training. That report is not concerned with men who may wish to acquire professional qualifications, as for example in accountancy or law, as a preliminary to entering the business world, and it also excludes those who may wish to graduate or take a postgraduate course in business administration, and for the same reason—that educational facilities and, if necessary, financial assistance are already available for both these classes. While this Committee may well be right in considering that the ex-Service men with whom they are concerned will want to obtain employment as quickly as possible after their release from the Forces, it is difficult to avoid the conclusion that the Committee has taken a narrow and short-term view of the problem, and that the long-term and national point of view has received insufficient attention.

The problem was considered almost entirely from the point of view of the ex-Service man and the employer, and for the most part the Committee's recommendations for provision of a course of basic general training in business administration lasting about three months full-time, or longer part-time, and given at technical and commercial colleges before or after engagement by an employer, with financial assistance available

under the Further Education and Training Scheme, are of passing, rather than permanent, importance.

The main exception to this is a suggestion, falling beyond the Committee's terms of reference, for an interdepartmental committee of representatives of the Ministry of Labour and National Service and the Education and Service Departments to supervise the arrangements and co-ordinate schemes of post-release training with training given while men are still in the Services. Such a committee could usefully supplement the work which it is proposed the university appointments boards or the Appointments Department of the Ministry of Labour should do, and may well assist in the education of industry and business in this matter.

If business is to attract a sufficient proportion of the ablest men to ensure that wise leadership is always available, it will find itself in competition with other occupations, and the report of the Cambridge Appointments Board accordingly considers the use made of the university men in business. Probably the strongest incentive determining choice of occupation is a desire for responsibility. If a man has a receptive mind and has lived for three years in an atmosphere of ideas in close contact with men whose function is to stimulate them, he will be anxious to find an occupation providing an opportunity for the exercise of ideas. If he has not, he will be the type of graduate that employers are agreed they do not want. Able graduates should not therefore be recruited by firms unless there are obvious positions of responsibility to which they can reasonably look forward in the not too distant future.

The report makes the important point that the training given to university men in business should be adapted to their stage of mental development, which obviously differs from that of the schoolboy entering business. Again, those being trained for management should know something of the special skills in each department of a firm and their relative difficulty, and they should know a good deal about the interaction of departments ; and special stress is laid upon the value of sympathetic sponsorship of an appropriate senior member of the staff in helping the young graduate to appreciate the purpose and method of his training, stimulate or curb ardour as occasion requires, and ensure that he gets a fair deal at the hands of executives under whom he will be working during his tour of departments. Such handling will also encourage that feeling of loyalty which firms often say is one of the best features of university men in business, and which is one of the most valuable gifts a man can offer to an institution.

The Cambridge report also urges that a larger proportion of the higher administrative posts should be held by men with a scientific training, particularly in manufacturing firms. It challenges the fundamental snobbery running through the whole social system of Britain, which tends to regard those who deal with organization and finance as superior to those who deal with research and production ; and in its assertion that the only way to make science properly available in the public service and business is to insist that the technical expert be equal in status and pay to the non-technical administrator in every grade of promotion, the report is in line with the recommendations of the Barlow Committee on Scientific Staffs in Government Departments.

On the side of the University, the report makes a number of suggestions for strengthening its links with the world of business and industry and for improving the preparation of the graduate for that world ; these suggestions include the strengthening of the Appointments Board and the content of courses. All these observations, like those on the value of business experience before or during a university course, deserve the attention of other universities and appointment departments. Moreover, the whole report abounds in observations which are suggestive of ways and means by which firms could do much to eliminate the present weaknesses, and above all that tendency to regard technical posts as blind-alley occupations unless they lead to administrative posts in technical firms.

Another report recently issued is that of the Special Committee appointed, in April 1944 under Lord Eustace Percy as chairman, by the Minister of Education, Mr. R. A. Butler, to advise on the needs of higher technological education in England and Wales, with particular reference to the means for maintaining co-operation between universities and technical colleges (London : H.M. Stationery Office. 6*d*. net). The Committee's inquiries convinced it of the need for a standing organization, both to survey industry and to co-ordinate education. The evidence submitted concurred in the general view that the position of Great Britain as a leading industrial nation is being endangered by a failure to secure the fullest possible application of science to industry, and that this failure is partly due to deficiencies in education. In particular, the experience of war has shown that the greatest deficiency in British industry is the shortage of scientific men and technologists who can also administer and organize, and can apply the results of research to development. While recognizing that both educational institutions and industry may not have handled their material to the best advantage, the Committee concludes that industry and educational institutions training for industry are not getting their fair share of the national ability.

The Committee's suggestions for a campaign to increase the prestige of the technical professions and to arrest some of the present leakage of good brains from secondary schools at the age of sixteen include a continuance of the special State bursary system, both for universities and for technical colleges, with improved methods of selection, and the extension of the benefits of this system to candidates from industry as well as from secondary schools. It is urged that the whole question of scholarships for students of technology needs thorough reconsideration. Like the Nuffield College statement, the report challenges the adequacy and the dominance of evening classes for higher studies so exacting as those demanded of the modern engineer ; and in raising the whole question of adjustment between technical college and university courses, as parts of one coherent system of higher technical education, the report touches also on the

question of the movement of postgraduate students, and the coherent planning of technological research in Britain, or rather of the institutions where it can be prosecuted with adequate facilities and resources.

The main outcome of this report is a scheme for the co-ordination of higher technological education by a National Council of Technology and a series of regional advisory councils throughout England and Wales; but one looks in vain for any clear conception of the relative functions of the universities and technical colleges. In spite of the emphasis laid on quality, there is little attention paid to the vital importance of research. Quantitatively, the Committee has only attempted to define the needs in respect of mechanical, electrical and civil engineering, and its pre-occupation with engineering may be partly responsible for the proposal, on what might appear inadequate grounds, for the selection of a strictly limited number of technical colleges—for engineering, up to six is suggested—in which there should be developed technological courses of a standard comparable with that of university degree courses.

The need for further co-ordination of the work of the technical colleges and the universities of Britain has been emphasized in other reports, and the Committee's proposals go some way to meet these criticisms that the existing provision for advanced technical education lacks form and system. The regional advisory councils it proposes would be concerned with the co-ordination of technological studies in universities, colleges of technology and other technical colleges of the region. As an essential part of the regional machinery it suggests also regional academic boards of technology, composed of the academic heads of universities and technical colleges and of members of their teaching staffs, and the consultation with industry which is an essential purpose of the whole regional organization should be conducted largely through this agency.

The regional machinery would have its national counterpart in a National Council of Technology at least partly representative of regional advisory councils and of the regional academic boards, but appointed by the Minister of Education at his discretion. This body would be responsible for considering the national aspects of regional policies, and for advising the Minister and the University Grants Committee; but no change is suggested in the administrative responsibilities of these two central authorities, nor any restriction of their freedom of communication with local education authorities and universities and with the regional bodies. The constitution of the regional academic boards is outlined in more detail, and it is to these boards that the Committee believes that the country must mainly look for advice on the steps necessary to meet the demand of industry for quality.

These proposals obviously should help to provide industry with more of the technical leaders it requires, though their bearing on the all-important question of quality is less apparent. The report estimates the requirements of the engineering industries for senior administrators, engineer scientific workers and development engineers and engineer managers at about 3,000 each year, of whom upwards of half must be drawn from the technical colleges, the limit of the output of the universities and university colleges in England and Wales being put at 1,200. But it is for some 350 of the trained engineers coming from the technical colleges that the Committee proposes to develop the special colleges and courses already noted.

Two concluding recommendations of the Committee are, however, of more interest to this question of providing industry with the quality of leadership it requires. First, in regard to management studies, the report recognizes that this body of knowledge can be taught only by those who have a thorough practical and theoretical grasp of it, and comments on the poor quality of the present literature of the subject in Britain and the absence of the intellectual content of a sound mental discipline. The report accordingly recommends that all students of technology, whether at universities or colleges of technology, should be introduced to these subjects during the final year or two of their undergraduate course. It also recommends that at least one institution should be selected as a centre for postgraduate study of industrial administration. It should be the function of this centre to set standards in the teaching of the subject, to systematize it as a mental discipline, to conduct the necessary research, to develop the literature of the subject and to train teachers for it. The report also recommends that management studies should form a part of the courses of all technical colleges teaching for the national certificates and diplomas and should form the subject of short or refresher courses organized jointly by teaching institutions and industry.

The second matter relates to the special needs of teachers of technological subjects in universities and technical colleges. The only really satisfactory way for such teachers to keep up to date in the industrial technique of their particular subject is for the teacher to return to industry for substantial periods. This is a matter which might well be dealt with by the regional academic boards in collaboration with the industries in the region, while the National Council of Technology might arrange for exchanges with teaching institutions abroad. Something might also be done for teachers in the way of refresher courses of an academic character, while industry should be prepared to release senior members of staff to give advanced courses of lectures during the day. But the most effective remedy will probably be found in the upward adjustment of the salary scales of teachers and lecturers in the technical colleges and universities.

The first of these matters is clearly related to the proposals for an Administrative Staff College announced almost simultaneously with the publication of the Percy Report. This new venture, initiated with the support of individuals and groups from industry, local government, education, commerce and distribution—but not, seemingly, the Civil Service—is intended to bring together able young men and women who have already mastered the arts of

organization in their own departments, in a more intensive study of the science of administration in its wider applications. The College is not to be concerned with preliminary training, but is rather an experiment which, if it is to succeed, must provide a meeting place of the administrative officers of both the public and the private services. It is a staff college and not a training college, and is intended to be and to do something quite different from any eventual Civil Service college. Indeed its most valuable function may be to promote the closer understanding by the two types of administrators of each other's problems.

In future, as in war-time, the industrial and the public administrator must work increasingly together, and if friction and frustration are to be avoided in whatever changes may take place in the structure and organization of industry, the public services or the machinery of Government, these two types of administrator must understand the very different situations in which they are placed and the different responsibilities which they carry. The success of the venture will be judged by the measure in which it issues in better practice directed to the fuller service of the public interest—the same criteria by which the success of that other experiment by the 'working party' initiated by Sir Stafford Cripps will be judged. Before it can well start, however, two conditions have to be fulfilled, as Sir Hector Hetherington, himself one of the court of governors, has pointed out. Staff of the right kind—experienced, lively, knowledgeable and skilled in the Socratic art—must be found; and the student body must be sufficiently numerous and varied to achieve the fertilizing purpose of mutual criticism and stimulus. It is difficult to see that adequate numbers of students or sufficient variety will be secured without the participation of the Civil Service; but there can be no question as to the importance of experiment along such lines, so that we may be able to secure both the closer integration of industry and business with the work of government and the service of social needs, and to provide managers and administrators who are fully equipped to deal with the ever-increasing complexities of the task of administration in the modern world.

ECOLOGY IN THE SERVICE OF MAN

Natural Principles of Land Use

By Edward H. Graham. Pp. xiii+274+32 plates. (London, New York and Toronto: Oxford University Press, 1944.) 16*s*. net.

THE theme of this book is set out in its opening paragraph: "We live in an environment of many facets related not as single pieces but as a mosaic, the pattern of which is not easily discerned at first glance. It must be seen in different lights before we appreciate its full design and real worth". Disturbances of one of the pieces of the mosaic may have far-reaching effects, yet directly man passed out of the hunting and fruit-collecting stage he began to disturb the pattern, sometimes with unforeseen and disastrous results.

Clearly man must go on interfering with Nature, but he should at least know the consequences of his actions so that he may make them as innocuous as possible. It follows that land utilization must be planned and not haphazard. But a plan involves the detailed study of the region, the classification of its component parts and the study of their mutual interrelations. Dr. Graham has amassed a great quantity of material much of which will be new to many English readers; he deals largely with American investigations. He shows that the inter-relations between plants or animals with individual factors of their environment can rarely be expressed in simple terms because of the far-reaching nature of their effects. Thus attempts to relate plant-growth with rainfall have succeeded only to a limited extent either in America or in Great Britain. On the other hand, the natural mosaic of any region is a faithful integration of the environmental conditions and so affords reliable guidance about its agricultural possibilities. Hence the need for a close survey which should not be confined to plants, but should also extend to animals, including insects; the soil; the topographical and climatic conditions. He instances the well-known fact that land, which in its natural state is covered with grass and other herbs, is naturally well suited to cereals, while some types of forest indicate suitability to fruit trees.

When natural grass or prairie land is used for grazing, no important change in the flora need be expected provided the grazing is light; but the change becomes very marked when it is too heavy, and deterioration of the herbage then sets in. The changes in any region follow a certain sequence so that the danger can be recognized before much harm has been done, and steps taken accordingly.

Some of the most interesting sections of the book deal with the chain of consequences following on man's disturbance of Nature's mosaic. As one would expect, the 'Dust Bowl', the termination of the soil erosion process, is fully dealt with, as also is the reverse process of rehabilitation. The results of introducing a new component to the mosaic cannot yet be predicted, nor is it clear why the new introduction sometimes romps away and multiplies at a tremendous rate, like rabbits in Australia or water hyacinth in Bengal, and sometimes dies out more or less gradually leaving no trace behind. The converse problem of eliminating one of the components of a natural community presents many interesting possibilities. In Utah, sweetened poisoned bran was set to control grasshoppers. It succeeded, but raised new troubles for apiarists, orchardists, soil conservers and others. Bees were killed, yields of honey went down, pollination was reduced, fruit yields fell, clover seeds did not set, and hence the plants failed to reproduce themselves; the soil cover suffered and soil erosion set in. So the tale goes rippling on, apparently *ad infinitum*, further proving

> "that thou canst not stir a flower
> without troubling of a star".

The author quotes with approval the work of M. A. C. Hinton on rats. The common rat of England was the black rat, which originated in the forests of India and Malaya and came to Britain at the time of the Norman Conquest or the Crusades; it can carry the plague pathogen and was responsible for the Black Death and the Plague of London. Then

the brown rat came in from the plains of Asia. It gradually ousted the black rat from the level places and became the common rat in Britain. It has plenty of sins to its charge, but at least it does not carry plague. Before the War, however, the cellars of London were being made rat-proof, and so it found life difficult. On the other hand, flat roofs, sky-lights, cables, etc., were multiplying, and overhead London became a very suitable habitat for the black rat. So being safe from the brown rat, it was multiplying before the War and was becoming the common rat of London. Should plague break out it might become a menace. As Mr. Hinton says: "If you create a vacancy it is your own very difficult business to fill it".

The independent calculations of Fawcett and of Shantz indicate that something like 6–8 acres of cultivable land in the world per head of population are available to provide food and raw material. On present yields and practices this area barely suffices. Higher levels of production must be widely attained, and this will mean more and more interference with the mosaic of Nature.

The book will serve a useful purpose in setting out the principles on which rational land utilization must be based if unforeseen and undesirable effects are to be avoided. E. JOHN RUSSELL.

PRINCIPLES OF EDUCATION

Education

Its Data and First Principles. By Sir Percy Nunn. Third edition, revised, and in part rewritten. Pp. 283. (London: Edward Arnold and Co., 1945.) 7*s*. 6*d*. net.

OF all the late Sir Percy Nunn's numerous and varied writings, this book is the acknowledged masterpiece. Within a comparatively short compass, it reveals his educational doctrine and sets forth the powerful arguments by which he supported it. In a sense it is a summary of his life's work. Published in 1920, and reprinted many times during the ensuing ten years, it reached its second and revised edition in 1930. For this third and, as the sad event has proved, final edition, the author completed the revision himself, and sent the result to England from his enforced exile in Madeira a few weeks before his lamented death.

The previous editions contained fifteen chapters, all of which have been thoroughly revised by him, considerably expanded, and in some places rewritten. A new chapter has been added. The recent remodelling of our school system had made the fundamental problems of education the subject of unprecedented debate and had made it desirable to treat some old questions more fully, and to give new questions their place in the argument of the book. As the author emphatically declared, however, the central thesis of the book remains unchanged; it maintains as firmly as ever that "the primary aim of all educational effort should be to help boys and girls to achieve the highest degree of individual development of which they are capable". It is good to know that the author lived long enough to see with satisfaction that a widespread acceptance of this idea was a striking, and bade fair to be a permanent, by-product of the war years.

The new chapter to which reference was made above is the tenth in this edition and is entitled "Mental Development". The author's eminent work in the teaching of mathematics enabled him to put the whole matter so simply that any intelligent person can follow the argument, provided he or she is both able and willing to devote the necessary time and trouble. One is left, however, with a lurking suspicion that many teachers and administrators will regard this matter as one for the experts, who are by no means in close agreement even upon fundamental issues. The non-experts will continue to give respectful attention to the results of 'intelligence tests', but they will also continue to believe that when scientific analysis has said its last word, they must turn to the whole personality, the living child whose immediate future is being decided. Fortunately, the Act of 1944 puts an end to the absurd practice of making irrevocable decisions about children at the tender age of ten. T. RAYMONT.

BOTANY IN LATIN AMERICA

Plants and Plant Science in Latin America

Edited by Frans Verdoorn. (A New Series of Plant Science Books, Vol. 16.) Pp. xl+384 (38 plates). (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1945.) 6 dollars.

THIS volume contains a great number of articles dealing with the botany and geology of South America. The botanical contributions cover a wide field including taxonomy, ecology, plant geography, economic botany, cytology and genetics. There are also accounts of rubber culture, fibre plants and a sketch of the geology of the Antilles and a brief account of the general geological features of South America.

The editor has enlisted the aid of eighty-five contributors from South America, the United States and a few from Europe. The book is divided into two parts, the first of which deals with problems of tropical agriculture, phytogeography of the continent, economic plants, with a special supplement on plant breeding, genetics and cytology. The second part consists of revised articles which have appeared in *Chronica Botanica*, chiefly on the floras of different regions. Many of these articles are of great interest, such as "The Falkland Islands" by Dr. Scottsberg, and "The Vegetation of Ecuador" by Dr. Svenson, to mention only two out of more than a dozen on phytogeography. A geological sketch of South America is given by Dr. Darrah.

It is impossible in the space of a review to give any detailed impression of this extensive and varied subject-matter; the index alone covers fourteen pages. The arrangement of the articles does not appear to follow any definite plan, so that reference to any subject is not easy; even the longer contributions are restricted to a few pages and merely represent summaries of extensive subjects. Scattered between these are a number of short notes regarding some regional aspect of agriculture or economic botany. A short bibliography to some of the longer articles is a useful feature.

A number of plates taken from various sources embellish the text, and many of the contributions are illustrated by outline maps.

While little detailed information can be obtained from many of the articles owing to their short length, this volume can be recommended as a most valuable general reference book to all botanical and allied subjects in Latin America.

THE MISSION OF SCIENCE*

By Sir HENRY DALE, O.M., G.B.E., F.R.S.

THE scientific men of the world now have before them the task of readjustment which, we may hope, will mean the whole-hearted devotion of the available resources of scientific research and development to their proper and beneficent uses. It has become a commonplace that the urgent needs of war have greatly accelerated discoveries and inventions which will now promote the advancement of science and its applications in peace. Some of these scientific swords and spears will be thus immediately applicable as peaceful implements, or with only a minimum of beating and bending—radar, for example, to the safety of transport by sea and air, and all the new wealth of chemotherapeutic agents and insecticides to peace-time hygiene and agriculture. There will certainly be many others of a less direct and obvious kind—discoveries and developments arising as side-issues from the urgent uses of science in war, but capable now of applications which may open new possibilities of scientific advance for its own sake, or for a whole range of peaceful purposes. The Royal Society has recently agreed to collaborate with the Service Departments concerned, in setting up committees to organize such peaceful uses of the special facilities for purely scientific observation and experiment as are presented by Service flying, including aerial photography, by the voyages undertaken by the ships and officers of the Royal Navy in the course of their normal duties, and by the large surplus of explosives—of the pre-atomic type, be it understood—which a great war leaves in hand.

Let me make brief mention, by way of another example, of an unexpected gift to science, arising as a curious side-issue from the large-scale application in war of knowledge which science had provided. Some thirty years ago my former colleague, Dr. Charles Todd, published in the *Proceedings of the Royal Society* two papers dealing with the antigenic individuality observed, even within the limits of a single breed of chickens, when the red blood corpuscles of one bird are injected into another. This was an observation, one might think, of an interest purely theoretical, though great; but the widespread application of blood transfusion during the War, to replace blood lost by the wounded, civilians now as well as warriors, has given to phenomena of this type a practical importance. Apart from the familiar natural incompatibilities, due to the known human blood groups, it was found necessary to be alert for reactions in persons who, having had an earlier transfusion, might have acquired, by an immunity reaction, a new incompatibility to the donor's red blood corpuscles. The case of such reactions hitherto most completely studied concerns an antigenic factor which Landsteiner and his colleagues had discovered, early in the War, in the red corpuscles of the Rhesus monkey, and had accordingly termed *Rh*. This factor they found to be present, as a Mendelian dominant, in the corpuscles of most white people, but absent from those of a minority. So, in the slang of the subject, about 85 per cent of people of the white races are '*Rh*-positive', while 15 per cent are '*Rh*-negative'. Now it appears that the blood serum of an *Rh*-negative person, if he receives a transfusion of *Rh*-positive blood, acquires immune substances destructive to the 'positive' red corpuscles. In consequence, he suffers a dangerous reaction if given a second, similar transfusion. This observation has brought to light the much more important fact that, when an *Rh*-negative woman, whose husband is *Rh*-positive, becomes pregnant by him of an *Rh*-positive child, her serum is liable therewith to acquire, and to transmit through the placenta, an antibody destructive of the child's red corpuscles, so that the offspring of such a union are prone to a high rate of mortality, before or soon after birth. Whether those who survive the infantile malady thus produced show a greater liability to other hereditary defects, or whether deleterious maternal antibodies of this type can be formed in relation to other kinds of cells than the red blood corpuscles, are matters on which investigation must be awaited.

I mention the matter as an example of the gleanings which peaceful science may expect from fields of knowledge which war has been tilling and reaping. Unless I am mistaken, the widespread use of blood transfusion has thus been largely responsible for enabling human genetics now to explore a new category of congenital defects, due, not to the coincident presence of a detrimental gene in both parents, but to the possession by a father of one which is harmless, unless it excites an immunity response in a mother who lacks it.

Whether by following in new directions clues which have thus been discovered under the stimulus of war, or by resumption of researches which the War interrupted, it is clearly a matter of urgent importance that our scientific activities should now, as rapidly and as smoothly as possible, reacquire the character proper to peace. There are directions in which official action can accelerate a process of such outstanding significance to the position which our nation will be able to achieve and to hold in a world civilization, now so clearly entering its scientific era. We need our leaders and teachers in science back in the universities, and the students whom they can inspire and train, as rapidly as these can be released from war-time duty and service.

A number of our leading men of science have learned much from war-time experience of organization and team-work in research, and have been freely devoting great abilities to planning and to securing proper conditions for researches by others. It is unlikely that the debt of the nation and of its allies to the work of many of these will ever be fully known, beyond the limits of certain circles. The experience of these men should help them still to serve the nation in peace, by counsel and by advocacy, when the needs of scientific reconstruction demand these.

I venture to hope, however, that there will be no such demands on the time and the energies of those who should now be our leaders in research, as to keep them away from their benches and their studies, and to deprive of their inspiration the younger men who should now be their pupils and collaborators. When the world emerged from the War of 1914–18, the scientific men who in Britain and other countries were then at the height of their powers for research, who, in Newton's fine phrase about himself, were 'in the prime of their age for invention', were back in their laboratories with little delay. As a result, even in the two decades of uneasy armistice which followed, curtailed at both ends by the confusion of recovery from one war and the gathering menace of another, research for the normal

* From the anniversary address to the Royal Society, delivered on November 30.

purposes of peace was resumed with an astonishing promptitude, and the advance of knowledge surged forward with an imposing acceleration. Almost any man of science who can cast his mind back to the state of knowledge in his own special subject in 1919, and compare it with that which had been reached in 1939, must be impressed by the transformation. To mention an example which cannot be far, at the moment, from anyone's thoughts, consider the revolutionary changes made, between the wars, in our whole conception of the material universe, by new theories of atomic structure, with new apparatus of mathematics to deal with them, by the experimental attack on the atomic nucleus leading to transmutation of elements and, still before war's dark curtain fell again, clear evidence of atomic fission, with the release of atomic energy. As one other example, who would have predicted in 1919 that, of the vitamins and hormones then known and differentiated only by the effects of their withdrawal and replacement, imposing ranges would have been isolated, identified and made by artificial synthesis before 1939 ? Now that we are emerging from another war, into what, if we men of science can do anything to prevent it, will not be just another precarious interlude before a worse disaster, we must try to ensure that the free advancement of natural knowledge, which this Society exists to promote, is able to claim again, with as little delay as possible, the full service of its natural leaders.

Another condition of the revival of scientific activity for the normal purposes of peace, seen clearly by our predecessors in 1919, was a rapid reconstruction of the international community of science. Before there had been time for the full attainment of their aim, the forces of cleavage had again begun to operate ; but, as soon as it became possible once again to think of rebuilding what another war had broken, it was the first duty of the Royal Society to ensure that use was made of all that was of proved value in the framework of international collaboration which had been constructed between the wars. Past officers of the Royal Society, especially Sir Arthur Schuster and Sir Henry Lyons, had taken prominent parts in the foundation and development of this organ of international collaboration. Our foreign secretary, Sir Henry Tizard, now coming to the end of his term of office, was early at work preparing for its revival with the chairmen of the British national committees, in consultation with its present general secretary, Prof. F. J. M. Stratton, and with such representative scientific men of other countries as were accessible. Their aim was to review the past achievements and potential value of this system of the international scientific unions, and the possible need for its extension or modification in certain directions. The Council's reports record the progress which has been made.

While, however, the Royal Society has had a special responsibility for our national participation in this existing system, it has always welcomed any opportunity of the fullest and most friendly collaboration with any other agency for the promotion of international friendship and community of action among the scientific workers of different countries. The Society looks forward now to the possibility of collaborating also with any scheme or mechanism for the promotion of international relations in science, which may arise under the general Organisation of the United Nations. We recognize that, through such channels, it may be possible, not only to give most valuable support to the existing unions for international action in the various fields of scientific research, but also to supplement the functions of these in many other directions in which the interests of science may yet require to be internationally organized and promoted. The Society stands ready and eager, now as ever, to work with any responsible agency for the restoration and extension of international friendship and collaboration in science.

In my address to the Royal Society last year, I referred to the aim of building anew, and on a firm and broadening foundation, a world community in science, as "an aim worthy of our utmost effort and devotion". Can it be doubted now, after what has happened since then, that upon our success in achieving that aim may well depend, not only the free progress of science henceforward, but even the survival of civilization ? I have spoken of existing and prospective mechanisms for promoting scientific intercourse between the people of different nations. We must use and develop these to the full limit of their value, but we shall still want something which no formal mechanism can restore to us. Meetings of national representatives and delegates may, indeed, do service of great importance to science, as by framing and accepting international conventions on units of scientific measurement, or on technical terminology ; but no mechanism which merely brings scientific men together as national representatives, no finding of formulæ or passage of resolutions, will do for science to-day what the world so desperately needs.

If we are to achieve anything really to meet that need, we must somehow get rid of barriers which hinder the scientists of different countries from meeting simply as scientists, for the frank and informal interchange and friendly criticism of each others' observations and ideas, in complete freedom from any national inhibitions or restrictions. Before 1914 we were able to claim that science belonged thus to the world, knew no frontiers, was one and indivisible. Many of us had been cherishing the hope that the union of so much of the world in a war for the defence of freedom—freedom, we understood, for science as for all man's other activities—would have brought, with victory, a possibility of reviving this claim and restoring this ideal, which the intervening years had so shaken and obscured. Even a few weeks ago the trend of events did not appear to encourage that aspiration ; but we may find, in the end, that it will suffer less from an open challenge, which all the world can see, than from a more gradual discouragement.

To all but a few men of science, as to the rest of the world, the use of the atomic bombs on Japanese cities brought the first news of a tremendous scientific and technical achievement, as well as the recognition of a new problem of overpowering importance to the world. Scientific workers might well take pride in it, as a triumphant verification of a purely scientific prediction. The main lines of this had been completed before the outbreak of war in 1939, by experimental and theoretical physicists of many countries. We think proudly here of the pioneer part which our own Rutherford with his pupils and associates had played in the opening of a new science of nuclear physics ; but we recognize that its development was a widely international achievement. The practical realization in a little over three years of what these academic scientists had foreseen as a distant possibility required a scientific and technical undertaking of a new order. It is unlikely that any stimulus

other than the urgency of war would have sufficed to induce any national, or other, organization to embark upon such an enterprise. It is certain that, under the world conditions in which that stimulus was applied, the United States of America was the only country in the world where the project could have been undertaken. The result was a prodigy of organization and achievement, both scientific and technical; and though, in the nature of the case, America made the largest contribution even to the team of scientific workers engaged in the great volume of theoretical and experimental researches still required, we may be glad to think that, on that side, the enterprise still owed much to a widely international effort. It drew into its service a large proportion of the nuclear physicists of Britain and of Canada, with others who had escaped from the clutches of the German invader in Denmark and in France, and yet others who had fled before the War from Germany, from Austria and from Italy to conditions of freedom and new opportunity in Britain and the United States.

The enthusiasm with which the world of science would normally have received the news of an event of such magnitude in scientific history was qualified by the unique conditions of its general announcement. The world at large has not been slow to grasp the tremendous implications which it may hold for the future of civilization, and the nature of the choice with which it has so dramatically faced mankind. The problems which it has raised are clearly everybody's concern. Nevertheless, and in spite of certain threats and rumblings, I believe that general opinion will allow to us men of science, in addition to our common rights as citizens, a special claim to be heard on the uses which the world is to make of this great new gift of science to mankind. General opinion, I think, would further recognize that the many scientific workers who have taken a direct part in this great achievement have a special right and duty to let the world know how, in the light of their intimate and expert knowledge, they view the promise and the threat which it offers to humanity. Surely they, if any, have a right to speak; and we others can welcome the firmness and the substantial unanimity with which many of them have let their opinions be known. We have a duty, indeed, to the statesmen, who are carrying this new and heavy burden of responsibility for the world's future, and who have to deal with aspects of the problem in which science is not directly concerned. It is a part of that duty, however, to keep them in touch with the general body of opinion among the scientific workers of the free peoples whom they represent, so that, in framing their policy, they may be confident that the service required of science to make it effective will be given with enthusiasm and conviction, and not, if at all, with a reluctant acquiescence. Most, if not all of you, will have read words which the Prime Minister spoke to the Canadian Parliament, and emphasized by repeating them to our own House of Commons a week ago. "Unless we apply to the solution of these problems a moral enthusiasm as great as that which scientists bring to their research work, then our civilization, built up over so many centuries, will surely perish." I do not doubt that you will share my glow of gratitude for a tribute which we must try to deserve.

It is not fitting that I should discuss here matters which belong to a much wider constituency than ours, and my particular purpose to-day is to ask you to consider an aspect of this world problem, which is, beyond challenge, our special concern as men of science—the effect of present and prospective developments upon the integrity of science itself. Will any deny our claim to hold that as a sacred trust for the world, and to be alert to defend it from any danger which may seem to threaten it? I believe that we have a duty to be watchful now against a serious danger to it from the intrusion of secrecy, which we know here from long tradition and experience to be alien to the spirit of science as we have known and cherished it. I cannot claim the time which would be required to deal adequately with such a theme. Permit me, however, to bring certain aspects of it briefly to your notice, without attempt at full or ordered discussion.

1. This danger, of course, has not newly arisen with the explosion of the first atomic bomb. We have known it long in connexion with the use of scientific research by industry, and with the relatively minor and accessory part played, until recently, by science in preparing the apparatus of war. Even in those connexions, there was a growing recognition of the detrimental effect of secrecy on the relations between the scientific men concerned and the general scientific community, and a consequent effort to reduce its applications to the minimum which industrial or military opinion would accept.

2. The real and growing danger arises, however, from the new conception of war, due to the breach and consequent abandonment, in rapid succession, of conventions and restrictions which, not long ago, seemed permanent and sacred. Thus by the end of this recent War, step by step, with Germany always leading, the combatant nations had come to regard, as a proper war aim, not merely the winning of mastery over the enemy's fighting forces, but also the compulsion of his surrender by indiscriminate destruction, by any means, of his people and their possessions. This principle of 'total war', as we learned too easily from our enemies to call it, having once been accepted, science found itself no longer a mere accessory of military action, but increasingly a central agent, a direct combatant, and the provider of a limitless vista of destructive possibilities. Last year I spoke of the warning of such developments which the German 'V' weapons had given, and the dropping of the first atomic bombs has now given to that warning a new and a sterner emphasis.

3. Preparation by our enemies for the use of science in such total war, and our own for defence against it by reprisal, have alike involved the binding of a nation's scientific effort to secrecy on a scale beyond all earlier experience. This we accepted readily, with so much else, as a necessity of war. The freedom of science, as of all that made life worth living, was at stake; if by submitting for a while to secrecy we could help to save that freedom and to establish it for ever, we could not hesitate; but we must be watchful now against any easy assumption that that submission will be continued into peace.

4. As has now been recognized by international pronouncement, it cannot be assumed that the atomic bomb, or any contrivance using the release of atomic energy, represents the only direction, or even of necessity the most effective one, in which science could be perverted to the purposes of this 'total war', as a direct agent for the destruction of one people by another, or of dominance by the threat of it. The atomic bomb has given immediate prominence to the

problem, but the world might have had to face it, even if the attempt to release atomic energy had failed, or had never been made. The nations, in fact, have now to decide how they intend to use the powers and the resources which science stands ready to offer in growing abundance. Will they let science work again and henceforward in freedom, once more as an international community, and use what it offers for the raising of all mankind to levels of material prosperity and of culture above any that we can picture ? Or will they try still to bind science to secrecy, for the competitive invention of ever more effective means of destruction, and thus hold civilization in instant peril of dissolution ? It is surely our duty as men of science to help the world with our knowledge to make that decision, and to make clear our own views and intentions.

5. The danger to science from the intrusion of secrecy, against which I suggest that we need to be alert, does not arise, of course, simply from the question whether a particular technical invention shall be given away at once, or not until somebody else has made it. If policies now developing can bring about a frank and effective abandonment of all national secrecy about science, we need not, as men of science, be critical of their beginnings. Our experience so far, however, of the application of secrecy to science for military or industrial advantage must keep us on guard. It has not, in our experience hitherto, dealt with inventions which can, once for all, be locked up or given away. The most that it has hoped to achieve has been to keep its particular employer, at each new stage, a jump ahead of his rivals. What we have now to fear is that, in default of the international agreement which we must hope and work for, national military secrecy should try to maintain, or to extend, its war-time dominance. If that were to happen, we must expect it, with its new experience of the possibilities of science in total war, to be watchful for any advance, whether fundamental or technical, whether in nuclear physics or in any other progressive field of science, which could be impounded and put under seal for war-like preparation, presumably under the name of 'security'. It is impossible to forecast how much of science might thus become involved. The release of atomic energy is yet a novelty, and we have to think what might be made of it, for good or ill, twenty, thirty or forty years ahead. I think that we, as men of science, should make it clear to the world that, if national military secrecy were allowed thus progressively to encroach upon the freedom of science, even if civilization should yet for a while escape the danger of final destruction, a terrible, possibly a mortal wound would have been inflicted on the free spirit of science itself, to the immeasurable loss of what it stands ready to offer to a wiser world.

6. I do not believe that there is any division of opinion on this issue among scientists, anywhere in the world, in so far as they are able to express it simply as scientists. We scientists of the United Nations, in despite of all our normal traditions and instincts, were ready to submit for years to any secrecy or restriction which could help or hasten victory in the War for the world's freedom. The War has been won, and we shall not be ready to accept, as its result for science, a tightening of the chains. We have the right to expect that its freedom will be restored ; and the freedoms which we ask for science are freedom from secrecy and freedom from national barriers.

7. Secrecy as the enemy, and resistance to the attempt of authority to impose it, are no new experiences for science or for scientists. Giordano Bruno was burned at the stake and Galileo was imprisoned and threatened, because they refused to be secret about discoveries which were thought to be harmful to religion in their day ; and, in a later century, there was an attempt, for a like reason, to discourage scientific men by moral ostracism from telling the truth as they had seen and discovered it. Science was not halted, the world still moved, the moral stature of mankind was raised by the encounter, and organized religion gained more from it in wisdom than it lost in intellectual dominance. We do not know yet who, or how many, of Europe's men of science, in the terrible years now closing, have suffered for the scientific truths which political tyrannies desired to suppress or to distort. Unless the growth of international understanding and confidence can now prevent it, unless efforts to outlaw the abuse of science for 'total war' should succeed, science may find itself again facing an attempt to impose secrecy upon it, this time in the interests of national suspicion and rivalry, and in flat negation of its true service to mankind. If that danger should threaten, can we hope that the scientists of all the world may yet stand together against it, determined to preserve the integrity of science, to prevent its further perversion from its proper and beneficent uses, and to save civilization from misusing science for its own destruction ?

Our Charter of 1663 lays down, as the object of the Royal Society, "promoting by the authority of experiments the sciences of natural things and of useful arts, to the glory of God the Creator, and the advantage of the human race". Each of us may read these old words to-day in terms of his personal convictions. Freely to seek "by the authority of experiments" and freely to proclaim the truth as science reveals it, for its own beauty and excellence and for the help, the healing and the enlargement of the means of happiness which it can bring to all mankind —does any man of science, anywhere in the world, whatever his creed or his loyalties, desire for science any aim but this ? The old mandate still embodies the purpose for which the Royal Society has stood for more than 280 years, and still must stand, as a beacon to the world and as one of its centres of inspiration.

AN ELECTRICAL HYPOTHESIS OF SYNAPTIC AND NEUROMUSCULAR TRANSMISSION

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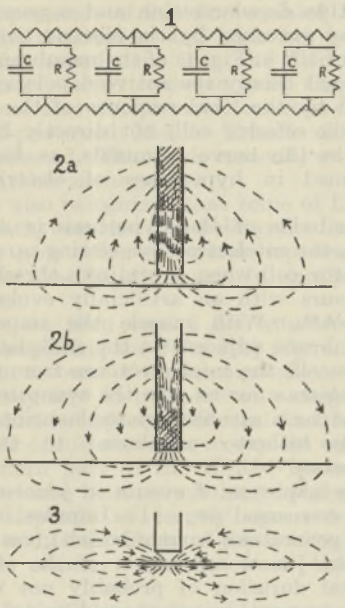
SINCE 1933 the transmission of impulses across synaptic or neuromuscular junctions (henceforth called junctional transmission) has been the occasion of a controversy[1]. The electrical hypothesis has had the grave defect that (except for the falsified isochronism theory) it has never been stated in such precise terms that it could be subjected to crucial tests[1,2,3,4,5,6]. On the other hand, the chemical hypothesis in its original form (acetylcholine as transmitter) was falsified by an investigation of the action of eserine, and has had to be modified by the addition of *ad hoc* hypotheses[7] ; but the

situation remains unsatisfactory because there seems little hope of testing these *ad hoc* hypotheses independently, and because recent work suggests that chemical transmission plays a subordinate or negligible part in junctional transmission in sympathetic ganglia[3] and the spinal cord[4]. Meanwhile, during the last eight years important advances have been made in the investigation of the electrical properties of nerve fibres, and of the electrical events occurring in junctional transmission; hence the time has seemed opportune to elaborate on these bases an electrical hypothesis (or model) of transmission that is capable of experimental test.

The initial assumptions of the hypothesis are: (*A*) That the geometrical situation at the junction may be schematically represented by the terminal nerve fibre ending as a cylinder with a closed end in close apposition to the large plane surface of the effector cell (nerve or muscle), as is shown in longitudinal section in Fig. 2. (*B*) That in general the surface membranes have the electrical properties demonstrated for peripheral nerve and muscle membranes—resembling a leaky condenser (in Fig. 1, *C* is about 1 μF and *R* about 400–1,000 Ω per sq. cm.) which has a resting charge of 50 mV., and which also acts as a rectifier[8,9,10,11], outwardly directed currents (cathodal) decreasing *R* to as little as 1/13, while anodal currents have the reverse effect. For present purposes the inductance[8] of the membrane will be ignored, because the absence of oscillatory potentials in the electrical responses of normal vertebrate nerve and muscle suggests that it is much smaller than in the squid. Both exterior and interior have the conductivity of a weak (0·6–1·0 per cent) salt solution. (*C*) That the junctional region of the effector cell has unique electrical properties, in that cathodal polarization (lowering of resting charge) sets up a graduated 'local response'[12–18] with a temporarily irreversible and large diminution of potential and resistance (cf. ref. 8, p. 46), but not the all-or-nothing membrane 'breakdown' characteristic of the propagated impulse. It may be likened to the nerve membrane in a refractory, anæsthetized or deteriorated condition[16,18,19].

Assumption *A* is based largely on the generally accepted histological picture of the junction, but electrical investigation also shows that there is a transverse membrane[1]. Assumption *B* is based on direct measurements on nerve and muscle, and on the evidence that nerve cells resemble nerve fibres in their electrical excitability[5] and in the propagation of impulses from a nerve cell to its axon and vice versa[5,20]. Assumption *C* is based on the responses of nerve under special conditions (as above) and on direct observation of the electrical response set up by a nerve impulse at an isolated neuromuscular junction before and during curarization[21]. This end-plate potential rises smoothly to the full height of the spike potential without showing the sudden inflexion characteristic of impulse initiation. The impulse appears to be initiated a little later by an adjacent region of the membrane when it reaches a critical intensity of catelectrotonus. Progressive curarization produces *pari passu* a diminution in the end-plate potential, impulse initiation occurring adjacently at lower end-plate potentials and after longer delays. It may therefore be assumed that the junctional region of the muscle is specialized to give 'local responses' of high and graduated intensities without incurring the membrane breakdown characteristic of the impulse[21]. This evidence of its unique



electrical properties can be related to its well-known unique pharmacological properties[22,23]. Assumption *C* is extended to the synaptic regions of nerve cells.

It appears that, assuming *A* and *B*, we have to expect that the current generated by an impulse propagating into a nerve terminal will in part penetrate the effector cell and give a diphasic action, first an anodal focus at the junctional region with a cathodal surround (Fig. 2*a*), which quickly reverses when the peak of the impulse reaches the junction (Fig. 2*b*). The penetrating current will be limited by polarization of the membrane condensers, and in the initial phase by the increasing resistance at the localized anode. On account of its much larger area, the membrane resistance at the cathodal surround will be so much lower that its simultaneous diminution will be relatively insignificant in tending to increase the flow of penetrating current. However, in the second phase the situation is reversed, because the lowering of the initially high resistance at the localized cathode will have a preponderating effect in increasing the flow of current; hence a much larger penetrating current will flow in the second phase than in the first phase, the current being as it were canalized through the localized low resistance at the cathode (cf. ref. 8, Fig. 3). According to assumption *C*, this cathodal current of high density would evoke at the junctional region of the effector cell an intense 'local response' which would run through a cycle of increasing and decreasing intensity, much as does the spike response of a propagating impulse[15,16,17,18,19]. This local response thus would outlast the second phase of penetrating current flow, and provide a relatively enduring focus of very low polarization and resistance through which adjacent regions of the membrane proceed to discharge (Fig. 3). (Assumption *C* here is essential for the hypothesis.) The anodal surround of Fig. 2*b* therefore gives place to a catelectrotonically polarized surround which spreads spatially according to the 'core conductor' theory. Such catelectrotonic potentials have been observed to play an essential part in all junctional transmissions so far investigated. It has further been shown that these potentials have a time course which may be interpreted as due to

a brief active depolarization and a passive exponential decay governed by the electric time constant (the product CR in Fig. 1) of the membrane[4,6,15,24,25]. In the present theory the active depolarizing action is provided by the local response of the junctional region of the effector cell, not directly by currents generated in the nerve terminals, as has hitherto been assumed in hypotheses of electrical transmission.

The remainder of the hypothesis is on conventional lines, the catelectrotonus setting up an impulse in the effector cell when it attains a threshold value, just as occurs with an artificially evoked catelectrotonus[4,6,15,25]. With muscle the impulse arises in the membrane adjacent to the end-plate region[21]. With nerve cells the catelectrotonus from the diverse synaptic region sums to give the synaptic potential, which provides a satisfactory explanation of all the phenomena hitherto attributed to the central excitatory state[3,4,24].

Thus the sequence of events in junctional transmission is envisaged as: (1) Impulse in terminal nerve fibre generates a current which gives a diphasic effect at the junctional region of the effector cell with a total duration of probably not more than 1 m.sec. in mammalian muscle and spinal cord: (*a*) initial anodal focus with cathodal surround; (*b*) more intense cathodal focus with anodal surround. (2) This cathodal focus sets up a brief and intense local response at the junctional region. (3) From this local response a catelectrotonus spreads decrementally over the effector cell membrane. (4) A propagated impulse is set up in the effector cell if this catelectrotonus is above a critical value; if it is below, then as the local response subsides, the catelectrotonic surround decays passively.

The hypothesis offers an explanation of the following observations on junctional transmission.

(*a*) Irreversibility of junctional transmission would be predicted because an impulse in the effector cell would sweep past the nerve terminals on the surface and exert on them also the third phase of anodal depression as predicted by the theory of electrical interaction and observed in artificial synapses[2,26,27], so abruptly terminating the local cathodal effect.

(*b*) The delay in onset of the local response and catelectrotonus of the effector cell (synaptic or junctional delay) is attributable to the initial penetrating current setting up an anodal focus, which has to be removed by the reversed current before the cathodal focus would be built up sufficiently to generate the local response; that is, there would be a delay until the impulse at the nerve terminal was on its declining phase. The observed value of about 0·6 m.sec. for mammalian neuromuscular junctions[25] and central synapses[4] accords well with this explanation. A further delay of about 0·2 m.sec. is attributable to the time of rise of the catelectrotonus to the threshold for impulse discharge[4,25].

(*c*) The brief phase of low resistance (additional to the catelectrotonic effect) during the initial part of the end-plate potential[11] is attributable to the local response at the junctional region, which, because of its sharp localization, would contribute relatively more to current flow than to potential.

(*d*) Analysis of junctional potentials gives a time course for the active depolarizing agent corresponding to that expected for the local response of the effector cell[4,6,15,24,25].

(*e*) If the junctional region cannot give the all-or-nothing impulse response (assumption C), its 'local response' might be expected to survive the transmission of a muscle impulse whether generated adjacently or propagating past—as is found to occur for the active depolarizing agent[15].

(*f*) The hypothesis would predict that a non-propagated catelectrotonus of the effector cell, for example, a synaptic potential, would give rise to a sharply localized cathode at the nerve terminal and hence produce there the same conditions as occurred in the effector cell in Fig. 3. Catelectrotonus spreading from this focus provides an explanation of the dorsal root potentials[28].

In its present largely qualitative form, the testing of the hypothesis may be considered at two levels.

(i) The picture of the diphasic flow of penetrating current and the cathodal focus is based on assumptions A and B. In connexion with the present hypothesis, assumptions A and B are to be considered, in the main, as established rather than as open to tests by experiments on junctional transmission. The mechanism of this action has already been investigated in the artificial synapse or ephapse made by two nerve fibres in close apposition[2,14,26,27]. (Figs. 2, 3, 4, and 5 of the first paper are particularly pertinent as they show a 'terminal' effect with an initial diphasic wave generating a local response exactly as predicted by the present hypothesis. The oscillatory decline of this local response may be related to the high inductance of the squid nerve membrane[8].) Further study of ephaptic transmission will provide a test for this aspect of the hypothesis.

(ii) The hypothesis states that the cathodal focus at the junctional region is adequate both in intensity and time course to set up the observed local response, the subsequent spreading catelectrotonus and finally the propagated impulse. These predictions should be testable by transmission experiments. In particular the tests would attempt to evaluate the role of the chemical transmitter, which is relegated to a subsidiary position by the present hypothesis. The action of eserine indicates that the junctions of nerve-muscle[7], the sympathetic ganglion[3], and the spinal cord[4] form a series of decreasing significance for chemical transmission.

A crucial test for the electrical hypothesis will be its ability to explain the junctional block by curare. Since curare is known to act specifically on the junctional (end-plate) region of muscle[22], and since the block is explained by the observed depression of the junctional potential[6,21,25], the simplest explanation is that curare depresses the local response set up at the end-plate by the cathodal focus, that is, it depresses the electrical excitability of the end-plate. In a recent attempt to test this by electrical stimulation of the isolated neuromuscular junction before and after curarization[23], the initiation of propagated muscle impulses was used as the criterion of end-plate excitability. Yet, if the end-plate region reacts by local responses rather than by propagating impulses (assumption C), it seems probable that this investigation tested the excitability of regions adjacent to the end-plate, confirming the previously observed absence of curare action there; that is, it provides no evidence for or against a specific depression of end-plate excitability. However, if curare blocks solely by its known depressant effect on chemical transmission, then, in a very deep curarization, the residual catelectrotonic effects produced by the cathodal focus (that is, by electrical transmission) should be observable uncomplicated by chemical transmission. The problem of curare action

is particularly significant, because it also specifically blocks transmission through sympathetic ganglia[24], where chemical transmission seems to play a subordinate role[3].

In conclusion, it may be stated that the present hypothesis will have to stand up to many severe tests, particularly pharmacologically. Mathematical development has been beyond my competence and may be premature, though it should be possible; but the absence of quantitative prediction as regards intensity of action is a grave defect. Nevertheless, on the basis of the properties observed for peripheral nerve and muscle membranes, the hypothesis gives a statement of electrical transmission sufficiently precise (particularly as regards time course) for experimental testing, offers a coherent explanation of many previously unrelatable observations, only some of which are mentioned in this preliminary account, and has already proved fruitful in suggesting new experimental investigations.

I wish to thank Dr. K. R. Popper for his stimulating and helpful criticism.

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OBITUARIES

Dr. J. C. Merriam

THE death on October 30 of Dr. J. C. Merriam at the age of seventy-six will be deplored by all palæontologists and many other scientific men.

After a training under von Zittel in Munich, Merriam went to the University of California to teach palæontology and historical geology, and in time became professor and head of the Department of Geology.

Not long after his appointment, Dr. Perrin Smith, who was working on ammonites, gave Merriam some frâgmentary remains of reptiles from the Upper Triassic Trachyceras beds of Shasta Co., North California. These proved to belong to Ichthyosauria, and Merriam based on them the first satisfactory account of any Triassic member of that group. The obvious importance of this find enabled Merriam to interest Miss Alexander, and with her help he was able to take expeditions into the field, which, in several years, not only collected much Upper Triassic material but also found new localities in Nevada where well-preserved Middle Triassic Ichthyosaurs could be collected. The whole material was described in an admirable monograph.

Merriam also recognized that some of his material was not ichthyosaurian but belonged to members of an entirely new order of aquatic reptiles, which he described as the Thalattosauria in another splendid monograph.

Dr. Merriam then turned his attention to fossil mammals, exploring the John Day region of Oregon, giving us an account of the stratigraphy, and descriptions of many new or little-known animals found in it. From this, led by an accidental find, he went on, with the aid of his students, to explore other regions of the western part of the United States, work of great importance because our knowledge of Tertiary mammals depends so largely on materials from the Plains and Great Basin of the Rocky Mountains, the whole country to the west having been barren.

Merriam's well-directed and long-continued explorations not only showed us many successive faunas from the west, but also in some cases gave us mammal faunas from rocks in a marine succession, and thus for the first time enabled us to correlate the terrestrial formation of the interior of the continent with the 'normal marine succession'.

In 1920, Merriam was appointed president and chief administrative officer of the Carnegie Institution of Washington, but he still retained his interests in palæontology, himself continuing to work on fossils and supporting the work of other men. After his appointment to Washington, Merriam became much interested in the problem of the time at which man first appeared on the American continent, drawing up a detailed discussion of the evidence in a report to the Sixteenth International Geological Congress in 1934. In this he showed that man had been a contemporary with some extinct mammals in America.

But Merriam's interests ranged widely: he wrote much on national parks, on the wide diffusion of culture among the 'common men', on many social problems of the modern world, and on spiritual values. He was in fact a man entirely worthy of the influential position he filled, and he was also a palæontologist of the first rank. D. M. S. WATSON.

Prof. Velyien Henderson

WE regret to record the death of Prof. Velyien Ewart Henderson, of Toronto, on August 6 at the age of sixty-eight. Prof. Henderson was born and educated in Canada and took his M.B. at Toronto in 1902. After a period as demonstrator in the University of Pennsylvania he studied at Prague and at Marburg under Hans Horst Meyer. He was appointed demonstrator of physiology in Toronto in 1904, lecturer in pharmacology in 1906 and professor of pharmacology in 1909. Except for a period of service in the Canadian Expeditionary Force during 1916–18, he was at Toronto for the remainder of his life.

At Marburg, Henderson worked on diuresis and on the salivary glands. With Otto Loewi he discovered that the vasodilator nerves in the chorda tympani

are not antagonized by doses of atropine, which antagonize the corresponding effect of drugs acting like acetylcholine. This fact provides a complication in the theory of the mode of action of cholinergic nerves, and this topic provided Henderson with one of the interests of his life. In 1932, with Roepke, he demonstrated the liberation of acetylcholine in salivary glands on stimulation of the nerve chorda tympani, and much other work on this and allied drugs has come from his laboratory.

Henderson's main interest in recent years was in anæsthetics. With G. H. W. Lucas he was responsible for the discovery of the properties of cyclopropane as a general anæsthetic in 1929. Though it is difficult to make and administer, this gas has been widely used because it is a powerful anæsthetic without toxic actions and is rapidly eliminated. This discovery formed part of a prolonged pharmacological study of the properties of a number of similar substances. In addition to these major investigations, Henderson published papers on a wide range of other topics, including morphine miosis, expectorants, intestinal peristalsis, the respiratory centre, and the mechanism of erection. The late Sir Frederick Banting owed much to the encouragement given to him by Henderson in the early days of work on insulin.

Pharmacologists all over the world mourn the passing of a very lovable man who achieved much for the advancement of knowledge and the welfare of mankind. J. H. GADDUM.

NEWS and VIEWS

Anniversary Meeting of the Royal Society

SIR HENRY DALE completed his term of office as president of the Royal Society at the anniversary meeting on November 30, and the main part of his address is printed elsewhere in this issue (p. 677). Speaking of domestic affairs, Sir Henry recorded the Society's thanks to the several people who undertook the guardianship of its historical treasures, now safely returned to London. He also announced that the Society is to increase the number of annual elections to twenty-five. Sir Henry himself, when he was a secretary of the Society, had a part in the movement which led in 1931 to the increase of maximum annual admissions to seventeen from fifteen, at which figure it had remained from the time when limitation was imposed eighty-three years before. In 1937, the number was raised to twenty; and now it is to be made twenty-five. This action has been taken in recognition of the recent rapid growth in number of those who have produced evidence of real scientific achievement. Sir Henry also referred to the election this year of two women to the fellowship of the Royal Society, following an alteration to the statutes to elucidate a legal position which had existed since 1919. He admitted that the decision was contested, but expressed his belief that the change was a normal adjustment of the Society's practice "to the growth in extent and distinction of women's contribution to the advancement of science by research".

The officers of the Royal Society as now announced are: *President:* Sir Robert Robinson; *Treasurer:* Sir Thomas Merton; *Secretaries:* Sir Alfred Egerton and Dr. E. J. Salisbury; *Foreign Secretary:* Prof. A. V. Hill; *Other members of Council:* Dr. C. H. Andrewes, Dr. W. T. Astbury, Prof. P. M. S. Blackett, Dr. E. C. Bullard, Prof. I. de B. Daly, Prof. R. A. Fisher, Dr. C. Forster-Cooper, Prof. F. E. Fritsch, Dr. S. Goldstein, Prof. E. L. Hirst, Prof. W. V. D. Hodge, Dr. G. M. Holmes, Prof. H. W. Melville, Prof. R. A. Peters, Dr. D. R. Pye, Prof. S. Zuckerman.

Sir Robert Robinson: President of the Royal Society

SIR ROBERT ROBINSON, Waynflete professor of chemistry in the University of Oxford, who has just been elected president of the Royal Society, is recognized throughout the scientific world as one of the most outstanding and versatile of organic chemists. His researches not only embrace all fields of pure organic chemistry but also include notable contributions to subjects of biological interest, such as antimalarials and phthioic acid. As a research student under the late Prof. W. H. Perkin, Robinson was early initiated into the chemistry of the alkaloids and other natural products, and he soon became an outstanding figure in the famous Manchester school. The unique collaboration between Perkin and Robinson thus established was continued until the former's death in 1929. While still less than thirty years of age, as professor in Liverpool, Robinson published his famous synthesis of tropinone, noteworthy on account of its simplicity and intuitive brilliance. This was quickly followed by a theory of biogenesis of plant products which collated for the first time the apparently dissimilar alkaloidal structures and which still stands as one of the most outstanding contributions to the chemistry of natural compounds. Among other significant investigations in this field, mention may be made of Robinson's morphine formula, now universally accepted, and also his classical work on the elucidation of the structures of brucine and strychnine.

On his return to Manchester as head of the Department of Organic Chemistry and with more students available, Robinson's research programme rapidly expanded, and he turned his attention to the problem of the anthocyans, the naturally occurring pigments of flowers and fruits. The synthesis of these was achieved in a comparatively short time and constitutes possibly the most brilliant example of planned research in organic chemistry. Less widely recognized but of equal importance is his work on the synthesis of the anthoxanthins, whereby readily accessible routes were secured for the preparation of a wide range of many naturally occurring flavones, flavanols and *iso*flavones. In 1930, Robinson went to Oxford as Waynflete professor. By 1935 much attention was being focused on sterols and related compounds, and Robinson, together with his students and collaborators, embarked upon the difficult problem of the synthesis of the secondary sex hormones. Once again his mastery of synthetic methods has been demonstrated in a series of memoirs noteworthy for their freshness of approach. Arising out of this work, Robinson, in association with Prof. E. C. Dodds, was responsible for the discovery of stilbœstrol, the first synthetic œstrogen.

During the war years, notwithstanding much heavy and responsible work on behalf of the Government,

[None of the vacancies in these columns relates to a Man between the ages of 18 and 50 inclusive or a Woman between the ages of 18 and 40 inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.]

MINISTRY OF AGRICULTURE AND FISHERIES

NATIONAL AGRICULTURAL ADVISORY SERVICE (ENGLAND AND WALES)

NOTICE

1. Notice is given that in accordance with the Regulations made by the Minister of Agriculture and Fisheries under Section 1 (2) of the Agriculture (Miscellaneous Provisions) Act, 1944, persons eligible for transfer to the National Agricultural Advisory Service including technical administrative and other grades of staff should now make application on a form to be obtained from the address given below. It is proposed to establish the Service on October 1, 1946.

2. Persons eligible for transfer are those who (i) were employed on August 23, 1939, in a whole-time capacity either (a) by a County Council wholly or mainly on (or in connection with) the giving of advice or education in agricultural matters; or (b) by any University or Agricultural College on (or in connection with) the giving of specialist advice on agricultural matters other than agricultural economics; and (ii) have been, between August 23, 1939, and the date of application continuously employed, either as stated above or in war service, or partly as in (i) above and partly in war service. For the purpose of this Act, war service means service with H.M. Forces and any employment which the Minister considers may properly be treated as war service (e.g., employment by War Agricultural Executive Committees).

3. Applications are also invited for technical appointments in the National Agricultural Advisory Service from persons not eligible for transfer. Applicants should have a degree or similar qualification in Agriculture, Dairying or Horticulture or degree in the appropriate Natural Sciences or its equivalent, though applicants without academic qualifications will be considered for certain posts if they have had sufficient practical experience.

4. Appointments will be made to the following technical posts:

(a) Provincial Specialist Advisory Officer and Assistant Advisory Officer in chemistry, entomology, plant pathology, bacteriology, animal nutrition, animal husbandry, crop husbandry, horticulture, farm machinery, farm buildings, analyst and assistant analyst (soils, feeding stuffs, milk).

(b) County Advisory Officer and District Advisory Officers; County Officers in milk production, horticulture, poultry (including small livestock), farm machinery and some other subjects in (a).

5. Forms of application and a memorandum explaining conditions of service may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 4 Bickenhall Mansions, London, W.1. Envelopes should be marked "N.A.A.S." in the top left-hand corner.

6. Applications should be completed and returned to the Ministry not later than January 31, 1946. In exceptional circumstances the Regulations provide for late applications for transfer where there is good reason for the delay. Applications from men and women at present serving in H.M. Forces will be accepted at any time up to the date of their discharge in the case of those eligible for transfer, and up to three months after their discharge in the case of those not eligible.

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

ACTON TECHNICAL COLLEGE

High Street, Acton, W.3.

Applications are invited for a full-time appointment as Lecturer in Chemistry. Candidates should be honours graduates with teaching experience. Research and/or industrial experience will be an advantage. The successful candidate will be required to teach Matriculation, Intermediate B.Sc. classes, and sections of the Final Degree work in which he has specialized. Duties to commence as soon as possible. Duties may be divided between Senior full-time, and part-time day classes and evening classes. Salary in accordance with the Burnham Scale (London area). Application forms may be obtained by sending a stamped addressed foolscap envelope to the Principal to whom completed forms should be returned not later than December 21, 1945.

T. B. WHEELER,
Chief Education Officer
of the Middlesex County Council.

THE INCORPORATED LIVERPOOL SCHOOL OF TROPICAL MEDICINE

(UNIVERSITY OF LIVERPOOL)

LECTURER IN MEDICAL PARASITOLOGY

Applications are invited for the appointment of Lecturer in Medical Parasitology. Candidates must hold a qualification in medicine and/or in zoology (a qualification in medicine is desirable but not essential). The selected applicant will be expected to assist in the teaching of students studying for the Diploma in Tropical Medicine, etc., and to devote his energies to some special line of research under the direction of the Professor of Entomology and Parasitology.

Preference will be given to candidates who have had experience of laboratory work during the war and who intend to make use of the appointment as a training for further research work, either at home or in the tropics.

The salary for a candidate holding a medical qualification will be at the rate of £600 per annum, and the appointment will, in the first instance, be for a period of one year.

The duties of the successful applicant will begin within a short period of the time of appointment or upon release from H.M. Forces or other National Service.

Applications, giving particulars of age, qualifications, previous experience and the names of three referees should be sent by March 1, 1946, to: The Secretary, Department of Entomology and Parasitology, School of Tropical Medicine, Pembroke Place, Liverpool, 3.

RUBBER RESEARCH SCHEME CEYLON

(Established under Ceylon Ordinance, Cap. 302)

The Board of Management requires the services of (1) a MYCOLOGIST and (2) a BOTANIST to undertake research on problems relating to the cultivation of Hevea brasiliensis. Candidates should have good academic qualifications and research experience.

Salary scale Rs. 7,200—Rs. 600—Rs. 14,400 per annum (present sterling equivalent £540-£45-£1,080) plus a temporary war allowance of 15 per cent. Provident Fund contribution 7½ per cent of salary to which the Board will add a similar amount. Quarters with heavy furniture provided, or equivalent allowance.

Initial salary up to the maximum of the scale according to qualifications and experience. In the case of one or other of the appointments the Board would prefer to engage a scientist of high standing and wide experience who could be expected to supervise the work of the Botanical Department.

Engagement in the first instance for a period of four years, subject to a termination clause at six months notice after the first two years. First class passage to Ceylon provided, with return passage and 8 months full pay leave on satisfactory completion of engagement. Leave and travelling allowances in Ceylon in accordance with local regulations.

Applications accompanied by copies of testimonials, and stating age and whether married or single, should reach the Chairman, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7, by registered post, not later than February 28, 1946.

CHEMICAL ENGINEERING COURSE

In response to many requests the Committee of the Birmingham and Midlands Section of the Royal Institute of Chemistry has decided to repeat the Chemical Engineering Course given in 1944 provided the demand justifies it.

The Course will be given in Birmingham from Saturday, April 6, to Saturday, April 13, 1946, and will be organized on a residential basis although some places will also be available to non-residents. Lectures, laboratory tours and probably Works visits will be included; social amenities will be provided as far as time permits. The lectures will be given by Mr. E. Woollatt, B.Sc., A.M.I.Chem.E., and his notes will be printed in book form for the benefit of those taking the Course.

The Fee for the Course will be nine pounds. This will include board and lodging, tuition and a copy of the notes. The non-resident fee will be three pounds ten shillings.

Application (indicating resident or non-resident) to join the Course should be made in writing to E. M. Joiner, 15 Halton Road, Sutton Coldfield, to reach him not later than January 31, 1946. No money should be sent until the applicant has been offered a place. Appropriate directions and further information will then be available.

In the event of the applications exceeding the vacancies preference will be given to members of the Royal Institute of Chemistry.

REFRIGERATED CARGO RESEARCH COUNCIL

A Senior Research Scientist is required in connection with the development of a long-term programme of research on the overseas transport of refrigerated food cargoes.

Applicants should preferably be between the ages of 30 and 45 years, and should have knowledge of the biology of foods and of the physics of refrigeration, together with experience of research in one or other of these aspects.

The duties will involve some ocean travel, and some administrative responsibilities, and will also give scope for laboratory research. The salary offered will be proportionate to the special qualifications and experience which are sought, and the appointment will carry superannuation under the F.S.S.U. scheme.

Applications setting out full particulars of age, educational and academic qualifications, and research experience, should be addressed to the Secretary, Refrigerated Cargo Research Council, c/o Australian Tonnage Committee, 88, Leadenhall Street, E.C.3, and should be received not later than December 22, 1945.

REFRIGERATED CARGO RESEARCH COUNCIL

A chief technical assistant is required in connection with research on the overseas transport of refrigerated food cargoes. Duties will involve supervision of the work of sea-going observers, and technical assistance to the Director in the general planning and execution of the research programme.

Applicants should preferably be between 30 and 40 years of age, and should have engineering qualifications, experience of research work, and knowledge of shipboard conditions and marine refrigerating plant and practice. The duties will include some ocean travel.

The salary offered will be in the range of £500 to £700, according to qualifications and experience, and will carry superannuation under the F.S.S.U. scheme.

Applications, with full particulars, should be addressed to the Secretary, Refrigerated Cargo Research Council, c/o Australian Tonnage Committee, 88, Leadenhall Street, E.C.3, and should be received not later than December 22, 1945.

UNIVERSITY OF BIRMINGHAM

EXTRA-MURAL DEPARTMENT

Applications are invited for the post of STAFF TUTOR for the teaching of SCIENCE in Adult Classes in the West Midlands.

Initial salary up to £500 per annum together with superannuation under F.S.S.U.

Good hons. degree in BIOLOGY preferred, but graduates in other scientific subjects considered.

Further particulars from the undersigned to whom three copies of applications and the names of two referees should be sent not later than December 15.

C. G. BURTON,
Secretary.

The University,
Edmund Street,
Birmingham, 3.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

Applications are invited for the post of Chemist in the Department of Dairy Chemistry. Duties include research and analytical work on milk, milk products, feeding stuffs, etc. Experience of research and analytical work, preferably in agriculture or food chemistry, is desirable. Commencing salary from £400 to £500 per annum according to qualifications and experience, plus war bonus at present £60. Application with names of not more than three referees should reach the Secretary, Shinfield, nr. Reading, by January 1, 1946.

HARPER ADAMS AGRICULTURAL COLLEGE

NEWPORT, SHROPSHIRE

Applications are invited for the post of RESEARCH ASSISTANT in the department of bacteriology at the above College, in connection with problems arising out of the work of the National Milk Testing and Advisory Scheme. Applicants should possess a degree in science from an approved University, though consideration will be given to an applicant with the National Diploma in Dairying with experience in dairy bacteriology. Further particulars can be obtained from the Principal, H.A.A.C.

UNIVERSITY OF CAPE TOWN

LECTURER IN PHYSICS required by University of Cape Town in the Department of Physics. Salary scale £450 x £25 to £500 x £50 to £675. Post vacant from April, 1946. Write quoting A.1197A to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed *in duplicate* by December 29, 1945.

UNIVERSITY OF GLASGOW

DEPARTMENT OF GEOGRAPHY

Applications are invited for a Junior Post in the Department of Geography. Commencing salary £320-£400 according to qualifications and experience. Further particulars may be obtained from the undersigned.

ROBT. T. HUTCHESON,
Secretary of University Court.

UNIVERSITY COLLEGE OF HULL

Required on January 1 or as soon as possible thereafter, temporary Assistant Lecturer in Mathematics. Salary according to qualifications and experience. Applications (one copy) should reach the Registrar not later than December 15.

The Iraq Government invite applications for the undermentioned posts:

DIRECTOR OF CHEMICAL LABORATORY. Must be F.R.I.C. and possess the Branch E. (The Chemistry, including Microscopy of foods, drugs and water) Diploma of the Royal Institute. Should have considerable experience of Police Work. Salary up to £150 per mohth according to qualifications and experience. (Ref. No. F. 5248A.)

ANALYTICAL SPECIALIST with wide experience preferably in analysis of soils, water, cement and other constructional materials, petroleum products, oil seeds and cake, etc. Preferably F.R.I.C. Salary up to £120 per month according to qualifications and experience. High cost of living allowance of £24 per month at present. Suggested first period contract three years. Free first class passage, generous leave, Provident Fund. (Ref. No. F. 5249A.)

Write quoting appropriate reference number to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by January 8, 1946.

Chair of Zoology. The University of Cape Town invite applications for the above post. Salary £1,000 by £25 to £1,150 p.a. Write quoting F.5269A to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed *in duplicate*, together with names of three referees, by January 1, 1946.

Imperial Chemical Industries Limited, Plastics Division, invite applications for appointments in their Development and Technical Service Departments. Applicants should possess scientific qualifications and/or technical experience in the Plastics, Cable or allied trades. Knowledge of a foreign language would be an advantage. Salary £450 p.a. minimum.

Write quoting F. 5262XA to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, for application form which must be returned completed by January 25, 1946.

Chemist required to take charge of laboratory control work on behalf of a national food distributor with London headquarters. Applicants should have sound experience in the analysis of foodstuffs and the administration of the Food and Drugs Act, some knowledge of food processing and the ability to participate in development work. Knowledge of bacteriology desirable. Preferably applicants should be between 30 and 45. Salary at commencement £700 to £850 according to circumstances; post is pensionable. Applications in writing, giving full details of previous work, should be made to Box 1452, A. K. Advg., 212a, Shaftesbury Avenue, W.C.2.

Required Assistant to Managing Director of well-known Public Company, with headquarters in London. Applicant must be qualified Engineer, experienced in production methods; proved administrative and commercial ability and possessing tact and energy. A commencing salary of £3,000 per annum will be paid to a man with the necessary qualifications, aged about 40 years. Apply in confidence to Box 472, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Scientific Instrument Maker, or mechanic experienced in general workshop practice and fine mechanical work, required for the University Science Laboratories, Durham. Salary according to qualifications, but not less than £300 a year. Applications should be sent to the Secretary, University Science Laboratories, South Road, Durham, not later than December 15.

The Forestal Central Laboratories, Harpenden Rise, Harpenden, have vacancies for junior and trained assistants in connection with the leather and allied trades. Reply as above stating age, qualifications and salary required.

Analytical Chemist required by well-known house of manufacturing chemists in N.W. area, preferably with previous experience of chemical and spectroscopic assays of Vitamin containing oils and food-stuffs. Box 1359, Scotts, 9 Arundel Street, Strand, W.C.2.

Required for large Textile manufacturing firm, highly qualified and experienced scientist to take charge of research work. Apply with usual full particulars to Box 470, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

A large industrial company in the North East requires young physicist for research on dynamical electro-mechanical and hydraulic problems. An honours degree in physics, mathematical ability and some research experience desirable. Salary in accordance with ability, qualifications and experience. Box 468, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Qualified Chemist or Pharmacist, man or woman, required by Allen & Hanburys, Ltd., Ware, Herts, as librarian and abstractor of current scientific literature. Some experience of patent specifications and working knowledge of French and German desirable. Apply Personnel Manager.

Qualified Chemist for Research and Development work on Synthetic Resins. Knowledge of Organic and Physical Chemistry with research and industrial experience required. London area. Salary £500 or upwards, according to qualifications. Write giving details to Revertex, Ltd., Laboratory, 27/29, Tavistock Place, London, W.C.1.

Graduate Chemist, experienced in synthesis of dyes, required for research laboratory. Write Box 469, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Assistant Bio-chemist (graduate) wanted for Clinical Laboratory, Royal Infirmary, Edinburgh. The post carries the rank of University Demonstrator. Salary £350. Apply Professor Dunlop, Clinical Laboratory, Royal Infirmary, Edinburgh.

Required for Industrial Research Laboratory, Mathematician with some years experience of mathematical work in a research laboratory. Write, stating age, experience and salary expected to Box 7989, A. K. Advg., 212a Shaftesbury Avenue, W.C.2.

Required for Industrial Research Laboratory, Engineer with some years practical experience of vacuum tube development or production. Write, stating age, experience and salary expected, to Box 7985, A. K. Advg., 212a, Shaftesbury Avenue, W.C.2.

Skilled Mechanics required for medical research workshop. Apply Director, Radiotherapeutic Research Unit, Hammersmith Hospital, W.12.

For Sale: Journal of the Chemical Society, 1852-1937, practically complete. Also *Agricultural Journal* 1840-1861; *Journal of the Royal Aericultural Society*, 1878-1936. Offers to Box 471, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

Limited supplies of marine biological material are still available, but orders should be placed well in advance.

For prices and detailed information apply to:
THE DIRECTOR, THE MARINE BIOLOGICAL LABORATORY, PLYMOUTH.

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Sir Robert Robinson still found time for new researches, and it is no secret that for the past five years he has concentrated much attention upon the problem of the structure and synthesis of penicillin. Reference must also be made to his electronic theory of organic reactions which, classifying on a common basis a diverse mass of data, has had a profound influence on the development of chemical thought. Sir Robert Robinson has indeed imprinted his genius upon every branch of organic chemistry. Throughout his career, students have flocked to his laboratory from all parts of the world, and while still less than sixty years of age he has the satisfaction of seeing his former students occupying some of the most prominent positions both in academic life and in industry.

Rowett Research Institute : Dr. D. P. Cuthbertson

David Paton Cuthbertson, who has been appointed head of the Rowett Research Institute in succession to Sir John Orr, graduated B.Sc. from the University of Glasgow in 1921 as a pure chemist. He was awarded a Ministry of Agriculture scholarship and commenced his research work in the biochemical laboratory of the Institute of Physiology at Glasgow. He soon realized that to carry out effective investigations in biochemistry he must have more biological knowledge, and accordingly he resigned his scholarship and began the study of medicine. He graduated M.B., Ch.B. in 1926 and, shortly after graduation, he was appointed the first clinical biochemist at the Royal Infirmary, Glasgow. He rapidly developed this post and managed to have attached to his laboratory a small number of beds for the study of metabolic disorders. In 1934 he returned to the University of Glasgow as Grieve lecturer in physiological chemistry. The Medical Research Council in 1943 applied for the loan of his services to act on its secretariat. In this last post he was appointed scientific secretary to a number of the Council's sub-committees and thus gained a very wide experience of the varied research work carried out on behalf of the Council. Earlier this year he accepted an invitation from the Government to visit Newfoundland to report and advise on the means requisite to alleviate the recognized nutritional deficiencies. He obtained the degrees of D.Sc. in 1931 and M.D. with honours in 1937. He also worked for a period in the biochemical laboratory of the University of Leipzig under Prof. Karl Thomas. Dr. Cuthbertson's research work has been mainly in the metabolic field, and particularly that of protein metabolism. His most interesting and outstanding contribution has been a series of papers on the metabolic reactions of tissues to injury with special reference to the effects of fracture of bones and of the immobilization of limbs.

Physical Society Awards : Duddell Medal

The Duddell Medal of the Physical Society is awarded at suitable intervals, usually annually, for the invention of scientific instruments or of materials used in their construction. The Council of the Society made the twenty-ninth (1945) award to Prof. J. T. Randall, professor of natural philosophy in the University of St. Andrews, for his very valuable work on phosphors and the cavity magnetron. The presentation is to be made on December 12, when Prof. Randall will deliver an address at a meeting of the Society at the Science Museum.

Before the War, Prof. Randall had made important contributions to the X-ray study of structure (notably those of carbon, graphite and glasses) and was also an early worker in electron diffraction. His investigation of luminescence just before and during the early part of the War, and his elucidation of the nature and depth of the 'electron traps' in phosphors, was a fine piece of work on the experimental side, and showed a complete grasp of theory. During 1939–43 he worked for the Admiralty as a member of the special team at Birmingham under Prof. M. L. E. Oliphant, mainly concerned with the research and development of valves for operation on high powers for centimetric radar. Assisted by Boot, Randall was responsible for the very brilliant adaptation of the already-known split-anode magnetron into the cavity magnetron, which enabled exceedingly high powers to be provided on centimetric waves. Randall's cavity magnetron and Sutton's *V-M* valve are basic to the present high pitch of perfection attained in British radar technique and in that of the United States ; without them radar might have been relatively ineffective. Both units are destined to play important peace-time parts, particularly in air and sea navigation.

Charles Vernon Boys Prize

By the will of Sir Charles Boys, provision was made for the foundation by the Physical Society of a memorial to one of its most distinguished past presidents, and the Council of the Society decided that it should be a prize to be awarded annually for experimental work either still in progress or completed not earlier than ten years before the date of the award. The first (1945) prize has been awarded to Dr. A. H. S. Holbourn, of the Clarendon Laboratory, Oxford, for his successful measurement of the angular momentum of circularly polarized light. Before this work, it was uncertain whether this momentum really was $h/2\pi$. Holbourn succeeded in suspending a half-wave plate on a $\frac{1}{2}\mu$ silica fibre and, working under good vacuum conditions, he was able to measure the torque produced when the direction of rotation of circularly polarized light was reversed in its passage through the plate ; torques as small as 2×10^{-11} dyne cm. were measured with an accuracy of 3 per cent. Apart from its great theoretical significance, this experiment represents a most delicate piece of manipulative work comparable with Boys' construction of the radiomicrometer. It was described briefly in *Nature* (**137**, 31 ; 1936) and the *Journal of Scientific Instruments* (**16**, 331 ; 1939) and at greater length in a D.Phil. thesis (Oxford, 1938). Historically, it is interesting to note that the work was carried out in a compartment of the same cellar of the Old Clarendon Laboratory in which Boys himself measured the mean density of the earth. The presentation will be made at the meeting on December 12.

Organic Chemistry at the Royal Technical Col'ege, Glasgow : Appointment of Dr. F. S. Spring

The chair of organic chemistry at the Royal Technical College, Glasgow, last occupied by the late Forsyth James Wilson, has now been filled by the appointment of Dr. F. S. Spring, of the University of Manchester. Dr. Spring graduated with honours in chemistry at the University of Liverpool in 1928, and while holding a United Alkali research scholarship followed by a University fellowship he carried out research on the chemistry of the sterols with Prof. I. M. Heilbron, being duly awarded the Ph.D.

degree. His first academic appointment was as assistant lecturer in organic chemistry at Manchester in 1930, under the late Prof. Lapworth. With the appointment of I. M. Heilbron to Manchester on the retirement of Lapworth, the Heilbron and Spring collaboration was resumed, and many papers, particularly on the chemistry of ergosterol, vitamin D and related compounds, testified to the success of the collaboration. With the departure of Heilbron to the Imperial College, London, Spring continued his interest in the chemistry of natural products, going on to studies in the triterpene group and especially the constitution of the α- and β-amyrins. He was awarded the D.Sc. (Manchester) in 1937, and made a senior lecturer in 1941. More recently, with an active research team, he has broken new ground in studies on the application of the Hofmann reaction to the synthesis of heterocyclic compounds, and in addition has carried out investigations for the Colonial Products Research Council.

At Manchester, Dr. Spring proved himself a very successful teacher and an able lecturer, his interest in the chemistry of natural products adding enthusiasm to his lectures to medical students and others. He has always been a staunch supporter of the Chemical Society, being at present a member of its Council, and, as well as being a frequent contributor of original papers, he has taken a very active part in the compilation of the annual reports published by the Society. During the War, Dr. Spring has acted as senior gas adviser to the North-West Regional Commissioner, and was responsible for the training of gas identification officers in this area, and, in association with Prof. A. R. Todd, carried out research for the Ministry of Supply.

Statistics in the Modern State

In his presidential address to the Royal Statistical Society on November 22, Lord Woolton said that the progress in statistics in public affairs in Great Britain during the last half-century has enabled the reading public to form political opinions and provided precise information for Ministers of the Crown, business men and the trade union movement. By 1939 the supply of information was comprehensive enough to show the size of the resources of the country and how they were being used; but there were many gaps in the information available, and those who found themselves in 1939 responsible for the government of the country in the rapidly changing conditions of the War had very little to help them. The proved competence of the statistician, both in the field of financial forecast and in the operations of Government, have given much stimulus to those who believe in national planning, and in particular, to its use in preventing economic waste and personal tragedy. Unemployment is the most urgent social problem confronting the modern State, and Lord Woolton believes that the use of the statistical method of ordering those operations of our economic life that are within the control and competence of Government can in a large measure solve the problem. We must have knowledge of facts, and capacity to forecast future trends from those facts ; but it is useless and aggravating to call for information in greater detail than is necessary to provide proper guidance to action. Enumerating the principal classes of statistics that must be obtained for the efficient operation of an employment policy, Lord Woolton said that to collect the information involves maintaining close collaboration between statisticians in Government services and their professional colleagues in trade associations, in the universities and research institutes.

Committee on Scientific Man-power and Resources

Mr. H. Morrison, Lord President of the Council, announced in the House of Commons on November 29 that he has appointed a Committee "to consider the policies which should govern the use and development of our scientific man-power and resources in the next ten years". The Committee is being asked to produce an early interim report to facilitate forward planning in fields which are dependent on the use of scientific man-power. Later the Committee will be asked to make recommendations for the establishment of permanent machinery for carrying out surveys into the best use of the scientific resources of Britain in the national interest. The Committee is constituted as follows : Sir Alan Barlow (temporary chairman), Sir Edward Appleton, Prof. P. M. S. Blackett, Mr. Geoffrey Crowther, Sir Alfred Egerton and Sir George Nelson.

Engineers' Study Group on Economics

Sir Richard Paget, retiring president of the Engineers' Study Group on Economics, at the annual general meeting held on December 1, announced that Sir John Boyd Orr will be president for the coming year, with Sir Geoffrey Bracken (formerly finance minister to the Madras Presidency) as deputy president. Sir Richard outlined some tasks that the Group might undertake. There is still an urgent need for the clarifying of public opinion throughout the world on the true role of money and as to the principles by which all nations should be guided in providing their national currencies and exchanging their surplus products for the common good of the world at large. Gold—a valuable metal—which could be profitably employed in making glorious and everlasting works of art for the admiration and delight of posterity, still lies buried in vaults. The problem of 'the role of money' might be made the subject of an impartial investigation by a team of economists and financial experts from many countries, similar to the teams of workers who, during the War, successfully attacked many scientific problems.

Sir Richard Paget further stated that the Ethics Section of the Engineers' Study Group, together with the Religious and Scientific Research Group, are paying special attention to developing an international ethical system, a code to which men and women of all nationalities, and all creeds, could agree. A stable world will need stable ethical foundations, fearlessly built on the rock of ascertainable truth—on fact rather than on faith.

Shirley Fellowship Awards

The British Cotton Industry Research Association has awarded the first two Shirley Fellowships for postgraduate research to Mr. F. Brown and Mr. T. G. Halsall, both of the University of Manchester, who will work on carbohydrate chemistry under the direction of Prof. E. L. Hirst. Mr. Brown has been working on chromatographic and other methods for the separation of closely related carbohydrate derivatives, and Mr. Halsall has been studying the action of periodate ions on polysaccharides. The new methods of end-group determination thus developed will be applied to problems in the chemistry of starch and cellulose. The fellowships date from January 1, 1946.

Acoustic Control in the Flight of Bats

At the discussion following Prof. H. Hartridge's paper on "Acoustic Control in the Flight of Bats" recently read before the Linnean Society (*Nature*, **156**, 490; 1945), Mr. A. J. Wilmott reported that when he was a child there was in Cambridge a well-known blind organist who was accustomed to walk about the town without the usual aids. When asked how he did it, he replied that the echoes, for example, from a brick wall, or from a low wall with railings above, appeared to him to be very different. By recognizing the different types of echo he could tell what was near him, and thus locate where he was. This acute sense of hearing even extended to the recognition—at just over two paces—of four ladies who in curiosity to see what would happen stood quite still right across the pavement in the organist's way. The organist hesitated a pace and then came to a complete stop. One of the ladies laughed; thereupon she was instantly recognized by the organist, who said, "I thought there was somebody there". This appears to show that sounds of ordinary frequencies have actually been used by man in much the same way as supersonic sounds are used by bats. (See also p. 692 of this issue.)

Royal Asiatic Society of Bengal

In celebration of the bicentenary of the birth of Sir William Jones, its founder and first president, in January 1946, the Royal Asiatic Society of Bengal is arranging a Conference on Indology and Oriental Culture in the first week of January, and terminating with a banquet on the Foundation Day, January 15. Representatives of learned societies in India, China, U.S.S.R., Iran, Turkey, Great Britain and the United States, as well as individual leaders and patrons of learning, have been invited to participate in the celebrations. A booklet issued by the Society outlines the programme of special publications which has been undertaken in connexion with the bicentenary and includes the address given to the Society by Dr. L. L. Fermor on its one hundred and fiftieth anniversary in January 1934, together with Sir John Anderson's speech on the same occasion, and a list of exhibits at the conversazione. The special publications now projected include a new series of monographs to which Dr. S. K. Mitra is contributing one on the upper atmosphere; a complete author- and subject-index of all the important articles in the Asiatic *Researches* and the *Journal* and *Proceedings* of the Society up to the end of 1945; and a commemoration volume to which Dr. S. L. Hora, Dr. K. P. Brocias and Dr. K. N. Bagchi have been invited to contribute an article on the progress of scientific studies in India.

Atomic Energy and its Implications

A joint meeting of the American Philosophical Society and the U.S. National Academy of Sciences to discuss "Atomic Energy and its Implications" was held in Philadelphia during November 16–17. The following papers were read: Prof. H. De Wolf Smyth, "The Scientific Background of the Atomic Bomb"; Prof. J. R. Oppenheimer, "Atomic Weapons"; Prof. R. S. Stone, "The Health Protection Activities on the Plutonium Project"; Dr. J. H. Willits, "The Process of Social Adjustment to Atomic Energy"; Prof. J. Viner, "Implications of Atomic Bomb for International Relations"; Dr. Ivirng Langmuir, "World Control of Atomic Energy"; Prof. J. T. Shotwell, "The Control of Atomic Energy under the Charter". The Franklin Medal Lecture, on "Atomic Energy as a Human Asset", was delivered by Dr. Arthur H. Compton.

Announcements

Dr. E. S. Russell has retired from the post of director of fishery investigations in the Ministry of Agriculture and Fisheries, but will continue to serve for some time in an advisory capacity.

Mr. R. R. Enfield has been appointed to a new post of chief economic adviser to the Ministry of Agriculture and Fisheries from December 4. Mr. D. A. E. Harkness, senior assistant secretary in the Ministry of Agriculture, Northern Ireland, has been appointed from the same date to succeed Mr. Enfield as principal assistant secretary in charge of the Economics and Statistics Division of the Ministry.

Prof. W. Weisbach, writing from Langeraar (Z.H.) A.95, Holland, states that he has now returned from German concentration camps, and is the sole owner of the publishing house of his partner and father-in-law, Dr. W. Junk, who died in 1942. *Tabulæ Biologicæ*, *Enzymologia*, *Mycopathologia*, etc., will be published as usual again in due course by the firm.

Dr. John R. Campbell, scientific officer on the staff of the Fuel Research Division of the Department of Scientific and Industrial Research, has been appointed lecturer in fuels at the Royal Technical College, Glasgow, in succession to Dr. G. S. Cruickshanks, who has retired.

The Royal Society of South Africa has elected the following as fellows: Dr. A. J. Boyazoglu, for outstanding work on agricultural problems including rural economic surveys in various lands; and Commander B. L. Goodlet, for many-sided researches in electrical engineering both in peace-time and in association with the Royal Navy.

The following appointments, promotions and transfers in the Colonial Service have recently been made: J. D. Hunter-Smith, to be agricultural officer, Tanganyika; G. E. M. Latimer, to be veterinary officer, Nigeria; J. P. Bernacca, to be entomologist, Uganda; E. G. N. Greaves, to be deputy Government chemist, Trinidad; Dr. E. Phillis, to be chief scientific officer, Department of Agriculture, Trinidad; D. Thornton (agricultural officer, Tanganyika), to be senior agricultural officer (soil erosion), Tanganyika; F. W. Toovey (botanist, Nigeria), to be senior botanist, Nigeria; J. A. N. Burra (assistant conservator of forests, Gold Coast), to be assistant conservator of forests, Palestine; W. J. Eggeling (senior assistant conservator of forests, Uganda), to be conservator of forests, Uganda; W. A. Fairburn (senior assistant conservator of forests, Nigeria), to be conservator of forests, Nigeria; C. B. Bissett (senior geologist, Uganda), to be deputy director of the Geological Survey, Uganda; T. Hirst (senior geologist, Gold Coast), to be deputy director of the Geological Survey, Gold Coast.

Erratum.—The British publishers of the book "Patrick Geddes" reviewed in *Nature* of November 24, p. 612, are the Oxford University Press, Amen House, Warwick Square, London, E.C.4, and not Messrs. Chapman and Hall, Ltd., as stated.

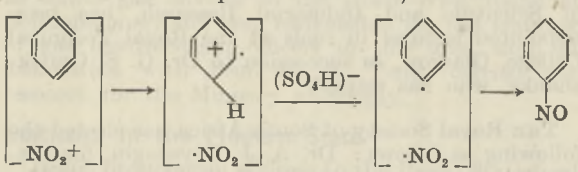
LETTERS TO THE EDITORS

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

Univalent Electron Transfers in Aromatic Nitration?

WE have been studying the kinetics of aromatic nitration on the lines indicated in a prefatory publication[1], and in consequence have an opinion to offer on the question indicated by the title, which has been raised more than once recently, notably in an interesting article by Kenner[2].

Any process of co-ordination between an atom with an unshared electron pair and another with an open sextet can conceptually be dissected into a univalent electron transfer and a succeeding homopolar union. It has not hitherto been usual to assume such a stepwise mechanism in the absence of some evidence of dimerization or other characteristic reaction of the radicals which would be formed intermediately. However, Kenner has proposed a representation which suggests that this evidential requirement can be obviated by supposing the radicals throughout their life to remain "within the sphere of each other's action". His nitration mechanism is expressed, for the nitration of benzene in the presence of sulphuric acid, in the following approximate manner (the brackets indicate 'spheres of action'):



Whereas Kenner's ideas undoubtedly have important applications, we think that, in this particular case, the assumption which might have accounted for the general absence of radical dimerization in aromatic nitration does not in fact provide a simple and entirely satisfactory escape from this and similar difficulties. The above scheme depicts three molecular encounters, and requires the nitrating agent to exist as nitrogen dioxide from the first to the third, that is, throughout the period in which the bisulphate ion and aromatic cation are finding, and reacting with, each other. The nitrogen dioxide molecule must be assumed to remain, during this kinetic transaction, continually within the 'sphere of action' of the aromatic molecule, though presumably bound therein by van der Waals forces only. This is not an easy assumption; and since the physical theory of such forces shows that they never exclude, or greatly interfere with, each other, one is caused to wonder why the nitrogen dioxide is prevented from being also within the 'sphere of action' of the solvent sulphuric acid, to which it will also be bound by van der Waals forces, and with which introduced nitrogen dioxide reacts to give products that are not formed under normal nitration conditions.

Our kinetic work does not suggest that the attack of a nitrating agent derived from nitric acid on an aromatic ring in liquid-phase nitration is ever anything but simply co-ordinative and heterolytic, as would be illustrated by telescoping Kenner's three steps completely, or at least so extensively as to render the step-wise representation an unsatisfactory approximation. The complete mechanism of this electrophilic substitution, including the preliminary formation of the nitronium ion, may, however, be 'unimolecular' or 'bimolecular', with appropriate kinetic differences[1], according as the heterolysis of the nitric acid molecule to yield the nitronium ion NO_2^+ is rate-determining or not. The kinetics show that the unimolecular step which can become rate-determining is a reaction of the nitric acid, and not of the solvent (as we once thought) or the aromatic substance; and, since it is too slow to be explained as heterolysis of an OH-group (proton transfer), it must be interpreted as the heterolysis of an NO-bond, necessarily to form nitronium ion.

It is by no means implied that univalent electron transfers[3], homopolar unions, and homolyses[4] never play any part in nitration. We think our kinetic results show that they have a role in nitrations by, or with the catalytic help of, nitrous acid. But it is probably relevant that nitrous acid can introduce odd-electron molecules into the system, notably nitrogen dioxide. All these matters will be more fully discussed elsewhere.

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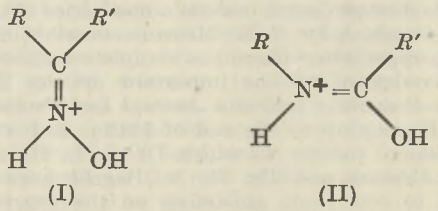
C. A. BUNTON. G. J. MINKOFF.
E. S. HALBERSTADT. R. I. REED.
E. D. HUGHES.

Sir William Ramsay and
Ralph Forster Laboratories,
University College, London.
Oct. 11.

[1] *J. Chem. Soc.*, 929 (1938).
[2] *Nature*, 156, 369 (1945).
[3] Cf. Weiss, *Nature*, 147, 512 (1941); *Trans. Faraday Soc.*, 37, 780 (1941); *J. Chem. Soc.*, 245 (1942); 468 (1943).
[4] Hey and Waters, *Chem. Rev.*, 21, 169 (1937). Hey, *Nature*, 156, 36 (1945).

Mechanism of the Beckmann Rearrangement

HIGMAN[1] recently suggested a new mechanism for the Beckmann rearrangement which postulates that the cation (I) rearranges by rotation of the central $>C=N<$ unit through 90° to form (II). This suggestion, though ingenious, is not in accordance with the known facts.



The rearrangement of the toluenesulphonates[2] and picryl ethers[3] of ketoximes to derivatives of amides is not prototropic and proceeds by separation of the potential anion attached to nitrogen. The evidence on the latter point is quite unambiguous. The reaction is much faster in solvents of higher dielectric constant; electron-repelling groups ($R.R'$) accelerate the reaction, although such groups in other rearrangements (for example, pinacol-pinacoline) have a lower 'migratory aptitude'; the 2 : 4-dinitrophenyl ethers do not rearrange, though the picryl ethers do so readily. None of these effects would be expected on the basis of Higman's mechanism.

For the acid-catalysed Beckmann rearrangement equally definite evidence is available, and here the proton probably attacks oxygen and not nitrogen.

Brodskiĭ and Miklukhin[4] have shown that when benzophenone oxime is rearranged in aqueous hydrochloric acid enriched with H_2O^{18}, complete exchange of oxygen with solvent takes place. Benzanilide exchanges none of its oxygen under these conditions. Therefore the oxygen atom in the resulting benzanilide molecule is not the same one that was present in the oxime. This is incompatible with Higman's mechanism, unless a highly improbable oxygen exchange takes place in the oxime itself. Such an exchange would involve inversion of configuration and formation of mixed amides, neither of which is observed under the operative conditions.

All the known facts are well interpreted in terms of the ionization mechanism which was lucidly set forth in the article[5] to which Higman referred. It is difficult to see why that theory should now be thought unacceptable, and in point of fact no criticism of it has been advanced.

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[1] *Nature*, 156, 242 (1945).
[2] Kuhara and Todo, *Mem. Coll. Sci. Kyoto Imp. Univ.*, 2, 387 (1910).
[3] Chapman and Howis, *J. Chem. Soc.*, 806 (1933). Chapman, *ibid.*, 1550 (1934). Chapman and Fidler, *ibid.*, 448 (1936).
[4] Brodskiĭ and Miklukhin, *C.R. Acad. Sci. U.S.S.R.*, 32, 558 (1941); *J. Chem. Phys.*, 11, 342 (1943).
[5] Brynmor Jones, *Chem. Rev.*, 35, 335 (1944).

Porphyrin Fluorescence in the Livers of Pellagrins in Relation to Ultra-Violet Light

The examination, by ultra-violet fluorescence microscopy, of frozen sections of fragments of livers removed by an improved biopsy procedure[1] from twenty African pellagrins, soon after admission to hospital, revealed the presence in eight cases of an intense scarlet red fluorescence. This fluorescence was localized to the hepatic cells, and, when severe, could involve the entire lobule. When the fluorescent material was dissolved in the fat droplets in the hepatic cells, these assumed an intense crimson colour.

In serial biopsies at weekly intervals of livers of these eight pellagrins maintained on a carbohydrate vitamin-poor diet, it was seen that this fluorescence disappeared first from the central zone and last from the periportal region of the lobules. In so doing, all gradations of colours from red to yellowish-brown background fluorescence, previously described[2], were observed.

Oxidized cytochrome, bilicyanin and porphyrins are, so far as we know, the only likely substances in animal tissue said to give a red fluorescence[3]. We are satisfied that the scarlet fluorescence in the livers of pellagrins is not oxidized cytochrome or bilicyanin for the following reasons: (1) We obtained no fluorescence in concentrated solutions of oxidized cytochrome prepared from beef heart by the method of Keilin and Hartree[4]. (2) Bilicyanin prepared by adding an alcoholic solution of zinc sulphate and iodine to an alcoholic solution of bilirubin gives a yellow-red fluorescence which is rapidly changed to yellow-green on the addition of alkalis and, simultaneously, the spectroscopic bands characteristic of choletelin make their appearance. (3) The red fluorescence of the livers of pellagrins is intensified by acids and alkalis. It is soluble in water and we have found it, in this respect, to react in a manner identical to dilute solutions of protoporphyrin and the red fluorescence we observed in a liver obtained from a case of severe porphyria in a woman seen in the acute stages of the disease.

Unfortunately, the core of liver tissue obtained from pellagrins was too small to allow for the extraction of porphyrin for spectroscopic identification. The porphyrin fluorescence in the pellagrous livers was invariably associated with evidence of active formation of cytolipochrome and cytosiderin. The iron in some of these livers may amount to as much as 5 per cent of dry weight of liver[6]. The transitory character of the scarlet fluorescence appearing in the acute phases of the disease can easily account for the presence of masses of iron pigment so constantly present in the livers of pellagrins[5,6,7] without any visible porphyrin fluorescence.

The association of scarlet fluorescence and iron pigment is further evidence in support of our view that cytosiderosis of the livers of adult pellagrins is an expression of the disruption of an iron porphyrin complex within the liver cell.

Three pellagrins who had lost their porphyrin fluorescence while on a carbohydrate vitamin-poor diet were afterwards exposed to ultra-violet light for ten minutes on five consecutive days. When biopsy was performed on the sixth day, a marked recrudescence in the fluorescence was noted in the livers of all cases, and in two it was even more intense than on the day of admission to hospital; there was no aggravation of the skin lesions or of the systemic reactions generally seen in this disease. Traces of porphyrins were found in the urine of only one of these cases. Examination of the liver of a healthy patient, admitted to hospital for a minor surgical injury, before and after treatment with ultra-violet light under conditions identical to those provided for the pellagrins, revealed the absence of visible scarlet fluorescence.

From these studies we conclude: (1) Porphyrin fluorescence in the liver can occur during the acute phases of pellagra. (2) The great accumulation of iron pigment in many livers of adult African pellagrins is probably caused by the disruption of an intracellular iron porphyrin complex, such as catalase and cytochrome, present normally in the liver cell. (3) Treatment with vitamin B complex is not required to resolve the porphyrin fluorescence in the livers of pellagrins while on a carbohydrate vitamin-poor diet. (4) Ultra-violet light can excite a recrudescence of the porphyrin fluorescence in the liver without causing an exacerbation of the other external manifestations of the disease. Massive quantities of porphyrins can appear in the liver cells without any detectable amounts in the urine. (5) These experiments emphasize the close inter-relationship between the reactivity of the skin to ultra-violet light and the deposition of iron and the appearance of porphyrin fluorescence in the liver in African pellagrins.

J. Gillman.
T. Gillman.
S. Brenner.

Medical School,
University of the Witwatersrand,
Johannesburg. July 6.

[1] Gillman, T., Gillman, J., and Bryden, J. G., *S. Afr. J. Med. Sci.*, 10. 53 (1945).
[2] Gillman, J., Gillman, T., and Brenner, S., *S. Afr. J. Med. Sci.*, in the press.
[3] Loofbourow, John R., "Fluorescence: Methods. Med. Physics", Otto Glasser (Chicago: Yearbook Publishers, 1944).
[4] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc., Lond.*, B, 122, 298 (1937).
[5] Gillman, J., Mandelstam, J., and Gillman, T., *S. Afr. J. Med. Sci.*, in the press.
[6] Gillman, J., and Gillman, T., *Arch. Path.*, in the press.
[7] Gillman, T., and Gillman, J., *Nature*, 154, 148 (1944).

Acetylphosphatase in Animal Tissues

In the course of experiments on the metabolism of acetylphosphate in rats, an enzyme which catalyses the hydrolysis of this substrate was found. The enzyme is present in homogenates as well as in cell-free extracts of liver, muscle, kidney, brain, but not in blood serum. Acetylphosphate $M/20$ (prepared according to Lipmann and Tuttle[1]) was incubated with liver homogenate and sodium bicarbonate buffer (pH 7·3) at 38° C. More than 80 per cent cleavage was observed in five minutes, and total cleavage was obtained in fifteen minutes. The spontaneous cleavage of acetylphosphate in the same conditions but in the absence of liver was 33 per cent in 180 minutes. The enzyme activity was found to be of the same order of magnitude in extracts of liver, kidney, brain and muscle.

Some properties of the enzyme are described below. The experiments were conducted at 25° C. in order to slow up the action. The hydrolysis was followed (*a*) by estimation of the amounts of inorganic phosphate liberated, using the method of Lipmann and Tuttle[2], (*b*) volumetrically in terms of carbon dioxide formed in the presence of sodium bicarbonate, due to the liberation of acid equivalents during cleavage.

The activity of the extracts was completely destroyed by boiling for five minutes. Acetylphosphatase is relatively resistant to fluoride poisoning. No inhibition was observed with concentrations of $M/100$ sodium fluoride. $M/20$ sodium fluoride retarded the hydrolysis by 50 per cent (as measured by the amount of substrate hydrolysed after fifteen minutes). Sodium cyanide failed altogether to influence the enzyme activity even at concentrations of $M/10$. On the other hand, inorganic phosphate is strongly inhibiting. Inorganic phosphate appears to compete with acetylphosphate for the enzyme: thus, at a substrate concentration of $M/100$, a concentration of $M/30$ inorganic phosphate caused complete inhibition, whereas at $M/20$ substrate concentration an inhibition of only 60 per cent was obtained. Enzyme activity at this substrate concentration is completely annulled by $M/10$ inorganic phosphate, the hydrolysis proceeding at the same rate as in the absence of enzyme.

The non-identity of acetylphosphatase with ordinary 'alkaline' phosphatase is shown by the different distribution of these enzymes in organs and their different behaviour with poisons. The presence of a highly active acetylphosphatase in animal tissues suggests an explanation for negative results obtained with the use of this substrate for phosphate transfer[3] and acetylation[4] in animal tissues. It seems probable that when acetylphosphate is added to animal tissues it is removed by hydrolysis before its possible action as a phosphate or acetyl donor can become manifest. When acetylphosphate appears as an intermediate in metabolism, it is probably maintained in an adequate steady-state concentration within the tissue because the action of acetylphosphatase in these conditions is retarded by inorganic phosphate.

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E. Wertheimer.

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[1] Lipmann, F., and Tuttle, L. C., *J. Biol. Chem.*, **153**, 577 (1944).
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[3] Ochoa, S., Peters, R. A., and Stocken, L. A., *Nature*, **144**, 750 (1939).
[4] Lipmann, F., *Fed. Proc.*, **4**, 97 (1945).

An Attempt to Obtain Nuclear Excitation by Means of X-Rays

When a substance is irradiated with γ-rays of an energy less than that necessary for disintegration of the nuclei (for most of the elements about 8 MeV.), only a nuclear excitation can take place. If radioactivity is obtained by such an irradiation, it is necessary to assume the existence of isomeric metastable states to which the nuclei have been excited and from which transitions to the ground-level take place by emission of (highly converted) γ-rays. Experiments in this direction were performed in 1939 by Pontecorvo[1] and Collins[2]. They succeeded in activating indium by means of X-rays with an energy of more than 1 MeV. By direct irradiation of eleven elements, Trumpy[3] later claimed to have ascertained the existence of thirty-five new isomeric nuclei with characteristic half-life periods. By varying the tube voltage from 300 to 1,800 kV., Trumpy was able to determine the critical excitation energy with an accuracy of 10 per cent. The values were surprisingly low and in fourteen cases less than 0·4 MeV.

With an X-ray tube supplied from a high-tension equipment for a 400 kV. maximum, I have irradiated aluminium, copper, rhodium, silver, cadmium, indium, tin, gold and lead. As the radiation emitted by the transition to the ground-level must be assumed to be rather weak, the counters are made of the element which is under investigation. In some cases, however, the substances (in the form of thick foils) have been investigated inside a specially constructed counter where the radiation from the active substance is only absorbed by the gas in the counter chamber.

The X-ray tube has worked at 390 kV. (max.) with a tube current of 5 mA. (max.). The anti-cathode is of tungsten and in the shape of a disk, so that about half the current is reflected backwards.

On the irradiation of copper, rhodium, cadmium, indium, tin, gold and lead, activity has in no case been observed. With a Geiger-Müller tube of aluminium made four years ago, a weak effect of the same order of magnitude as the zero effect was observed, the activity decreasing with a half-life period of about 2–3 min. Freshly made tubes or foils of aluminium do not show this effect. A Geiger-Müller tube of glass with a cathode of silver also showed a weak activity of the same intensity as the aluminium tube.

The negative result with rhodium is especially interesting as the nucleus ^{103}Rh is excited by irradiation with fast neutrons[4] to an isomeric state of the stable nucleus and situated only 19 kV. above the ground-level. For such an element, according to our present conception of the formation of isomeric nuclei by high-voltage X-rays, the activation levels might be expected to be situated nearer the ground-level than is the case when the lowest metastable state lies, for example, 200 kV. above the ground-level.

At the present stage, when the voltage of the tube cannot be increased, it can only be said that, with the intensity and energy of the X-ray quanta used here, no activation levels can be found in the elements named above. As pointed out by Wiedenbeck[5] and Northrup *et al.*[6] special care must be taken in investigations with irradiated Geiger-Müller tubes. Sherrer[7] has shown that in special circumstances field emission of electrons can take place from the Geiger-Müller tube cathode surface, thus falsifying an induced activity. It seems probable to me that

the excitation levels with low energy (< 400 keV.) found by Trumpy may be of such non-nuclear origin.

SIGVARD EKLUND.

Research Institute for Physics,
Academy of Sciences,
Stockholm. Aug. 23.

[1] Pontecorvo, B., and Lazard, A., *C.R. Acad. Sci.*, **208**, 99 (1939).
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[3] Trumpy, B., *Bergens Museums Arbok* 1943, Naturvitenskapelig rekke, No. 10.
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[7] Roggen, F., and Scherrer, P., *Helv. Phys. Acta*, **15**, 497 (1942).

Use of Growth-Promoting Substances in the Prevention of Apple Drop following Frost

EXPERIMENTS both in the United States and at Long Ashton Research Station have shown that certain substances, when suitably compounded and applied, will induce the parthenocarpic development of the tomato and other fruits. These fruits are, of course, seedless. The banana, Washington Navel orange, and seedless grapefruit are examples of fruits which are naturally parthenocarpically produced. Since, in Nature, some fruits may be found which are seedless, it follows that, given an understanding of the natural process, it should be possible to produce seedless fruits of almost any species. This has, in fact, now become an established commercial practice in the tomato. The materials and methods employed in Britain have already been published[1].

Similar experiments with apples and pears were carried out at Long Ashton in 1943 and 1944 and by other workers in the United States, but without success. At Long Ashton, certain compounds were partially effective in that they did cause the fruit to remain on the trees until July, when they fell off.

The severe frost of April 30–May 1, 1945, when most of the apple blossom had set and the fruitlets were already beginning to grow, killed the embryos and blackened the centres of all fruits. This provided a unique opportunity to try a number of compounds selected after recent experience with tomatoes.

Two varieties of apple were selected for trial, namely, Miller's Seedling and Cox's Orange Pippin, both about eighteen years old and carrying a heavy set of fruit. Six trees in each row were sprayed with a wash containing beta indole butyric acid, alpha naphthalene acetic acid, 2–4 dichloro phenoxy acetic acid and beta naphthoxy acetic acid at 5, 5, 5 and 60 p.p.m. respectively, making a total hormone concentration of 75 p.p.m. The choice of these materials and concentrations was based upon a wide experience of their use in the production of parthenocarpy in the tomato.

The wash was applied by a power sprayer using a pressure of 400 lb./sq. in. The day was reasonably calm, and each tree was thoroughly drenched with about ten gallons of wash per tree.

The results were spectacular. Within fourteen days almost every fruit had fallen from the unsprayed trees of Miller's Seedling, whereas none had fallen from the sprayed trees. Furthermore, these fruitlets had begun to swell. The spray also caused a considerable amount of leaf epinasty.

In contrast to the above effect upon Miller's Seedling, the spray had no effect whatsoever upon Cox's Orange Pippin. There was not even epinasty of the foliage and every fruit fell.

Observations were continued throughout the summer of 1945. By July 14 practically every fruit had fallen from the unsprayed trees of Miller's Seedling, but the fruits were literally clustered on the treated trees. Many of these fruits had grown to about a quarter normal size, but had ceased further development, so it was decided to thin some of these trees. During this operation it was found that the fruit tended to break away from the spur anywhere along the fruit-stalk rather than at the abscission layer, which was very firm indeed. By this date most of the fruits were about 1½ in. in diameter and were noticeably sweet and juicy.

Final observations were made on August 14 when the crop was picked except for two trees which were left as specimens. By this date the fruit was fully ripe and ready to harvest, but showed no tendency to drop even when the trees were shaken vigorously, whereas the few fruits which remained on the control trees had started to drop.

The effect of the treatments is shown in the accompanying table.

MEANS PER TREE (MILLER'S SEEDLING)

	Weight in lb.	No. of fruits more than 2 in. in diameter	No. of fruits 1½–2 in. diameter	No. of fruits less than 1½ in. in diameter
Treated :				
Unthinned	169	13	621	9,486
Thinned	60	30	325	2,025
Control	17	29	88	443

The extraordinary effect of the spray in keeping the fruit on the trees is shown by the fact that the unthinned trees had an average of 9,486 fruits per tree. Because of war-time difficulties it was not possible to thin these trees early enough to produce any really advantageous effects; but even when thinned as late as July 14, the effect is seen in the number of fruits which were graded 1½ in.–2 in. diameter.

So far as I am aware, this is the first time that any success has been obtained in preventing the fall of deciduous fruit by means of growth-promoting substances. It is admitted that the result is not at present of immediate practical or economic importance; but it is now only a matter of time before suitable materials and methods will be evolved for this purpose.

The complexity of the problem is indicated by the fact that materials which proved highly effective on Miller's Seedling were without any effect upon Cox's Orange Pippin. The specific nature of many of the growth-promoting substances is, of course, well known, and this serves as a particularly good example.

This preliminary trial has also revealed certain points of practical importance. The amounts of substances used were undoubtedly excessive, and in our endeavour to get a complete cover we used too much wash per tree. This is indicated by the fact that the 'buffer' trees which received only the spray drift set a fair crop and neither the foliage nor growth was adversely affected. The heavy application of the growth hormone mixture to the Miller's Seedling trees suppressed the 1945 extension shoot growth, so that these trees had a much lower leaf area during the 1945 growing season than had the control trees. This

suppression of shoot growth is in itself an undesirable effect, and in these trees may cause a lowered flower production both in 1946 and 1947.

Since this trial was initiated, other substances have been brought to my notice, and these may be even more effective on apples and pears than the ones used above. Furthermore, the success obtained with tomato flower extract and animal sex hormones as recently reported by me[2] offers still further scope for development along these lines.

T. Swarbrick.

Research Station,
(University of Bristol),
Long Ashton, Bristol.
Oct. 9.

[1] Swarbrick, T., Rep. Agric. Hort. Res. Station, Bristol, for 1944, 36 (1945).
[2] Swarbrick, T., *Nature*, 156, 300 (1945).

Accumulation of Sugars in Barley Seedlings on Very Acid Soil

For a number of years it has been noticed at Woburn that seedling barley plants sown in soil too acid to allow normal growth (*p*H 4·3 or thereabouts) were very much more attractive to small birds (chaffinches and the like) than similar seedlings grown on a normal soil (*p*H 6·0–6·5); and that consequently a very large proportion of the growing seedlings were dug up and the seeds eaten when little or no similar damage was done to plants on normal soil. At first the tendency was to attribute the difference to the slowness of growth on the acid soil, which kept the seedlings in a condition suitable for bird attack for a much longer period, but this explanation failed when it was found that the seedlings were attacked almost as soon as the shoots appeared above the ground.

It seemed certain that the seedlings on the very acid soil contained something which made them more attractive to birds, and it was suggested that there might be an accumulation of sugars which made them much sweeter than normal plants at the same stage of growth. We have now examined on several occasions seedlings from both types of soil, grown on trays under similar conditions to the point when the second leaf was just visible, when they are still quite attractive to birds. This stage was reached with normal soil in 11–15 days, and with the very acid soil in 19–21 days. The plants were then pulled up in the morning, the fibrous roots cut off, the seeds and the tops separated from one another and the total sugars soluble in alcohol determined with Fehling's solution after inversion with acid.

The results obtained in two separate experiments are shown below, the percentages being on the dry matter of the tops or the seeds.

Glucose equivalent of total sugars

	Normal soil (*p*H 6·5)		Very acid soil (*p*H 4·2)	
	Tops	Seeds	Tops	Seeds
a	5·3 per cent	26·8 per cent	24·1 per cent	42·6 per cent
b	7·2 „	21·1 „	29·7 „	30·6 „

It is clear, therefore, that there tends to be an accumulation of sugar both in the tops and in the seeds where the seedlings are grown on very acid soil, probably due to the feeble growth of the seedlings after germination has taken place.

The cause of the attractiveness to the birds is still better shown if the figures are given as sugar (that is, glucose equivalent) per 100 tops or seeds. These are as follows:

Glucose equivalent of total sugars per 100 tops or seeds

	Normal soil (*p*H 6·5)		Very acid soil (*p*H 4·2)	
	Tops	Seeds	Tops	Seeds
a	56 mgm.	457 mgm.	178 mgm.	984 mgm.
b	59 „	348 „	298 „	700 „

T. W. Barnes.

Woburn Experimental Station,
Husborne Crawley, Bletchley.
Aug. 15.

Acoustic Control in the Flight of Bats

Prof. Hartridge has suggested[1] a comparison between radar and acoustic range- and direction-finding in bats. He suggests that the interrupted supersonic note may be used to measure the range to obstacles. The note emitted lasts about 0·01 sec. During this time the first waves of the sound will travel about 10 ft. To determine range with any accuracy either the onset (leading edge) or the ending (trailing edge) of the echo must be used as a point of reference.

If it is assumed that a bat, like a radar set, uses the leading edge of the echo to judge range, the least range which it could perceive would be considerable. In a radar equipment with a 1 μsec. pulse the leading edge of the echo from an object at less than 150 metres from the aerials will be received during the period of transmission and therefore lost. For a bat there will be a similar range blind to the leading edge of about 5 ft. It is possible that the bat uses the trailing edge of the echo, however. In these circumstances there will be no well-defined lower limit of range measurement. One function of the complex intra-aural muscle reflex may be to make use of the trailing edge, for without this the reflected note from close objects would appear to the bat as continuous with the emitted one. In natural conditions the eyes no doubt also assist in perceiving near objects.

The maximum range at which an object can be detected may also be limited. In an airborne radar equipment which is so designed that the outgoing signals are not beamed, the maximum range at which an aircraft can be detected is equal to the height of the radar equipment. This is because the signals reflected from the ground tend to swamp all others. It is possible that the bat overcomes this difficulty by the great development of the pinnæ of the ears, which may allow it to hear only echoes from objects directly ahead.

D. W. Ewer.

Great Missenden,
Bucks.
Nov. 4.

[1] Hartridge, H., *Nature*, 156, 490 (1945).

Dr. Ewer has raised an interesting point with regard to bats' hearing which I have been trying to elucidate. We have been approaching the matter from somewhat different points of view. There is very strong evidence that bats are aware of obstacles ahead of them not only when they are several metres away, but also when they are quite close. Thus during my experiments in King's College in 1919, these animals were observed to fly quickly through an open doorway from one room to another. "If the intervening door was gradually closed to six

inches, fewer passed through and there was a good deal of fluttering before the passage was negotiated. If the door was closed to four inches, the bats would as it were come up and look and then fly off again without attempting to pass. This experiment was repeated with all lights extinguished, and it was found that many bats negotiated the six-inch opening though always with much audible fluttering; larger openings than this they swooped through without concern. This fact was found by closing the light switch suddenly and catching one on the point of entering or emerging."

Galambos and Griffin, who investigated the cries of bats with a supersonic detector, reported that "the supersonic cry lasts no more than 0·02 second on the records, and there is good reason to believe that inertial factors in the recording device introduce errors into this estimate. The cry probably lasts no more than 0·01 second." Now it is clear, if this estimate be correct, that a bat two metres away from a reflecting object should be able to hear the whole of the echo without any interference from the sound which it is emitting from its larynx. As it flies towards the object, however, more and more of the echo coincides with the period of sound emission, thus interfering with the hearing of the echo. There are three possible ways of avoiding this difficulty: to make use of the Doppler effect, to shorten the period of sound production and to screen the ears from the source of sound. With regard to the first way, a bat flying at 3 metres per second towards an object would hear an echo exceeding the pitch of its voice by about one fifth tone. The human ear would be able to identify this change of pitch; but it is very doubtful whether it would be able to detect the existence of such an echo when a strong voice tone was present at the same time. A similar statement may be made about a bat. But an even more important point is that when a bat slows up, and starts to flutter, as it approaches an obstacle, the Doppler effect disappears and the echo more and more resembles the voice tone in pitch.

It has been shown by Galambos and Griffin that the number of supersonic cries made by a bat depends on where it is and what it is doing. A resting bat usually produces 5–10 cries per sec. When it begins to fly, the number increases to 20–30. When it is approaching an obstacle it may produce 50–60 per sec. But as soon as it has passed the obstacle, the number drops abruptly to 20–30 again. Now it is possible, as the number of cries per second is increased, that the duration of each cry is correspondingly reduced. If such were the case, then overlap between the echo and the voice might be avoided as an obstacle is approached. The following table shows for different distances the maximum duration of the cry if overlap is to be avoided.

Distance	Duration (0·001 sec.)
200 cm.	12
100 ,,	6
50 ,,	3
25 ,,	1·5
16 ,,	1

Such short durations are not impossible in view of Galambos and Griffin's statements concerning their supersonic detector.

With regard to the screening of the ears from the voice tone, I am told that bats can be divided into two groups: those with flat snouts and normal ears, and those with the usual pointed snout but having a specially developed cartilage, the tragus, in front of the external auditory meatus. The flat snout, by directing most of the supersonic energy in a forward direction, may screen the ears and thus enable them to pick up faint echoes. The tragus in the other group of bats may have the function of screening the ears from the direct voice tone while it permits the entrance of reflected sounds.

With regard to Dr. Ewer's suggestion that it may be the trailing edge of echo which the bat uses for localizing purposes, I think it is more likely to be the leading edge that is used because the former is liable to be masked by sounds reflected by other objects in the vicinity. It is quite possible that the bat uses both leading and trailing edges of the echo for localizing purposes.

H. Hartridge.

With reference to the interesting article on bats by Prof. H. Hartridge in *Nature* of October 27, p. 490, I venture to submit certain observations made by a group of observers without professional scientific qualifications but with some theoretical and practical knowledge of aviation. The group in question consisted of three pilots and two gunners at a Royal Air Force camp in Italy. Our admiration was roused by the performance of a large number of bats that infested our camp soon after dark each evening.

Though we had no knowledge of the acoustic control system of bats described by Prof. Hartridge, we soon came to the conclusion that something of the sort must be employed. The room from which we made these observations was a lofty one with a very large area of french windows; when the electric light was on, the glass of these windows was entirely invisible from outside. The bats, apparently attracted by the light, would turn and dive repeatedly at these windows with the obvious intention of passing inside the room. They invariably detected the presence of the glass, however, and never once did they crash into it. This seemed the more remarkable as birds had occasionally been deceived in broad daylight; the open appearance of the room, which was comparatively narrow, with windows on both sides, encouraged them to attempt to swoop right through it, with disastrous results.

Detection seemed to occur about two feet from the glass, which left very little room for avoiding-action. This usually consisted of a steep turn to starboard, but we observed many stalled turns, and, much to our astonishment, half rolls! Since we had all been under the impression the latter manœuvre was unheard of in Nature, we took some trouble to confirm it. As the bat approached to within two feet of the glass, it would fold up its starboard wing, but keep the other extended; the unequal lift turned it on to its back in a flash, whereupon it extended both wings and fell vertically down the surface of the glass at a distance of a few inches, pulling out on a reciprocal course some three or four feet lower down. We confirmed this by watching from inside the glass where, in these cases, we had a clear, though very brief, sight of the bat with its belly and the underside of its wings presented to the glass and its head pointing straight downwards.

I think it possible that anyone making a serious study of a bat's manœuvring ability might find this method of observing at night from behind a brightly illuminated glass barrier extremely useful.

Martin Wilkinson.

Nov. 13.

MEDAL AWARDS OF THE ROYAL SOCIETY

Copley Medal

THE Copley Medal is awarded to Dr. Oswald Theodore Avery, of the Rockefeller Institute of New York, for his contributions to knowledge of the chemical basis of the specific properties of bacteria, particularly of the types of the pneumococcus. His researches in this field have appeared in unhurried and orderly sequence over the course of a long and distinguished career, and they have furnished a large and essential constituent of the framework now available for a fundamental science of immunochemistry.

We allow ourselves to claim Avery as Canadian by birth, though with acknowledgment that his life's work has been accomplished in the United States of America, and in the Rockefeller Institute of New York in particular, of which he has held the membership since 1913.

It was in 1917 that Dochez and Avery demonstrated that cultures of different strains of the pneumococcus yielded different 'soluble specific substances'. From 1923 onwards appeared a remarkable series of papers by Avery, with Heidelberger and other collaborators, in which it was shown that these specific substances had the nature of complex polysaccharides of highly individual characters. These were present in the regular capsular envelope characteristic of the pneumococcus in its virulent forms ; and each type of such virulent pneumococci, distinguishable by its immunological specificity, was shown to have its own distinct polysaccharide. Each of these reacted, with a like specificity, with the corresponding immune body. Not that these polysaccharides, the soluble specific substances isolated in chemical purity, had antigenic properties by themselves. It was only when they were artificially linked to proteins foreign to the reacting animal body, or retained their natural linkage with proteins of the bacterial strains producing them, that they elicited, on injection, the appearance in the blood of specific immune substances, causing agglutination or lysis of the corresponding organisms ; but, with the immune substances thus evoked, the pure, separated polysaccharides now exhibited the same specific affinities, each forming a precipitate with the corresponding antiserum.

Here, then, in chemically definite form, were separable, prosthetic, combining groups such as Paul Ehrlich had long earlier envisaged and prophetically named 'haptenes'. Here also was one of the principal foundation stones of a great building of immunological chemistry, which, in the hands of Avery's contemporaries and followers, notably in those of a distinguished fellow-member of the Rockefeller Institute, the late Karl Landsteiner, has rapidly included an ever-widening range of studies of artificial and natural antigens.

Meanwhile, in the hands of Avery and his coworkers, knowledge of the specific characters of the pneumococci, and of the manner in which these are acquired, had been moving quietly to a new pinnacle of achievement. They had long ago shown that pneumococci, which, in artificial culture, have lost the capsules endowing them with virulence and containing the specific polysaccharides, have reverted to avirulent non-specific types, growing in the rough, wrinkled colonies characteristic of such defective strains. It had been shown also, by the late Fred Griffith, that such a degenerate, non-specific pneumococcus, from whatever specific type it had its provenance, could be induced by cultivation in a medium prepared from a complete, virulent type to re-acquire a capsule conferring the corresponding specificity. And now, only last year, Avery, with Macleod and McCarty, has been able to isolate and to characterize a chemical principle acting in minute dosage as the specific stimulus to such a transformation. An unencapsulated, avirulent, typeless pneumococcus derived from a specific strain of type II responds to this stimulus by acquiring and retaining the capsule and specific polysaccharide, with the virulence and the cultural characters, of a fully specific strain of type III. Here surely is a change to which, if we were dealing with higher organisms, we should accord the status of a genetic variation ; and the substance inducing it—the gene in solution, one is tempted to call it—appears to be a nucleic acid of the desoxyribose type. Whatever it be, it is something which should be capable of complete description in terms of structural chemistry.

Avery, a veteran now among investigators, has thus, on the eve of his retirement, attained this new peak of discovery—a fitting climax to a devoted career of such wide influence on the progress of science.

Royal Medals

A Royal Medal is awarded to Prof. John Desmond Bernal, professor of physics in Birkbeck College, University of London, in recognition of his distinguished contributions to the theory and the applications of X-ray crystal analysis.

Bernal's first important work in this field, published in 1926, was a fundamental study of the basis of the interpretation of X-ray rotation photographs of single crystals ; and the methods which he then evolved are still in use. He was largely concerned with the initiative which led to the construction of the "International Crystalline Tables", and himself accepted an important share of the editorial work required. Later he became a leader in the application of X-ray crystallography to the elucidation of the structure of highly complex organic molecules. Organic chemists had encountered difficulties, long insuperable, in formulating a satisfactory structure for the sterols. Here Bernal's crystallographic data, indicating the general shape and dimensional limits of the sterol molecule, supplied a key which opened the way to a convincing reconstruction of the polycyclic ramework of cholesterol, ergosterol and calciferol in the first place, and eventually to the structural formulation of a vitally important series of gonadal and adrenal hormones, as these, in due course, were isolated and identified. With admirable enterprise he, with his pupils and associates, proceeded to apply the methods of X-ray crystallography to crystals of some of the simpler proteins, as these became available, such as crystalline pepsin and, later, insulin. Then the discovery, by Stanley, that a plant virus—that causing the 'mosaic' diseases of tobacco—could be obtained in crystalline form, opened the way for Bernal to apply his technique to elucidate the structure of a protein endowed with such paradoxical characters. He was able to describe the virus units as long, rod-like structures, 1,500 A.

in length by 150 A. in diameter, and with an inner regularity in structure fitting a hexagon lattice and, apparently, consisting of cubical sub-units measuring about 11 A. The readiness with which the long virus units, in a solution, set themselves parallel in a two-dimensional lattice provided an explanation for the double refraction and other physical properties which such solutions of the virus exhibit.

Just before the War, Bernal had published a preliminary note on the structures of hæmoglobin and of chymotrypsin. Then, like others, he found his activities diverted to the scientific service of the special needs of the nation and its allies at war. The time is not yet for detailed mention of the important special researches he has carried out during the years immediately past, for the Ministry of Civil Defence, the Combined Operations Command, and other Service Departments, which have successively made claims on his special knowledge and ability. We are glad to know that some of his pupils have been able to keep the thread of his more normal scientific activities unbroken over this interval. Biochemistry, as well as the physics of his primary discipline, will expect much now from his resumption of personal participation and leadership in a field which he has made so much his own.

A Royal Medal is awarded to Dr. Edward James Salisbury, director of the Royal Botanic Gardens, Kew, in recognition of his distinguished contributions to plant ecology.

Salisbury's work has had a most important influence in broadening the basis of the study of British plant communities, and in diverting ecological work in Great Britain from an essentially floristic outlook to one in which the habitat and the autecology of individual species have been put in the forefront of interest.

Combining his expert ecological knowledge with a wide acquaintance with cultivated plants and their conditions of growth, Salisbury has shown an exceptional capacity for relating horticultural practices to known physiological and ecological facts, nowhere more strikingly shown than in his "Living Garden". A similar faculty served the country well in the earlier part of the War in connexion with his manifold activities on the Agricultural Research Council.

Making his first contacts with ecology by a detailed study of the oak-hornbeam woods of Hertfordshire, to which he brought some of the experience gained by co-operation with F. W. Oliver in the investigation of the maritime communities at Blakeney Point, Norfolk, Salisbury soon exhibited a more generalized approach to ecological problems. Examples are furnished by his papers on the calcicolous habit and on leaching, which traverse a wide field and open up new points of view. Although somewhat different in scope, the investigation on stomatal frequency, supported by a very large mass of data and published in the *Philosophical Transactions* in 1927, is essentially directed to clarifying the ecological picture.

In his presidential address to the Ecological Society in 1929 on the biological equipment of species in relation to competition, a topic which is repeatedly touched upon in his earlier work, attention was directed to the almost complete lack of information on the reproductive efficiency of the different species of flowering plants. This aspect of a species' equipment had already interested Salisbury for some years, and a number of significant data were given in the course of his address. Despite preoccupation with many other matters, he continued actively to accumulate information on reproductive capacity during the subsequent years, collecting data on the seed production of more than 240 British species, which involved the examination of several hundreds of thousands of individual plants. The numerous important conclusions derived from this comprehensive study, which disposes of several fallacies, were published in 1942 in a book, "The Reproductive Capacity of Plants", which constitutes a landmark in the progress of plant ecology.

In addition to his ecological work, Salisbury is known to his botanical colleagues for earlier work on fossil seeds and for important contributions to the distribution of British plants and to the interpretation of floral morphology.

Davy Medal

The Davy Medal is awarded to Prof. Roger Adams, professor of chemistry in the University of Illinois, in recognition of his distinguished researches in organic chemistry.

Roger Adams is undoubtedly the outstanding organic chemist in the United States at the present time, and his school, the largest and most vigorous of its kind in that country, is of international repute.

His researches, distinguished by great originality and dogged perseverance alike, embrace a remarkably wide field. In a series of brilliant papers he has described the complete elucidation of the structure of gossypol, a highly complex pigment present in cotton seed. This achievement is all the more noteworthy since several other investigators had failed to make much headway in examining this highly sensitive compound. His experimental skill and theoretical insight have, in recent years, led to notable advances in alkaloid chemistry, and in this connexion special mention may be made of his work on the structure of monocrotaline, the toxic constituent of various Crotalaria. Adams has been responsible for pioneering research in attempts to find synthetic substances antagonistic to the leprosy bacillus and other acid-fast bacteria, and this led him to a detailed study of the chemistry of hydnocarpic and chaulmoogric acids. He has contributed notably to our knowledge of the constituents of *Cannabis sativa* and *C. indica* (marihuana and hashish), and he has determined the structure of some of their major physiologically active components. His wide interests are clearly exemplified by his researches on stereochemical problems, particularly of the phenomenon of restricted rotation, where his work, especially with diphenyl derivatives, and more recently with aryl olefines and arylamines, is of fundamental importance. Another indication of his versatility is to be found in his detailed studies of catalytic hydrogenation with noble-metal catalysts; the platinic oxide catalyst which he perfected is now universally employed and is known as Adams's catalyst.

While Adams's researches place him in the first rank of contemporary organic chemists, his share in inaugurating the publication of "Organic Syntheses", and "Organic Reactions", immensely valuable standard works of an original type, has ensured that future generations of chemists will ever remain in his debt.

During the War, Adams's activities have been largely transferred to administrative spheres, where his foresight and organizing ability have enabled him to play an important part in the vast scientific effort of our American colleagues.

Hughes Medal

The Hughes Medal is awarded to Prof. B. F. J. Schonland, director of the Bernard Price Institute of Geophysics, University of the Witwatersrand, in recognition of his important physical studies of atmospheric electricity and thunderstorms.

Schonland's main contributions to physical research have been in the field of atmospheric electricity, and have dealt particularly with the complex series of electric discharges which constitute a 'stroke' of lightning. Although the study of phenomena associated with thunderstorms could be undertaken under especially favourable natural conditions in his native South Africa, it needed enthusiasm and perseverance to overcome the many technical difficulties encountered in a country in which physical research had not yet been greatly developed, and to bring the research to such definite and illuminating conclusions.

Schonland's early work (1927, 1928) dealt with the polarity of thunderclouds; it was established that the negative was below the positive pole of the thundercloud, and that the currents flow in such a direction that they carry negative charges to the earth. Schonland also studied the importance of point discharges (from trees, etc.) in the maintenance of the earth's negative charge. He next used (1934–38) a rotating lens camera of the type devised by the late Sir Charles Boys to photograph and analyse the lightning discharge, and obtained results of great importance for knowledge not only of the nature of the lightning discharge but also of electric discharges in air in a more general sense.

Schonland has taken an active part in the study of cosmic radiation and particularly of the relation between penetrating radiation and thunderstorms; there is a reduction in the intensity of penetrating radiation when thunderclouds are overhead, and this fact provides information as to the total charge carried by penetrating radiation. The occurrence of impulses in a Geiger-Müller counter coincident with discharges in distant thunderstorms shows that some type of penetrating radiation is produced by electrical discharges during thunderstorms. This work on cosmic rays in Schonland's laboratory is of special importance, since few such systematic observations have been continued over long periods in the southern hemisphere.

Schonland has also taken a prominent part in the study of the nature of the 'atmospherics' interfering with wireless transmission, and of the part played by the ionosphere in their structure. These studies have equipped him on the technical side for various military positions he has held during the War; for these, also, his experience in the War of 1914–18 as a captain in the Royal Engineers (Signals) had given him additional equipment. In the War now ended he rose to the charge of an Army Operational Research Group with the rank of brigadier, and later became scientific adviser to the 21st Army Group commanded by Field-Marshal Montgomery; and now General Smuts, as Prime Minister of the Union of South Africa, has claimed Dr. Schonland's services as his adviser on the promotion and development of scientific research in his own country.

BOSE RESEARCH INSTITUTE, CALCUTTA

ANNUAL REPORTS

THE annual report of the governing body of the Bose Research Institute, Calcutta, for the year 1943–44 refers to the way in which the growing difficulty in securing photographic materials, glass goods and chemicals, especially organic chemicals, hampers the work of the Institute. With grants received from the Board of Scientific and Industrial Research, schemes of research on the setting up of a powerful generator of ultrasonic waves and on testing and cutting quartz plates for the radio industry have been undertaken, and with grants from the Bengal Immunity Co., Ltd., schemes for applied research in microbiology and on the vernalization of paddy in Bengal are also being undertaken. Among the investigations referred to in the report are those on cosmic rays, and an important paper on the Wilson chamber study of meson spectra has been published in the *Transactions* of the Institute, results obtained in the laboratory agreeing with the predictions of the theory of Moller and Rosenfeld. The investigations with the Wilson chamber photographs are being continued to verify and extend the results obtained with lead absorbers with other absorbers like iron and carbon. Other physical researches were concerned with nuclear fission, the nuclear isomerization of Br^{80}, the construction of a neutron generator and an ultrasonic generator. A valve tube amplifier circuit has been assembled for measuring dielectric potentials set up in plant tissues, either simultaneously or under stimulation, and the transmission of excitation in *Nitella* and *Chara* is being studied.

An important part of the activity of the Biochemistry Department is the preparation of biologically active compounds required for physiological and microbiological studies of plants, including such substances as glucose 1-phosphate, adenylic and nucleic acids, *cis*- and *trans*-crocetin dimethyl ester, crocin and picrocrocin, and it has been possible to isolate *cis*- and *trans*-crocetin dimethyl ester, crocin and saffranol from saffron obtained from Kashmir, the yields of these compounds from the Indian variety being higher than those obtained by Kuhn and Karrer from saffron from Spain, the south of France and Asia Minor. A series of manurial experiments has been conducted with jute plants, and further investigations completed on the effect of the *p*H values of nutrient solutions on the growth of jute plants.

In the Biology Department preliminary experiments on the auxin effect on *Desmodium gyrans* indicate that at low concentrations the auxin is a respiratory catalyst for some substrates present in the cells of *Desmodium gyrans*, and that malate is one of the substrates on which this auxin acts. Different concentrations of synthetic auxin were tried to produce roots in gootes and cuttings of cinchona, indolylbutyric acid being the most effective in the formation of roots. The study of the growth of the root is being carried out by an automatic recording device previously constructed in the Institute. In the Microbiology Section, studies of the diseases of tropical fruits and vegetables are being undertaken to discover the nature of the relation between the parasites and their specific hosts, nature of infection, and mechanism of rotting, factors influencing the susceptibility of fruits and control of wastage. A

special retting substance named 'Hiparol' has been discovered which is capable of retting jute, coco-nut and other fibrous plants in 8–18 hours instead of the 6–10 weeks in the natural process. Strains of various species of *Penicillium* have been isolated and their growth-rates and rates of production of penicillin studied in modified Czapek-Dox and other media. These investigations on penicillin and yeast are being continued under a grant from the Bengal Immunity Co., Ltd.

In the report for the year 1944–45, reference is made to the working out of a theory of the mechanism of enzyme action, based on the assumption of differential catalysis for reversible enzymic processes, and the preliminary indications on the possible existence of two different phosphorylases in potato have been confirmed. Other investigations have related to the chemical transmission of stimulation and the problem of vernalization and the phasic development of some Indian crops, including wheat and paddy, and breeding work on cotton. The enzyme complex, hiparol, is also capable of yielding butanol and acetone when mixed with suitable substrates, and the industrial application of this result is being investigated. A strain of *P. notatum* isolated from local garden soil possesses certain advantages over strains imported from abroad. Large-scale production of the antibacterial agent is being undertaken; the crude filtrate is being used for surgical dressings on cases of *Staphylococcus* infection with very satisfactory results.

RECENT CHEMICAL RESEARCH IN THE U.S.S.R.

SEVERAL chemical journals from Soviet Russia have recently been received, and a few of the many interesting papers in them may be briefly mentioned.

Kapustinsky[1] has modified his well-known equation for the lattice energy of an ionic crystal by assuming an exponential equation for the repulsion force (Born–Mayer) instead of an inverse power law. The equation then becomes, in k.cal.mol.$^{-1}$,

$$E = 287{\cdot}2\,\Sigma n\,\frac{z_1 z_2}{r_1 + r_2}\left(1 - \frac{0{\cdot}345}{r_1 + r_2}\right),$$

where Σn is the number of ions in the molecule, z_1 and z_2 are the valencies, and r_1 and r_2 the radii of the ions. The calculated values are compared with those determined by the Born cycle method and the discrepancies do not as a rule exceed 1 or 2 per cent. The new equation is only slightly more complicated than the older one, and comprises the same variables: it is likely to prove of service in the study of ionic crystals.

Zvektov and Sosnorsky[2], by studying the dielectric properties of an anisotropic liquid (liquid crystal) in a rotating magnetic field, measuring the torque exerted on the substance, have extended the work of Zvektov[3] to several other liquids. The results provide a measure of the specific diamagnetic anisotropy, that is, the difference between the susceptibilities parallel to and perpendicular to the axis of symmetry. It had previously been shown that the effect is due to the single molecules and not, as was once assumed, to molecular clusters. The effect is particularly marked in aromatic derivatives, and is in agreement with Pauling's view that in the benzene ring three of the four valency electrons of carbon have orbits in planes uniformly distributed in space while the orbit of the fourth lies in the plane of the ring. The implications of this are fully discussed, and the general assumption that the magnetic anisotropy of the liquid crystals examined is determined by the number of benzene rings in the molecules is, on the whole, substantiated.

The mechanism of the combustion of carbon in oxygen has been studied recently by several investigators. Klibanova and Frank-Kamenetzky[4] point out that the mechanism of reaction at ordinary pressure is quite different from that under very low pressures. It appears that at ordinary pressure at about 600° the surface of carbon in contact with carbon dioxide is covered with a film of surface oxides, CO and CO_2, and oxygen reacts with these much more easily than with a free carbon surface. At very low pressures, these surface oxides are absent. A difficulty in the kinetic measurements is that, in most cases, only the diffusion velocity is measured. In the present experiments, carbon filaments with a smooth deposited layer of crystalline carbon were used. The filament was electrically heated in a current of air or gas. The absolute reaction velocity was measured with oxygen (10^{-4} moles/cm.^{2} sec.), and the order of reaction was found to be much lower than unity, varying from 0·4 to 0·8, the usual assumption of a first-order reaction not being confirmed. The deviation from unity is regarded as applying to the true order. Theory shows that the lower the order of reaction, the earlier and more sharply it passes into the diffusional region.

An acetylene flame emits a continuous spectrum and band spectra corresponding with CH, OH and C_2. Avramenko[5], with a rarified acetylene-air flame, found a new band spectrum corresponding with the so-called 'ethylene bands' and supposed to be due to CHO. Changes of conditions led to its disappearance, so that CHO may be regarded as an unstable intermediate product in the combustion of acetylene.

Several papers on co-ordination compounds have appeared, for example, on hydroxylamine compounds of palladium[6], $[Pd4NH_2OH](OH)_2$ and salts, and very stable Magnus type compounds $[Pd4NH_2OH]\,[PtCl_4]$; thiosulphate compounds of palladium[7] of two types; and iridium sulphites of the type of Claus's salt[8].

Several interesting papers of metallurgical interest have been published[9].

In the field of organic chemistry, mention may be made of a synthesis of cyclopentylpentene[10], organometallic compounds of mercury[11], and the synthesis of olefins with a quaternary carbon atom[12].

It is not possible in such a short notice even to mention the many other interesting and important papers, but some indication has perhaps been given of the great activity in chemical research in the many institutions of the U.S.S.R.

[1] *Acta Physicochim. U.R.S.S.*, **18**, 370 (1943).
[2] *Acta Physicochim. U.R.S.S.*, **18**, 358 (1943).
[3] *Acta Physicochim. U.R.S.S.*, **10**, 555 (1939).
[4] *Acta Physicochim. U.R.S.S.*, **18**, 387 (1943).
[5] *C.R. Acad. Sci. U.R.S.S.*, **40**, 110 (1943).
[6] Goremykin, *Bull. Acad. Sci. U.R.S.S.* (Chim.), 248 (1943).
[7] Riabchikov and Issakova, *C.R. Acad. Sci. U.R.S.S.*, **41**, 161 (1943); Riabchikov, *ibid.*, **41**, 208 (1943).
[8] Lebedinsky and Gurin, *C.R. Acad. Sci. U.R.S.S.*, **40**, 322 (1943).
[9] For example, Mikheeva and Krjukova, on the ternary T-phase in the Al, Mg, Zn system, *Bull. Acad. Sci. U.R.S.S.* (Chim.), 296 (1944); Boky and Wainstein, on crystal chemistry of Laves phases, *C.R. Acad. Sci. U.R.S.S.*, **40**, 232 (1943); Sirota, on the thermodynamics of intermetallic compounds, *C.R. Acad. Sci.*, **44**, 331 (1944).
[10] Galpern, *Bull. Acad. Sci. U.R.S.S.* (Chim.), 397 (1943).
[11] Nesmejanov and Luzenko, *Bull. Acad. Sci. U.R.S.S.* (Chim.), 296 (1943).
[12] Lieberman and Kasansky, *C.R. Acad. Sci. U.R.S.S.*, **40**, 353 (1943).

FORTHCOMING EVENTS

Saturday, December 8

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, DIVISION FOR THE SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1).—Conference on "Scientific Research and Industrial Planning". At 10.15 a.m.—"Economic Aspects of Research" (Speakers: Prof. P. Sargant Florence, Mr. F. E. Smith, Prof. M. L. E. Oliphant, F.R.S.); at 2.15 p.m.—"The Human Factor" (Speakers: Sir Arthur Fleming, Dr. C. P. Snow, Mr. J. Kendall, Prof. J. D. Bernal, F.R.S., Mr. J. A. Lauwerys).

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne 1), at 2.30 p.m.—Mr. F. T. P. Dickins: "Training Within Industry".

Monday, December 10

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 5.30 p.m.—Major-General G. Cheetham: "New Medium and Small-Scale Maps of the Ordnance Survey".

Tuesday, December 11

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. P. Weeks: "Canada and Post-War Reconstruction".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., Pres.R.S.: "Recent Developments in Chemical Therapeutics", (ii) "Sulphanilamide and its Derivatives".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Servicing of Radio and Television Receivers" (to be opened by Dr. R. C. G. Williams).

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Discussion on "D.D.T." (to be opened by Prof. G. R. Cameron, Dr. A. Thelwall Jones and Dr. H. D. Clarke).

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. J. N. Aldington: "Bright Light Sources".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the NUTRITION PANEL OF THE FOOD GROUP and the INSTITUTE OF BREWING, at the Horseshoe Hotel, Tottenham Court Road, London, W.1), at 6 p.m.—Dr. F. W. Norris: "Carbohydrate, Nitrogenous, Mineral and Alcohol Constituents of Beer"; Mr. J. W. Tullo: "Vitamins in Beer".

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Scientific Papers.

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (at Heriot-Watt College, Chamber Street, Edinburgh 1), at 7 p.m.—Prof. M. G. Say: "Ultra-High Frequency Techniques".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 7 p.m.—Dr. C. Sykes, F.R.S.: "Hydrogen and its Importance in Large Masses of Steel".

Wednesday, December 12

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Horace Wilson, G.C.B.: Amulree Memorial Lecture.

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 4.30 p.m.—32nd Annual General Meeting; at 5.30 p.m.—Mr. J. F. Waters: "Some Problems encountered during Well Shooting Operations in the Nottinghamshire Oilfields".

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. E. Billig: "Mechanical Stresses in Transformer Windings".

BRITISH ASSOCIATION OF CHEMISTS (joint meeting of the LONDON SECTION with the SCIENTIFIC FILM ASSOCIATION, in the Cinema of the British Council, 3 Hanover Street, London, W.1), at 6.30 p.m.—Programme will include films on Penicillin, D.D.T., and the discovery of a new pigment.

Thursday, December 13

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Prof. G. F. J. Temple: "Newtonian Aerodynamics".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 5 p.m.—Prof. W. E. Le Gros Clark, F.R.S.: "The Contribution of Anatomy to the War".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir James Jeans, O.M., F.R.S.: "Physical Astronomy", (iii) "The Dust and Gas of Interstellar Space".

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. W. Tomlinson and Mr. H. M. Wright: "Mineral-Insulated Metal-Sheathed Conductors".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Mr. G. H. Farrington: "Automatic Temperature Control of Jacketed Pans".

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (in the Reid-Knox Hall, British Institute of Radiology and Rontgen Society, 32 Welbeck Street, London, W.1), at 6.30 p.m.—Dr. E. G. Richardson: "The Production and Applications of Supersonics".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Prof. H. Wright Baker: "Recent Trends in the Education of Engineers".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Dr. C. J. Blok: "Pharmaceutical Conditions in Holland under the German Occupation".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 8 p.m.—Discussion on "The Teaching of Tropical Medicine" (to be opened by Dr. L. Everard Napier).

Friday, December 14

PHYSICAL SOCIETY, OPTICAL GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 3.30 p.m.—Discussion on "The Coating of Optical Components to reduce Reflection" (to be opened by Dr. K. M. Greenland).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. M. L. Oliphant, F.R.S.: "The Utilization of Nuclear Energy".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. F. Shotter and Mr. H. D. Hawkes: "A Precision A.C./D.C. Comparator for Power and Voltage Measurement".

BRITISH ASSOCIATION OF CHEMISTS, ST. HELENS SECTION (at the Y.M.C.A. Buildings, St. Helens), at 7.30 p.m.—Mr. A. V. Harrison: "Technical Education and its relationship with Industry".

Saturday, December 15

ASSOCIATION OF SCIENTIFIC WORKERS, LEEDS BRANCH (at the Riley-Smith Hall, University Road, Leeds 2), at 2.30 p.m.—Second Conference on "Science and Education". Prof. J. D. Bernal, F.R.S.: "The Policy of the Association of Scientific Workers in regard to Science and Education".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the FOOD GROUP with the YORKSHIRE SECTION of the S.C.I. and the HULL CHEMICAL AND ENGINEERING SOCIETY, in the Lecture Theatre of the Mining Department, The University, Leeds), at 3 p.m.—Mr. J. Pryce Jones: "Honey".

APPOINTMENTS VACANT

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

ENGINEERING ASSISTANT—The Engineer and Manager, Northampton Water Undertaking, Municipal Offices, Fish Street, Northampton (December 14).

LECTURER IN MECHANICAL ENGINEERING, to teach Production Engineering Subjects, Machines Theory and Design—The Principal, Derby Technical College, Normanton Road, Derby (December 14).

ASSISTANT ENGINEER for large Rubber Works in Scotland—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting C.2806.XA (December 15).

ASSISTANT LECTURER (temporary) IN MATHEMATICS—The Registrar, University College, Hull (December 15).

LECTURER (full-time) IN PHYSIOLOGY—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (December 15).

SECRETARY OF THE APPOINTMENTS BOARD—The Registrar, The University, Manchester (December 15).

ELECTRICAL ENGINEER by the Sudan Railways—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting D.1590.A (December 17).

CIVIL ENGINEERING ASSISTANT—The Engineer-in-Chief, South Staffordshire Waterworks Co., 50 Sheepcote Street, Birmingham 15 (December 21).

DISTRICT MECHANICAL ENGINEER (WORKSHOPS) by the Iraqi State Railways—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting C.2429.A (December 22).

LECTURER IN PHYSICS in the University of Cape Town—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting A.1197.A (December 29).

ASSISTANT LECTURER IN BOTANY—The Registrar, The University, Sheffield (December 31).

LECTURER (full-time) IN THE DEPARTMENT OF PHYSICS AND MATHEMATICS—The Principal, Birmingham Central Technical College, Suffolk Street, Birmingham 1 (December 31).

LECTURER IN PHYSICAL CHEMISTRY, and an ASSISTANT LECTURER IN CHEMISTRY—The Registrar, The University, Sheffield (December 31).

LECTURER IN PRODUCTION ENGINEERING at the Municipal College, Southend-on-Sea—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea.

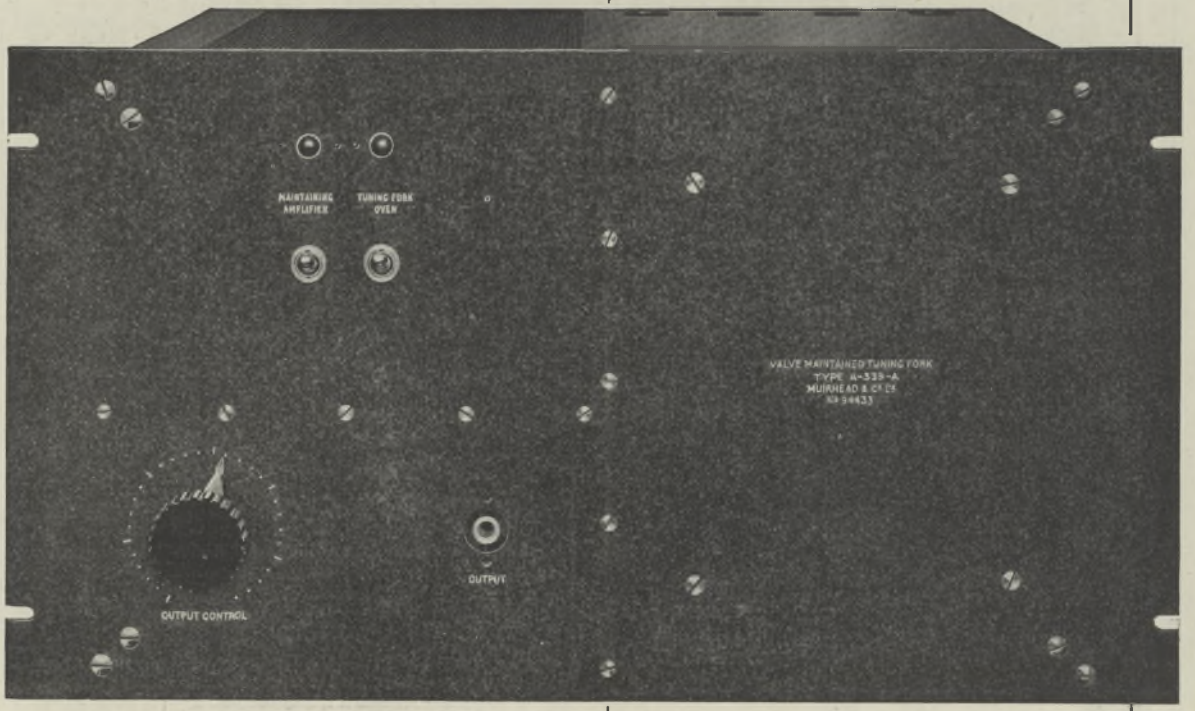
JUNIOR ASSISTANT BACTERIOLOGIST (B.Sc.) for Central Laboratory—The Medical Officer of Health, 23 Montrose Street, Glasgow.

RESEARCH ASSISTANT IN THE DEPARTMENT OF BACTERIOLOGY—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

YOUNG GRADUATE, preferably in PHYSICS or PHYSICAL CHEMISTRY, for research work on moulding materials, their properties and testing, and a YOUNG GRADUATE, preferably in CHEMISTRY or METALLURGY, for research on corrosion and related problems—The Director, British Cast Iron Research Association, Alvechurch, Birmingham.

TECHNICAL ASSISTANTS (CHEMICAL) for Petroleum Research Laboratory in London area for small experimental plants—The Ministry of Labour and National Service, London Appointments Office, 1–6 Tavistock Square, London, W.C.1, quoting CN.48.

BACTERIOLOGIST with a good knowledge of serological method, to assist in the study of streptococci associated with acute disease in infants—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.



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