NATURE

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

Vol. 158, No. 4023 SATURDAY, DECEMBER 7, 1946 ONE SHILLING & SIXPENCE

NATURE

No. 4023 SATURDAY, DECEMBER 7, 1946 Vol. 158

CONTENTS

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London
Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone : Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

THE ATOMIC ENERGY ACT

THE Atomic Energy Act has become law, and many of its provisions affect, or may affect, the work of scientific men in Great Britain. Most clauses of the Act have no immediate effect beyond conferring certain powers of control on the Minister of Supply. Their practical consequences cannot be assessed until the Minister issues the orders which the Act authorizes him to make. The attitude of the Prime Minister and the Minister of Supply in the Commons debate, on which we commented recently in the "News and Views" column (*Nature*, Oct. 19, p. 545), has done much to reassure scientific men that it is the intention of the Government to work the new powers with the least possible interference with the freedom of science.

The only important section of the Act to become effective at once is Clause 11, which prohibits the unauthorized communication of information on certain matters. It should be noticed that this prohibition is therefore already in operation ; and exemptions from it are possible only by administrative order, to be issued by the Minister.

The field covered by the prohibition would appear to be very narrow and far removed from academic research, since the clause refers to "plant . . . for producing or using atomic energy". At a first reading this may be interpreted as a reference to the large plants used for the military and industrial applications of atomic energy. No man of science could claim the privilege of spreading information about such plants at will, much as we look forward to a time when world confidence will have been restored to a level at which these matters need no longer be regarded as secret.

However, a closer study of the Act, and in particular of the definitions in Clause 18, reveals that "plant" includes "any machinery, equipment or appliance", and that "atomic energy" is defined in a way which covers any process in which atomic nuclei give up energy. Natural radioactivity is excluded, but the provisions of the Act include artificial radioactivity. Moreover, any reference to the production of atomic energy also applies to any process "preparatory or ancillary to such production. . . ."

It has been pointed out that, on the basis of these definitions, a cyclotron, for example, would be a plant for the production of atomic energy. Indeed, it is likely that a scientific investigator who talks to another about a new feature of cyclotron design, or who writes a paper on that subject, or any journal which publishes his paper, is committing an offence under the Act. In order to remedy this, the Minister undertook "to make an order, at once on the passage of the Bill, freeing . . . the ordinary tools of the nuclear physicist's trade". Once this order is made, the most flagrant divergence between the law and the normal working practice of the man of science will have been removed.

There are, however, many other ways in which the normal practice of the scientific worker may bring him into conflict with these very sweeping and vague definitions. The question of the results of measurements with a cyclotron (as opposed to its

construction or method of operation) was raised in the debate in the House of Commons, but the Minister was unable to give an assurance on it. Legally it seems that Rutherford's experiment on the disintegration of nitrogen, if done to-day, would be subject to the Act as a "plant for the production of atomic energy". Such difficulties arise over a wide field, since the inclusion of ancillary processes presumably covers, for example, plants for the separation of isotopes. Any idea in this field may be regarded as representing a "proposed plant", and hence could not be discussed with anybody without the consent of the Minister.

The Act directs the Minister not to withhold consent if the information is not important for the purposes of defence; but this is surely not a very effective safeguard. Even if scientific men could be sure of getting permission to publish on application, the need to apply for such permission frequently—and not only in matters of clear military importance—would stifle free and informal discussion, and rapid publication, two of the essentials of scientific progress. In fact, most scientific workers would probably fail to understand the legal technicalities, and will continue to let common sense be their guide, even where this may mean that technically they are breaking the law. The Minister will have to weigh the bad practice of encouraging them to ignore the law against the risk of an irresponsible person making reckless disclosures.

Under the Official Secrets Act, a scientific worker undertakes not to disclose information about research on certain specified matters—and usually such activities are those carried on in Government establishments—to which he has been given access in the full knowledge of what is involved. Under Clause 11 of the new Act, however, all men of science may break the law if they communicate information, however acquired, in a much wider field; and it will be difficult for the individual to know where the line is to be drawn. Even if most of the parts of physics investigated in university laboratories are exempted by order of the Minister, a legal right is now lost to science, and free publication has now become a matter which can only be undertaken with permission, instead of by right.

If it is intended that most university research shall be exempted from the working of the clause, then the purpose of the Act must be to cover eventualities outside the scope of the Official Secrets Act. Perhaps it could be used if a new discovery of great military importance were made in a university laboratory; it could be used to ensure that further work on this subject should be carried out under conditions of secrecy. This would probably mean, except in wartime, that the work would have to be carried out in a Government establishment. No objection can be raised to the use of the Act in this way.

It would be more serious if the Act were used to allow the representatives of the Minister to examine the results of each piece of research in nuclear physics before publication. We hope this is not the intention of the Minister. A censorship of this kind would be possible only if research workers from foreign countries were excluded from university laboratories where nuclear work was in progress, and the undergraduate students, too, were denied any intimate knowledge of the research work going on in departments where they are studying. The loss this would involve to the vitality of scientific life in Great Britain would, from the point of view of work of potential military value alone, far outweigh any loss through leakage of information.

It is possible also that the Act as it stands might be used to prosecute men of science, not working in Government establishments and not bound by the Official Secrets Act, who deliberately disclose to the agents of a foreign Power secret information about atomic energy plants, acquired in one of the many ways which are possible to anyone actively working on nuclear physics. Leakage of information in this way must, of course, be prevented. But the price now being asked for this precaution is too high. In any prosecution brought before the courts under the Act, the defendant would obviously plead that he did not know that the information was secret, and that he had done nothing but discuss a matter of scientific interest with a colleague. A successful prosecution in such a case would immediately discourage even *bona fide* discussion. It needs little imagination to see what that would mean for nuclear physics, or indeed any other branch of scientific investigation. We should lose the chance that we now have of regaining our lead in the subject, and the chance that we shall have information worth 'giving away' will become small.

A very grave responsibility therefore rests with the Minister so to frame his orders for exemption that genuine discussion is not impeded. He must also make it clear that his very wide powers are to be used in an emergency only. Until the necessary orders are issued, there will be a cloud of doubt overhanging all teaching and discussion in the field of nuclear physics. It is to be hoped, therefore, that there will be no unnecessary delay in defining clearly and unambiguously the particular matters which, in the opinion of the Minister of Supply and his advisers, must come within the scope of the Act.

THE METAMORPHOSIS OF PLANTS

Goethe's Botany

The Metamorphosis of Plants (1790) and Tobler's Ode to Nature (1782). By Agnes Arber. Chronica Botanica, Vol. 10, No. 2. Pp. 63–126+pl. 23–26. (Waltham, Mass: Chronica Botanica Co.; London: Wm. Dawson and Sons, 1946.) 2 dollars.

GOETHE'S essay on "The Metamorphosis of Plants", first published in 1790, provides a theme of recurrent interest. Yet it would probably be not untrue to say that while the majority of contemporary botanists are familiar, in a general way, with the underlying idea of this work, few have studied the original edition or had access to the English translations. Indeed, the latter are not readily accessible to the ordinary reader. By preparing a new and critical translation, Dr. Arber has rendered a signal service to botanists. But more

than that, she has rendered a service to botany, for the translation is preceded by an introduction which is a model of its kind. To those who have occupied themselves with the history of botany, particularly that relating to the last two hundred years, the introduction will indeed prove all too short. For the author has much to say that is interesting and important about the genesis and development of Goethe's idea, its intrinsic merit, its place in botanical science and, more generally, in the philosophy of biology. The aphoristic terseness and sureness of touch with which these matters are set out make it difficult to do more than emphasize the value of the new translation and introductory essay.

Students of plant morphology are familiar with the general idea underlying Goethe's theory of metamorphosis, namely, that all the external parts of the shoot are regarded as being due to the transformation of a single organ, that organ—an ideal leaf—being itself an abstraction. Or, in the words of the new translation . . . "the laws of transmutation according to which she (Nature) produces one part from another, and sets before us the most varied forms through modification of a single organ . . . the process by which one and the same organ presents itself to our eyes under protean forms, has been called the *Metamorphosis of Plants*". Contrary to a view widely held, Goethe was apparently not acquainted with the earlier related work of Kaspar Wolff ("Teoria Generationis") published in 1759, when he wrote the "Metamorphose". The view now before us is that he was an independent observer, a philosopher who looked closely at plants, and who was imbued with the idea of developing some general conception, or nexus of ideas, to cover the diversity of form which he saw everywhere in Nature, as well as in the individual plant. His method of presenting his views was not that of the man of science, but, as Dr. Arber points out, essentially that of a man of letters. The ideas in the "Metamorphose", which are set out in an easy, familiar and somewhat tentative fashion, on close examination prove to be rather elusive. Here Dr. Arber supports other critics in the view that the difficulty of grasping Goethe's ideas of metamorphosis is largely due to the fact that he did not always succeed in grasping them firmly himself. Nevertheless, that he was preoccupied with morphological developments of a most important kind cannot be denied; moreover, he was interested in the underlying mechanism, he tried to formulate general ideas admitting of synthesis; and he produced an essay, which if not good science, still provokes thought. There is, of course, always a danger of reading into a work of this kind considerably more than the author intended. Nevertheless, after reading some passages in the "Metamorphose", it is interesting, if idle, to speculate on the contribution which Goethe might have made to biological theory had he been alive to-day.

Dr. Arber has not only concerned herself with the text of the "Metamorphose": she has also made use of much additional matter from Goethe's correspondence and the comments of his contemporaries. Hence she has been able to present as critical an estimate of his contribution to botany as we are likely to get. Thus she emphasizes that Goethe's great service to morphology—we owe the word to him—was his recognition that its basis must be essentially comparative. On the difficult question of Goethe's scientific status, she remarks that . . . "This question still remains fraught with difficulty, for the catholicity of his mind, and the kaleidoscopic character of his activity, defy neat labelling. As a botanist, he began with a simple utilitarian interest in plants; he passed through a brief period in which he studied the multiplicity of the plant world from the standpoint of the descriptive naturalist; this was succeeded by a phase in which his mind was entirely possessed by comparative morphology, a subject to which the value of his contribution, and the inspiration which later workers have derived from it, are undeniable; and, finally, by a transition natural to his mental growth, he reached a stage in which his morphological thought reached out to the reconciliation of the antithesis between the senses and the intellect, an antithesis with which traditional science does not attempt to cope. It has been suggested by a literary critic that Goethe was 'a great poet who grew out of poetry'. Approaching him, as we have done here, through the medium of his plant studies, we may perhaps offer the comparable conclusion that Goethe was a great biologist, who, in the long run, overstepped the bounds of science."

The publication under review also contains the original and a translation of the rhapsody on Nature, attributed to Goethe—"Nature: Aphoristic"—a translation of which by T. H. Huxley opened the first issue of *Nature* in 1869.

By this new work of scholarship, Dr. Arber has again placed a wide circle of botanists in her debt.

C. W. Wardlaw

HISTORY OF BRITISH SCENERY

Britain's Structure and Scenery

By Prof. L. Dudley Stamp. (The New Naturalist Series.) Pp. xvi+255+64 plates. (London: Wm. Collins, Sons and Co., Ltd., 1946.) 16*s*. net.

IT is gratifying that the editors of the New Naturalist series have taken a wide view of their province, and have provided a volume which presents "a general view of the stage and setting of Britain's Natural History". With the growing interest in ecological studies, naturalists require to be increasingly aware of the physical background, of the fundamental differences between the various British regions, and of the factors which lead to their modification. These considerations apart, however, geology is a branch of natural history, appealing to a band of amateurs whose numbers are once more increasing, and this well-illustrated introduction to some aspects of the subject is therefore doubly welcome.

The author, Prof. L. Dudley Stamp, has not been content to provide a work which will merely meet the needs of the ecologist, but has adopted a broad interpretation of his subject; indeed, much besides the structure and scenery of Britain is dealt with in this book. He describes the chief surface features and also indicates the long and complex series of events which have determined their present form and distribution. He has, in short, attempted "to compress a large section of the science of geology" into a single volume.

After four introductory chapters (thirty-six pages) there are seven short chapters on general physiography (the work of rivers and of the sea, the scenery of sedimentary rocks and of glaciation, etc.). Then follow three chapters (sixty-nine pages) on the geological history of Britain, and ten chapters

(sixty-nine pages) on the various regions of Britain. In the latter, chief emphasis is laid on south-eastern England. London and Hampshire basins and the Weald get more than twenty pages, while Wales (including the Welsh borders) and the North of England (including the Lake District and Pennines) each have less than five pages. The author, faced with such a task, must have found great difficulty in allocating his space, and one can only wish that the book had been extended to allow a more adequate treatment of these regions, for this section will surely be the one most frequently consulted, both by the amateur naturalist and by the intelligent reader with a general interest in the countryside.

Faced with a choice between such a reduction of this part of the volume or of some earlier section, many would have preferred a shorter treatment of the historical and stratigraphical section. It is true, however, that an account of geological history provides a basis for summarizing the distribution of rock types, and that no constructive geological thinking is possible except in terms of a time-scale ; some knowledge of geo-chronology is almost essential as a basis for the interpretation of scenery.

In this historical section the author has freely used diagrammatic palæogeographical maps ; there are some twenty of these—more than a quarter of the text-figures provided in the volume. He quite properly indicates that many of these are based on inadequate information ; but it may be wondered if he sufficiently emphasizes the fact that each map gives a synopsis of the conditions during a considerable interval of time. For example, the map showing the geography of Millstone Grit times (Fig. 44), based on the well-known diagram by the late Prof. Gilligan, may puzzle many readers, with its river flowing across the sea for some three hundred miles, joined on its way by various tributaries before finally building its delta as it reaches St. George's Land.

To condense so much information for a reader with no previous knowledge may lead an author into generalizations which would not be accepted without qualification by his colleagues ; but it is unfair to criticize him on this account. In order to avoid technical terms he may find himself driven to rather inexact statements. There are, however, some misleading sentences in this book which it may be possible, without adding to the reader's difficulties, to correct in a new edition. For example, it is incorrect to speak of the "corrosive" power of ice (p. 83), or, in its context, of "submarine" denudation (p. 81). Eustatic movement is not merely the gentle elevation or depression of blocks of the earth's crust relative to sea-level (p. 22), and if no greater precision is needed, the term eustatic would be better omitted altogether. The ordinary reader may find difficulty in understanding the map (Fig. 1) illustrating Highland and Lowland Britain (apparently showing the areas occupied by older and newer rocks) when he realizes that the mountainous isles of Mull, Skye and Arran are counted as lowlands, and the lowlands of Scotland are reckoned as highlands.

It is probably unnecessary to say that the volume is beautifully produced in the style which we have been led to expect in this series, and many of the illustrations are excellent. The colour photographs are well reproduced, and apart from the features they illustrate, many of them are very attractive as pictures. The author in some cases has provided a diagram showing the structures represented, a valuable feature which might have been extended. Perhaps the most useful plates are those based on oblique air-photographs, which are particularly successful as demonstrations of geological structure. There are a good index and a short annotated bibliography.

A. E. Trueman

PURIFICATION OF TEXTILE FIBRES

An Introduction to Textile Bleaching

By J. T. Marsh. Pp. xiii+512+32 plates. (London : Chapman and Hall, Ltd., 1946.) 32*s*. net.

THE bleaching of textile materials is undoubtedly an ancient art, the origins of which are lost in the mists of antiquity. Like other such arts, it was for many centuries based simply on traditional and empirical knowledge. As the author of the present volume, speaking of the state of textile bleaching prior to 1914, states in his preface, "The purification of textile materials, scouring and bleaching, followed a characteristic routine in which secret recipes were handed down from father to son, surrounded by such an aura of mystery that it was impossible to approach the subject on a rational basis". The purpose of the present work is to set forth the rational basis on which the new science, as distinct from the old art, of bleaching must rest, in the light of the new knowledge which the past two decades of intensive research on textile fibres have revealed.

The actual bleaching of textile yarns and fabrics is only one of numerous processes having the common aim of producing an æsthetically satisfactory material for use or ornament ; from the strictly utilitarian point of view the vast majority of fabrics would give better service were bleaching omitted. In this sense bleaching is to be regarded as a necessary evil, and the aim of the bleacher is to produce the necessary improvement in appearance with the minimum of damage to serviceability. To this end, bleaching processes, many of which are severe in character, have to be carefully controlled, and such control is possible only when the chemical constitution and physical properties of the particular material are thoroughly known and appreciated. The author, therefore, very properly opens his treatise with a fairly comprehensive description of the nature, chemical structure and physical properties of the main types of natural fibres, and, in less detail, those of the older and newer synthetic fibres or rayons. In parenthesis it may be stated that the total available volume of information on rayon is small compared with that relating to the natural fibres : the section in the present work dealing with the bleaching of rayon, for example, occupies only two pages ; the author cannot be held responsible, however, for the fact that while much research on rayon has been carried out, little has been published.

Having thus laid a very necessary foundation, the author proceeds to describe the purification processes preliminary to bleaching proper. In some cases, for example that of wool in many of its applications, these are, in fact, more important than the bleaching processes themselves, and upon their proper execution the success or failure of the latter generally rests. Hence it is not really surprising that the actual subject of bleaching is not reached until the author has run one third of his appointed course. Then, however, the matter is dealt with very faithfully, and the various types of bleach, as applied on

one hand to cellulosic fibres, natural and synthetic, and on the other to the protein fibres and their artificial counterparts, are described, examined, and criticized in considerable detail.

Finally, and since bleaching really is a necessary evil, logically, a section is appended in which the various types of damage which can be inflicted upon textile fibres by unskilful processing are dealt with, and the methods in general use for assessing such damage are described.

The author in one or two instances perpetuates errors of fact, such as, for example, that nylon does not swell in water, and that wool fibres become brittle when completely degreased; but these are minor defects in a work which will undoubtedly prove of great service both to those actively engaged in the industry, and to those students to whom the industry must look for its future technologists. The treatment is strictly scientific throughout, and free from any suggestion of empiricism, and the text is liberally supplied with references to the literature. One might have wished, perhaps, that in some instances, where the literature presents an ambiguous or even contradictory picture, a more critical attitude had been adopted in this respect; for it is precisely in such cases that the non-expert reader is entitled to expect from the expert author guidance as to the reliability or otherwise of published work.

This volume is, nevertheless, a useful successor to the recently revised "Introduction to the Chemistry of Cellulose" by the same author and F. C. Wood, and should find a place on the shelves of all who are interested in the science of textile materials and processes.

N. H. CHAMBERLAIN

AN X-RAY ENCYCLOPÆDIA

X-Rays in Practice

By Dr. Wayne T. Sproull. Pp. vii+615. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 30*s*.

THE description of this book as an encyclopædia is scarcely an exaggeration. To quote from the dust cover . . . "the book deals with the generation, absorption, scattering and diffraction of X-rays; measurement and recording of X-rays; X-ray equipment; industrial radiography; medical application; X-ray diffraction and crystallography; fluoroscopy, automatic inspection, microradiography, gem coloration, etc.". There are also some nuclear physics and electron diffraction, and it is indeed difficult to think of any other subject that might have been included.

But this method of treating the subject raises an important question: Ought one man to write an encyclopædia? One man cannot be expected to be so expert on all the branches of a subject that he can present them to others, and this defect is apparent in certain portions of this book; Dr. Sproull has failed in several instances to convey an adequate idea of the present state of knowledge or of practice. For example, the section on X-ray tubes is very detailed, far more detailed than any other book of which the reviewer is aware, and on that account extremely valuable. But it omits entirely any reference to commercially made demountable tubes, and gives the impression that a supply of sealed-off tubes will fulfil the needs of any laboratory. This is not the general experience in Great Britain, where tubes with interchangeable targets are very popular; it would, for example, not be economical to make sealed-off tubes with manganese or zinc targets.

The weakest part of the book, however, is that on X-ray diffraction. Here Dr. Sproull is obviously out of touch with modern developments, and gives the reader an outline which is of little practical use. For example, he describes W. L. Bragg's method of determining the structures of NaCl and KCl. The historic importance of this work is unquestioned; but crystal structures are not worked out that way nowadays.

There are still more serious defects than this, however; these are illustrated by the following direct quotations:

"The only system (of space-group nomenclature) that nearly everybody understands is the Schonflies system" (p. 311). (The Mauguin system is mentioned, but an error is made in the accompanying example.)

"At ordinary temperatures one may regard f and f_0 (the atomic scattering factors at room temperature and at absolute zero respectively) as practically identical" (p. 357).

"Although the Laue method is the oldest method of crystal analysis it is still used by some of the foremost crystal analysts" (p. 371).

There may be a grain of truth in each of these statements, but the cumulative effect must be to give a quite misleading impression to the beginner.

Dr. Sproull has also introduced some rather unusual terms. Outstanding is the word 'suppression', used in connexion with the systematic *absence* of reflexions due to space-group symmetry. Buerger recently, and apparently quite unnecessarily, introduced the term 'extinction', which is unfortunate, since it already has a definite meaning in X-ray analysis. But in the reaction from this, is it necessary to introduce still another term? Similarly, the term 'crystal lattice' (p. 302) is used to describe what is already known as 'crystal structure'. It is a merit of the book that there are few loose statements, and it is perhaps this that makes such defects stand out; many writers use the word 'lattice' without a clear statement of the meaning they attach to it, and Dr. Sproull certainly does not do this. But why not leave the word 'lattice' to fulfil its ordinary and quite proper function?

It will be seen that most of this criticism of the book applies to the sections on X-ray diffraction; the sections on apparatus and industrial applications are much more satisfying. Nevertheless, even in these sections some elementary mistakes have crept in. The author speaks of "absorption per c.c." (p. 72), and on p. 100 he gives the impression that an angle is greater than 90° if its sine is greater than unity.

On p. 449 the same symbol is used for two different meanings in the same equation, so that the following monstrosity occurs:

$$2d\theta = -\frac{2\,dd}{d}\,\frac{sin\theta}{\cos\theta}.$$

The difficulty of nomenclature in differentiating Bragg's equation because of the presence of d is well known; but a judicious use of δ's would have solved the problem.

Apart from the universality of its scope, the book also attempts to cater for too wide a range of reader. Many parts of the book require a fair knowledge of physics and mathematics; yet flat-irons and base-

ball, pistols and bullets, continually obtrude themselves. It can fairly be said that one to whom such analogies appeal could derive little benefit from the rest of the book; and those who find the book at their own level must be irritated by these sudden intrusions.

To summarize, then, one might say that this would have been a much better book had its scope been less. On the technicalities of X-rays it is good, and the large number of references to original work should make it extremely useful. But those sections with which the author is presumably unfamiliar should have been omitted. H. LIPSON

ORGANISATION OF AGRICULTURE

Farming and Mechanised Agriculture

Edited by Sir R. George Stapledon. Pp. 492. (London and New York: Todd Publishing Co. Ltd., 1946.) 21*s*. net.

THIS annual reference book, now in its third edition, provides a conspectus of the organisation of agriculture in the United Kingdom. Farmers are well aware, perhaps painfully aware, of the complexity of this organisation; but the reader who has no professional contact with agriculture may well be surprised at the number of official and private bodies which exist to control or develop different parts of the industry. Ten Ministries or Departments, and twenty-eight statutory bodies with numerous committees, the work of which is concerned in varying degree with agriculture, are listed in addition to thirty-five national societies or associations and many local ones. According to the point of view of the reader, these figures may be taken as a striking illustration of the size and importance of the agricultural industry, and the diversity of its products, or as an example of the insidious growth of bureaucracy.

The book begins with a series of articles covering a wide field, ranging from the world supply of food and timber to the chemical control of weeds. The purpose of this section is not clear from its contents; if it was intended to present a comprehensive view of the present state and current problems of agriculture, the selection of subjects is not a well-balanced one; for example, two of the articles, by members of the same branch of the U.S. Department of Agriculture, deal with closely related topics. This section is likely to be of more interest to the general reader than to the agriculturist, for the subjects have been fully discussed in many recent articles in the technical Press, and in books, in some cases by the same authors. It is followed by a short section on legislation and policy.

The middle section consists of directories of the official bodies concerned with agricultural administration, including some in the Dominions and the United States, statements of the objects and policy of these bodies and of private organisations and officially appointed committees, an account of the organisation of agricultural education, a directory of educational and research institutions and a directory of organisations interested in farming and mechanized agriculture. This is perhaps the most useful part of the book, for the information which it contains is not all available in any other single publication. Some small changes in arrangement might make consultation easier; for example, the laboratories directly controlled by the Ministry of Agriculture, the Department of Scientific and Industrial Research and the Agricultural Research Council are not included in the directory of research institutions but appear earlier, in the official directories.

Later sections give tables of statistics of agricultural production, a list of books, periodicals and films on agricultural subjects, a "Who's Who in Farming and Mechanised Agriculture", and a subject index. There are a number of obvious omissions from the "Who's Who", as well as some scarcely justifiable inclusions, and in future editions it would be preferable to replace this section by an index of names referred to earlier in the text.

Two general criticisms may be made: first, the title is misleading, for the book contains little information on the practice of husbandry, and still less on mechanization; secondly, the book is unnecessarily well made and the price too high for an ephemeral work which is to be renewed annually.

D. J. WATSON

THE STORY OF LEATHER

Leather in Life, Art and Industry

Being an Outline of its Preparation and Uses in Britain Yesterday and To-day, together with some Reflexions on its Place in the World of Synthetics To-morrow. By John W. Waterer. Pp. 320 + 111 plates. (London: Faber and Faber, Ltd., 1946.) 50*s*. net.

MR. WATERER has written a remarkable and a fascinating book. It should be read not only by all who have any connexion, however remote, with leather and leather goods, but also by all who take an interest in the social and industrial history of Great Britain. Mr. Waterer has a knowledge of his subject that only first-hand experience can give, and, more than this, he writes with the fervour that springs from advocating a worth-while cause, namely, that in these days of factory production a study of industrial design can ensure that meetness of material, form and purpose which existed in the days of the old craftsman who carried through the making of an object from start to finish with his own hands and brains.

The making of leather and leather goods is one of England's oldest industries, and one of the first to achieve the distinction of an export trade. Over the centuries the reputation of certain English leather goods was built up, so that even to-day things like English saddles and sports goods, certain classes of luggage, and men's shoes are still regarded as the best that can be made. This aiming at a high standard of quality was achieved in the early middle ages by the efforts of the trade guilds, of which about a dozen were connected with articles of leather, with six surviving to this day though no longer exercising supervision over the crafts they nominally represent.

About a third of Mr. Waterer's book is devoted to the leather guilds and crafts. The story of the guilds is not unamusing—founded to protect the interests of the members, all of whom were originally active participants in the crafts concerned, and to maintain a high standard of quality in the wares offered to the public, they soon allowed these high moral principles to give way to ordinary human nature, and we find them quarrelling with each other over spheres of influence (even to actual bloodshed), opposing the employment of foreign political refugees, and making

a bid for the 'closed shop'—in fact, behaving in a manner quite familiar to us in 1946.

The next section of the book is devoted to a brief account of different classes of leather produced by modern factory methods, and to an enumeration of the many uses of leather in modern life. This will astonish most readers, for besides the obvious uses that are encountered in every individual's daily life there are also the many uses that leather finds in this mechanical age, namely, as essential parts in machines for spinning and weaving and as washers and cups in hydraulic machinery—for example, all the oil that is pumped up to the earth's surface passes over leather washers.

Finally, the book summarizes the facilities in Great Britain for education in modern methods and for the research which is so vitally needed to keep the age-old industry abreast of modern life.

The volume is beautifully produced and lavishly illustrated, and reflects great credit on both author and publishers. It is a pity that the general impoverishment of post-war England has necessitated a cloth binding—it is certainly worth one of those beautiful tooled leather bindings shown among the illustrations.

D. Jordan Lloyd

PLANTS OF THE PACIFIC

Plant Life of the Pacific World

By Prof. Elmer D. Merrill. (Pacific World Series.) Pp. xv+295. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 16*s*. net.

THE vast area covered by the Pacific Ocean, combined with the range of climatic and physiographic conditions of the lands surrounding it and the islands it surrounds, inevitably results in a rich and varied plant life. The interesting and practical guide prepared by Prof. Merrill, however, covers only that portion of the Pacific, mainly the north-western tropical island groups, brought into prominence through the war against Japan. Even within this portion there are certainly in excess of 50,000 different species and 2,500 different genera of higher plants. From the Philippines alone some 9,500 species of vascular plants have been recorded. Wisely, in a work intended for the lay reader, it is the ecological and economic aspects of the plant life that are emphasized. The major physiognomic groupings are covered by chapters with headings such as plants of the seashore, the mangrove forest, the secondary forests and open grasslands, and the primary forest. Attention is also given to plants of special interest, to weeds, and to cultivated plants. A chapter of practical value deals with 'jungle foods'. The professional botanist will find much that is new to him in all these chapters, mainly because Prof. Merrill so often draws upon his own wide experience.

In two chapters, problems of plant distribution are especially considered for Malaysia and Polynesia respectively. Such disputed questions as the Wallace and Weber lines, the relationship and historic connexions between Malayan and Australian plants, and hypotheses concerning changes in physiography are considered very judiciously. The author is obviously opposed to accepting the Wegener hypothesis of continental drift in order to explain problems of distribution, and sums up his position in the words "Like some other theories, its acceptance would explain certain observed phenomena, but at the same time would leave unexplained another great mass of data that does not conform".

The Micronesian–Polynesian floras largely consist of the same general types as are characteristic of the Malaysian region, and this is true even of Hawaii. The floras of low islands are markedly different from those of high islands. The full explanation of when and how natural floras reached remote Pacific islands remains unknown. As the author says, "hypothetical land bridges have been scattered right and left all over the Pacific basin to explain the present-day distribution of this or that group of plants".

Particular attention should be directed to the well-selected bibliography, which will serve as a very adequate guide to the student seeking further information concerning the plant life of the far-flung lands of the Pacific Ocean.

W. B. Turrill

STELLAR SPECTROPHOTOMETRY

Photometric Atlas of Stellar Spectra

By W. A. Hiltner and Robley C. Williams. Pp. iii+24+246 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1946.) 42*s*. net.

A WARM welcome must be given to this first photometric atlas of stellar spectra, a useful reminder of the increased importance attached to the quantitative study of stellar radiation. Eight bright stars ranging from *B*8 to *M*2 have been photographed with the Coudé spectrograph of the 82-inch reflector of the McDonald Observatory, Texas University. The dispersion varies from 2·1 A. per mm. at 4000 A. to 14·2 A. per mm. at λ 6500 A. The spectra have been analysed at the University of Michigan with a null-type direct-intensity microphotometer. The resultant tracings with the intensity scale are reproduced for each star in a set of some sixty sections ranging from 20 A. at λ 4000 A. to 100 A. at 6600 A.; the magnification from spectrogram to published tracing is 21·6.

The stars selected are β Orionis, α Lyræ, α Canis Majoris, α Cygni, α Persei, α Canis Minoris, α Bootes and α Orionis. It is instructive to watch the changes in the tracings through the sequence for selected stretches of the spectra and to compare them with what one notices by examining the spectra directly with the eye. Such an exercise shows at once what seems the chief defect in the atlas, the failure to put a wave-length scale along the tracings, or alternatively to mask sufficient lines to make easier the identification of the weaker lines. Admittedly this would have been a heavy additional labour to the authors of the atlas, but it would have been a great help to those making use of it. A comparison made between the atlas for α Cygni and the table of wave-lengths given by Struve for spectrograms of the star secured with the same instrument (*Astrophys. J.*, **94**, 344; 1941) shows that the effect of the grain on the microphotometer has been somewhat disappointingly large, and that the weakest lines, of intensity 0, and many lines of intensity 1 are lost. Messrs. Hiltner and Robley Williams cannot be blamed for this, the trouble being inherent in the material available, and they are to be congratulated on having led the way in a new field and having produced a work of considerable usefulness to their fellow-workers.

F. J. M. Stratton

He Conquered Death

The Story of Frederick Grant Banting. By Margaret Mason Shaw. Pp. xiii+111+11 plates. (Toronto: The Macmillan Co. of Canada, Ltd., 1946.) 8*s*. 6*d*. net.

INFORMING children of famous discoveries in science presents many difficulties, and the method of tracing the biography of the discoverer is probably likely to be most successful. With a man of such varied interests and lovable qualities as the late Sir Frederick Banting, the task of the biographer is made easy. Yet Miss Shaw, who worked under Banting for eleven years at the University of Toronto, must be commended for the skill with which she has kept faith with Banting's tenacity for truth and for the way in which she stimulates the imaginative faculties of the young readers for whom her book is intended. This she achieves by allowing Banting's life-story to be told by a practising doctor, who was a contemporary of Banting in his undergraduate days, to a group of interested boys. As the story unfolds they learn of the discovery which made Banting world-famous, the methods and attitudes of research workers in general, Banting's marked abilities as a painter and his friendship with A. Y. Jackson, his experiences in two world wars in military medicine, and other events and incidents which made up a full and varied life. Miss Shaw has written a moving account of the great Canadian man of science which should be bought for every juvenile library where English is read. T. H. HAWKINS

Survey of Askham Bog

By Bootham School. Pp. 75. (London: Bannisdale Press, 1946.) 8*s*. 6*d*.

IN 1879, three Bootham School masters, assisted by local naturalists, made a thorough survey of Askham Bog, near York. Their report was published in a magazine published for the Society of Friends Schools called the *Natural History Journal*. Recently this report was discovered by Mr. Clifford Smith, the present biology master at Bootham, who had the happy idea of making another survey of the same area. The present report is a record of the patient team-work of ninety Bootham boys under Mr. Smith's general direction.

The bog itself is a small piece of swampy ground about a mile and a quarter in total length and at no point more than a quarter of a mile broad. Much of the bog remains more or less as it was when the original survey was written; this adds greater significance to the recent investigation. Independent surveys were made into the geology, botany and zoology of the bog, and these were brought together in a general ecological report and summary. All these sections were recorded and reported by the boys themselves.

The value of the report lies not so much in the findings—although the discovery that the bog could not be fitted into any of the generally accepted ecological categories is of intrinsic importance—as in its educational worth. By giving boys experience in accurate observation, by teaching methodical recording of what they had seen, and by quickening the desire for further knowledge, this project has made a useful contribution to increasing the talents of the individuals concerned and to their harmonious development. It is noteworthy that several of the participants have already passed beyond the stage of being interested amateurs in natural history.

A Laboratory Manual of Qualitative Organic Analysis

By Dr. H. T. Openshaw. Pp. viii+95. (Cambridge: At the University Press, 1946.) 6*s*. net.

ALTHOUGH there are already many books which deal with this subject, it is usually only a part of the whole, and a small volume devoted entirely to organic identification is a welcome addition. This work is written for students, is based on the author's many years teaching experience, and has been thoroughly tested in practice. The first part describes a series of tests for the more characteristic groups commonly encountered in organic compounds, but the larger part deals with the final identification of an organic substance by the preparation of a suitable derivative, the melting point of which (and mixed melting point) can be determined: in this part directions are given for the preparation of each derivative, and indications as to which is likely to prove suitable for the purpose in view in any particular case. Tables of melting points of various derivatives of all the commoner organic compounds which might be met by the student are given, and these are sufficiently complete to make them of value to research workers. The book can be confidently recommended to all those studying or teaching organic chemistry.

F. B. KIPPING

Practical Chemistry

For Medical Students. By William Klyne. Pp. xvi+460. (Edinburgh: E. and S. Livingstone, Ltd., 1946.) 20*s*. net.

THIS volume is a product of the experience gained in teaching medical students in the University of Edinburgh and deals with practical chemistry for such students from A to Z. General scientific method is first discussed in a manner which should go far to explaining to the dullest student exactly why he is performing an experiment, and indeed why experiments are ever performed. There follows a general account of practical methods such as heating and cooling, production of reduced pressures, crystallization, weighing, etc., in fact all those operations which must first be mastered by a student. The later parts of the book deal with general and physical chemistry, inorganic chemistry and organic chemistry systematically, all treated from the point of view of the medical student. Throughout, great stress is laid on the methods of recording experimental results and of note-taking—topics on which most students are lamentably ignorant. Altogether the work seems to accomplish what it sets out to do in a very efficient manner.

The Cathode Ray Oscillograph in Industry

By Dr. W. Wilson. Second edition revised. Pp. xii+244. (London: Chapman and Hall, Ltd., 1946.) 18*s*. net.

THIS excellent technological book on the industrial applications of the cathode ray oscillograph has been considerably enlarged in this second edition by the author, particularly by the incorporation of new photographs, for one of which a magnification of 200,000 is claimed. The author excludes television tubes, but includes full descriptions of straight and pumped cathode ray tubes and varieties of the electron microscope, all of which in many forms have proved themselves key tools in recent scientific progress in industry. L. E. C. HUGHES

ORGANIC CHEMISTRY: PHYSICAL METHODS AND BIOLOGICAL RELATIONSHIPS*

By Sir ROBERT ROBINSON, Pres.R.S.

THE future historian of science will certainly characterize the first half of the twentieth century as an age of unsurpassed progress of discovery in physics. He will also note the *crescendo* in the elaboration of physical techniques and the decisive part they played in the dramatic developments of the sister sciences. Examples are the commonplaces of our scientific practice, and could be culled from almost any active region of investigation. That almost self-evident fact is well illustrated by the record of the Royal Society's medallists of 1946, and I invite reflexion on the extent to which their distinguished experimental contributions have been rendered possible by a quick appreciation of the potentialities of new physical methods. The thermionic valve, the photo-electric cell, high-vacuum technique, high-pressure technique, production and management of very low and very high temperatures, X-rays, and the use of isotopic and radioactive tracers, are but a few of the tools which modern physics has placed at our disposal.

The vastness of the subject is very significant, and even if, as is necessary, I confine myself to organic chemistry, only a small part of it can be mentioned.

The forty years of my own experience have seen a revolution in the methods of experiment, and unquestionably the great waves of advance are clearly identified with the introduction of new techniques. The improvement of balances and the pioneering work of Pregl brought in microanalysis and, following in its wake, microchemical manipulation. It is safe to say that this has increased the output of a given laboratory man-power by at least 100 per cent because of the saving of time and energy expended previously on pure routine. But even more important is the fact that microchemistry has made possible the successful attack of problems, especially in the field of biochemistry, which could not even be attempted thirty years ago.

Many of the more spectacular researches concerned substances of high biological activity, and a vital part was played by the co-operation of botanists, zoologists, physiologists and bacteriologists. But equally necessary was the help of physicists in the provision of methods of investigation of 1–2 mgm. of material.

Among the more valuable of these new resources are ultra-violet and infra-red spectroscopy and X-ray crystal analysis. The triumphs of the latter are well known, and I will only add that the last details of the constitution of penicillin were revealed by the X-rays in the hands of Crowfoot and Rogers at Oxford and Bunn and Turner-Jones at Northwich. The laborious Fourier analysis which the complete mapping of electronic densities still demands will soon be carried out by machines, and it is not at all improbable that molecular structures will eventually be ascertained with ease, and almost by inspection. That will not close the organic chemical and biochemical laboratories, but, on the contrary, will give impetus to their work in many fascinating directions.

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

Ultra-violet spectroscopy, once the concern of specialists, is now practised universally; for many purposes, however, the study of infra-red absorption promises even greater usefulness.

Although subject to constitutive influences, the bands in the infra-red are far less so than those in the ultra-violet, and the method provides a kind of elementary analysis of the simpler groups contained in the molecule. It has been used *inter alia* to follow the course of polymerization, for the analysis and characterization of hydrocarbons, such as the isomeric octanes or butanes, and in the everyday control of industrial processes.

We were very impressed by, and grateful for, a recent demonstration of the power of infra-red spectroscopic analysis. A crucial test was devised in order to establish a detail of the constitution of strychnine, and the outcome depended on the unequivocal identification of a degradation product obtained in very small quantity. Our own work indicated that it was carbazole mixed with one of the four C-methylcarbazoles, and probably with 3-methylcarbazole. But we could not be quite certain. Mr. Pausacker made the four methylcarbazoles, of which one was new, and Mr. Richards kindly studied their infra-red spectra. They were characteristic and differed also from that of carbazole. Using only 1·5 mgm. and a novel technique, Richards showed conclusively that the specimen was essentially carbazole containing about 10 per cent of 3-methylcarbazole. The probable course of events recalls the stages through which mountains have been said to pass—an inaccessible peak, an interesting course for experts, an easy day for a lady.

In many directions there have been notable advances in the processes of purification and analysis, but I will merely mention in passing the so-called molecular still, the ultra-centrifuge, polarography and electrophoresis.

I would, however, like to direct attention to a recent series of researches which foreshadow a leap forward in our knowledge of the proteins, again because of the introduction of a new technique. In doing this, I hope to make some amends for having recently bemoaned in another place the relatively small contribution of British men of science to protein research. The equipment for those who venture to follow the pioneers is not elaborate. I gather that the chief requirements are a lead tray, an earthenware drain-pipe and a sheet of paper.

Although the use of animal charcoal for the removal of coloured impurities from solutions has a respectable antiquity, and the separation of dyes in solution on filter paper has long been employed as a method of analysis, modern chromatography was introduced by Tswett forty years ago. He showed that coloured substances are selectively adsorbed from suitable solutions and that distinct bands are formed in a vertical column when the solution of a mixture is poured in at the top and allowed to fall through the adsorbant. In this way Tswett showed that leaf-green chlorophyll consists of two substances, later investigated by Willstätter and Stoll.

The many developments have included various devices for applying the method to colourless substances. A coloured group may be added to the molecule, the fluorescence of the bands may be observed instead of the colour, the adsorbant may be pre-coated with a fluorescent substance (Brockmann), or the column may be streaked with a reagent to produce a visible effect.

Chromatography is now a standard laboratory procedure, and in Great Britain Sir Ian Heilbron was the first to perceive its advantages.

Another well-known method of separation of substances depends on their partition between immiscible or partially immiscible solvents, and an apparatus for carrying out a large number of successive partitions has been devised by L. C. Craig at the Rockefeller Institute for Medical Research.

A still more ingenious idea is that of the partition chromatography which A. J. P. Martin and R. L. M. Synge (1941) worked out in the laboratories of the Wool Industries Research Association. It makes use of a Tswett column but is based on the principle of partition rather than on that of adsorption. This distinction is evidently valid in reference to the phases concerned, but it is not so certain that the two processes are not basically similar at the molecular level. As one example, particles of silica gel can be impregnated with a buffer solution on the alkaline side and placed in a column through which the substances to be separated, dissolved in a suitable immiscible solvent, are passed. The effect is obviously that of a large number of successive extractions, and bands analogous to those of a chromatogram are produced; the order of the bands from top to bottom will be one of decreasing acidity of the components of the mixture. *Ceteris paribus*, the most acid constituent, will be found in the top layer. This technique has been found to be well adapted for the separation of the penicillins on the laboratory scale. In 1944, Martin, in collaboration with R. Consden and A. H. Gordon, made a further step forward by the use of water-saturated cellulose as the stationary phase and a mobile phase consisting of a solvent such as phenol or collidine, partially miscible with water. Gordon, Martin and Synge had already shown in 1943 that strips of filter paper could be used to separate amino-acids, and the later work is an extension of this observation for the same purpose. The development may be one-dimensional or, preferably, two-dimensional, in which procedure the first solvent is removed by drying and a second solvent is allowed to ascend the paper at right angles to the direction taken by the first. A drop of protein hydrolysate suffices, and its constituent amino-acids become segregated in definite areas the position of which is dependent on the nature of the amino-acid and the solvents used. The well-known colour reaction with ninhydrin is used to show up the spots. Thus a rapid qualitative analysis of protein *bausteine* is achieved and, moreover, the presence of a new amino-acid will be indicated and a rough idea of its constitution will perhaps be obtained. Furthermore, the simpler peptides are separated and by subsequent hydrolysis and repartition their amino-acids can be recognized.

These researches will, I believe, be recognized as the greatest contribution to the study of the structure of the proteins made since the classical work of Emil Fischer.

How the method can be used is well shown by an outstanding investigation of the molecular structure of gramicidin-S by Consden, Gordon, Martin and Synge (1946). A partial hydrolysate was fractionated on two-dimensional paper chromatograms. The location of dipeptides and tripeptides having been determined, these were taken from a duplicate paper, hydrolysed, both before and after deamination, and the amino-acids identified by means of further chromatograms. The dipeptides so recognized were synthesized, and their behaviour on partition paper chromatography was found to be identical with that of the respective constituents of the partial hydrolysate. The method of ionophoresis was also used and the findings were consistent. From the chain *ABCDE*, *AB*, *BC*, *CD*, *DE*, *ABC* and *DEA* were obtained and identified.

Hence, not only is the order of the five amino-acids established but also it is rendered very probable that the substance is a cyclic polypeptide. The crystallographic results of Crowfoot and Schmidt are compatible with the hypothesis that the ring contains ten amino-acid groups.

At the Liverpool meeting of the British Association for the Advancement of Science (Section B, 1923) I mooted the idea that many high molecular weight substances of repeating pattern type should be regarded as mammoth rings, basing this speculation mainly on the absence of end-groups required on the open-chain hypothesis. A cyclic decapeptide would include a ring of thirty members.

I will now refer to a subject pursued in my own laboratory in collaboration with biologists, namely, Dr. C. E. Coulthard, of the Research Department of Boots Pure Drug Company, Ltd., and Dr. J. Ungar, of Glaxo Laboratories, Ltd.

The tubercle bacilli are characterized by the possession of a waxy envelope which has often been considered to confer some degree of immunity against the attack of chemotherapeutic agents. Consequently, it has been sought to endow the latter with fat-soluble groups in the hope of penetrating the supposed protective covering. Actually, it may be doubted whether this scheme, which has brought little success, is based on a sound conception, for it may be argued that all that could be achieved would be the establishment of a reservoir of the agent in the lipins. On these lines it would seem necessary to link the fatty part of the molecule to the water-soluble part, which it is hoped will attack the organism, by a readily hydrolysable linkage. Several variations of this theme can be envisaged. Be this as it may, it is obvious that the chemical nature of the lipins of the bacteria deserve close attention, and the first chemist to attack the problem, and with important results, was R. J. Anderson (1929 and later). The fatty acids obtained by hydrolysis of the waxes from the bacterial bodies were fractionated, and one of them, tuberculostearic acid, was found by Spielman, a colleague of Anderson, to be 10-methylstearic acid.

Important constituents of the mixture were acids of the formulæ $C_{26}H_{52}O_2$ and $C_{30}H_{60}O_2$; the former, termed *phthioic acid*, has been the more closely studied. Anderson was of the opinion that it was a branched-chain acid similar in constitution to tuberculostearic acid; but the evidence garnered by him and his collaborators and by Wagner-Jauregg was insufficient to establish the details.

E. Stenhagen and S. Ställberg then studied the behaviour of phthioic acid in monomolecular films and also the X-ray reflexions from barium phthioate. They came to the conclusion that the acid is ethyldecyldodecylacetic acid, or something very similar, but the synthesis of this substance by N. Polgar showed that this was an error probably due to the unusual degree of tilt of the molecules.

I will not burden you with the organic chemical details of Polgar's further work; but combined analytic and synthetic attack of the degradation

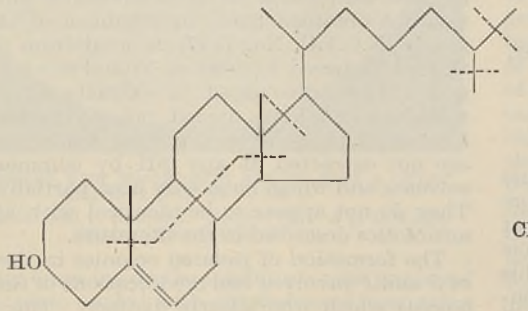
products made it very probable that phthioic acid is 3 : 13 : 19-trimethyltricosanoic acid, a straight chain of twenty-three carbon atoms with three methyl branches. Phthioic acid is feebly optically active, but the optically inactive, synthetic 3 : 13 : 19-trimethyltricosanoic acid closely resembles phthioic acid in respect of its physical properties, including the behaviour of monomolecular films on water, and in the melting-points of its derivatives. We thus returned to the original general hypothesis of Anderson.

It has been known for some years that phthioic acid possesses toxic properties (F. Sabin, of the Rockefeller Institute for Medical Research, New York, and others) and that it produces lesions when suitably injected into experimental animals, for example, the guinea pig. But the observations of Coulthard and Ungar are new in that they have been able to reproduce, by a single intraperitoneal injection of synthetic acids of known constitution, a pathological picture which is almost identical with that of tuberculosis, in respect of the particular manifestations observed. There is no doubt whatever of the reality of the phenomenon, and it is highly significant.

The study of a range of synthetic branched long-chain fatty acids from this point of view is in its infancy, but the following results can be cited. The acids have been synthesized by N. Polgar, partly with the collaboration of S. David and E. Seijo. 3 : 12 : 15-Trimethyldocosanoic acid is even more active than phthioic acid, or synthetical 3 : 13 : 19-tricosanoic acid, which are equal within the limits of the method. On the other hand, 2 : 13 : 17 : 21-tetramethyldocosanoic acid is inactive. 13 : 17 : 21-Tricosanoic acid is inactive, and so is 2 :13-dimethylpentacosanoic acid. 13 : 16-Tricosanoic acid is active, but it was suspected that the specimen contained a 3-methyl-substituted impurity. A purified specimen exhibited greatly diminished activity. 4 : 13 : 16-Tricosanoic acid is very active, and though here again the presence of some 3-methyl substituent is not excluded, the activity is such that it can scarcely be due to an impurity. 3 : 13 : 19-$\Delta^{13:19}$-Tricosadienic acid is active but less so than the related saturated substance. It is probable that the specimen contains several geometrical isomerides. The syntheses are very laborious and the biological tests are prolonged, so that progress is necessarily slow.

At present it looks as if a methyl substituent in the 3- or 4-position is necessary. The biological property is evidently highly constitutive, but it is too early to attempt an identification of all the requisite structural features. A working hypothesis is that the methyl groups block β-oxidation, and some relation to physiologically active unsaturated substances may well be brought to light in the future.

An extremely interesting discovery, quite unrelated to this work in its origin, has been announced by R. P. Cook from the Biochemistry Laboratory, University of Cambridge. He has obtained an acid, or a mixture of acids, $C_{25}H_{50}O_2$, by feeding cholesterol to rats. This is very suggestive of an extraordinary process of unwinding of the tetracyclic nucleus of the sterinoid by breaks at the points where the rings are fused, and also at some peripheral point, and in the side-chain. For example, one possible degradation is illustrated below :



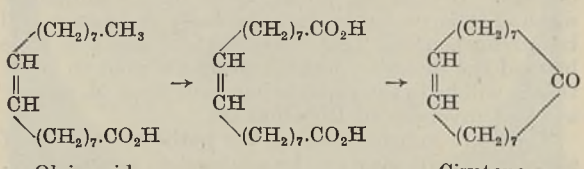
reduction and oxidation →

$CH_3(CH_2)_4.CHMe(CH_2)_{12}CHMe(CH_2)_3.CO_2H$

5 : 18-dimethyltricosanoic acid

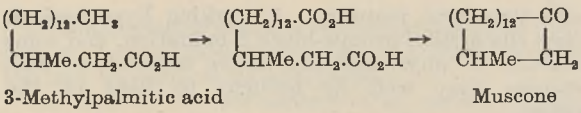
We are unable to equate the constitution of any substance that could be obtained in this way with that of phthioic acid, but such a direct relation was scarcely to be anticipated. If Cook's acid is really derived from the cholesterol molecule by some transformation, it must be a branched-chain acid, and the determination of its structure is a most urgent problem, the solution of which must surely shed some light on an aspect of the biochemistry of phthioic acid.

The temptation to carry speculation a little further cannot be resisted. In 1926, Prof. L. Ruzicka elucidated the constitution of civetone, the odoriferous principle of the civet cat, and made the dramatic discovery of the existence of large carbocyclic rings in Nature. He also noted the structural relation of civetone with oleic acid. Since the ketone has one less carbon atom than the acid and the latter is widely distributed, the degradation of oleic acid to civetone is more probable than the reverse synthesis. It may be suggested that oleic acid suffers ω-oxidation, a biochemical process to which Verkade has paid attention, and that this is followed by a familiar ketonization.



Oleic acid — Civetone

But analogy then leads us to assume a similar mechanism for muscone from the musk-rat, which was also studied by Ruzicka. We find that its progenitor should be a 3-methylpalmitic acid,



3-Methylpalmitic acid Muscone

The occurrence of the 3-methyl-substituent is interesting in relation to phthioic acid. Further, Prof. Hans T. Clarke and his collaborators at Columbia University, New York, have shown by the use of C^{13} that the fatty acids are produced in the organism from acetic acid only. In parenthesis, this is a remarkable experimental justification of J. N. Collie's speculations on the role of keto-methylene chains in biosynthesis. An additional molecule of acetic acid could be used to introduce methyl substituents by the mechanism:

$$R.CO_2H + CH_3CO_2H \rightarrow R.CO.CH_2.CO_2H \rightarrow R.CO.CH_3$$

$$R.CO.CH_3 + CH_3.CO_2H \rightarrow R.CHMe.CH_2.CO_2H$$

3 : 13 : 19-Tricosanoic acid is not a possible product of this scheme of biosynthesis. It would therefore not be surprising to find that phthioic acid, as at present known, is a mixture of a trimethyldocosanoic acid and a trimethyltetracosanoic acid. On this hypothesis the chain should in any event be even-numbered and the methyl groups can only be attached to the odd-numbered carbon atoms. The constitution proposed for tuberculostearic acid conforms to the first condition, but not to the second. It could, however, be 9-methylstearic acid, if oxidation occurs at carbon atoms 9 and 10 and is accompanied by a pinacol-pinacolone migration. Alternative views to that already mentioned involve the intervention of molecules of propionic acid or formaldehyde (or an equivalent) in order to provide the methyl substituents. These, however, fix the methyls on even-numbered carbon atoms and, though tuberculostearic acid then falls into line, they are at variance with our own deductions in regard to the constitution of phthioic acid.

Following the clue afforded by chaulmoogric and hydnocarpic acids in the treatment of leprosy, Roger Adams prepared a range of substituted fatty acids, some of which had considerable action on *B. leprœ* (or possibly an analogous organism) *in vitro*. The irritating action of these substances precluded their use in practice.

Our first efforts in the field of tubercle fatty acids had a similar objective, but we have now abandoned the idea of a frontal attack on the organism in favour of an attempt to alleviate the symptoms of the disease. If this can be achieved by an immunity method it is probable that the body resistance will be strengthened. That investigation has not gone beyond the planning stage, but we are glad to know that it will be in the capable hands of Prof. M. Stacey at the University of Birmingham.

There are indications that the pathological role of abnormal lipins may not be confined to tuberculosis. Thus Novak and Grey (1938) found tuberculous tissue, with lesions, associated with granulosa cell tumours, and suggests that these effects were due to lipins produced by the malignant growths. These observations have very recently been confirmed and extended in the United States.

ADAPTATION OF *STAPHYLOCOCCUS AUREUS* TO GROWTH IN THE PRESENCE OF CERTAIN ANTIBIOTICS

By Dr. E. P. ABRAHAM, D. CALLOW and K. GILLIVER

Sir William Dunn School of Pathology, Oxford

IT has been noticed that certain antibiotics, when tested against *Staphylococcus aureus* (*H* strain, N.C.T.C. No. 6571) by the cylinder-plate method[1], give zones of inhibition which have clear edges, but which contain, scattered through them, small numbers of isolated colonies of *Staphylococci* (Fig. 1). Among the first antibiotics found to show this phenomenon was one obtained from an organism of the *subtilis* group (N.C.T.C. No. 7197) isolated from the soil at Oxford (referred to here as *S*) and one which Chain and Callow[2] discovered in extracts of *Polystictus versicolor* and have named polystictin (referred to here as *P*). Both are water-soluble substances which are not extracted at any *p*H by common organic solvents and which have only been partially purified. They do not appear to be identical with any of the antibiotics described in the literature.

The formation of isolated colonies in the presence of *S* and *P* involved two modifications of the *Staphylococcus* which were clearly distinct. This is shown in the three plates which are illustrated. Plate 1 (Fig. 1) was seeded with the normal strain of *Staphylococcus*. Plate 2 (Fig. 2) was seeded with a strain derived from the normal strain by picking off a colony from inside the inhibition zone caused by *P* on plate 1. When tested on plate 2, *P* was apparently inactive, whereas *S* produced a zone of inhibition similar to that which it gave on plate 1. Similarly, by starting with a colony from within the inhibition zone caused by *S* on plate 1, a plate could be prepared on which *P* produced a normal zone of inhibition but *S* gave no inhibition. Lastly, by picking

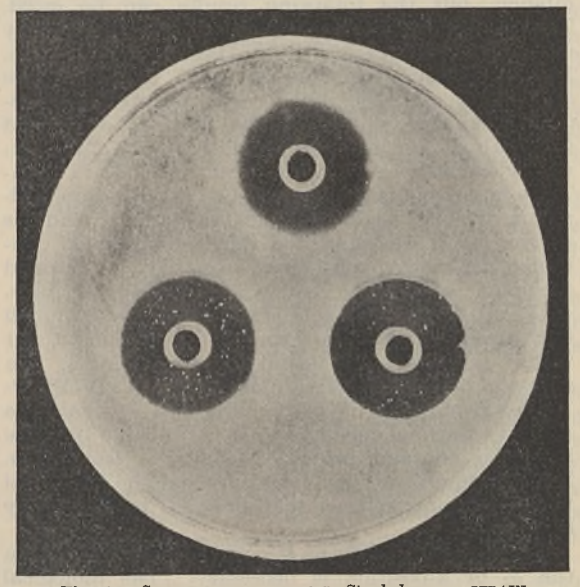


Fig. 1. SEEDED WITH NORMAL *Staphylococcus* STRAIN
Top: Helvolic acid (1 in 5,000). Bottom left: *S* (1 in 2,000). Bottom right: *P* (1 in 200)

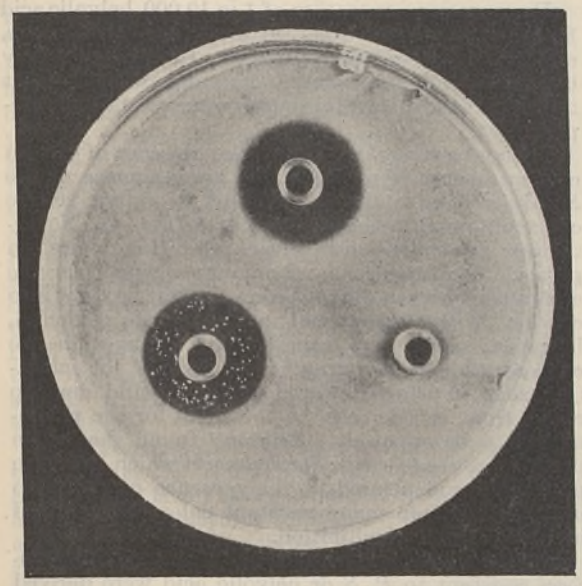


Fig. 2. SEEDED WITH *Staphylococcus* DERIVED FROM A COLONY RESISTANT TO *P* ON PLATE 1
Top: Helvolic acid (1 in 5,000). Bottom left: *S* (1 in 2,000). Bottom right: *P* (1 in 200)

off a colony from inside the inhibition zone produced by *S* on a plate seeded with *Staphylococci* insensitive to *P*, or by *P* on a plate seeded with *Staphylococci* insensitive to *S*, organisms were obtained which were insensitive to both *S* and *P* (Plate 3, Fig. 3). These insensitive strains of *Staphylococci* could be kept on agar slopes, or subcultured several times in a heart extract medium, without undergoing any noticeable reversion.

In view of the large number of antibiotics—in many cases still in an impure condition—which are being described in the literature, methods of distinguishing between these substances at an early stage of the investigations are of interest. Stansly[3] suggested that strains of organisms trained specifically to grow in the presence of different antibiotics could be used for this purpose. The procedure described here with *P* and *S* shows beyond doubt, in a very simple manner, that these two substances are different. It remains to be seen, however, how far the procedure can be extended to distinguish between other substances which give inhibition zones containing resistant colonies; the results of attempts to use the method to differentiate between antibiotics produced by certain members of the *subtilis* group have not so far been encouraging. One general limitation of the method is due to the fact that it is not known how far the resistance developed by an organism against a given antibacterial substance is specific. Organisms made resistant to one penicillin, for example, are found to have become resistant to other penicillins[4].

The majority of antibiotics investigated hitherto do not produce inhibition zones containing isolated resistant colonies on staphylococcal plates. Thus helvolic acid produces clear zones of inhibition on a plate seeded with the *Staphylococcus* even though the organism can be trained to grow well in the presence of this substance[5]. *Staphylococci* made resistant to *P* or *S*, or to both substances, showed a normal sensitivity in the cylinder-plate test to helvolic acid (Figs. 2 and 3). By seeding a plate with *Staphylococci* trained to grow in the presence of helvolic acid (1 in 20,000) in liquid medium, and then picking off resistant colonies formed inside the inhibition zones produced by *P* and *S*, a culture was obtained which showed resistance, when used in the cylinder-plate test, to all three substances, though its resistance to helvolic acid was reduced during the procedure.

In the case of *S* and helvolic acid it was shown by measurements of the activity of these substances before and after cultures had grown in their presence that the resistant strains of *Staphylococci* did not inactivate the antibiotics in the medium.

The difference in the nature of the inhibition zones produced by *P* or *S* from that produced by helvolic acid was reflected in the different types of growth curves shown by the *Staphylococcus* in the presence of these substances in liquid media. Fig. 4 shows growth in normal heart broth (*p*H 7·3) and in heart broth containing *S* (1 in 15,000), from an inoculum of 50×10^6 *Staphylococci* per ml. In the presence of the antibiotic the cells were at first killed rapidly and approximately logarithmically (mean survival time about 30 minutes). After 4 hours, when the number of viable cells per ml. had fallen to $0{\cdot}70 \times 10^6$, the survivors began to multiply at a rate which soon reached that of a normal culture in the logarithmic phase, having a mean generation time (m.g.t.) of 28 minutes. These changes were accompanied by an initial decrease and subsequent increase in the total number of organisms, but lysis only reached its maximum after more than 6 hours and was clearly a secondary process superimposed on that causing the death of the cells. The final 'stationary population' attained in the presence of *S* was much smaller, however, than that reached by the control culture. It appeared from this curve (Fig. 4) that when *S* was tested by the cylinder-plate method most of the organisms within the inhibition zone were killed, but a small proportion survived and grew rapidly in the presence of the antibiotic, leading to the appearance of isolated resistant colonies.

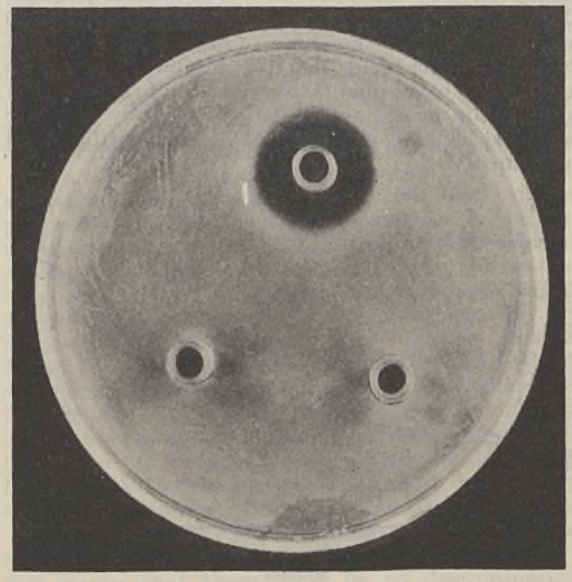


Fig. 3. SEEDED WITH *Staphylococcus* DERIVED FROM COLONY RESISTANT TO *S* ON PLATE 2
Top: Helvolic acid (1 in 5,000). Bottom left: *S* (1 in 2,000). Bottom right: *P* (1 in 200)

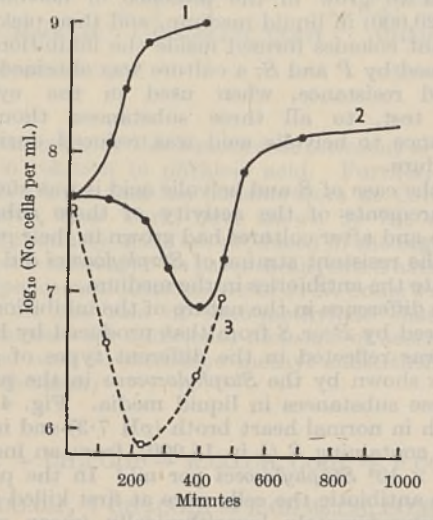


Fig. 4. GROWTH OF *Staphylococcus aureus* IN THE PRESENCE OF *S* (1 in 15,000). (1) CONTROL CULTURE; (2) TOTAL CELLS IN THE PRESENCE OF *S*; (3) VIABLE CELLS IN THE PRESENCE OF *S*

Fig. 5 illustrates the remarkable facility with which the *Staphylococcus* became resistant to helvolic acid (1 in 200,000) in heart broth (*p*H 7·3). The inoculum was 6×10^6 cells per ml. For nearly twelve hours growth was very slow, the m.g.t. being 260 minutes. A transition then occurred to a much faster rate of growth in which the m.g.t. fell to 57 minutes before the stationary population was approached. When cells from this culture were used to inoculate fresh medium containing the same concentration of helvolic acid there was rapid growth (m.g.t. 30 minutes) after a short lag period of 70 minutes. Thus after less than seven divisions the *Staphylococci* were able to grow almost as well in the presence of this concentration of helvolic acid as in normal medium. Their capacity to do this was not lowered significantly by three subcultures in normal medium. Cells which had grown in the presence of 1 in 200,000 helvolic acid were then able to grow readily in 1 in 20,000 helvolic acid (lag 70 minutes, m.g.t. 53 minutes). Curves qualitatively similar to those given by helvolic acid have been obtained by growing bacteria in the presence of other antibacterial substances[6,7].

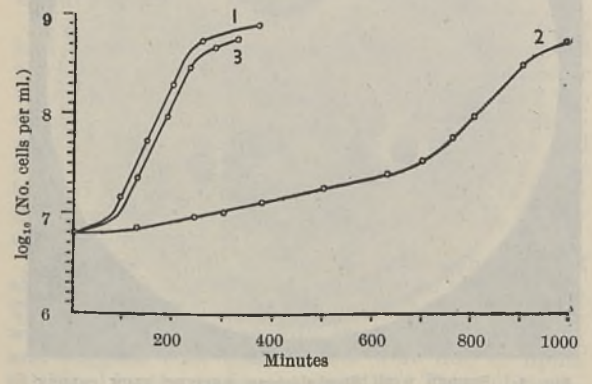


Fig. 5. ADAPTATION OF *Staphylococcus aureus* TO GROWTH IN THE PRESENCE OF HELVOLIC ACID (1 IN 200,000). (1) CONTROL CULTURE; (2) PRIMARY CULTURE IN HELVOLIC ACID; (3) SUB-CULTURE FROM (2) IN HELVOLIC ACID

Even at a concentration of 1 in 10,000, helvolic acid had no bactericidal effect, at least for several hours, on the *Staphylococcus*[8] (*H* strain). Its predominantly bacteriostatic action was in harmony with the fact that it produced clear inhibition zones in the cylinder-plate test.

It may be remarked that in the presence of certain concentrations of penicillin the growth-curve of the *Staphylococcus* in liquid medium[9] is similar to the curve obtained in the presence of *S* (Fig. 4). Nevertheless, penicillin gives clear inhibition zones on plates. The proportion of organisms which survive and multiply when *Staphylococci* are first brought into contact with suboptimal amounts of penicillin, however, varies very rapidly with changes in the concentration of the drug[10]: the part of the inhibition zone in which isolated colonies could develop might thus, in this case, be too small for the phenomenon to be apparent. Eriksen[11] found that when plates were seeded with *Staphylococci* which had been previously subcultured in the presence of penicillin in liquid medium many resistant colonies developed inside the zones of inhibition.

The question arises whether the strains of *Staphylococci* resistant to *P*, *S* or helvolic acid were derived merely by a process of natural selection from a bacterial population which was initially heterogeneous, or whether they were produced because staphylococcal cells could adapt themselves very rapidly to grow in the presence of concentrations of these antibiotics to which they were normally sensitive.

The simplest hypothesis which might have been put forward to account for the development of resistant strains in terms of natural selection was that the original *H* strain contained small amounts of a number of substrains, each of which was stable and was resistant to a given antibiotic. This hypothesis had two consequences, however, which made it untenable. First, it required that the emergence by natural selection of a substrain resistant to one of the antibiotics should have been accompanied by the recession and eventual elimination of other resistant substrains. In fact, a strain of *Staphylococci* resistant to *P* produced cells resistant to *S* as readily as did the original *H* strain. Secondly, it required a culture derived from a single cell of the *H* strain to have comprised cells which were all sensitive, or all resistant, to a given antibiotic. Experiment showed that the inhibition zones produced by *P* or *S* on twelve plates seeded with cultures derived from different single colonies of *Staphylococci* (obtained by plating out a culture of the *H* strain which contained, for the most part, discrete cells) were all very similar, each having about the same diameter and containing approximately the same number of resistant colonies. Even if all the single colonies had not been derived from single cells the probability that some of them would have contained only 'sensitive' cells, had these been present in the original culture, is very large. Similarly, the sensitivity of the *Staphylococcus* to helvolic acid in liquid medium was not changed by using cultures derived from single colonies. These difficulties could have been partly circumvented by supposing that the *H* strain, even when grown in normal medium, was continually producing 'variants' which were resistant to one or other of the antibiotics, so that a single cell gave rise to a heterogeneous population. Lewis[12] considered that this was the manner in which *Bact. coli mutabile* acquired the capacity to ferment lactose, and Demerec[10]

thought it was the way in which the *Staphylococcus* became resistant to penicillin. In the present case, however, such an explanation was not readily acceptable. Unless the variants were unstable, or divided more slowly than the normal cells, their proportion would continuously increase during the growth of normal cultures, since new variants would be formed both from normal cells and by division of the variants themselves. In fact, the strains of *Staphylococci* resistant to *P*, *S* or helvolic acid showed no tendency, at least in pure culture, to undergo a rapid reversion, nor did their growth-rates appear to differ significantly from that of the original *H* strain; but nevertheless they were obtained just as readily from samples of the *H* strain which were derived by one subculture from a single colony as from a sample which had passed through a number of subcultures.

These considerations indicate that the development of resistance by the *H Staphylococcus* to *P*, *S*, or helvolic acid is not easily explained by a theory based exclusively on natural selection. On the evidence available a more satisfying hypothesis is that the process is caused initially by a specific modification of staphylococcal cells which is induced by the antibiotic concerned; although, once any such modified cells have been formed, natural selection may obviously accelerate the emergence of a resistant strain.

[1] Heatley, N. G., *Biochem. J.*, **38**, 61 (1944).
[2] Chain, E., and Callow, D. (unpublished work).
[3] Stansly, P. G., *Science*, **103**, 402 (1946).
[4] Eisman, P. C., Marsh, W. S., and Meyer, R. L., *Science*, **103**, 673 (1946).
[5] Chain, E., Florey, H. W., Jennings, M. A., and Williams, T. I., *Brit. J. Exp. Path.*, **24**, 108 (1943).
[6] Davies, D. S., and Hinshelwood, C. N., *Trans. Faraday Soc.*, **39**, 431 (1943).
[7] Abraham, E. P., *Biochem. J.*, **39**, 398 (1945).
[8] Chain, E., and Duthie, E. S., *Lancet*, i, 652 (1945).
[9] Hobby, G. L., Meyer, K., and Dawson, M. H., *Proc. Soc. Exp. Biol.*, N.Y., **54**, 281 (1942). Abraham, E. P., and Duthie, E. S., *Lancet*, i, 455 (1946).
[10] Demerec, M., *Proc. U.S. Nat. Acad. Sci.*, **31**, 16 (1945).
[11] Eriksen, K. R., *Acta Path. Scand.*, **23**, 284 (1946).
[12] Lewis, I. M., *J. Bact.*, **28**, 619 (1934).

EDUCATION IN THE BRITISH ARMY*

By Major-General CYRIL LLOYD, C.B.E., T.D.
Director of Army Education

III: Education in the Post-War Army

THE years between the two World Wars were notable for two distinct phases which are important to remember. First there was the apathy in low places and the frequent opposition in high ones which met the newly formed Army Educational Corps as it faced its new task. Second was the change of attitude on the part of officers and men as the grinding, hard and courageous work of those early years began to show its effect. The earlier trickle of men coming forward for higher education in their leisure time became a steady stream in the late 'twenties, and by the time war broke out it was in some places becoming a flood which could be contained only with difficulty. No less important was the change in the attitude of senior officers; opposition changed into co-operation, interest and, in some cases, real enthusiasm. As horse and foot were replaced by the machine, the traditional conception of the still-tongued, non-thinking but superbly disciplined soldier gave place to a new ideal: the man who would think, not at the rate of the moving horse, but at the speed of the motor-vehicle which was rapidly superseding it; a man who would observe discipline not from fear of punishment, but because of a real understanding of its efficacy. This was real progress; but it was still hampered by the shackles of an elaborate and extensive examination system which limited the horizon and absorbed, in great quantities, time and energy which could have been far more profitably employed.

With the outbreak of war in 1939 all official educational work ceased for a time, but it soon came to be realized that, in total war, care of the soldier's mind is no less important than care of his body and soul: morale must be built up, war-weariness and boredom must be eliminated, mental stagnation must be replaced by mental alertness; knowledge must make the soldier the full man. The scheme which sought to achieve all these ends brought to army education the rich experience of free adventure in an unlimited field. Instead of trying to entice the soldier into his academic parlour, the teacher was forced to go forth and mould his knowledge and culture to the lives of men who in peace-time make machines, build houses, drive trains and dig coal, and in so doing his gains have been great.

Not the least of the advantages which accrued was the bridging of the gulf which had too long separated military from civilian educational administrators, and the release period scheme has provided opportunities for an extension of this advantage: the close contact and collaboration between the War Office and the Ministry of Education is being repeated at lower levels by liaison between His Majesty's inspectors and command and district education officers in the field both at home and overseas.

The continuation of compulsory service is important, because it introduces considerations which would not exist were we concerned only with the long-service professional soldier. It will, for example, be important to make the militia-man understand why he is compelled to become a soldier: it will be equally important to prepare him for those civic responsibilities to which he will return at the end of his militia service.

At a time when, under the Education Act of 1944, educational opportunities in the civil field will be progressively expanding, the soldier, be he professional or militia-man, will have the right to demand similar opportunities within the Service. Education is a national and not a sectional privilege, and it should be a continuous process unbroken by the accident of compulsory or even of voluntary service. If this be accepted, we must accept also the need for a continuing close liaison between the War Office and the Ministry of Education, for how else can continuity of purpose be achieved? Moreover, the circumstances of Service life make the Army an admirable ground for controlled experiments which might be less easy to conduct in the freer field of civilian adult education.

It will be important to make the militia-man realize that he is an essential part of the Army: this means that there must be no discrimination in units where militia-men and professionals serve side by side, for there is only one British Army and all who share its service share its honour. All

* Continued from page 780.

the same, it provides an obvious problem for those who plan the details of organisation and syllabus.

Perhaps the greatest advance made in army education during the war years has been the recognition of the soldier's right and need to develop the personal side of his life. Sir Ronald Adam will be long remembered for his successful efforts to provide for the soldier wide opportunities to develop cultural interests, hobbies and non-vocational craftsmanship. It is idle to suppose that the Army will readily relinquish what it has learnt to appreciate. Moreover, it must be remembered that the bulk of the Army will be, not at home, but abroad where amenities are fewer, where boredom is the bitter enemy of morale and where the homeliness of contact with the civil population is a blessing rarely enjoyed.

We can therefore now proceed to a broad classification of the needs of the post-war British soldier. First there is the continuation of general education, which must include current affairs and citizenship, and, for those who need it, basic education of the most elementary type. Second comes professional education, the importance of which lies in its potential influence on our national efficiency and prosperity, and herein there must this time be no overlooking the claims of the long-service soldier. Finally there is education for a richer life through appreciation of the arts, skill at handicrafts and an ability to derive pleasure in the wide fields of scholarship and culture.

An examination of the factors of the problem would be incomplete without consideration of the problems of staff requirements, which will be inescapably large because of the variety of the provision required for numbers which for many years to come will be very great. Certainly a larger Army Educational Corps than before the War will be required, and this means improvement in prospects of pay and promotion sufficient to attract the right type of man in adequate numbers. It would, however, be idle to hope to get through the financial and manpower limitations any plan for staffing the entire plan with fully qualified, and therefore expensive, teachers. There should, however, be no dearth of potential talent in the ranks of the Army. Recent improvements in pay will, it is hoped, attract into the Army men of higher educational attainment, and, compulsory service having been approved, the militia should provide a good leavening of prospective teachers and others suitable for educational work of all kinds.

It is obvious that a full picture cannot be painted while so many essential military details have yet to be decided; but it is possible to begin to develop the broad outlines to which form and colour will be added in due course.

In order that the close association with civil adult education in war-time may be continued and strengthened in peace-time, the Secretary of State for War has set up an Army Education Advisory Board. This Board is composed of persons in civil life with educational qualifications and experience, and of representatives of the Ministries of Education and of Labour and National Service and of the Scottish Education Department. It is the responsibility of the Board to keep under review the educational policy of the Army and to advise the Secretary of State on such matters connected with Army education as it thinks fit and upon any questions referred to it by him. The chairman of the Board is Sir Philip Morris, vice-chancellor of the University of Bristol, who brings to the Board not only his wide knowledge of civil education but also the valuable experience of the problems of army educational administration which he gained as Director-General of Army Education. The Army will therefore start its new scheme assured of its civilian contacts, and this should go far to ensure that education in the Army is an integral part of the national plan.

It is essential that education in the Army should be a normal part of military life designed to fit into its place in daily routine. This being so, the military 'unit' must be the basis of educational organisation, and the commanding officer must be charged with the responsibility for his unit's educational efficiency in the same way and to the same extent as he is responsible for all other aspects of his unit's efficiency and welfare. In the main he will be responsible for a general scheme of community education which will be a compulsory part of the day's work. Community education has here a wider connotation than its present one in the release scheme, where it covers only current affairs and citizenship. In the future plan it covers not only current affairs and citizenship but also all those basic subjects which are the necessary equipment of the good citizen; for example, English, calculation, geography and history. Side by side with this compulsory work, the unit will be required to provide individual education on a voluntary basis in the men's own time. Here the man could continue studies he may have started before joining the Army, or he could acquire new interests in art or music, in literature or handicrafts, according to his tastes and the resources locally available. It seems likely that instructors for this unit work will be provided from unit resources as was done both before and during the War with considerable success. Suitable non-commissioned officers would be given a course of, say, three months at the army school of education, where they would receive training in teaching method and more advanced instruction in selected subjects.

It would be unfair to expect the unit with its limited teaching resources and its heavy training commitments to undertake the more difficult types of teaching: these would be provided or organised at garrison-level, where better qualified instructors could be pooled and, possibly, supplemented from external sources. At one end of the scale in this group would be the illiterates and near-illiterates receiving compulsory basic education to fit them to take their places in the community life and community education of their units. At the other end of the scale would be higher education on a voluntary basis, and here it is probable that liaison with local education authorities would, at home at least, enable troops to take advantage of classes in the technical schools, evening institutes and art schools. It is hoped that garrison classes in this group may be able to develop on the lines of the study centres which have grown up everywhere during the War as a result of individual initiative and which have given education a habitation and a home.

A third type of provision which finds a place in preliminary plans is re-settlement education (as opposed to re-settlement training) for regular soldiers. Here it is possible that the correspondence course, the local technical school and garrison classes might all contribute to the preparation of the long-service man for his return to civil life. The Secretary of State for War went even further than this when in opening

one of the Army's formation colleges, he expressed a hope that it would be possible in the post-war period to retain at least one such institution for the benefit of the long-service soldier.

Examinations, much as we dislike them, serve two important purposes. First they are required as a part of the process of assessing the man's all-round ability for purposes of proficiency pay. If, as seems probable, a test of this sort cannot be escaped, it will be devised to do its work in a manner which will at once avoid heavy waste of time and effort and elude the constricting danger of a fixed and immutable syllabus. The second purpose served by the examination is the provision of the 'scrap of paper' which experience proves is highly valued by soldiers at all levels as a passport to well-paid employment when they leave the Army. To satisfy his needs in this respect it is felt that the soldier should be encouraged to take the examinations open to his civilian brothers, for these are more acceptable to civilian employers, who in the past have shown diffidence in accepting the less familiar Army certificates of education.

In addition to the types of possible provision described, there are the institutions which train boys as apprentice tradesmen: these will probably continue along much the same lines as hitherto, though, of course, general education will have to be brought into line with that in units. Band-boys are, and always have been, a special problem, for the numbers of them in units are usually too small for satisfactory arrangements to be made to meet their educational needs. Proposals are, however, being examined with the view of eradicating the weaknesses of the pre-war system so that band-boys may be assured of an educational opportunity worthy of the future that lies before them.

At the end of a period of war few will need convincing that however gallant and efficient the rank and file may be, their efforts will be nullified if they are not backed by an efficient staff corps. Army education as an extensive operation on a global scale will no less need a highly trained and efficient staff corps to plan, stimulate, administer and provide. Between the Wars the Army Educational Corps suffered continuously from a sense of frustration: promotion, slow at all levels, was almost non-existent in the intermediate commissioned ranks; numbers were inadequate to develop the opportunities which all keen men could see; the burden of an examination system kept educational staffs enslaved to the chores of education when they should have been leading the way to its shining corridors. As a result, few were attracted to its service from outside the Army.

Proposals have now been accepted which will ensure a constant flow of new blood from the civilian system and, for those who wish to make a career in Army education, prospects of pay and promotion equivalent to those in other corps and in the education profession generally.

Much praise has been given to the Army for its great educational efforts during and since the War; but if these efforts are to survive and flower in the years of peace, more will be required than mere lip service. If Army education is worth while in war, it is doubly worth while in peace, and if it is worth while it must be staffed and equipped in a manner worthy of its great task. This is not a matter of mere domestic politics for the Army; it is a matter of vital concern for the nation, of which the Army is a living, though in peace often a forgotten and neglected, part.

OBITUARY

Sir Frank Heath, G.B.E., K.C.B.

Henry Frank Heath was born on December 11, 1863. He was the eldest son of Henry Charles Heath, miniature painter to Queen Victoria. He was educated at Westminster School and University College, London, after which he spent a year at the University of Strassburg. When he came back to England he was appointed professor of English at Bedford College, London, and lecturer in English language and literature at King's College, London. He held these posts until 1895, when he became assistant registrar and librarian of the University of London. He was appointed academic registrar in 1901, holding the post only for two years, when he joined the Government service as Director of Special Enquiries and Reports under the Board of Education (1903–16). He became principal assistant secretary of the Universities Branch of the Board from 1910 until he was appointed secretary to the Department of Scientific and Industrial Research in 1916. He retired from the Department in 1927, and from then until the end of his life gave voluntary service to a number of important institutions. He died on October 5.

These are the bare facts of Heath's long life and of his great services to the State, to science, and to education. Few men, except those who knew him well and worked in intimate co-operation with him, know how great these services were.

Heath first became interested in scientific education and research when he became head of the Universities Branch of the Board of Education, which was formed in 1910. There existed at that time a Treasury Advisory Committee on Universities, of which Heath was a member. This Committee advised on Treasury grants to certain university faculties but not to the universities of Great Britain as a whole. It was converted in 1910 into a general advisory committee on universities, and attached to the Board of Education. Sir William McCormick was appointed chairman, and Heath ceased to be a member, as the recommendations of the Committee came to him to administer. It was then that he formed that close friendship, and began the long association, with McCormick that was to prove so fruitful.

In the course of his work at the Board of Education, Heath devised simple and effective provisions for giving grants to universities in respect of engineering and medicine. Previously such grants had only been given under the attendance regulations for technical schools. Before long these grants were absorbed in block grants to the universities; and the medical schools, in London and in the provinces, came to be State-aided under the new system. All this work of Heath's, in which he showed the vision and the administrative ability which were so characteristic of him, and which are seldom combined in one man to such a degree, led finally to the evolution of the University Grants Committee, and to the great spread of State aid to the universities of Great Britain without affecting their autonomy.

When the War broke out in 1914, it soon became painfully clear how dependent Britain was for vital war material on German industries, and how far we had failed to keep pace with Germany in the application of science to industry. Heath acted with characteristic vigour. By Christmas 1914 he had submitted a memorandum to the president of the

Board of Education, pointing out how the failure of industry to enlist the services of science had caused a great shortage of men trained in scientific research at the universities. This highly important memorandum was referred to a small secret committee under Sir William McCormick. By May 1915 the Government, on the advice of this committee, had decided to establish a permanent organisation for the development of scientific and industrial research, and when the Royal and Chemical Societies approached the Government to ask for the establishment of a National Chemical Advisory Committee, they received the reply that a much wider attack on the whole problem was in its initial stages.

The Department of Scientific and Industrial Research was formed in 1916 on Heath's plan. There can be little doubt that many of his ideas were improved in detail by McCormick's committee; but the whole scheme was primarily due to his imagination and foresight. It was he in particular who foresaw the advantages of placing the new Department, which was destined to have such close relations with other departments of State as well as with the universities and industry, under the Lord President of the Council, who had then no departmental duties. This decision has had the consequence that the Lord President of the Council has become the chief Minister of the Crown responsible to Parliament for advice on the general scientific development of the country. The Medical Research Council, which was the successor of the Medical Research Committee of the National Health Insurance Joint Commission, the appointment of which pre-dated the Department of Scientific and Industrial Research, was placed under the Lord President in 1920. The Agricultural Research Council became responsible to him in 1931.

McCormick was appointed chairman of the Advisory Council of the Department, and Heath was made its permanent secretary. So it came about that the first great venture of the State, in this or in any other country, to exercise a comprehensive influence over the development of research to meet national needs was guided by two professors of English. Needless to say, there was much criticism at the time in the scientific world, criticism that was wholly falsified by events. Speaking as his successor, I record emphatically that I can think of no scientific man at the time who could have done what Heath did in the nursing of this new venture through a most difficult period, and in its final establishment in a secure position. Nor should McCormick's services in this respect ever be forgotten. He supplied qualities that Heath lacked. Heath was apt to be too interested in, and too worried about, details. A talk with McCormick, who cared nothing for details, often resolved Heath's difficulties and refreshed his mind. McCormick's natural geniality, too, and interest in human beings, made much easier the relations between Heath and the great men of science who served on the first Council of the Department. Heath was indeed the driving power, and McCormick was the lubricant.

During the next few years the main structure of the Department was erected. The scheme for the establishment of research associations, which was due to Heath, started in 1917. The Fuel Research Board was established in 1917, the Food Investigation Board in 1918, and the Building Research Board in 1920. Sir George Beilby was the first director of research and chairman of the Fuel Research Board. He was succeeded later on as chairman by Sir Richard Threlfall. Sir William Hardy was the first director of food investigation. Beilby, Threlfall and Hardy were the three members of the Advisory Council who had most executive responsibility for the research of the Department. Beilby and Threlfall were great industrialists who had also done work of high scientific importance. Hardy, the best scientific worker of the three, had no experience of applied research until he joined the Department. All three had vigorous personalities, strong individualities, and did not suffer fools gladly. But all three got on very happily indeed with Heath, formed close friendships with him, and were always prepared to be guided and influenced by him. It is difficult to think of a better tribute to Heath's own personality and work than this statement.

The general structure of the Department has not changed since those early days. New research boards and stations have been added, but they have been formed on Heath's original plans, which have stood the test of time. Research associations have had a chequered career, and are being exposed at the moment of writing to some severe criticism. Their establishment was a bold experiment, fully justified, and their present value is far greater than some of the critics conceive. Whatever improvements are necessary and desirable in detail, no one would wish to abandon the general scheme. What is more, the basic idea of forming associations to meet the needs of the older and scattered industries is being copied in other countries.

In 1925 Heath was invited by the Government of Australia to advise on the development of scientific and industrial research. After a comprehensive survey he recommended that the existing Commonwealth Institute of Science and Industry should be developed to a Council of Scientific and Industrial Research to serve all Australian national needs in science, industry and agriculture. His recommendations were adopted by the Government and passed into law in June 1926. He then went on a similar mission to New Zealand, where the Government accepted his recommendation to establish a Department of Scientific and Industrial Research. The National Research Council of Canada, which replaced the Honorary Advisory Council for Scientific and Industrial Research, had been established in 1924. In South Africa developments have been slower, and it is only recently that a similar council has replaced the organisation for the encouragement of research that was the responsibility of the Minister of Mines and Industries. All these developments have resulted from Heath's original report to the Government of the United Kingdom in 1915.

Soon after Heath returned from these visits he resigned his secretaryship of the Department. It was not necessary for him to do so; but he felt that his main work had been done, and that the time had come to hand over the chief executive responsibility to a scientific man. All three of Heath's successors have been men of science, and it is highly probable that all future successors will be; but Heath will always have a special place of honour in the history of the Department.

After his retirement in 1927, Heath became for a short time the secretary, and afterwards the honorary director of the Universities Bureau of the British Empire, and threw himself with the same passionate eagerness into its affairs as he had into the larger affairs of State. He was an active governor, from 1931

until his death, of the Imperial College, where his wide knowledge and experience of education and research, and his constructive criticism, were of inestimable value. His many other activities included the chairmanship (1935–39) and the vice-chairmanship since 1939 of the British Standards Institution, and membership of the Royal Commission for the 1851 Exhibition since 1924. Whatever he did was done thoroughly and well; no one ever turned to him in vain for help.

Heath's publications include chapters on English language and literature to the time of Elizabeth in "Social England". He was co-editor with A. W. Pollard and others of the Globe Chaucer, and editor of the *Modern Language Quarterly* from 1897 until 1903. Many of his best writings were published anonymously in official documents, such as the annual reports of the Department of Scientific and Industrial Research; but fortunately he found time, before his death, to complete a book on "Industrial Research and Development" in collaboration with A. L. Hetherington, a close friend and colleague for many years.

Sir Frank married twice. His first wife, Antonia Johanna Eckenstein, died in 1893, only a year after their marriage. In 1898 he married Frances Elaine Sayer, who died in 1939. Two sons of the second marriage survive him. H. TIZARD

NEWS and VIEWS

Royal Society

Annual Meeting

THE anniversary meeting of the Royal Society was held, as customary, on November 30, and the president, Sir Robert Robinson, delivered his presidential address, a main part of which is printed on p. 815 of this issue, and also presented the medals for 1946 (see p. 841). In addition, he made some brief comments on the relationship of scientific men to world affairs. He welcomed Sir Henry Dale's plea last year for the general release of scientific knowledge. Speaking of the danger to scientific ideals and integrity in the conception of 'total war', he pointed out that men of science are faced with a dilemma—a conflict between their ideals of service to humanity and their duty as citizens of a democratic community—which can only be resolved by the establishment of real friendship and concord among the nations of the world. Speaking for himself, he said that all men of science should strive for the promotion of international peace and the outlawry of all methods of warfare which by their nature involve 'total war'. The existence of the universal brotherhood of scientific workers shows that this hope is not impractical idealism. Nevertheless, in this connexion there can be no clear-cut distinction between peace and war, and a nation's defences must be prepared at all times against attack. Sir Robert continued, "it is inconsistent to praise our scientists for their outstanding contributions to the war effort and at the same time to suggest that they offend against our ethical code if they serve the country in a similar fashion during an uneasy peace. It is useless to attempt to disguise the fact that such service implies some sacrifice of freedom. During the War the scientific effort was nation-wide and control extended to many university departments. Nevertheless, the universities have preserved intact their precious liberty of action, and I see no signs of any attempt to curtail it. Surely this suggests a feasible line of demarcation in that extra-mural contracts, placed by Service departments with the universities, need not, and should not, contain any clauses restricting free publication of the results. Although it has sometimes been irksome, the refusal of many universities to accept theses that cannot be published is a step in the right direction."

Officers and Council

THE following is a list of those elected as officers and Council of the Royal Society at the anniversary meeting: *President*, Sir Robert Robinson; *Treasurer*, Sir Thomas Merton; *Secretaries*, Sir Alfred Egerton and Sir Edward Salisbury; *Foreign Secretary*, Prof. E. D. Adrian; *Other Members of Council*, Dr. C. H. Andrewes, Prof. W. T. Astbury, Prof. W. Brown, Dr. E. C. Bullard, Prof. A. C. Chibnall, Prof. C. A. Lovatt Evans, Dr. N. H. Fairley, Prof. R. A. Fisher, Prof. S. Goldstein, Prof. E. L. Hirst, Prof. H. W. Melville, Prof. M. H. A. Newman, Prof. M. L. E. Oliphant, Dr. C. F. A. Pantin, Prof. H. H. Read, Sir Reginald Stradling. In his anniversary address, Sir Robert Robinson announced the resignation of Mr. John D. Griffith Davies, assistant secretary of the Society; Mr. Griffith Davies has been appointed a member of the Library Committee and will be chairman of a subcommittee preparing for the celebration of the tercentenary of the Society.

Nobel Prize for Physics:

Prof. P. W. Bridgman

PROF. P. W. BRIDGMAN, to whom the Nobel Prize for Physics for 1946 has been awarded, is celebrated for his comprehensive researches into the properties of matter at very high pressures, which began in 1906 and have continued with unabated vigour to the present day. By the ingenious applications of principles in themselves simple and by the informed utilization of new steels, he extended the range of pressures at which systematic measurements could be made from 3,000 atmospheres, the limit reached by Amagat, to 12,000 atmospheres. Up to this pressure he measured, for example, compressibilities, viscosities, electrical conductivities, thermal E.M.F.'s and transition points of a large number of elements and compounds, with results of the highest interest. This work, which necessarily involved the working out of new methods of measuring pressure, is described in his book "The Physics of High Pressure", which appeared in 1931 and has become the classic of the subject.

Since then, Bridgman has again extended the range of pressures. By constructing the vessels of the steel known as 'carboloy' and by special methods of construction, including, for the highest pressures, the immersion of the pressure vessel in a fluid which is itself maintained at 30,000 atmospheres, he has pushed the limit up to 100,000 atmospheres. A number of systematic measurements of polymorphic transitions and of compressibilities have been made up to 50,000 atmospheres. It is an extraordinary

feat to have increased thirtyfold the range of pressures which was practicable when he first took up the subject. Clearly, the pressures now reached are of the greatest importance not only to physicists, chemists and engineers, but also to geologists. Bridgman's work has been a source of strength to the various schools of high-pressure work which have been set up of recent years. A valuable review of work in the field of high pressure since 1930 was published at the beginning of the present year by Bridgman in the *Reviews of Modern Physics* (vol. 18, pp. 1–93). Bridgman has written several outstanding books, besides his standard treatise on high pressure, dealing not only with the thermodynamics of the processes in which he is interested, but also with such subjects as dimensional analysis and the general philosophical aspect of modern physics.

Nobel Prize for Chemistry :

Prof. J. B. Sumner

Biochemists will learn with pleasure that Prof. J. B. Sumner's name is included among those who share, this year, the Nobel prize for chemistry. Prof. Sumner, professor of biochemistry in Cornell University, will always be remembered as the first person to succeed in crystallizing an enzyme—urease. This he accomplished in May 1926, and in doing so he helped greatly to dissipate the fog of obscurity which had surrounded the subject of enzyme chemistry. The isolation of the crystalline enzyme suceeded only after many years of preliminary work, during which period every conceivable method of purification was tried. Eventually, after studying the constituents of the jack bean and paying special attention to the properties of its proteins, an extremely simple procedure for the isolation of urease was adopted. It consisted of stirring 100 gm. jack bean meal with 500 ml. of 32 per cent acetone and allowing the mixture to filter in an ice chest. After standing overnight, the filtrate was seen to contain colourless octahedral crystals, which were found to be crystals of urease. Sumner's claim to have isolated the first enzyme in crystalline form was strongly contested, especially by members of the Willstätter school, and biochemists will recall the general scepticism with which the claim was at first received. Sumner's finding was, however, quickly confirmed, and it was followed during 1930, 1931 and 1933 by the crystallization of the proteolytic enzymes pepsin, trypsin and chymotrypsin by Northrop, and by Northrop and Kunitz. More than twenty enzymes have now been obtained pure, among these the well-known enzyme catalase crystallized by Sumner and Dounce in 1937. The use of crystalline enzymes has led to a major advance in our knowledge of the chemistry of enzymes, and they are now familiar objects of study in the hands of biochemists and physical chemists. Sumner's name is also associated with much interesting work on enzyme kinetics and on the production of anti-enzymes by immunological methods.

Dr. W. M. Stanley

Half of the Nobel Prize for Chemistry for 1946 has been awarded to Dr. W. M. Stanley and Dr. J. H. Northrop of the Rockefeller Institute for Medical Research, Princeton, New Jersey, and it is appropriate enough that these two workers should be honoured together since an important part of Stanley's work was carried out by means of Northrop's technique. It was in 1935 that Stanley announced (*Science*, **81**, 644) the isolation of the virus of tobacco mosaic in crystalline form, and thereby opened the way to the intensive studies of plant viruses which in the last decade have revolutionized the whole subject. Although Stanley was not the first to conceive of a virus as a chemical substance rather than an organism —Vinson and Petre may be mentioned as pioneers in this direction—he was the first to isolate a crystalline or paracrystalline virus protein, and thus enabled workers to visualize a virus as a tangible entity rather than a mysterious agent the existence of which could only be deduced from its effects on its host. This discovery was soon confirmed by workers in Britain and elsewhere. There was at first a good deal of scepticism as to whether the protein really was the virus itself. The biologist was loth to exchange his conception of a very small organism for that of a crystalline protein with the power to multiply, and the chemist was equally unwilling to contemplate the possibility of a mutating molecule. Stanley, however, showed that the virus protein could be obtained from plants botanically unrelated such as the tobacco and the phlox, but only if these plants were infected with tobacco mosaic virus. He also showed that a closely related strain of the tobacco mosaic virus could be isolated, and that it was similar to the first but yet possessed properties which were distinctive and characteristic. Nowadays, no plant virus worker doubts that the virus and crystalline protein are one and the same ; several more viruses have been isolated in crystalline form, four of them as three-dimensional crystals, and all have been shown to be nucleoproteins.

Dr. John H. Northrop

The nature of the enzymes was a matter for considerable speculation so recently as twenty years ago, and the isolation of the gastric proteolytic enzyme pepsin by Dr. John H. Northrop in 1930 as beautiful hexagonal crystals having the composition of a protein did much to confirm their protein nature. Various tests applied to the pure preparations showed beyond reasonable doubt that the enzymatic activity was intimately related to the protein, and subsequent work by Northrop and other workers has amply confirmed the protein nature of the soluble enzymes. In 1932, in collaboration with Dr. M. Kunitz, also of the Rockefeller Institute, he was responsible for the isolation and crystallization of trypsin, and afterwards of several other proteolytic enzymes from pancreas. In the course of these studies, several inactive precursors of these enzymes were also isolated in a pure form, and it was found that trypsin and pepsin are capable of synthesizing themselves from their precursors. This autocatalytic synthesis has been compared with the multiplication of the viruses, but it has not the same specificity, as, for example, chicken pepsin is formed from chicken pepsinogen whether the reaction is catalysed by swine pepsin or chicken pepsin. It is interesting, however, that a possible inactive precursor of the tobacco mosaic virus has been reported recently. Besides his work on the isolation of the proteolytic enzymes and their precursors, Dr. Northrop has been responsible for studies on enzyme kinetics, on the estimation and purification of bacteriophage and on a large number of physico-chemical studies of which probably the best known are on the diffusion of solutes through porous membranes, on micro-cataphoresis and on the application of Gibbs's phase rule to the solubility of protein solutions as a test of their homogeneity.

Prof. W. T. Astbury, F.R.S.

AT the recent celebrations of the liberation of the city of Strasbourg in 1918 and 1944, the solemn 're-entry' of the University was marked, on November 22, by its first honorary degree ceremony since the end of the War. Among other recipients, the degree of *Docteur honoris causa* was conferred on Prof. W. T. Astbury, of the Department of Biomolecular Structure and Textile Physics Laboratory of the University of Leeds. Prof. Astbury was also recently elected a member of the Royal Society of Sciences of Uppsala.

L.M.S. Railway: Scientific Research

MR. F. C. JOHANSEN has been appointed deputy scientific research manager of the L.M.S. Railway. Mr. Johansen graduated with first-class honours from King's College, University of London, gaining the degree of B.Sc.(Eng.), and afterwards obtaining his M.Sc. On leaving the university, he took up an appointment with the Yorkshire Electric Power Co.; later he joined the National Physical Laboratory, where he did research into certain aspects of fluid motion, and carried out a comprehensive investigation into air resistance of trains. In 1932 he joined the Scientific Research Department of the L.M.S. Railway as engineering research officer.

University of Glasgow

DR. ERIC CLAR has arrived from Czechoslovakia to work in the Chemistry Department as an I.C.I. Fellow. After graduating at Dresden and working for a time at Cambridge, Dr. Clar became head of the Chemistry Department of the Istituto Ronzoni at Milan in 1930. Since 1933 he has been working mainly in his own laboratory at Herrnskretschen, but has also been part-time lecturer in the University of Prague and has had connexions with Rütgers A.G. at Niederau. For many years he has been especially interested in polycyclic hydrocarbons and their derivatives, and he is author of the monograph, "Aromatische Kohlenwasserstoffe" (1941).

Mr. Cyril A. Halstead has been appointed assistant in geography. The following resignations have been accepted: Dr. G. F. Asprey (botany) to become lecturer in plant physiology in the University of Aberdeen; Mr. E. Duffy (bacteriology) to become assistant pathologist to the Royal Cancer Hospital, Glasgow; Dr. Janet S. F. Niven (pathology) to join the staff of the National Institute of Medical Research, London.

The North Ferriby Boats

LITTLE is known about the efforts of primitive man in northern Europe to overcome the inherent defects of the dugout boat and to develop a seaworthy planked vessel. The Scandinavian tradition was to use the clinker build; but apart from the Hjortspring canoe, really early examples of this kind are so incomplete that it is impossible to gather any clear idea of their shape or size. In all of them, however, the planks are secured by stitching. The remains of two large boats as primitive as any planked vessel from Northern Europe and, in one case, sufficiently complete to allow reconstruction of the original form to be made with fair certainty, have been found by Mr. E. V. Wright and his brother, the first in 1937, the second in 1941. They were between high and low water, buried in the old river clays on the north bank of the River Humber at North Ferriby in east Yorkshire. Much of the first boat was lost during the War by erosion; but records survive of what has disappeared. The end of the War made it possible to recover what was left. The enthusiastic support was secured of the late Sir Geoffrey Callender and the National Maritime Museum, who organised the salvage of the boats with the help of the Admiralty. Although the first boat was not extracted in one piece, as was hoped, no information or timber was lost, and a successful restoration is certain.

The boats were highly developed examples of a technique of sewing planks together to form a 'fabricated dugout'. They had a flat bottom made up of three composite planks, the centre one being turned up like the end of a punt at the end that was preserved complete, and probably at the other also. The centre plank was twice as thick as the others but was made of two lengths joined with an absurdly short scarf joint in the middle. The seams were grooved, caulked with moss, with a covering slat and sewn up with yew withes. The bottom planks were further secured by groups of cross-battens passing through cleats left standing on the upper surface of the planks. Part of the first strake survived on one side. It was cut on the curve from the solid wood. No form of framing was discovered, although there were probably at least some thwarts to support the sides of the hull. The meagre archæological evidence at present points to an Early Iron Age date for the deposits in which the boats were found. The botanical evidence may throw further light on their age. The work of recording is now very nearly completed and that of preservation will shortly begin. All being well, these splendid monuments of primitive craftsmanship will in due course be on exhibition at the National Maritime Museum at Greenwich.

An Automatic Computing Engine for the National Physical Laboratory

FOLLOWING upon Lord Mountbatten's presidential address to the Institution of Radio Engineers, in which he referred to the E.N.I.A.C. (described in an article in *Nature* of October 12, p. 500), a statement was issued from the Department of Scientific and Industrial Research stating that plans for a machine to be called the Automatic Computing Engine (A.C.E.) are being completed at the National Physical Laboratory. A short statement about this machine was broadcast by Sir Charles Darwin, director of the National Physical Laboratory, in the B.B.C. Home Service on November 9. While paper plans have made good progress, the technical design is only beginning, and it will be a year or two before any units are operating. The completion of the machine will take several years. The project is under the charge of Mr. J. R. Womersley, superintendent of the Mathematics Division, and the machine will form part of the Division's equipment. The team of mathematicians who are planning the machine is led by Dr. A. M. Turing, formerly a fellow of King's College, Cambridge, in whose paper "On Computable Numbers, with an Application to the Entscheidungsproblem" (*Proc. Lond. Math. Soc.*, 1937), the possibility of such machines is foreseen, and methods of organising work on them are discussed.

Council for the Preservation of Rural England

IN the report of the Council for the Preservation of Rural England, the first after the war years, the aims, objects and policy of the Council are re-stated. Briefly, these relate to the protection of rural scenery,

the preservation of amenities in country and town and the education of public opinion on these matters. This comprehensive report gives a clear impression of the many activities which engage the attention of the Council. The policy of the Council, which is discussed at some length, is based on the view that the development of agricultural resources, and the improvement of the social environment of the rural population, provide the best means of realizing the aims of the Council. National and regional planning of the land in the interest of the community is supported; genuine rural industries are to be encouraged, while rural housing and services should be improved. Other sections are devoted to the location of industry and the provision of new towns, road construction, the provision of National Parks and open spaces, afforestation, prohibition of outdoor advertisements in certain localities, and the release of areas from military occupation. In many of these and other matters, the Council for the Preservation of Rural England works in close co-operation with other bodies, for example, the National Trust.

Training Grants for Engineers

THE Ministry of Labour and National Service is now awarding grants under the Further Education and Training Scheme to assist young engineers who have been on military service to complete their practical training in industry. University graduates in engineering and others who have qualified as graduates of the Institutions of Civil, Mechanical or Electrical Engineers are entitled to apply for grants. The awards are intended to supplement the payments which employers normally make to engineering graduates. A plan of training must be drawn up by the employer and approved by the Ministry before a grant will be made. Three types of course are contemplated, lasting twenty-four, twelve and six months respectively. The longest course is intended for those who have had no previous industrial experience and only limited technical experience in the Services. The Institution of Electrical Engineers announces that young electrical engineers will be advised to take a twelve-months course if they have had little or no industrial training, but have served eighteen months or more on suitable workshop duties in technical units, or have had 12–18 months previous industrial training and only limited technical experience on military service. Those with more than nine months previous industrial training and more than eighteen months technical experience in the Services will generally be regarded as having completed their training, but some may be advised to take the six-months course. Further particulars may be obtained from the Regional Appointments Officers of the Ministry of Labour and National Service.

Catalogue of Scientific Films in Britain

A CATALOGUE compiled by the Scientific Film Association lists alphabetically 595 films of general scientific interest at present available in Great Britain, ranging from films of technique and process to films relating science to society (London: Association of Special Libraries and Information Bureaux. 5*s*.) Most films entirely of use for juvenile teaching have been excluded, but some films on cooking and related topics, and selected films on international relations, national cultures, ways of life and tradition have been included to give that social background against which all human activities must be assessed and studied. Of the films listed, 266 have been appraised and graded by special committees, and it is the intention of the Association to supply synopses, appraisals and gradings for every film and to keep the lists up to date in this respect. The graded films are marked recommended, suitable or unsuitable in three categories: for general audiences and audiences of mixed scientific workers; for more specialized audiences with a knowledge of the subject-matter of the film; and for adult teaching or training purposes. Silent films are indicated by printing the title in italic capitals, and sound films with silent versions by an asterisk. Films of which the distribution is restricted for any reason are also marked, and sponsor and production agency, where traced, are indicated. The name of the distributor is usually abbreviated and followed by a catalogue reference for use in ordering. A list of film distributors with these abbreviations is included, and there is a classified subject index.

Association of Scientific Workers: Social Sciences Committee

A MEETING to inaugurate a National Social Sciences Committee of the Association of Scientific Workers will be held in Gas Industries House, 1 Grosvenor Place, London, S.W.1, on December 14. The meeting will be held under the chairmanship of Mr. J. R. M. Brumwell. Prof. S. Zuckerman will speak on the outlook for the social sciences, Dr. G. Wagner will report on the work of the Social Sciences Committee, Mr. D. Chapman will discuss future work for social scientists in the Association of Scientific Workers, and Mr. R. Innes will discuss the constitution of a National Committee for Social Scientists. Further information can be obtained from the Honorary Secretary, Social Sciences Committee, Association of Scientific Workers, 15 Half Moon Street, Piccadilly, London, W.1.

Announcements

Sir Alexander Fleming and Sir Howard Florey have been awarded the Gold Medals in Therapeutics of the Society of Apothecaries of London, in recognition of their discovery and work on penicillin.

THE title of professor emeritus in the University of Durham has been conferred upon Prof. J. W. Heslop Harrison, formerly professor of botany, and Commander C. J. Hawkes, formerly professor of engineering, both at King's College, Newcastle-upon-Tyne.

RECENT appointments to the staff of the University of Leeds include the following: Dr. H. J. Rogers, to be Nuffield Research Fellow in oral biology; Dr. A. B. Moggy, to be Brotherton Research Lecturer in physical chemistry in the Department of Textile Industries; Dr. R. N. Tattersall, to be lecturer (full-time) in medicine.

DR. E. C. BARTON-WRIGHT has been appointed microbiologist to Whitbread and Co., Ltd., and has taken up his duties in the laboratories at Chiswell Street, London, E.C.1.

REFERRING to the notes under the title "Abnormal Solar Radiation on 75 Megacycles" in *Nature* of October 12, p. 511, Dr. S. E. Williams states that the phrase (par. 2, line 3) "visual changes on the sun's disk as recorded on spectrohelioscope observations . . ." should read, "visual changes on the sun, namely, the appearance of an eruptive prominence recorded in the spectrohelioscope observations . . ."

UNIVERSITY OF LONDON

Applications are invited for Research Fellowships founded by Imperial Chemical Industries, Ltd., and tenable in the University of London and normally of the value of £600 per annum. The Fellowships will be awarded for original research in chemistry, physics, and allied subjects such as biochemistry, colloid science, chemotherapy, engineering, metallurgy, and pharmacology, or in any other subject of study which is deemed by the Senate to be related to the study of chemistry or physics. A Fellow will be required to take a limited part in the teaching in the department in which he works. Fellowships will be tenable from October, 1947, but applications from candidates now on national service who cannot take up appointment to the Fellowship until later will also be considered. Detailed regulations and application forms can be obtained from the Academic Registrar, University of London, at the Senate House, London, W.C.1, and applications must be received at that address not later than April 30, 1947.

UNIVERSITY OF LONDON

Applications are invited for Research Fellowships founded by Turner and Newall, Ltd., and tenable in the University of London and normally of the value of £600 per annum. The Fellowships will be awarded for original research in inorganic chemistry, engineering, physics, and allied subjects. A Fellow will be required to take a limited part in the teaching in the department in which he works. Fellowships will be tenable from October, 1947, but applications from candidates now on national service who cannot take up appointment to the Fellowship until later will also be considered. Detailed regulations and application forms can be obtained from the Academic Registrar, University of London, at the Senate House, London, W.C.1, and applications must be received at that address not later than April 30, 1947.

MINISTRY OF HEALTH

Blood Transfusion Service

APPOINTMENT OF TEMPORARY SCIENTIFICALLY QUALIFIED OFFICER IN THE NORTH-WEST REGION

The Minister of Health invites applications for the undermentioned appointment in the Blood Transfusion Service in the North-west Region, with headquarters at the Royal Infirmary, Manchester. Candidates are required to hold a scientific degree, e.g., B.Sc. or Ph.D., and to have at least three years' postgraduate experience:

Scientifically Qualified Officer at a salary of £540 per annum, plus a consolidated addition of £90 per annum (men), and £522 per annum plus a consolidated addition of £72 per annum (women).

Applications, stating age, qualifications with dates, present appointment, if any, and previous experience, together with copies of not more than three testimonials, should be addressed to the Regional Establishment Officer, Ministry of Health Regional Offices, Sunlight House, Quay Street, Manchester, 3, not later than December 21, 1946.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

Trinidad, British West Indies

has vacancies for a Senior Lecturer and a Junior Lecturer in Animal Husbandry. Applicants should possess a degree in science or agriculture or a postgraduate agricultural diploma. Postgraduate experience in animal husbandry, practical experience in the care of livestock desirable. Duties comprise research and lecturing.

Senior Lecturer's starting salary according to qualifications, but in grade £600 by £25 to £650 by £50 to £800 (with efficiency bar after £650). Temporary cost-of-living bonus £127, superannuation under F.S.S.U., house or house allowance, passage out and home, and four months' leave with passage every other year. Junior Lecturer's starting salary according to qualifications, but in grade £450 by £25 to £575 (efficiency bar after £500). Temporary cost-of-living bonus approximately £105, house or house allowance on reaching salary of £525, passages and leave as for Senior Lecturer above.

Applications to be made by January 20 on form obtainable from Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2. Candidates from overseas should apply by air-letter giving full particulars and naming three referees.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the post of Lecturer in Mathematics. Commencing salary £575, increasing to £800, per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before Thursday, December 12, 1946.

SWANSEA EDUCATION COMMITTEE

LECTURER IN BIOLOGY

Applications are invited from suitably qualified men or women for the post of full-time Lecturer in Biology. The duties of the successful applicant will be divided between the Swansea Technical College and the Swansea Grammar School (boys), and he/she will be required to lecture to first-year pharmacy and medical students and to teach biology at the higher school certificate stage.

Applicants should possess a good honours degree in biology with, if possible, subsidiary zoology and botany. Salary, Burnham scale. Further particulars and application forms may be obtained from me on receipt of a stamped addressed foolscap envelope and should be returned not later than December 19, 1946.

L. J. DREW,
Director of Education.

Education Department,
The Guildhall, Swansea.

BRITISH BROADCASTING CORPORATION

Applications are invited from men (British) for two senior posts in the Television Section of Research Department, based near Oxford in first instance. Applicants must be qualified engineers or physicists and must have specialized in telecommunications during their university training. Experience in practical television problems, together with a sound theoretical knowledge of the principles involved, is essential. Preference will be given to those who have themselves contributed in the field of television research or development. Commencing salary will be dependent on qualifications and experience and, subject to favourable report, will rise by annual increments, in one case to £1,360 per annum and in the other to £1,100 per annum.

Applications, stating age, qualifications, and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, not later than January 8, 1947.

EDUCATION COMMITTEE FOR THE COUNTY BOROUGH OF BRIGHTON

Brighton Technical College

Principal:

G. E. Watts, M.A., Ph.D., B.Sc., F.R.I.C.

Applications are invited from honours graduates in chemistry for the appointment of Lecturer in Organic Chemistry. The duties of the post will include the teaching of organic chemistry up to honours degree standard. The salary will be in accordance with the Burnham (technical) award, with full allowances for approved research, industrial, and teaching experience.

Forms of application, which may be obtained from the undersigned, should be returned to the Principal, Brighton Technical College, Brighton, 7, not later than Saturday, December 28, 1946.

F. HERBERT TOYNE,
Education Officer.

Education Office,
54, Old Steine, Brighton, 1.

CITY OF LEEDS

APPOINTMENT OF CURATOR OF THE CITY MUSEUMS

The Corporation invite applications for the position of Curator of the City Museums. Candidates must have had experience in general museum work. The salary scale is £700-£800 per annum, plus cost-of-living bonus, which is at present £59 16s. per annum. The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the passing of a medical examination. Canvassing in any form, either directly or indirectly, will be a disqualification.

Applications, stating age, education, experience, and qualifications, accompanied by copies of two recent testimonials, and endorsed "Curator of the City Museums," must be delivered at my office, Room 57, Civic Hall, Leeds, 1, not later than Tuesday, December 31, 1946.

O. A. RADLEY,
Town Clerk.

IMPERIAL AGRICULTURAL BUREAUX

SCIENTIFIC ASSISTANT

Vacancy for science graduate (zoology) for bureau literary work. £354 by £18 to £570 inclusive. Good knowledge of German desirable. Staff are required to join the Federated Superannuation System for Universities, under which 5% is deducted from salary and 10% added by the bureau, the whole 15% being applied to a policy chosen by the employee. All appointments are subject to one month's notice on either side.

Latest date for receiving applications December 25. Apply Director, Imperial Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey.

BRADFORD EDUCATION COMMITTEE

Technical College, Bradford

Applications are invited for the appointment of Assistant Lecturer in Engineering in the College.

Basic salary according to the Burnham scale, which is from £300 to £525 per annum. Commencing salary according to qualifications and experience. The commencing salary may, subject to approval, be increased up to a maximum of ten increments of £15 per annum in respect of approved service in industry.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College within two weeks from the date of publication of this advertisement.

THOS. BOYCE,
Director of Education.

UNIVERSITY OF BRISTOL

Department of Agriculture and Horticulture, Long Ashton, Bristol

Applications are invited for the post of Organic Chemist now vacant at Long Ashton Research Station. The appointment is in connexion with investigations on mineral deficiencies of plants, financed by special grants made by the Agricultural Research Council.

Commencing salary will vary according to age and experience between £255 and £470 per annum for men, plus consolidated bonus of £78 to £90, and for women between £255 and £400, plus consolidated bonus of £63 to £72, and superannuation under the F.S.S.U. Candidates should possess a university degree with honours (or equivalent) and should have had research experience in organic chemistry.

Further particulars may be obtained from the undersigned, to whom applications, with copies of three recent testimonials, should be addressed not later than December 28, 1946.

WINIFRED SHAPLAND,
Secretary and Registrar.

The University,
Bristol, 8.

NATAL UNIVERSITY COLLEGE

Applications are invited for the post of Lecturer in Chemistry. The appointment will be in the first place for a probationary period of one year. Salary scale: men, £450 by £25 to £600; women, £350 by £25 to £500. There is a possibility from January 1, 1947, that this salary will be increased to: men, £550 by £25 to £700; women, £450 by £25 to £600. Current cost-of-living allowance is paid in addition. The initial salary will depend on qualifications and experience. Membership of the University Teachers' Provident Fund is compulsory. The successful applicant will be expected to assume duty on March 1, 1947, or as soon thereafter as possible.

Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24, Gordon Square, London, W.C.1.

THE POLYTECHNIC

309, Regent Street, W.1

Department of Chemistry and Biology

Required as soon as possible, a full-time Teacher of Biology to take Botany and Zoology up to degree standard. Salary in accordance with the Burnham (technical) scale for London, subject to the usual deduction of 5 per cent for superannuation.

Further particulars and form of application, which must be returned by December 16, may be obtained by sending a stamped addressed foolscap envelope to the undersigned.

J. C. JONES,
Director of Education.

THE BRITISH COUNCIL INVITES APPLIcations for the post of Assistant Librarian in the Medical Department. Applicants must not exceed thirty years of age and should be Fellows or Associates of the Library Association or hold the Diploma of the School of Librarianship. Previous experience in a university or special library preferred. Some knowledge of Spanish and German required. Salary within the scale £450-£600, according to qualifications.

Application forms may be obtained from the Director, Appointments Department, the British Council, 3, Hanover Street, W.1, and should be returned completed within three weeks of the appearance of this advertisement.

CHEMIST, AGE 25-35, DEGREE OR EQUIVAlent, required by a London firm of Electrical Component Manufacturers. Industrial experience, preferably in the electrical industry, essential. Salary £400-£500 per annum, according to qualifications. Box 776, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

UNIVERSITY OF ABERDEEN
LECTURESHIP IN STATISTICS

Applications are invited for a Lecturer in Statistics, who will take up duty on April 1, 1947, or as soon thereafter as may be arranged.

Salary £500-£750, according to qualifications and experience. In addition a children's allowance of £50 per annum for the first child and £40 per annum for each subsequent child under 16, or while the child is undergoing full-time education, is payable.

Applications should reach the Secretary to the University (from whom forms of application and conditions of appointment may be obtained) not later than January 15, 1947.

H. J. BUTCHART,
Secretary.

The University,
Aberdeen.

SIR JOHN CASS TECHNICAL INSTITUTE
Jewry Street, London, E.C.3

The Governors invite applications for the post of Senior Lecturer in Physics. The work is of university standard, and candidates should have research qualifications and experience which will secure recognition as a Teacher of the University of London. Salary in accordance with the Burnham (technical) scale for London. The post is one for which a responsibility allowance has been recommended. Details and form from the Principal, to whom applications should be sent as soon as possible.

CHELSEA POLYTECHNIC
Manresa Road, S.W.3
Department of Chemistry

The following Courses will be given during the Lent Term, 1947:

1. Some Modern Aspects of the Chemistry of Oils and Fats, by J. H. Skellon, Ph.D., F.R.I.C. Course of six lectures, Fridays, 7.30 p.m., commencing January 10, 1947.

2. Waxes. Modern Views on the Chemistry and Technology of Waxes, by L. Ivanovzsky. Course of five lectures, Fridays, 7.30 p.m., commencing February 28, 1947.

Fee for both courses, 20s. Each separate course, 10s. Full particulars on application to the Principal.

UNIVERSITY OF MELBOURNE
SENIOR LECTURESHIPS IN CHEMISTRY

Applications are invited for the following appointments on the full-time staff:

Senior Lecturer in Organic Chemistry.
Senior Lecturer in Physical Chemistry.

Salary £650-£850 (Australian), plus cost-of-living adjustment (at present £48 per annum), subject to provident fund contributions, commencing rate according to qualifications and experience. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24, Gordon Square, London, W.C.1. Applications with the required particulars must be lodged with the Registrar, University of Melbourne, Australia, not later than January 15, 1947.

UNIVERSITY OF MELBOURNE

Applications are invited for the following appointment on the full-time staff:

Senior Lecturer in Zoology.

Salary £650-£850 (Australian), plus cost-of-living adjustment (at present £48 per annum), subject to provident fund contributions, commencing rate according to qualifications and experience. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24, Gordon Square, London, W.C.1. Applications with the required particulars must be lodged with the Registrar, University of Melbourne, Australia, not later than January 15, 1947.

SUDAN GOVERNMENT

The Sudan Veterinary Service has a vacancy for an Entomologist to carry out a survey of the tsetse areas of the Southern Sudan and undertake research work. Appointment will be on short term or provident fund contract for seven years. Salary according to qualifications and experience. Further particulars and forms of application may be obtained from the Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1. Mark envelopes "Veterinary Entomologist."

SUDAN GOVERNMENT

The Sudan Veterinary Service has a vacancy for a Botanist to carry out a survey of the grazing areas of the Sudan. Appointment will be on a short-term contract for four years with a possibility of extension to undertake research work on pastures. Salary according to qualifications and experience. Further particulars and forms of application may be obtained from the Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1. Mark envelopes "Pasture."

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the posts of Assistant Lecturer in Mathematics, Assistant Lecturer in Physics, and Assistant Lecturer in Chemistry. Present salary in each case £400 per annum.

Further particulars concerning the posts may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before December 27, 1946.

UNIVERSITY COLLEGE OF NORTH WALES
Bangor

Trained Gardener, either sex, required as soon as possible for care of Grounds and assistance to the Department of Botany. Experience in a botanical garden will be an advantage. Salary according to experience and qualifications.

F. P. G. HUNTER,
Bursar.

UNIVERSITY COLLEGE, EXETER

Applications are invited for the post of Lecturer or Assistant Lecturer in Mathematics. Candidates should have special qualifications in applied mathematics or mathematical physics.

Applications must be lodged as soon as possible with the Registrar, from whom further particulars should be obtained.

UNIVERSITY OF READING
Faculty of Science

Applications are invited for the post of Demonstrator in Physics at a salary of £300 per annum. Applications should be received by the Registrar not later than December 16, 1946, from whom further particulars may be obtained.

APPLICATIONS ARE INVITED FOR POSTS in the research laboratory of Messrs. Pilkington Brothers, Limited. The laboratory is situated at St. Helens, Lancashire, and is concerned with the problems of manufacture and use of glass in many forms; there is close association between the laboratory and the firm's works both at St. Helens and elsewhere. The research staff deal with a wide range of problems involving both applied and basic research.

Candidates should have a good honours degree or an equivalent qualification in science, mathematics, or engineering. There are vacancies as follows:

1. Physicists. Candidates should preferably have had research experience in one or more of the following fields: (a) X-ray crystallography, (b) physical optics, (c) infra-red technique, (d) heat transfer, (e) use of scale models, (f) fluid flow. It is proposed that one of the successful candidates should be primarily a theoretical physicist.

2. Chemists. Experience in one or more of the following fields is desirable: (a) spectroscopy, (b) physical methods for chemical analysis, (c) chemical thermodynamics, (d) flame and combustion problems, (e) clays and refractories.

3. Mathematician. A mathematician is required to apply statistical methods to problems in the laboratory and on larger scales, and to assist in the framing of experiments. An aptitude for applied mathematics would be an additional qualification.

4. Research Engineers. Graduates in engineering are required to undertake experimental work on mechanical problems and to assist in the development of experimental equipment.

Applicants should preferably be between the ages of 24 and 32, but suitable candidates outside these limits will be considered, due allowance being made for war service. Initial salary will be in accordance with age, experience, and qualifications. The posts carry superannuation benefits under the firm's scheme.

Applications should be addressed to the Chief Personnel Officer, Messrs. Pilkington Brothers, Limited, St. Helens, Lancashire.

CHEMISTS REQUIRED FOR LARGE OIL refinery in South of England:

(a) Assistant Chief Chemist possessing first- or second-class honours degree in chemistry or oil engineering. Experience in industry or research an advantage, but not essential. Not over forty. Minimum starting salary £700 per annum. Reference F.1281A.

(b) Chemist possessing honours degree in chemistry, and preferably with experience of petroleum industry, otherwise experience in the coal tar or allied industry. Minimum starting salary £550 per annum. Reference F.1282A.

Write, quoting appropriate reference, to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application form, which must be returned completed by January 4, 1947.

THE GOVERNMENT OF IRAQ INVITE applications from qualified candidates for the undermentioned posts. Appointment is for three years in the first instance. A high cost-of-living allowance of Iraq dinars 288 a year is payable in addition to the salaries indicated (I.D.1 = £1). Free first-class passages. The posts are not pensionable, but there is a provident fund.

Associate Professor of Chemistry and Physics, Royal College of Medicine, Baghdad. Salary I.D.1,440 a year. Candidates must hold an honours degree in chemistry with adequate qualifications in physics, and have had teaching experience in a medical or pharmacy school. It is desirable that they should be Fellows or Associates of the Royal Institute of Chemistry.

Expert in Entomology. Salary I.D.1,800 a year. Candidates must be Ph.D. and have liberal knowledge of general entomology with wide practical experience of economic insect problems, particularly biological control. Previous service in a sub-tropical country is desirable.

Entomologist. Salary I.D.1,200 a year. Candidates must be Ph.D. or M.Sc. and should be capable of undertaking the study and identification of insects in Northern Iraq and of advising regarding means of combating them.

Soil Technologist. Salary I.D.1,200 a year. Candidates must hold a university degree in science or an equivalent qualification and have good scientific knowledge and practical experience of problems of soil fertility, use of fertilisers, and soil analyses, especially analyses relating to salts. Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/13724 on both letter and envelope.

APPLICATIONS ARE INVITED FOR THE following temporary appointments in the Ministry of Supply at the Guided Projectiles Establishment, Westcott, Berks. Candidates should be between the age of 19 and 45 years on December 1, 1946.

(i) Experimental Officers for abstracting and indexing of scientific and technical papers and reports. Candidates should have qualifications in (a) mechanical engineering, (b) electrical engineering, including radio, or (c) mathematics, including preferably aerodynamics. A knowledge of German is desirable.

(ii) Assistant Experimental Officer to assist in a technical library. Candidates should have technical qualifications, preferably in engineering or physics. Some experience of technical library work is desirable, whilst a knowledge of German and/or French would be an advantage.

Salary will be according to age and experience, within the following inclusive ranges: Experimental Officers, £452-£610 (men) and £354-£492 (women); Assistant Experimental Officer, £195-£398 (men), £195-£323 (women).

Forms of application may be obtained from the Director of Scientific and Technical Administration (D), Room 27, Ivybridge House, Adam Street, Strand, London, W.C.2, to whom completed forms must be returned within twenty-one days from the date of this advertisement, quoting vacancy No. D.1/46.

APPLICATIONS ARE INVITED FOR THE post of Assistant in Anatomy (with medical qualifications) for Cape Town University. Some experience of teaching and working at anatomy and an interest in the scientific side of anatomy are essential, one who wishes to become an anatomist with a reasonable tenure of office. Salary scale £500 by £50 to £650 per annum, plus a temporary cost-of-living allowance, at present for a married man £75 per annum (and £12 per annum for each child under 18 years), for an unmarried officer £44 per annum.

Written applications (in duplicate, with copies of testimonials), giving date of birth, full details of qualifications and experience, and of posts held including dates, should be addressed to the Appointments Officer, Ministry of Labour and National Service, quoting reference No. F.A.1083 (from whom a memorandum giving the conditions of appointment is obtainable), by December 23. Only candidates selected for interview will be advised.

FIRM IN N.W. LONDON SPECIALIZING in the manufacture of industrial instruments and controls requires Assistants for its engineering and hydraulic laboratories. Candidates for either laboratory should have a degree in physics or engineering or equivalent qualification, and applicants for a position in the hydraulic laboratory should have sound knowledge of hydraulics and flow measurement. Applications, stating age, experience, and salary required, should be addressed to Box 775, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

(Continued on page ccviii)

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

LETTERS TO THE EDITORS

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

G. B. Airy and the Discovery of Neptune

THE account by Prof. W. M. Smart of the discovery of Neptune, of which a summary was published in *Nature* for November 9, depicts the part played by G. B. Airy, the Astronomer Royal, in a most unfavourable light. He describes the treatment of Adams by Airy as "unbecoming to the leading astronomer of his generation". Prof. Smart's verdict is not, in my opinion, justified, and I feel that, for the sake of historical accuracy, a reply is needed.

In judging Airy's actions, it is necessary to remember the tremendous load of work which he carried. Besides attending to all the details of the work of the Royal Observatory, he maintained an extensive correspondence with astronomers in all parts of the world and was consulted on a great variety of general scientific questions outside the range of his strict official duties. No man could have been more meticulous in replying promptly to all letters and inquiries. An examination of Airy's day-book shows that in the period covered by the investigations of Adams, Airy visited France for the purpose of examining and reporting upon the design and construction of the breakwater at Cherbourg; he went to York to see experiments on the running of engines; he visited Portsmouth to inquire into and report upon the defects of the engines of H.M.S. *Janus*; he was occupied with the Tidal Harbour Commission and he was frequently called to London for meetings of the Railway Gauge Commission, the draft report of which he prepared.

Airy first learnt that Adams was working on the theory of Uranus from Prof. Challis, who wrote to Airy in February 1844 asking for the errors of longitude of Uranus, as indicated by the Greenwich observations, for the years 1818–26. Airy by return of post sent the Greenwich data not merely for those years, but also for the whole period 1754–1830, data invaluable for the purpose of the investigation.

Adams twice called at Greenwich in the course of his investigations in the hope of seeing the Astronomer Royal and discussing the results he had obtained. It would have been a matter of ordinary courtesy for a young man like Adams, personally unknown to the Astronomer Royal, to have written and asked for an appointment, but Adams on each occasion called without any previous notice. On the first occasion, towards the end of September 1845, Adams called at Greenwich and left a letter of introduction from Challis; Airy was then in France on the Cherbourg breakwater investigation. Immediately on his return, he wrote to Challis and said: "would you mention to Mr. Adams that I am very much interested with the subject of his investigations, and that I shall be delighted to hear of them by letter from him". This letter should surely have encouraged Adams to write. On the second occasion, on October 21, 1845, Airy was in London attending a meeting of the Railway Gauge Commission. Adams left his card and said that he would call later. The card was taken to Mrs. Airy, but the message was not given to her. When Adams made his second call, he was informed that the Astronomer Royal was at dinner; there was no message for him and he went away feeling mortified. This visit is not mentioned in Airy's day-book, and it is clear from Airy's private correspondence that he was not told either of Adams' intention to call again or of his second call. It may also be mentioned that this visit of Adams was made a few days before Mrs. Airy gave birth to a son, Osmund.

Adams left at the Observatory a paper with a summary of his results, and a comparison between the observed longitudes of Uranus and those computed from his theory. On November 5, Airy wrote to Adams putting his famous query about the errors of the radius vector of Uranus. Adams never replied to this letter. In a later letter to Airy of November 18, 1846, he stated how deeply he regretted his neglect and mentioned that he had always experienced a strange difficulty in writing letters. But to a man so methodical and precise as Airy, it was a barrier to any further communication. As Airy afterwards wrote to Challis, "It was clearly impossible for me to write to him again". This is why Adams' statement remained, in Prof. Smart's words, "in Airy's pocket for eight months".

Prof. Smart seems to regard Airy's query as trivial. Airy was, of course, thinking of the possibility that perturbation by an unknown planet might not be the only possible cause of the irregularities in the motion of Uranus. His views were clearly expressed in a letter to Challis (December 21, 1846). "There were two things to be explained, which might have existed each independently of the other, and of which one could be ascertained independently of the other: viz. error of longitude and error of radius vector. And there is no *a priori* reason for thinking that a hypothesis which will explain the error of longitude will also explain the error of radius vector. If, after Adams had satisfactorily explained the error of longitude he had (with the numerical values of the elements of the two planets so found) converted his formula for perturbation of radius vector into numbers, and if these numbers had been discordant with the observed numbers of discordances of radius vector, then the theory would have been false, not from any error of Adams' but from a failure in the law of gravitation. On this question therefore turned the continuance or fall of the law of gravitation."

Prof. Smart mentions that even so late as 1844 Airy regarded as possible that gravitation might not be exactly according to the inverse square of the distance. It is perhaps well to recall that, fifty years later, the same suggestion was seriously examined by Simon Newcomb and other eminent astronomers in the endeavour to explain the anomaly in the motion of the perihelion of Mercury.

It is also stated that towards the end of June 1846 Le Verrier applied to Airy for assistance in the search for the planet, and that this request for practical aid passed unheeded. What were the facts? Airy had written to Le Verrier putting to him the query about the errors of radius vector which he had previously put to Adams, and had at once received a satisfactory reply. The assurance that the hypothesis of an unknown planet accounted for the errors of both longitude and radius vector of Uranus had convinced him of the reality of the planet's existence. He considered that the telescopes at Greenwich were probably of insufficient size to detect the planet and that the Northumberland telescope at the Cambridge Observatory was the most suitable for the purpose of the search. He therefore wrote to Challis on July 9, 1846, inquiring whether he could undertake the search and, if not, whether he

would superintend the examination if Airy supplied him with an assistant from Greenwich for the purpose. He concluded by saying, "The time for the said examination is approaching near".

When Challis informed Airy that he would undertake the search, Airy drew up as a guidance for Challis his "Suggestions for the examination of a portion of the Heavens in search of the external planet which is presumed to exist and to produce disturbances in the motion of Uranus" (dated July 12, 1846). In sending this paper to Challis he wrote, "I only add at present that, in my opinion, the importance of this inquiry exceeds that of any current work, which is of such a nature as not to be totally lost by delay". Airy could not have done more to further the search and to impress upon Challis its urgency. There is little doubt that if the search had been carried out by an assistant from Greenwich, the planet would have been found, for it was an essential part of Airy's system that reduction of observations proceeded *pari passu* with the observations themselves.

As regards the actual researches of Adams and Le Verrier, full abstracts of Le Verrier's investigations had been published in the *Comptes rendus*, but neither Airy nor Challis had received anything from Adams beyond the bare summary of his results; they knew nothing of the methods he had employed.

After the discovery of the planet by Galle at Berlin, Airy wrote to Le Verrier and informed him that collateral researches, which had led to the same result as his own, had been made in England, and that they had been known to him earlier than those of Le Verrier. His "Account of some circumstances historically connected with the discovery of the planet exterior to Uranus" presented to the Royal Astronomical Society on November 13, 1846, left no doubt about the priority of the researches of Adams. In a letter of later date to Biot, Airy wrote, "I believe I have done more than any other person to place Adams in his proper position".

Prof. Smart agrees that the contemporary criticism of Airy, made in ignorance of many of the facts, was on some points unfair and unjustifiable. In my opinion, his verdict that Airy's treatment of Adams was unbecoming is equally unjustifiable.

H. Spencer Jones

Royal Observatory,
Greenwich,
London, S.E.10.

The Astronomer Royal does not see eye to eye with me in my judgment of Airy, in connexion with the Neptune controversy, as expressed in my article in *Nature* for November 9. This article, which was written in response to an editorial request, was a summary of the two addresses—dealing with different aspects of the discovery of Neptune—which I gave at the centenary commemoration on October 8; these addresses were themselves a summary of a fairly long 'essay' (if I may call it so) written at the invitation of the Council of the Royal Astronomical Society and accepted, as I understand, by the Council for eventual distribution to the fellows in one of the Society's publications. The 'essay' is a historical study of events of a century ago, and I was very conscious throughout its preparation that I must follow the methods of the historian as efficiently as I knew how. The job of the historian, as I see it, is to elicit facts, to present these in proper form, and to paint as accurate and complete a picture as possible. The 'essay' was accordingly built up on a very large amount of historical documents—I explain in the 'essay' how many of these became available, for the first time, for a study of the Neptune controversy, in which Sir Harold's great predecessor was in many ways the dominant figure.

All this, it seems to me, must be said before one turns to the criticism of the Astronomer Royal. Sir Harold's arguments, when documentary evidence is invoked, are based on Airy's letters alone. Most of his quotations will also be found in my 'essay', if—in one or two instances—not as direct quotations then as transcriptions of them. There is no suggestion in my article or 'essay' that Airy was to blame for Adams's failure to see the former on the occasion of his abortive visit to the Royal Observatory in October 1945—it was far otherwise—and as to the famous query about the 'radius vector', Adams never failed to reproach himself for not replying to Airy, although he was convinced that the matter was 'trivial', an opinion shared at the time by Challis.

The main questions are: Why did Airy claim to know the whole history of the business? Why did he declare unambiguously that Le Verrier must be regarded as the real 'predicter' of the planet? Why did he affirm that there was no one (in England) in competition, as regards scientific insight, with Le Verrier, etc.?

It is to be remarked that Airy's correspondence with Le Verrier was understood by him to be 'private', and he was exceedingly indignant—and justly so—when his letters were published in the French press without his sanction being even asked. Later, Airy described Adams as his 'oracle' in all matters relating to lunar and planetary theory; but this has nothing to do with the Neptune controversy as a historical episode. Airy was unjustly criticized on many points, as the Sedgwick correspondence makes abundantly clear, and as I hope my article and 'essay' demonstrate.

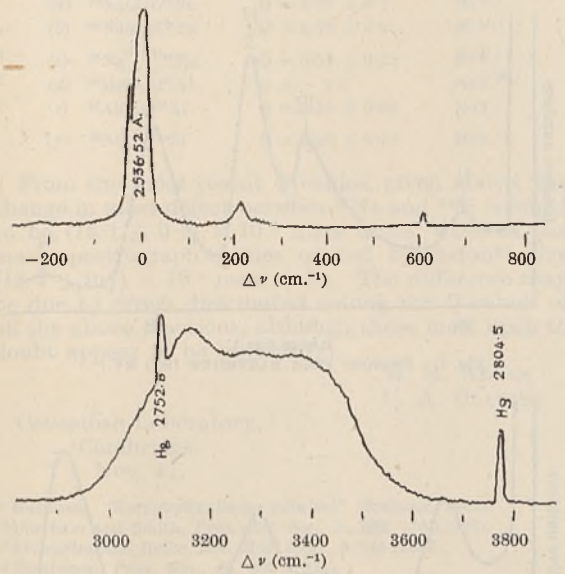
Any judgment on Airy's actions must be based, not on his letters alone, but on the whole corpus of contemporary documents. I do not claim that my 'essay' is the last word on the subject, but I do claim that, whatever its faults may be, it was written as a purely historical study with all the implications that this description suggests.

W. M. Smart

University Observatory,
Glasgow.

Elastic Constants of Ice

Experiments on the thermal scattering of X-rays by ice crystals, made by Dr. K. Lonsdale, have revealed an interesting pattern consisting of strong diffuse bands which extend along the boundary of the second and third Brillouin zone, and to a lesser degree between the fourth and fifth zone. An explanation of this behaviour in terms of atomic vibrations seems scarcely possible. Another feature of ice difficult to explain with the help of vibrations is the Raman effect. A figure representing the Raman scattering of ice according to Cross, Burnham and Leighton[1] is reproduced herewith. Other experiments made by Hibben[2] agree with these in all essential features. One sees that there are two small peaks at about 200 and 600 cm.$^{-1}$, and an enormous hump between 3,000 and 3,600 cm.$^{-1}$. Cross, Burnham and Leighton try to explain this hump as a superposition



Raman effect of ice at 0° C., produced by the Hg line 2536·52 A., according to Cross, Burnham and Leighton. There is no Raman line in the gap between 800 and 2900 cm.$^{-1}$ which separates the two diagrams

of a great number of frequencies due to different 'states of co-ordination' of hydrogen bonds; but this assumption seems to be completely arbitrary, and I doubt whether even the order of magnitude of the range of frequencies can be explained in this way.

In order to clear up these two remarkable observations, I have asked my collaborator, Miss A. H. A. Penny, to make a systematic investigation of the vibrations of the ice lattice. The position of the oxygen nuclei is well known and corresponds to a tridymite lattice. The hydrogens are situated somewhere between the oxygens, but in such a way that two of them are always near one oxygen atom, forming with this oxygen a water molecule. In order to correlate the frequencies with the elastic properties of ice, we first made the simplifying assumption that the hydrogen atoms are in the centre of the line connecting two oxygens. If the forces are considered effective only between next neighbours, one can show by group theoretical considerations that there are six independent atomic constants. We have further simplified the elastic theory by the assumption that the hydrogen atoms surrounding an oxygen atom form a regular tetrahedron. Then one can show either by group theoretical considerations or by using an explicit force law between next neighbours that there are two atomic constants left. The number of elastic constants for a hexagonal crystal is five. Therefore there must be three relations between them. They are too complicated to be reproduced here. We have tried to determine the elastic constants numerically, using the scarce and doubtful measurements on polycrystal ice available[3]. The Poisson ratio seems to be the best known. We took $\mu = 0{\cdot}37 \pm 0{\cdot}01$. The modulus of rigidity can be taken with some confidence to be $N = 1{\cdot}0\ (\pm\ 0{\cdot}1) \times 10^{10}$ dynes/cm.^{2} radian. Strangely enough, the measurements of the compressibility are contradictory. At 0° C., it seems to be in the neighbourhood of $3{\cdot}0 \times 10^{-11}$ cm.^{2}/dynes.

We have used the formulæ given by Voigt[4] for the average values of an isotropic mixture of hexagonal crystals. In this way we could calculate our two atomic constants from two of the measured quantities mentioned above, and we found the third in reasonable agreement. With these constants we found the following values of the true elastic constants of the single crystal: $C_{11} = 4{\cdot}92$, $C_{12} = 2{\cdot}95$, $C_{13} = 2{\cdot}67$, $C_{33} = 5{\cdot}20$, $C_{44} = 0{\cdot}88$. Each constant is multiplied by 10^{10} and measured in dynes/cm.^{2}. We suggest that accurate measurements with supersonics ought to be made on ice monocrystals using a method like that of Bhagavantam and his pupils[5] in order to check these values.

Accepting the two atomic constants, we can now calculate the first-order Raman effect. We find two frequencies $\nu_1 = 172$, $\nu_2 = 718$ cm.$^{-1}$ which agree fairly well with the two small peaks visible in the diagram. It seems, therefore, that these correspond to the elastic reaction of the lattice calculated by replacing the real positions of the hydrogen atoms by fictive mean positions.

I do not think that a broad hump like that revealed by the experiments can be explained by small vibrations at all, and I suggest the following explanation. The hydrogen atoms exchange their positions by finite jumps from the neighbourhood of one oxygen atom to that of another, in such a way that there are always two hydrogen atoms near an oxygen atom. One can express the same assumption also by saying that the water molecules jump from one of the six orientations available in each lattice point to another. I have succeeded in showing that finite transitions of this kind produce a continuous X-ray pattern depending on temperature. It is essentially determined by the correlation coefficient of the orientation of two neighbouring water molecules. It is probable that this explanation will also account for the broad Raman band. Investigations on this question are in progress.

Max Born

Department of Mathematical Physics,
University of Edinburgh.
Nov. 4.

[1] Cross, P. C., Burnham, J., and Leighton, P. A., *J. Amer. Chem. Soc.*, 59, 1134 (1937).
[2] Hibben, J. H., *J. Chem. Phys.*, 5, 166 (1937).
[3] Dorsey, N. E., "Properties of Ordinary Water-Substance" (Reinhold Publishing Corporation, New York).
[4] Voigt, W., "Lehrbuch der Kristallphysik" (Teubner, Leipzig).
[5] Bhagavantam, S., and Bhimasenachar, J., *Proc. Ind. Acad. Sci.*, 20, 298 (1944).

Use of the Electrolytic Tank for Magnetic Problems

It is well known that a convenient method for obtaining the solution of problems of potential theory is to make a model in a water tank in which the equipotentials of the real problem are represented by equipotentials, conductors by conductors and field intensity by current density. Charges, that is sources in the real field, are represented in the model by sources of current, namely, electrodes. This model is satisfactory for any problems involving a vortex-free, but not necessarily source-free, field.

If the problem is that of the magnetic field produced by conductors carrying currents, we have a source-free, but not vortex-free, field. In this case lines of force will in general be closed circuits, and the direct representation of this in the model, as stated, is evidently impossible.

It does not seem to be generally known that, for two-dimensional problems, a convenient procedure is to use the conjugate problem, in which the roles of lines of force and equipotentials are interchanged. This leads to a model in which the lines of force of the real problem are represented by equipotentials, iron (if idealized to have infinite permeability) by an insulating substance and conductors carrying a current at right angles to the plane of the problem, by electrodes. If the net current in the real problem is not zero, the net current from all electrodes in the model is unequal to zero, and the excess should flow to or from infinity. In practice, it is sufficient to make the sides of the tank conducting, and use them as an extra electrode if the tank is of generous dimensions.

If the conductors in the real problem are of finite cross-section, with a continuous current distribution, an approximation is necessary, using in the model a number of fine wires as electrodes, adjusting either the distribution of the wires or the current supplied to each of them. The spacing of the wires should be small enough to ensure that the error introduced by the discontinuous distribution is not excessive. This error can be estimated by calculation, or by repeating the model experiment with a larger spacing, say, leaving out every second wire.

The diameter of the wires must be reasonably small, so that the distortion of the field by the images formed in them becomes negligible.

This note arises from an interesting discussion with Mr. K. J. R. Wilkinson, of the British Thomson-Houston Co., Ltd., and Mr. J. S. Gooden.

R. E. Peierls
Department of Mathematical Physics,
University, Birmingham.
Nov. 6.

Disintegration of Magnesium and Aluminium by Deuterons

The nuclear masses of the elements between neon and silicon in the Periodic Table are known with much less accuracy than those of lighter elements. In order to check the values given in the most recently published tables[1], we have studied the emission of protons from magnesium and aluminium under deuteron bombardment at 900 kV. The protons were observed at right angles to the deuteron beam: the experimental technique employed has already been described[2].

The proton groups obtained from magnesium targets are shown in Fig. 1. No search was made for groups of range less than 16 cm. because of the presence of strong contamination groups. We attribute Groups I, II and VI of Fig. 1 (mean ranges 15·8, 21·5 and approximately 52 cm.) to deuterium, nitrogen and carbon contamination respectively, since they appeared with blank targets and have the ranges to be expected from the reactions $^{2}D(d,p)^{3}H$, $^{14}N(d,p)^{15}N$ and $^{13}C(d,p)^{14}C$. Groups III, IV and V, of mean ranges 30·85, 35·4 and 42·2 cm., appear to come from magnesium, and might arise from any of the three isotopes. The ranges to be expected from the published mass values are: $^{24}Mg(d,p)^{25}Mg$, 37 cm.; $^{25}Mg(d,p)^{26}Mg$, 121 cm.; $^{26}Mg(d,p)^{27}Mg$, 29 cm. It therefore appears plausible to assign Group IV to the reaction $^{24}Mg(d,p)^{25}Mg$, and Group III to $^{26}Mg(d,p)^{27}Mg$. We have checked that magnesium targets after bombardment show

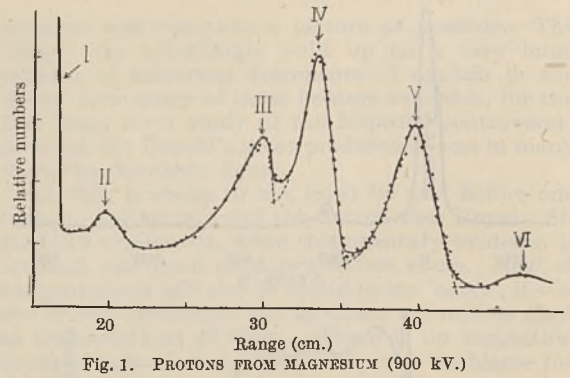


Fig. 1. Protons from magnesium (900 kV.)

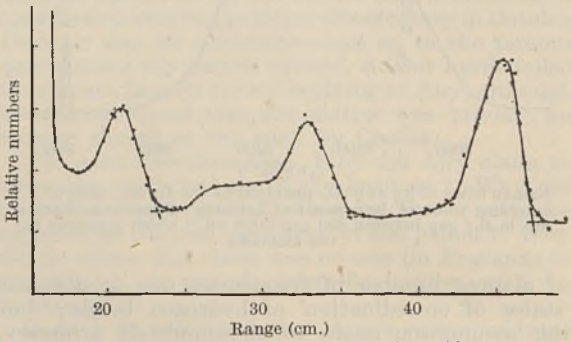


Fig. 2. Protons from aluminium (900 kV.)

the 10-minute β^--activity characteristic of ^{27}Mg [4], and that the amount of activity is in rough agreement with that to be expected from the number of protons in Group III. On these assumptions, Group V cannot arise from either ^{24}Mg or ^{26}Mg. We have made an unsuccessful search out to 130 cm. for any other proton group which might be allocated to the reaction $^{25}Mg(d,p)^{26}Mg$, and therefore make the tentative assumption that Group V arises from this reaction, but that the ^{26}Mg nucleus is formed in an excited state, with energy some 5 MeV. above the ground-state. Groups corresponding to excited states at 1·85 and 3·00 MeV., as reported by Pollard[5], were not detected.

Our results on the disintegration of magnesium by deuterons may be summarized as follows:

	Mean range of protons (cm.) (deuteron energy 900 kV.)	Q-Value (MeV.)
$^{24}Mg(d,p)^{25}Mg$	35·4 ± 0·4	4·49 ± 0·05
$^{25}Mg(d,p)^{26}Mg^{*}$	42·2 ± 0·4	5·05 ± 0·05
$^{26}Mg(d,p)^{27}Mg$	30·85 ± 0·4	4·08 ± 0·05

Fig. 2 shows the proton groups obtained from aluminium under deuteron bombardment. Here only one isotope is involved, and the groups presumably all arise in the reaction $^{27}Al(d,p)^{28}Al$. The mean ranges (for deuteron energy 900 kV.) and Q-values are:

23·4 ± 0·4 cm.	Q = 3·34 ± 0·05 MeV.	excited states
35·7 ± 0·4 cm.	Q = 4·49 ± 0·05 MeV.	excited states
48·0 ± 0·5 cm.	Q = 5·49 ± 0·06 MeV.	ground-state

These values are in rough agreement with those found by other workers[6,7].

We have attempted to use our results to build up a set of mass values for the elements between neon and silicon, by the procedure of Livingston and Bethe[3]. The method is based on the following sequence of reactions:

(*a*)	$^{23}Na(d,\alpha)^{21}Ne$	$Q = 6{\cdot}75 \pm 0{\cdot}1$	MeV.[8]
(*b*)	$^{23}Na(d,p)^{24}Na$	$Q = 4{\cdot}76 \pm 0{\cdot}1$	MeV.[8]
(*c*)	$^{24}Na \xrightarrow{\beta+\gamma} {}^{24}Mg$	$Q = 5{\cdot}53 \pm 0{\cdot}22$	MeV.[9]
(*d*)	$^{24}Mg(\alpha,p)^{27}Al$	$Q = -1{\cdot}8$	MeV.[3,10]
(*e*)	$^{27}Al(d,p)^{28}Al$	$Q = 5{\cdot}50 \pm 0{\cdot}06$	MeV.
(*f*)	$^{28}Al \xrightarrow{\beta+\gamma} {}^{28}Si$	$Q = 5{\cdot}03 \pm 0{\cdot}23$	MeV.[11]

From the most recent Q-values, given above, the change in mass defect between ^{21}Ne and ^{28}Si is found to be $(15{\cdot}1 \pm 0{\cdot}5) \times 10^{-3}$ mass units, whereas the mass spectrograph values quoted by Aston[12] give $(13{\cdot}1 \pm 0{\cdot}7) \times 10^{-3}$ mass units. The difference may be due to errors distributed among the Q-values of all the above reactions, although those most open to doubt appear to be (*d*) and (*f*).

H. R. Allan
C. A. Clavier

Cavendish Laboratory,
Cambridge.
Nov. 11.

[1] Mattauch, "Kernphysikalische Tabellen" (Springer, 1942).
[2] Burcham and Smith, *Proc. Roy. Soc.*, A, **168**, 176 (1938).
[3] Livingston and Bethe, *Rev. Mod. Phys.*, **9**, 245 (1937).
[4] Henderson, *Phys. Rev.*, **48**, 855 (1935).
[5] Pollard, *Phys. Rev.*, **59**, 942 (1941).
[6] McMillan and Lawrence, *Phys. Rev.*, **47**, 343 (1935).
[7] Schultz, Davidson and Ott, *Phys. Rev.*, **58**, 1043 (1940).
[8] Murrell and Smith, *Proc. Roy. Soc.*, A, **173**, 410 (1939).
[9] Siegbahn, *Phys. Rev.*, **70**, 127 (1946).
[10] Bethe and Henderson, *Phys. Rev.*, **56**, 1060 (1939).
[11] Eklund and Hole, *Ark. Mat. Astr. Fys.*, **29A**, 4, No. 26 (1943).
[12] Aston, "Mass Spectra and Isotopes" (Arnold, 1941).

Rate of Spread of Discharge Along the Wire of a Geiger Counter

In 1939, one of us[1] made a determination of the half-life of thorium C′ as 2×10^{-7} sec., using a coincidence technique with variable resolving time. It was found, however, that delays were occurring in the system of the same order of magnitude, and these could only be attributed to the Geiger counters. The outbreak of war prevented any further work until now; but in the meantime there have been published several important papers on the subject of Geiger counters[2,3,4]. In particular, Stever[5] observed that a small bead on the wire of a self-quenching counter prevented the discharge spreading down the wire, and reported that Brode had shown that the discharge did not travel instantaneously.

It was decided to redetermine the period of thorium C′ and at the same time make an investigation of the delays in self-quenching counters. Random delays in counters have usually been attributed either to the time of build-up on the Townsend avalanche or to the time taken for the electron produced by the initial ionization to travel to the intense field around the counter wire. If, however, the time taken for the discharge to travel down the wire is considerable compared to the time intervals under consideration, we would expect the rate of build-up of charge on the counter wire to depend upon whether the discharge spreads from one end of the counter, or spreads

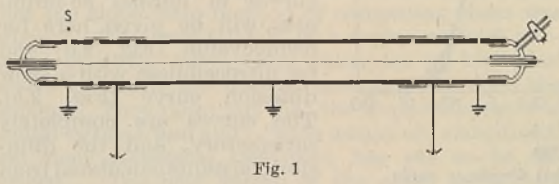


Fig. 1

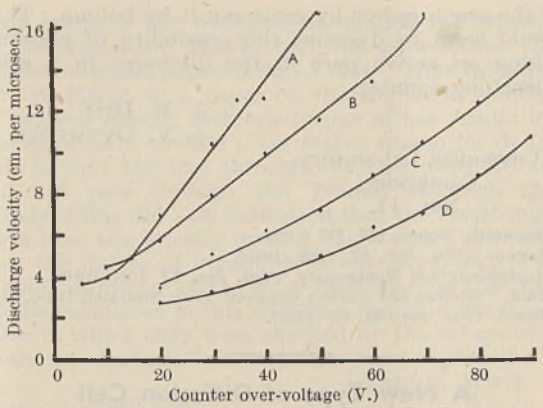


Fig. 2. *A*, 2·5 cm. argon; *B*, 9·5 cm. helium; *C*, 4·5 cm. argon; *D*, 9·5 cm. argon. All with 0·5 cm. alcohol

in both directions from some place in the middle of the wire.

Three sets of experiments were made by a combination of delay line and coincidence techniques, thereby avoiding the use of extremely narrow pulses and separating the effects of random delays from those of fixed delays occurring in one arm with respect to the other. First, observations were made on β–γ coincidences from a source where there was no reason to expect a γ-ray life-time approaching 10^{-7} sec. Delays were observed of the order of 10^{-7} sec.; and these decreased with increasing over-voltage. Secondly, a twin counter was built in which a narrow open slit was left joining the two counters, the slit being in the plane of the two wires. β-particles were fired through a window in one of the counters and could actuate both counters only if they passed close to each wire. The delays observed were similar to those observed in the β–γ coincidence experiment. (There was no tendency for one counter to cause actuation of the other, despite direct optical and gaseous path between them.) The third experiment to measure the rate of spread of discharge along the wire of a counter made use of counters consisting of a single wire but with the cathodes cut into several sections (Fig. 1), the portions of the cathode connected to earth being used as A.C. guard rings between the two portions connected to the timing circuit. The discharge could be initiated by means of a β-ray source opposite one of the windows at the ends of the counter. Measurements of the time intervals between the pulses produced on the two cathodes were made, first using the delay line coincidence circuit with a counter 4 cm. long, and later by means of a high-speed triggered oscilloscope on a counter 100 cm. long.

Fig. 2 indicates the variation of propagation velocity for different over-voltages and gas fillings in a counter having a wire diameter of 0·008 in. and a cylinder diameter of $\frac{3}{4}$ in., and having 5 mm. pressure of alcohol as the quenching vapour in each case.

The mechanism by which the discharge spreads down the wire has not yet been fully explained; but it would seem that it must be due either to the emission of photons causing further ionization before they can be adsorbed by the alcohol or possibly the positive ions being accelerated in the direction of propagation of the discharge by the distortion of the field at the edge of the ion sheath. From the few measurements taken so far, it appears that the speed of propagation is affected only slightly by the alcohol concentration, but markedly by changing the pressure

of the argon gas or by replacing it by helium. This would seem to discount the possibility of photons taking an active part in the discharge in a self-quenching counter.

J. M. Hill
J. V. Dunworth

Cavendish Laboratory,
Cambridge.
Nov. 11.

[1] Dunworth, *Nature*, **144**, 152 (1939).
[2] Ramsey, *Phys. Rev.*, **57**, 1022 (1940).
[3] Montgomery and Montgomery, *Phys. Rev.*, **57**, 1030 (1940).
[4] Korff, "Electron and Nuclear Counters" (Van Nostrand, 1946).
[5] Stever, *Phys. Rev.*, **61**, 38 (1942).

A New Type of Diffusion Cell

The well-known metal diffusion cell with slide constructed by Lamm[1] has been used almost exclusively during the last ten years for accurate determinations of diffusion constants. However, as Lamm points out, it is difficult to tighten this cell in experiments with organic solvents; in such cases cylindrical diffusion tubes of glass are mostly used, making it difficult to take full advantage of the great accuracy obtained with the Lamm scale method.

A new type of diffusion cell will be described here which can be used both for water solutions and organic solvents. The cell has the shape shown in Fig. 1. It is made from stainless steel plate (10 mm. thickness) which is enclosed between two glass disks held in position by frames and screws. The piece A is moved by the eccentric arrangement B and slides between the two windows. It is held against the bottom plane by the spring S. When the cell is in use, the denser liquid (the solution) is filled through the hole D,E into the lower part of the cell proper (G) and thereafter the piece A is moved to close G. Then the cell is filled *up to the level* N with the lighter liquid (the solvent) and the hole E is closed with a screw stopper. The cell is then put into the thermostat and the diffusion started by moving the piece A back to the position shown in Fig. 1. Diffusion takes place in the cell proper (F,G), and no leaking can occur *as there is the same liquid in* F *as outside at* H. No grease or other sealing agent is needed on the piece A as the increase in density in F during the diffusion process is much too small to force the solution out into H. During the experiment, the glass tube (R) for the key to the eccentric arrangement is closed by a glass stopper. It is seen that the boundary-forming arrangement here is of the same type as in Tiselius' electrophoresis apparatus; extremely sharp boundaries are obtained in this way. The cell is, furthermore, simple to manufacture and consists of only three metal pieces. It is consequently easy to clean.

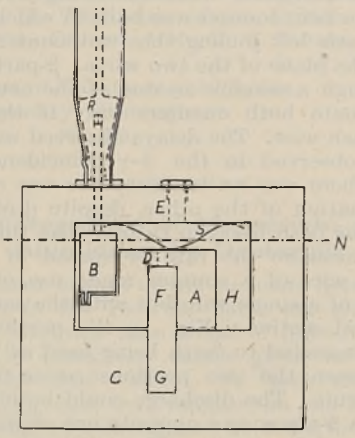


Fig. 1. Diffusion cell

Hæmocyanin (*Helix pomatia*) 0·25%	0·08 *M* acetate buffer	*p*H = 6·2, 0·2 *M* NaCl Temp. 20° C.
Time (sec.)	$D_A \cdot 10^7$	$D_m \cdot 10^7$
142,000	1·16	1·13
179,000	1·15	1·12
226,000	1·12	1·10
257,000	1·10	1·12
Mean:	1·13	1·12
Nitrocellulose 0·40% in acetone solution.		Temp. 20° C.
50,200	2·76	2·53
81,400	2·80	2·97
112,000	2·61	2·34
129,000	2·68	2·65
168,000	2·78	2·56
Mean	2·73	2·61

By making more than one pair of slots in the pieces A and C several experiments can be performed at the same time provided that the solvent is the same. A cell with three pairs of slots (instead of only F,G) has been used for some time at this Institute. The interval (12 mm.) between the three cells is then so small that one fixed camera can be used, and the only alteration from the standard equipment is that one scale is needed for each cell proper.

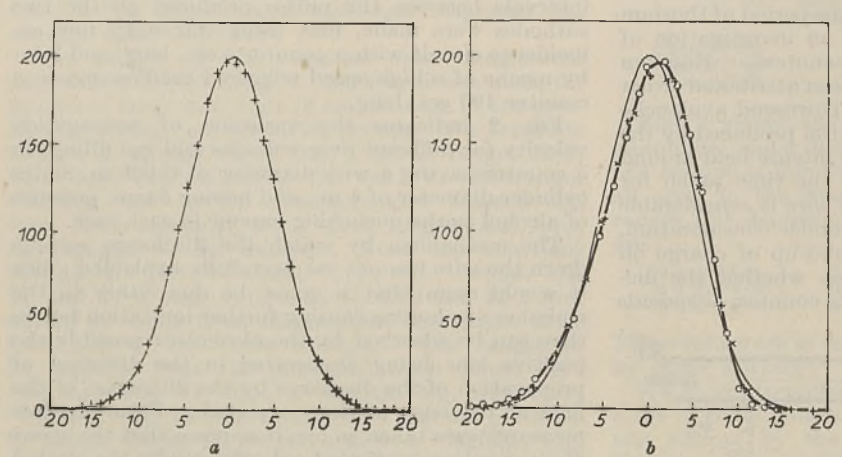


Fig. 2. Diffusion curves in normal co-ordinates
a) Hæmocyanin. (*b*) Nitrocellulose; the thin line is the normal frequency curve

The cell has worked well both for substances with small and great diffusion constants (hæmocyanin, sodium chloride) and with different solvents (water, acetone). Only the diffusion curves in normal co-ordinates will be given here for hæmocyanin (Fig. 2,*a*) and for nitrocellulose with a skew diffusion curve (Fig. 2,*b*). The curves are completely satisfactory, and the diffusion constants calculated from

exposures at different times are given in the accompanying table.

I wish to express my thanks to Prof. The Svedberg for his interest in this work.

Stig Claesson

Institute of Physical Chemistry,
University of Uppsala.
Nov. 4.

[1] Lamm, O., *Nova Acta Reg. Soc. Sci. Upsaliensis*, iv, **10**, No. 6 (1937).

Computation of Biological Assays

In microbiological assays of essential amino-acids, and of members of the vitamin B_2 complex other than riboflavin and nicotinic acid, it is usually found that when the mean responses are plotted against either the dose or the logarithm of the dose, a non-linear relationship is obtained. It has been customary to compute the result in such cases by the direct-reading method, which from the statistical point of view is unsatisfactory in more than one respect, while further examination of the data is difficult or impossible.

On examination of the protocols of several assays by various workers (to whom acknowledgment will be made elsewhere), I find that in most cases the results are fitted well by a straight line, at least over a reasonable range, when the logarithm of the response is plotted against the logarithm of the dose. As an example, reference may be made to a tryptophan assay, the standard curve for which has been published by Barton-Wright[1]. The experimental data plotted in the manner just described are linear over a dosage range of 2–12 μgm., or 3·75–12·6 ml. in terms of response.

This 'log-log' transformation provides, for those assays which conform to it, a method of computation which is both sound and simple. The formulæ are precisely the same as in the case, well known in macrobiological assays, in which the response is linearly related to the logarithm of the dose, except that the logarithm of the response is used instead of the response itself. The test and standard lines when plotted on the same graph should theoretically be found to be parallel; a significant departure from parallelism renders the validity of the assay suspect; and the best estimate of the potency-ratio of the two preparations is obtained from the horizontal distance between the two lines.

Fuller details with illustrative examples will be published later. I should be very interested to receive reports from workers in this field who may test the applicability of the 'log-log' relationship to their own assays. There are further implications which concern the *design* of assays of this type—for example, doses should be in geometrical rather than arithmetical progression—but this cannot be discussed here.

May I take this opportunity of pointing out that in my previous communication in *Nature*[2] about assays in which the response is linearly related to the dose, I neither claimed nor intended to claim that the slope-ratio method of computing them was original. Bliss and Cattell, in a review article[3] published in 1943, quote three instances of biological assays in which the dose is linearly related to the response. They point out that the slope-ratio method should be used, and add: "such assays are exceptional and their statistical treatment has yet to be described". The best known of the assay techniques they quote is the bradycardia method for aneurin as developed by Harris and his co-workers, the earliest of whose papers is dated 1934[4]. More recently, Dr. M. Kerly, in a paper on the riboflavin content of canteen meals[5], calculated some of her results by the slope-ratio method; her stated reason for doing this is that the line through the test observations did not pass through the 'blank', although the standard line did—an indication that the result may have been statistically invalid. It is clear, however, that the degree of invalidity is not large, and it is a point in favour of the slope-ratio method that the results calculated in this way were found in the three cases in which they were checked by the rat-growth method to be in satisfactory agreement therewith.

Eric C. Wood

Virol Ltd.,
Hanger Lane, Ealing, W.5.
Nov. 8.

[1] Barton-Wright, E. C., *Analyst*, **70**, 283 (1945).
[2] Wood, E. C., *Nature*, **155**, 632 (1945).
[3] Bliss, C. I., and Cattell, McK., "Ann. Rev. Physiol.", **5**, 479 (1943).
[4] Birch, T. W., and Harris, L. J., *Biochem. J.*, **28**, 602 (1934).
[5] Kerly, M., *Biochem. J.*, **38**, 423 (1944).

Surface Charge of 'Electrets'

Certain dielectric materials, if solidified from the molten state in a strong unidirectional electric field, are known to remain in a polarized condition for considerable periods of time and, under certain conditions, surface charges as high as 5 e.s.u./cm.^{2} are retained for several years[1–4]. The materials generally used for the preparation of these so-called 'electrets' are mixtures of carnauba wax and colophony, or carnauba wax, colophony and a small proportion of beeswax.

Several interesting effects have been observed by following the variation with time of the charge on the cathode and anode layers of electrets, these being the surfaces which were adjacent to the negative and positive electrodes, respectively, during preparation. These effects appear to have escaped notice previously, attention having generally been confined to variations in the charge of the cathode layer only.

The preparation consisted in allowing different types of dielectric materials to solidify in a field of approximately 10,000 v./cm., between two parallel metal electrodes, the tension being maintained for about two hours. When the dielectric had cooled to room temperature, the electrodes were connected to earth for some time to remove temporary surface charges. The samples were then withdrawn, wrapped in tin foil and stored over calcium chloride in a desiccator. Measurements of the surface charges were taken from time to time using a Lindemann electrometer.

Fig. 1 shows typical curves obtained for electrets prepared from two different qualities of prime yellow carnauba wax. It is seen that shortly after the rapid transition from a hetero- to a homo-charge, the anode layer assumes a short-lived high positive charge; this subsides rapidly to the steady lower charge, which is retained for some time.

In the case of colophony, the charges on the cathode layer were invariably lower and decayed more rapidly than those on the anode layer, when metal electrodes were used in the preparation (Fig. 2, *A*). It is possible that this is due to interaction between the dielectric and the electrodes, or between

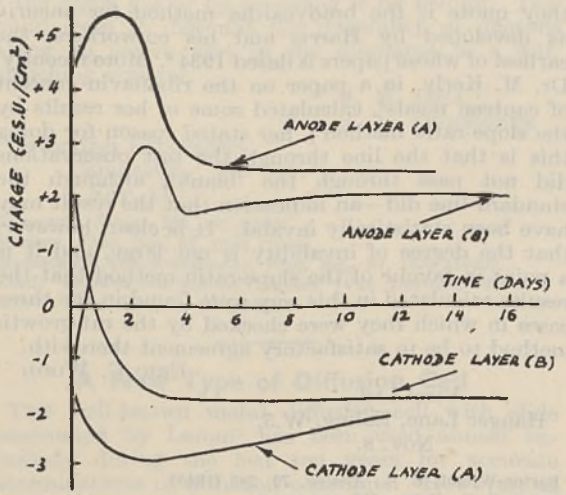


Fig. 1. CHARGE-TIME CURVES. CARNAUBA WAX

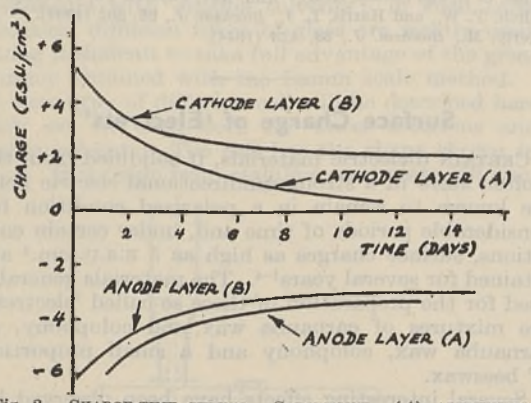


Fig. 2. CHARGE-TIME CURVES. COLOPHONY. (*A*), ALUMINIUM ELECTRODES; (*B*), ELECTRODES LINED WITH 'CELLOPHANE'

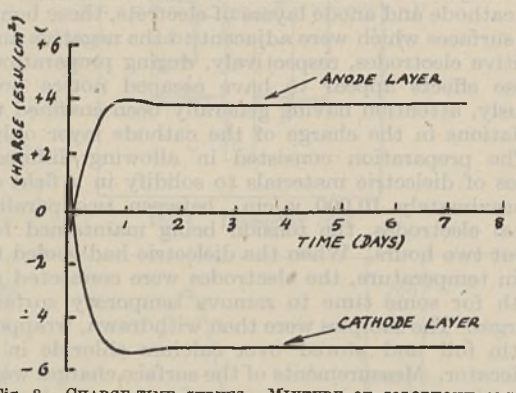


Fig. 3. CHARGE-TIME CURVES. MIXTURE OF COLOPHONY AND CARNAUBA WAX

the electrodes and some surface impurity. By the use of metal electrodes lined with dry 'Cellophane', a marked increase in the charge of the cathode layer was obtained (Fig. 2, *B*).

Fig. 3 shows the time variation of the charges in an electret prepared from a mixture of equal weights of colophony and carnauba wax, using tin electrodes. The resultant negative charges are seen to exceed somewhat the positive ones, an effect due to the colophony component.

The quality of the materials used, especially the carnauba wax, was found to be of some importance. Mixtures containing fatty grey carnauba wax, which is obtained from older plants than the prime yellow variety, or slightly inferior grades of the prime yellow wax, attained only comparatively low charges.

A fuller account of the work will be published later.

J. R. PARTINGTON
G. V. PLANER
I. I. BOSWELL

Chemistry Department,
Queen Mary College,
(University of London).

Addison Electric Co., Ltd.,
163 Holland Park Avenue,
London, W.11.
Nov. 5.

[1] Eguchi, *Phil. Mag.*, 49, 178 (1925).
[2] Gemant, *Phil. Mag.*, 20, 929 (1935).
[3] Jaeger, *Ann. Phys.*, 21, 481 (1934).
[4] Thiessen, Winkel and Herman, *Phys. Z.*, 37, 511 (1936).

Function of Bacterial Polysaccharides in the Soil

MOST aerobic micro-organisms such as *B. subtilis*, *B. megatherium*, *Leuconostoc* species, Rhizobia, etc., are capable under favourable cultural conditions of producing highly viscous polysaccharides either as heavy capsular material or as extracellular products. Apart from their role in the defensive mechanism of the micro-organism against soil Protozoa, etc., little is known regarding the function of microbial polysaccharides in the soil.

In view of the highly mucilaginous nature and high chemical stability of some of these complex carbohydrates, it occurred to us some years ago that they might play an important part in conserving the moisture content of soils and clays. Accordingly, investigations were begun along three lines: (1) an examination of the moisture, total carbohydrate and polysaccharide contents of rich and poor soils and clays from different localities; (2) the influence on the moisture-conserving capacity of light soils of the addition of known bacterial polysaccharides; (3) the determination of the effect, on soil microflora, of known concentrations of sugars and hexose phosphates particularly in respect of polysaccharide production and of the moisture-binding capacity of various soils.

Project (1) was carried some distance before the work had to be suspended for other urgent work. By extracting soil with buffers, followed by the usual methods for isolating polysaccharides, it was shown that poor soils with a low content of organic matter contained traces only of polysaccharide material. On the other hand, those soils with a high content of organic matter contained significant amounts of polysaccharide (for example, 1 kgm. of moisture-free soil gave 0·5–1·5 gm. polysaccharide) and in general possessed a greater moisture-retaining capacity. From various soils there were isolated polysaccharide fractions having rotations varying from $[\alpha]_D + 20°$ to $[\alpha]_D - 80°$, from which in most cases levans ($[\alpha]_D - 90°$) could be separated. The products usually gave viscous solutions in water and had nitrogen contents of 0·3–0·5 per cent.

In regard to projects (2) and (3), it was shown that the addition of viscous bacterial mucopolysaccharide particularly of the dextran type (nitrogen contents *c.* 0·3–0·5 per cent) have an important effect on the moisture-binding capacity of soils. The nature of the free sugars in the soils is also of high significance. This is particularly so in regard to the presence of

sucrose in soils, without which levan and dextran formation cannot proceed. Extracellular synthesizing enzymes under appropriate conditions can function in the soil at distances remote from the microbial cell, and build up complex hydrated polysaccharide structures from sucrose and the hexose phosphates. It is hoped to continue and extend these investigations.

W. N. Haworth
F. W. Pinkard
M. Stacey

Chemistry Department,
The University, Birmingham, 15.

Influence of Bacterial Polysaccharides on Aggregate Formation in Soils

It has long been assumed that micro-organisms play an important part in producing a crumb or aggregate structure in soil, and it is known that following the addition of sucrose to soil there is a marked development of water-stable aggregates.

At Jealott's Hill, we have been studying the effect of bacterial polysaccharides of the levan and dextran types on the binding of soil particles. While this investigation was in progress, we became aware of work going on along similar lines at the University of Birmingham (see preceding letter) and in the United States[1].

We have studied the aggregation of soil by the wet sieving technique and were able to show that the addition of washed bacterial cells, for example, those of *B. subtilis*, had very little aggregating effect.

When *B. subtilis* was cultured in a sucrose medium there was gum production; and following dialysis, removal of the cells, and concentration of the solution, etc., alcoholic precipitation gave a white product which was a levan (nitrogen content, 0·2–0·3 per cent; 97–98 per cent fructose after hydrolysis (cf. Martin[1])). By using different culture media and methods of extraction, levans having varying nitrogen contents could be obtained from *B. subtilis*, and the significant discovery was made that whereas those products containing 0·2–0·3 per cent nitrogen had a marked aggregating effect on soil, those with a nitrogen content of less than 0·1 per cent had but little action. Further, it was observed that both the nitrogen content and the aggregating effects were related to the relative viscosity of the levan solution.

The polysaccharides capable of aggregating soil appear to be very similar to, or identical with, those polysaccharides which show antigenic activity. Thus it will be recalled that polysaccharides appear to owe certain of their immunological properties to the presence in them of a nitrogenous constituent; for example, Fitzgerald[2] from serological studies found that the antigenic activity of a polysaccharide produced by *L. mesenteroides* disappeared when its nitrogen content was reduced to less than 0·2 per cent. In this connexion Stacey[3] has suggested that dextrans and other polysaccharides in their most natural state consist of polyglucose chains 'cemented' together by units of the synthesizing enzyme which remains as an integral part of the complex mucopolysaccharide. The levans we have examined may possibly consist of polyfructose chains held together in a similar way.

Microbial polysaccharides are probably only one of the groups of metabolic products having an ameliorative effect on soil structure. However, since the diverse microflora of soil may synthesize many types of polysaccharides from the constituents of vegetable remains, we wish to point out the importance to soil of this group and to emphasize that a knowledge of the chemistry of microbial products would do much to elucidate the composition and functions of humus in the soil.

We are indebted to Profs. Haworth and Stacey for the supply of a number of levans and a dextran.

M. J. Geoghegan
R. C. Brian

Imperial Chemical Industries, Ltd.,
Jealott's Hill Research Station,
Bracknell, Berks.
Nov. 20.

[1] Martin, J. P., *Soil Sci.*, **61**, 157 (1946).
[2] Fitzgerald, J. G., *Trans. Roy. Soc. Can.*, **27**, 1 (1933).
[3] Stacey, M., *J. Soc. Chem. Ind.*, **62**, 110 (1943).

Role of Sulphydril Groups in the Action of Acetylcholine and Inhibition of the Vagus Nerve

Work on the chemical constitution and fine molecular structure of protein bodies has appreciably advanced our knowledge of the nature of the process of the reversible denaturation of protein bodies, which underlies a number of fundamental biological phenomena, including those of muscular contraction.

In particular, the work done in this domain has demonstrated the important part played in the processes of denaturation of protein bodies by the sulphydril groups. As the chemical groups of side-chains of protein bodies, endowed with particular activity, the sulphydril groups are not only likely to participate in processes of direct structural alterations of certain protein bodies, probably including myosin[1,2], but also, as active groups of the protein component of definite enzymes, they participate in a number of fermentative processes invariably attending the complex phenomena of reversible denaturation of protein structures under the conditions prevailing in a live cell. Among the enzymes the activity of which is dependent upon the sulphydril groups we find more than one playing a most important part in carbohydrate metabolism, in particular in that accompanying the enzymic transformations of pyruvic acid[3], and also in cholinesterase[4].

On account of the paramount importance of the enzymes of carbohydrate metabolism and of the enzyme cholinesterase in the course of synthesis and breakdown of acetylcholine, and accordingly that of the relation between the 'acetylcholine cycle', and the 'adenyl cycle'[5], which is intimately connected with the reversible denaturation of the contractile protein of myosin and the general chemodynamics of the muscle in the process of excitation, we endeavoured to find out the role of the sulphydril groups in the action of acetylcholine and nerve stimulation upon the cardiac muscle.

To examine the possible role of the sulphydril groups in nerve stimulation and of physiological doses of acetylcholine, we have tested the effect of stimulation of the vagus nerve and that of acetylcholine upon the cardiac muscle of the frog when the sulphydril groups are bound, followed by the introduction of these groups. As a substance likely to bind the sulphydril groups, use was made of a solution of mercury bichloride (1×10^{-3}, 1×10^{-4}), which is known to form with the sulphydril groups a mercap-

tide bond; as a donator of the sulphydril groups, cystein was applied (2×10^{-3}).

Our experiments, carried on in a large number of replications, led to the following conclusions. The clearly pronounced inhibitory effect on rhythmical contractions of the heart muscle, due to the action of the vagus nerve and of acetylcholine, was found to be removed after the application of mercury bichloride solution, that is, after binding the sulphydril groups; as a rule, the effect was restored after the heart was washed with cystein solution. In control experiments, no similar action could be obtained with Ringer or cystein solution.

When the mercury bichloride solution was introduced against a background of the influence of acetylcholine, that is, when the contractile substrate and the corresponding chain of enzymo-chemical processes was subjected to the influence of acetylcholine, but the phase of restoration had not yet begun, the mercury bichloride solution was no longer able to cause the effect recorded by us: after the normal height of the contractions has been restored, every application of acetylcholine was followed by a typical effect of inhibition of the rhythmical contractions of the heart. This effect vanished as a rule in all experiments in which mercury bichloride was applied against a background of normal contractions.

Preliminary experiments have shown that, unlike the effect of mercury bichloride, the well-known effect of elimination of the action of acetylcholine with atropine cannot be restored with cystein, which points to a peculiar biochemical mechanism underlying the action of atropine.

Experiments in this direction are in progress.

Ch. S. Koschtojanz
T. M. Turpajew

Department of Comparative Physiology,
Institute of Evolutionary Morphology,
Academy of Sciences of the U.S.S.R.,
Moscow. Sept. 13.

[1] Astbury, W. F., *J. Chem. Soc.*, 337 (1942).
[2] Anson, M. L., "Adv. in Prot. Chem.", 2, 363 (1945).
[3] Barron, E. S. F., "Adv. in Enzym.", 3, 177 (1943).
[4] Nachmanson, D., and Lederer, E., *Bull. Soc. Chim. Biol.*, 21, 797 (1939).
[5] Koshtojanz, Ch. S., *C.R. Acad. Sci. U.R.S.S.*, 19, 4 (1938); 43, 8 (1944).

Specific Action of Optical Isomers of Mepacrine upon Dextral and Sinistral Strains of *Bacillus mycoides* Flügge

The normal colonies of *Bacillus mycoides* Flügge growing on the surface of agar medium have filaments with an anti-clockwise spiral and should be called sinistral or *L*-forms; there occur also as very rare exceptions colonies with a clockwise spiral (dextral or *D*-forms).

Our cultures (two *D*-strains and two *L*-strains) were obtained from Prof. E. N. Mishustin (Institute of Microbiology, Academy of Sciences of the U.S.S.R.). Three of them were isolated from soils collected in the vicinity of Lake Sewan, Armenia. Optical isomers of mepacrine hydrochloride were prepared at the Institute of Malaria and Parasitic Diseases according to the method of Chelinzev and Ossetrova[1]. *Bacillus mycoides* was cultivated on a medium with 3·5 per cent of German agar in a potato broth (200 gm. of potatoes boiled for 30 min. in 1,000 c.c. of water). Mepacrine was added to the hot medium, which was again heated on the following day up to boiling point in a water-bath, or autoclaved. Throughout all experiments (with one exception) 0·01 per cent of mepacrine in the medium was used. This concentration causes approximately a 30 per cent depression of colony growth. Each 10-cm. Petri dish received four point inoculations. The diameter of the colonies was measured after 24, 48, 72 or 120 hours from the beginning of growth, by means of dividers. As a measure of the relative toxicity of dextro- and lævo-rotatory mepacrine an index (d/l) 100 was taken, where d represents the average diameter of four colonies grown on a medium with *d*-mepacrine, and l that of colonies grown in the presence of *l*-mepacrine.

Seven experiments were carried out. Omitting the third experiment, in which there were some defects in the preparation of the medium, in all experiments the index for dextral colonies was lower than for sinistral ones (74·4 as against 114·1 per cent). The difference between the indices is statistically significant, being equal to 6·51 with five degrees of freedom. A contingency table for the direction of the spiral and the value of the index lying below and above 100, using the Yates–Fisher adjusted formula, gave $\chi^2 = 17{\cdot}15$, with a probability much below 0·01. This can be considered as a proof of the existence of a relation between the direction of the spiral and of the value of the index. We may conclude that the two forms of *B. mycoides* are characterized not only by an inversion of colonial morphology but also by an inversion of some mepacrine 'receptors' on a molecular level.

According to previous investigations in our laboratory all living organisms, beginning with normally spiralized or *L*-forms of *B. mycoides* and Infusoria up to higher Vertebrata[2], show an index greater than 100. This means that their living matter is less sensitive to *d*-mepacrine than to *l*-mepacrine. The only exception to this rule known at present is the dextral form of *Bacillus mycoides* Flügge, which evidently originated by mutation from the normal sinistral form. Gause[3] succeeded in showing that the *D*-form of *B. mycoides* contains an enzyme which can split unnatural dipeptides (of dextral steric series). In connexion with this, one must keep in mind that Kögl and Erxleben[4] have isolated from malignant tumours the unnatural isomer of glutamic acid (of dextral steric series), and Waldschmidt-Leitz and Mayer[5] have discovered in the blood serum of patients with malignant tumours enzymes of unusual stereochemical structure. Taking all these facts into consideration our experiments with *D*- and *L*-strains of *B. mycoides* perhaps represent a first step towards developing a rational cancer therapy utilizing optical isomers. Drugs similar to *d*-mepacrine inhibiting the growth of cells containing substances with abnormal molecular configuration more strongly than that of cells with normally configurated molecules might perhaps be useful in depressing malignant cell-growth in the animal and human body.

This work was carried out in collaboration with my assistant, Mrs. O. C. Nastukova.

V. V. Alpatov

Institute of Zoology,
University of Moscow.

[1] Chelinzev, G. V., and Ossetrova, E. D., *J. Gen. Chem.*, 5, 10 (1940) (in Russian).
[2] Gause, G. F., and Alpatov, V. V., *C.R. Acad. Sci. U.S.S.R.*, 32, No. 7 (1941) (in English).
[3] Gause, G. F., *Biochemistry*, 7, No. 1–2 (1942) (in Russian).
[4] Kögl, F. and Erxleben, H., *Z. physiol. Chem.*, 261 (1939).
[5] Waldschmidt-Leitz, E. K., and Mayer, K., *Z. physiol. Chem.*, 262 (1939).

Effect on some Blood-sucking Arthropods of 'Gammexane' when Fed to a Rabbit

THE physiology and nutrition of the bedbug (*Cimex lectularius*) has been the subject of investigation in this laboratory for a number of years. A preliminary report has been published[1], and a paper dealing with the matter more fully is in the press. One of the problems we have set ourselves is to make the blood of the host unsuitable for the bedbug by altering it in one way or another. The ultimate aim was to find some substance, non-toxic for the host, which when fed to animals would kill or control bedbugs and other blood-sucking arthropods. Numerous attempts in this direction, with a wide variety of materials, have been made, and some success has been obtained. Recently, through the kindness of Dr. W. C. Walmsley, of African Explosives and Chemical Industries, Ltd., Northrand, a few grams of the pure gamma isomer of hexachlorocyclohexane was obtained. Results with this substance have been so striking that it has been considered of interest to make them known immediately.

The 'Gammexane' was powdered and mixed with a solution of agar. The agar, when set, was cut into portions each of which contained approximately 50 mgm. One of these portions was fed to a rabbit weighing 1,730 gm. every morning. The arthropods, from known healthy stocks, were confined in glass tubes, covered with gauze, and placed on the rabbit's ear. In the case of the mosquitoes, a small gauze cage was applied to the shaved side of the animal.

Toxic effects on blood-sucking arthropods became evident on the second day, that is, after the rabbit had taken a total dose of 100 mgm. of 'Gammexane'. It will be convenient to give the results of experiments done after a total dose of 200–250 mgm. of 'Gammexane' had been given to the rabbit.

Cimex lectularius. Feed fully in all stages and show signs of paralysis immediately after feeding. First-stage nymphs were given their first meal on the 'Gammexane' rabbit, subsequent instars were reared to each particular stage on a normal animal and then fed on the 'Gammexane' rabbit. The mortalities, within 24 hours, for each instar were as follows: I, 50–90 per cent; II, 50 per cent; III, 50 per cent; IV, 33 per cent. Adults also show signs of paralysis immediately after feeding, but recover completely within 24 hours. Egg-laying is apparently not impaired, though no record was kept of the number of eggs laid per female. Nymphs which survive their first feed, moult, and are then again fed on the 'Gammexane' rabbit, show approximately the same death-rate as nymphs of the same stage feeding for the first time. Surviving nymphs are, therefore, not resistant to subsequent feeds, and a colony of bedbugs would have little chance of surviving many generations if they feed continuously on a 'Gammexane' animal.

Aedes ægypti. Feed fully and show signs of paralysis, for example, inability to rise from the bottom of the cage, within one hour. All fully fed females died within 24 hours. Females which did not feed and males confined in the same cage were unaffected.

Ornithodorus moubata. Attach immediately but do not feed fully (adults take only an average of 9 mgm. of blood), after which they immediately detach themselves and show obvious signs of distress. Incoordination of movement and inability to walk in a straight line away from light are the most obvious signs. These signs persist for days; some ticks appear to die, others linger on with progressing signs of toxæmia. To date, ten days later, no recoveries have been noted.

Kirkwood and Phillips, working with *Saccharomyces cerevisiæ*, have shown that *i*-inositol inhibits the effect of 'Gammexane'. It is of interest to note that an intravenous injection of 10 c.c. of a 5 per cent solution of *i*-inositol into a rabbit after it had had a total dose of 250 mgm. of 'Gammexane' did not reduce the toxicity of its blood for *O. moubata* fed a few minutes after the injection.

The toxicity of 'Gammexane', when fed to animals continuously, is, so far as I am aware, not known. This will have to be determined. The fact is established, however, that it is possible to interfere with the economy of blood-sucking arthropods by feeding insecticides to the host. The use of such a method in the veterinary sphere appears to have great possibilities.

I gratefully acknowledge the technical assistance of Misses F. Hardy, U. B. Arvidsonn and Messrs. W. Ray and J. M. Thorp.

BOTHA DE MEILLON

Department of Entomology,
South African Institute for Medical Research,
Johannesburg.

[1] De Meillon, B., and Goldberg, L., *Nature*, 158, 269 (1946).
[2] Kirkwood, S., and Phillips, P. H., *J. Biol. Chem.*, 163, 251 (1946).

Physiological Isolating Mechanisms and Selection within the Species *Gasterosteus aculeatus* L.

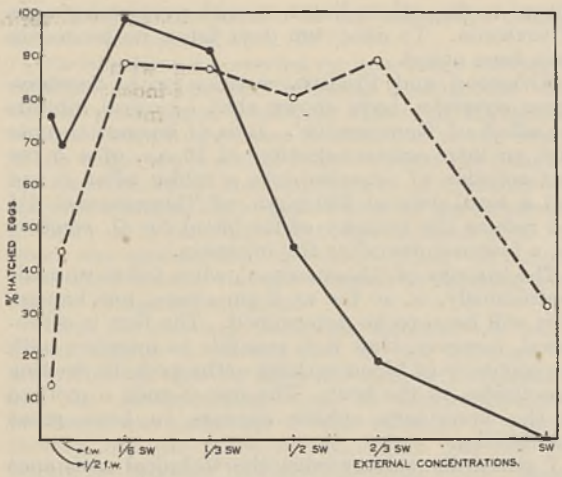
PREVIOUS work on the osmo-regulatory properties in relation to the migration of the stickleback[1] attracted our attention to physiological differences between 'forms' of this species, morphologically distinct, which Bertin[2] believed to represent modifications of a single genetic type.

Further investigations[3] provided physiological causes for the characteristic geographical distribution of these forms. The extension of the study of the osmo-regulatory properties of adult specimens, morphologically distinct as regards their number of lateral shields, at different temperatures proved the existence of physiological barriers between adult populations.

In order to investigate whether these physiological characters are in fact genetic, we undertook a breeding experiment which involved the rearing of approximately 30,000 eggs from ninety pairs of sticklebacks. The parents came from two populations, one of the form *gymnura* with a low mean plate-number, the other of *semiarmata* and *trachura* forms, with a high mean plate-number. The artificially fertilized eggs were allowed to develop at a constant temperature of 23° C. and at different salinities. The different salinities were produced from artificial sea water or ordinary fresh water, dilutions being made with glass-distilled water. The accompanying graph shows the differences in hatching percentages of the eggs.

At high and low salinities, the differences are especially sharp. Other experiments show that these differences are increased at lower temperatures. It seems probable, therefore, that under natural conditions of temperature the two populations differ sharply in their reproductive adjustment to the salinity of the habitat.

Death-rates at given salinities are not at random, but selective. This is shown by the correlations be-



—●—, eggs from *gymnura* forms;
— —○— —, „ „ *trachura* „

tween the number of plates and vertebræ of the parents, the percentage of viable embryos produced and their morphological characters when reared.

The geographical variation of the species as regards the number of lateral shields is also caused by an underlying genetic pattern, as will be shown by detailed publication elsewhere.

The evidence indicates that the mechanisms thus far detected, namely, the physiological differences between adults, the inherited physiological differences between their eggs, and the selective action of external factors, are powerful barriers to the diffusion of genes throughout the species, and maintain the variation at the evolutionary level actually reached.

M. J. Heuts

Zoophysiological Laboratory,
University of Louvain.
Oct. 31.

[1] Koch, H. J., and Heuts, M. J., *Arch. Internat. Physiol.*, **53**, 253 (1943).
[2] Bertin, *Ann. Inst. Oceanogr.*, N.S., 2, Fasc. 1 (1925).
[3] Heuts, M. J., *Ann. Soc. Roy. Zool. Belg.*, **76**, 88 (1945).

Mechanism of Crossing-over

A number of theories have emerged from time to time attempting to visualize the exact mechanism involved during crossing-over, which is now known to be the sole agent conditioning the formation of the cytologically visible chiasma. Among these the one proposed by Darlington[1] based on torsions is the most elaborate, in the sense that it offers an explanation for the long and intricate succession of events. His hypothesis, however, implies a few assumptions for which there are formidable physical objections. The most important of these are: (1) the existence of a pairing force which brings homologues together in the zygotene of meiosis, and (2) the postulate that a break at a particular level in one chromatid under strain induces a break in a non-identical chromatid at precisely the same spot due to transfer of stress. In regard to (1), every cytologist is aware of the physical difficulties which are inherent in suggesting the existence of specific attractions operating over anything more than extramolecular ranges. However, Delbrück's[2] theory of autocatalytic synthesis of polypeptides appears to provide a physico-chemical basis for this force of attraction. In order to test the validity of the second assumption, an attempt is now made to examine the forces operating in a helical system which is in equilibrium under torsion.

In a two-strand rope which is held in the form of a helix, the axial force which will keep it in equilibrium in this form is

$$F = \frac{1}{lr^2}\,[(C\cos^2\alpha + B\sin^2\alpha)\,\eta + (C - B)\sin\alpha\cos\alpha.\,\theta],$$

where l is length of rope; r, α are the radius and angle of helix; η is axial displacement; θ is angular displacement at end of rope; C, B are constants. The tension at any point of the rope is constant and is $J = F\sin\alpha$. η and θ are proportional to l, so that at any intermediate point Q of the rope, distant l_1 from the fixed end, their values are

$$\eta_1 = \frac{l_1}{l}\,\eta,\quad \theta = \frac{l_1}{l}\,\theta.$$

Hence we may also write

$$F = \frac{1}{l_1r^2}\,[(C\cos^2\alpha + B\sin^2\alpha)\,\eta_1 + (C - B)\sin\alpha\cos\alpha\,.\,\theta_1].$$

Suppose now the string is in equilibrium under the action of F applied at its end. If one of the strands is cut at Q, the torsional couple at that point is annulled and the two ends will revolve in opposite directions. But it is an essential feature of the theory that this release of torsional strain is confined to a narrow region near the cut. This is based on the assumption of an affinity or lateral cohesion between the two strands. Hence we may suppose that the effect of the cut is to make the loose ends revolve through small angles. Since the torsional equilibrium of the rope is due mainly to the co-existence of torsional couples in both the strands, it follows that the local release of twist in one strand will result in a corresponding release of twist in the other also at the same point. This will result in changing η_1 and θ_1 at that point in the uncut strand to new values η_1' and θ_1', which will be less than the original values η_1 and θ_1. The corresponding equilibrium value of F, namely, F', is given by

$$F' = \frac{1}{l_1r^2}[(C\cos^2\alpha + B\sin^2\alpha)\,\eta_1' + (C - B)\sin\alpha\cos\alpha\,.\,\theta_1'],$$

so that

$$F' < F.$$

If we suppose that the rope was in limiting equilibrium under F, then it is clear that after one of the strands is cut, it is under the action of F which is more than the value F' required for equilibrium. Hence there is a high probability that the uncut strand will also break at the same point, since the tension at that section is greater than the value required for equilibrium.

Thanks are due to Mr. V. R. T. Achar and to Dr. B. R. Seshachar for helpful criticism.

K. V. Srinath

University of Mysore,
Central College,
Bangalore.

[1] Darlington, C. D., *J. Genet.*, **31**, 185 (1935).
[2] Delbrück, M., Cold Spring Harbor Symposia, **9**, 122 (1941).

MEDAL AWARDS OF THE ROYAL SOCIETY*

Copley Medal

THE Copley Medal is awarded to Prof. Edgar Douglas Adrian, professor of physiology in the University of Cambridge, for his outstanding contributions to nerve physiology.

During the last thirty years, Prof. Adrian has been engaged on a series of systematic investigations of the essential functions of the nervous system which have been extended from a study of the activity of single nerve fibres to the reaction of the cortex of the forebrain of man to impulses that reach it from the periphery. The advance of our knowledge of the working of the nervous system is largely the result of his researches into the nature of the fundamental process of individual cells and combinations of cells.

His early work with Keith Lucas provided important observations on conduction by nerve fibres and on the reactions of muscles. This was followed by a series of independent researches by the combination of a valve amplifier with a capillary electrometer which made possible an analysis of the behaviour of individual sensory receptors and of single motor units. Among many important discoveries these investigations revealed how the frequency of impulses conveyed by each fibre is used in the central nervous system to signal the intensity of peripheral and central events. By the same methods, he undertook a detailed analysis of the activity of many types of sense organs and of simpler reflex actions in terms of the activity of single nerve fibres, and in some cases demonstrated that the same principles underlie all nervous activity throughout the animal kingdom. Other investigations dealt with the nature of the fundamental process in nerve cells and in synaptic regions of the central nervous system.

During the past ten years Prof. Adrian has been mainly concerned with the interpretation of the potential waves in the cortex of the forebrain. Hans Berger had directed attention to the existence of these in man, but the subject was neglected until Adrian and Matthews reinvestigated it. Adrian's subsequent studies included, in the first place, an examination of the electrical activity of the brain and its reaction to messages from the periphery, and in the second place a mapping out of the regions of the cortex which serve as receiving centres for such messages. His aim has been to analyse these phenomena in terms of activity of simple nervous units, and the results of his work are the basis of the subsequent development of electroencephalography, which has attained an important place in both physiological and clinical investigations.

By his researches on the exposed brains of animals, Prof. Adrian determined the laws of spread of activity in the cortex, its reactions to natural and artificial stimuli that reach it, and showed that the interaction between a local excitation and the background of spontaneous activity is the essential feature of a cortical response. By a study of the comparative physiology of the sensory areas of the brain he has also shown how their development and to some extent their reactions to peripheral stimuli depend on the structure and mode of life of the animal.

After determining the representation in the brain of receiving stations for superficial and proprioceptive stimuli he investigated that of vision and hearing. He has even succeeded in demonstrating the different features of impulses that reach the visual cortex from the rods and cones of the retina; he has also dealt with the distribution and significance of certain non-sensory afferent impulses, as those that reach the cerebellum.

Adrian has blazed many trails in his exploration of the territory of nerve physiology. It is certain that for many years to come his lead will be followed and the new knowledge will be consolidated along the lines of his pioneering work.

Rumford Medal

The Rumford Medal is awarded to Sir Alfred Charles Glyn Egerton, professor of chemical engineering, University of London, at the Imperial College of Science and Technology, for his distinguished researches on combustion.

The Rumford Medal, founded in 1800, is awarded once every second year "to the author of the most important discovery or useful improvement which shall be made and published by printing or in any way made known to the public in any part of Europe during the preceding two years on Heat or on Light, the preference always being given to such discoveries as, in the opinion of the President and Council of the Royal Society, tend most to promote the good of mankind".

Sir Alfred Egerton admirably fulfils the requirements of these terms of award. He is a physical chemist whose researches have always been directed towards the application of physico-chemical principles to the process of combustion of hydrocarbons in all its ramifications. For some time the approach to combustion problems has been empirical because there was no satisfactory physico-chemical basis of the theoretical or practical aspects to make further significant progress possible. This background has now been partly provided by Egerton, who was one of the first to see clearly how necessary it was to apply the new conceptions of combustion to the complex processes occurring under the conditions obtaining in internal combustion engines. One of the great obstacles to achieving greater efficiency is the difficulty of preventing premature detonation. This phenomenon is essentially a chemical one in the sense that organic peroxides, produced during combustion, are known to be responsible for the pre-ignition. Thus the chemical behaviour of peroxides might provide a key to the solution of the problem, and much of Egerton's work has been devoted to this inquiry. The investigation involved the elaboration of special physical techniques, since ordinary chemical methods were inapplicable to this type of research.

During the War, Egerton has directed his attention to the vital problem of ensuring that combustion appliances should be devised and operated with the maximum possible efficiency. This can only be achieved by a thorough scientific analysis, hitherto lacking, mainly because the problem had scarcely been considered worthy of serious study. The result of his labours cannot fail to be of great benefit to Great Britain during the period of very low fuel production, and will lead to considerable economies in all circumstances.

The characteristic of Egerton's work has been the application of modern physico-chemical methods to current scientific and technical problems of great

* From the remarks made by the President of the Royal Society in presenting the medals for 1946.

moment, combined with experimental researches developed with great ingenuity.

Royal Medals

A Royal Medal is awarded to Sir William Lawrence Bragg, Cavendish professor of experimental physics in the University of Cambridge, for his investigations of the structure of solids.

The diffraction of X-rays by crystals was observed in 1912 by Laue, Friedrich and Knipping, but the pioneers of the present-day development are the late Sir William Bragg and his son Sir Lawrence. It was W. L. Bragg who formulated the law $n=2d/\sin\theta$ that is now so familiar in all studies concerned with the structure of molecules and their states of aggregation. Soon after Laue's discovery there followed, from father and son, a series of papers on the phenomena of X-ray 'reflexion' on one hand and the determination of fundamental crystal structures on the other, the far-reaching consequences of which could scarcely have been foreseen, even by their authors. At the present time, crystal analysis by X-rays is an established technique, a sharp tool of research that lays bare the complexities of organic and mineral matter alike.

The inspiration and genius of Bragg are seen in so many of the modern developments of X-ray diffraction to structural analysis that it is possible to select only a few outstanding illustrations. His principal interest has always lain in the interpretation of diffraction phenomena, with the view of making the actual methods of analysis more precise, more simple, and more extended. In developing such methods he and his collaborators have elucidated the atomic arrangement in a great number of fundamental types of inorganic crystal structures. Chief among these are those of the diamond and the elementary salts and oxides, in the study of which the subject found its first beginnings. After these, perhaps his greatest analytical success is shown in the field of the silicates. A chemical riddle has been transformed into a system of simple and elegant architecture. He has also contributed greatly to our knowledge of the structure of metals and alloys and their phase changes, and of the relations between their physical properties and atomic arrangement in the crystalline state. Latterly, he has brought to a still clearer focus the concept of X-ray diffraction as a branch of optics, and has thus initiated methods that have already gone far towards replacing the earlier laborious calculations by rapid devices based on the analogy of the diffraction of visible light.

The implications and applications of the principles and methods of X-ray spectroscopy and X-ray structure analysis are one of the wonders of modern science, and with this manifold triumph the name of Sir Lawrence Bragg is inseparably associated.

A Royal Medal is awarded to Dr. Cyril Dean Darlington, director of the John Innes Horticultural Institution, in recognition of his distinguished contributions to cytology.

The importance of Darlington's work lies not so much in the discovery of isolated new phenomena—although he has discovered many of these—but rather in the achievement of a synthesis which brings together a highly diversified body of apparently disconnected facts into an integrated system.

Darlington's first major achievement was the clarification of the relations between the two main forms of nuclear division—mitosis and meiosis. Out of the confused mass of available observations, he singled out as fundamentally significant two facts: first, that chromonemata attract one another specifically, by an attraction which is satisfied when two similar threads are associated; and secondly, that in the earliest stage of mitosis each chromosome is already split into two halves, while at the beginning of meiosis they are still single. On the basis of these two facts, he showed that the relation between the two forms of division could be understood as the result of a temporal shift in the operation of a single physiological process. His so-called 'precocity' theory of meiosis was then supported by a whole series of new observations, in which the resources of comparative study and of new techniques were used for the specific purpose of obtaining answers to critically formulated questions.

Starting from the basis of the relation between the two major forms of nuclear division, Darlington has pursued his inquiry in two directions. On one hand, he has accumulated a very large body of facts concerning the detailed mechanics of cell division in many different groups of plants and animals. The comparative method enabled him to reach important new conclusions as to the mechanism of crossing-over, the cycles of spiralization and contraction of chromosomes, the nature of the mitotic spindle and the forces exerted by it and within it, the role of the centromeres and so on. These results have laid a broad foundation of observation and deduction which appears, for the first time, firm enough to bear a superstructure of physico-chemical interpretation. Proceeding in quite another direction, Darlington discussed the implication of his cytological ideas on evolutionary theory. The existence of the mitotic and meiotic modes of division had been explained as the result of different modalities in the application of a single set of physiological principles; Darlington showed that, further, slighter modifications could produce many of the widely diverse series of reproductive mechanisms met with in the animal and plant kingdoms. He emphasized the fact that the mechanism of evolution is itself subject to evolutionary changes.

More recently, Darlington's work has led him to the investigation of the general problems of gene action, of the physiological action of the two major types of nucleic acid, and the relation between the gene and other similar bodies in the cytoplasm. Darlington was one of the first to enter this highly speculative field, and he has contributed not only his full quota of stimulating speculation, but also a large share of the still scanty facts. It is not too much to say that Darlington's results and theories are recognized as the basis of modern nuclear cytology.

Davy Medal

The Davy Medal is awarded to Prof. Christopher Kelk Ingold, professor of chemistry in the University of London, at University College, for his outstanding researches in physico-organic chemistry.

Progress in one of the most active fields of chemical science during the present century has resulted from attempts to elucidate the detailed mechanism of organic reactions in terms of modern physical concepts. Throughout this development, Ingold's contributions have been especially distinguished. Possessing detailed knowledge and understanding of both the physical and organic branches of the science, he has

been in a position to effect the synthesis of the two modes of approach without which a successful attack on the difficult, yet fundamental, problems involved could not be achieved.

It is not possible in short compass even to outline the range of investigations with which Ingold has been concerned, but brief mention may be made of the work on stereochemistry dealing with ring strain and the effect of *gem* dimethyl groups on the valency angles of carbon. A further application of underlying physical principles is evident in his investigations of tautomerism in triad systems, and in the development of our ideas on ring-chain tautomerism. This work led on to more general studies of the mechanism of reactions, including the difficult question of substitution in the benzene ring, in addition to the ordinary reactions of organic chemistry, such as hydrolysis and substitution, which despite their apparent simplicity have proved to be complicated and difficult to interpret. The success which Ingold has achieved in interpreting these phenomena in terms of the electron theory of valency is striking; but in addition he has played the most prominent part in the experimental investigations which have led to our present knowledge of the kinetics and mechanism of organic chemical reactions. Ingold always has been interested in the elucidation of the course of chemical change by application of physico-chemical methods based on reaction velocities, and in this field may be cited the extensive work on the mechanism of substitution at an aliphatic carbon atom, leading to the recognition of the uni- and bi-molecular processes, by means of which so much has been done to solve the difficult problems raised by the Walden inversion and the phenomena of racemization. In these intractable regions the contribution of Ingold and his flourishing school are of fundamental importance.

Another aspect of his work involves a still deeper concern with physical principles as applied to organic chemical problems. His interest in the chemistry of benzene has led him to investigate in the fullest detail, using infra-red and Raman spectra, and indeed all available physical methods of approach, the fine structure of the benzene molecule. In order to provide the necessary data it was necessary to devise methods for the preparation of the various deuterium-substituted benzenes—no mean feat of organic chemistry in itself—and the interpretation of the experimental results in terms of quantum mechanical principles has recently been published in an issue of the *Journal of the Chemical Society*, which he monopolized. Although his theoretical contributions have attracted more attention, the originality of his experimental technique is equally noteworthy and his happy selection of crucial tests amounts to genius.

Darwin Medal

The Darwin Medal is awarded to Sir D'Arcy Wentworth Thompson, professor of natural history in the University of St. Andrews, in recognition of his distinction as a zoologist.

Sir D'Arcy Thompson is now in his sixty-second year as a professor of biology and natural history. He published his first scientific paper in 1879. His most distinguished work, "On Growth and Form", appeared in 1917 and was republished in a new and enlarged edition in 1942. He is still writing, but mainly in the field of the classics, where he is a considerable scholar, and a great authority on all animals that have appeared in classical texts.

D'Arcy Thompson's scientific work ranges over a wide field of general zoology and marine biology. He is an expert on the subject of fisheries, and for a considerable period did tireless work both for the Conseil International pour l'Exploration de la Mer and the Fishery Board for Scotland, carrying out hydrographical observations and being responsible for a great deal of fishery statistics. In the main, however, D'Arcy Thompson's scientific reputation rests on his work on growth, and the dimensional relationships of animal forms. The better part of the foundation of modern research into these subjects is his demonstration of methods by which the shape of the living organism can be brought into the field of controlled mathematical inquiry.

D'Arcy Thompson's work springs essentially from an inquiry into the relationships of animal forms, and from an attempt to introduce a degree of mathematical precision into the otherwise purely descriptive language of systematic evolution. He was able to show, for example, that the evolution of one form from another could often be illuminated by the use of Cartesian transformations. By making clear the formal unity and coherence in the relationship of animals which apparently differ in a multitude of ways, his studies made possible the quantitative demonstration of steps in the evolution of different forms, and more so, the orderly process of change in the development of the same form. In his own words, growth can be studied as a systematic deformation of form at an earlier stage. He showed, for example, that relative growth-rates in different parts of the body are distributed according to an ordered system of growth-gradients. This concept can be applied to certain types of evolutionary transformation, since it helps to explain how a single genetic change can automatically affect both the size and the growth interrelations of several organs. The development and illustration of the theory of allometry is another extension of D'Arcy Thompson's ideas.

The wide variety of problems to the solution of which D'Arcy Thompson has opened the door is well indicated in the 'Festschrift' presented to him last year. In introducing his classic "On Growth and Form", D'Arcy Thompson declared that it required no preface, since it was all preface. His elaboration of the subject covers so wide a field, however, that, until such time as some different and all-embracing set of general propositions is put forward to take the place of those he propounded, individual contributions to the study of growth and bodily transformation must necessarily represent isolated developments of the structure which he has presented to us. D'Arcy Thompson's work will always be regarded as a necessary step in the development of biological knowledge.

Sylvester Medal

The Sylvester Medal is awarded to Prof. George Neville Watson, professor of pure mathematics in the University of Birmingham, in recognition of his distinguished contributions to mathematical analysis.

Prof. Watson is a mathematician of outstanding perseverance and analytical skill. For forty years he has devoted his energies to pure mathematics, and has made many important and exhaustive contributions, particularly in the field of analysis. The most important researches of Watson's earlier period are those on asymptotic expansions: his great memoir "A Theory of Asymptotic Series" appeared in the *Philosophical Transactions* of 1911 and was

followed by a stream of other writings dealing with the characteristics and transformations of these series, and with their applications to several well-known functions of importance in mathematical physics. This group of discoveries has enriched the region of mathematics in which Stirling was the pioneer two centuries ago, and where the methods of approximation are reduced to a precise science. These include the method of 'steepest descent', and any account of asymptotic series to-day must be based to a great extent upon Watson's discoveries.

About that time many of the ablest pure mathematicians were trying to sum a difficult oscillating series involving Bessel and Legendre functions, which had presented itself in the theory of the diffraction of wireless waves round the earth. Watson solved the problem by a new method (1918), and went on to study the more difficult case of the transmission of electric waves when it was assumed that the earth is surrounded by a concentric conducting layer, as suggested by Heaviside. Watson's powerful analysis made possible a great advance in the physical theory.

Another example of his capacity for providing a brilliant solution of a problem which had been attempted by many of his predecessors is furnished by his paper on the Rogers–Ramanujan identities. Following this came his work on general transforms in which he solved a problem which many celebrated mathematicians had attempted without success. This is probably Watson's greatest achievement, and ranks as one of the most important contributions to the subject made in recent years. In addition it has had the great merit of inspiring a large amount of work by other mathematicians. Among the more notable papers of the next years were those on "Generating Functions of Class-Numbers", on Ramanujan's continued fraction, and one that gave the proof of Ramanujan's assertion about the number 691 which occurs in 'almost all' the terms of a certain infinite product when expressed as a series. The series of papers on singular moduli, during the period 1932–36, are deservedly celebrated.

His great book on Bessel functions is perhaps the most impressive single work that has ever been written on the analysis of functions. In collaborating with Prof. E. T. Whittaker in the second and later editions of "Modern Analysis", he has shown the same breadth and power and has influenced the course of higher analytical mathematical teaching throughout the world.

Hughes Medal

The Hughes Medal is awarded to Prof. John Turton Randall, Wheatstone professor of physics at King's College, University of London, in recognition of his distinguished contributions to applied physics, and especially of his development of the magnetron.

In 1940 Prof. Randall, while working in the laboratory of Prof. M. L. Oliphant, at Birmingham, agreed to join Dr. H. A. H. Boot in an endeavour to utilize the magnetron principle for the production of electromagnetic waves of frequency greater than 3,000 Mc./sec. Previous work in the laboratory had shown that satisfactory circuits for these wave-lengths must be an integral part of the internal structure of the valve itself. Randall and Boot together put forward the suggestions that such a circuit, for a multi-segment magnetron, should consist of a revolver-like arrangement of holes, spaced evenly about a circle, each hole communicating by means of a slot with a central cavity in which the cathode was mounted. The first trials with demountable valves using tungsten cathodes were immediately successful, and it was shown that the suggested form of valve can generate continuously oscillations of the required wave-length.

With the assistance of S. M. Duke, Randall and Boot were able to develop methods of construction of the magnetron which enabled oxide-coated cathodes to be used, and which therefore gave high powers when the valve was subjected to pulsed operation. Empirical investigation fixed the best coupling arrangement by which the power could be fed into an external circuit. Careful investigation of the operation of a valve showed that it was subject to sudden changes of wave-length, a condition which limited its applicability to Service equipment. This difficulty was overcome by the 'strapping' methods developed by Dr. J. Sayers.

There is little doubt that the magnetron valve was the prime factor in the improvements made in radar during the War, and Randall deserves a very large share of the credit for this development.

He contributed also to the problem of crystal detection of centimetre waves.

Randall's studies of fluorescence and phosphorescence were of a high standard, and his careful and painstaking experimental work did much to establish on a firm basis the theories of semi-conductors developed by Wilson and others, and especially the assumptions about the existence of 'electron traps'. His work on practicable phosphors has been of importance in the development of fluorescent lamps, and of the screens of cathode-ray tubes.

Randall has also made contributions to the X-ray investigation of the structures of glasses and of liquids, and he developed satisfactory forms of oxide cathodes for the fluorescent lamps.

ELECTROMETRIC ANALYSIS

A JOINT meeting of the Physical Methods Group of the Society of Public Analysts and other Analytical Chemists, the Cardiff and District Section of the Royal Institute of Chemistry and the South Wales Section of the Society of Chemical Industry was held at University College, Cathays Park, Cardiff, on October 11, when three papers were read on "Electrometric Analysis".

In discussing the improvements to *p*H-measuring apparatus for use with the glass electrode, Mr. A. D. Elmsly Lauchlan pointed out that if the glass electrode is to be robust, its resistance will be very high, and accurate results can only be obtained if the valve is arranged to have a high grid resistance, such as 10^{13} ohms, and the lead from the electrode to the valve is well screened and carefully insulated; a leakage of 10^{9} ohms can produce errors of about 8–9 per cent. The use of modern insulating materials, however, has raised the insulation to such a level as to make error from this source negligible. Small four-electrode valves are now used instead of the large special electrometer types, and an instrument was shown in which these improvements have been carried out.

Some manufacturers in the United States have adopted the electronic detector, the so-called 'magic eye', in place of the usual galvanometer; but possibly on account of its slightly lower sensitivity and the difficulty in noticing small changes in the shadow at

the balance point, it has not been used on *p*H meters in Great Britain. The expansion of automatic recording and controlling of *p*H has been largely due to such improvements as have been made in manually operated instruments, rather than to any particular feature of the recorder itself.

Improvements in the glass electrode due to the use of pure materials free from aluminium oxide have enabled theoretical results to be obtained over a wide range of *p*H. Such electrodes are thick and strong, and can be made as small as 2·5 mm. in diameter; they are useful for micro-tests and for medical and dental work.

Further improvements have resulted in the production of a glass electrode for use in the alkaline range up to *p*H 14; the sodium ion error of a 1 *N* solution at *p*H 12 is zero with the new electrode, whereas for the usual type it is about 0·6 *p*H. The accuracy of such an electrode was about 0·02 *p*H. Examples of various types of glass electrode were shown.

The latest types of electro-titration apparatus are much neater and smaller than the prototypes, and here again the galvanometer or the 'magic eye' is employed as the detector of the equivalence point. The slightly lower sensitivity of the 'magic eye' is of less importance, as much larger potential changes are encountered. The instruments are battery- or mains-operated, depending on the detector used, and there is little to choose between them in a matter of convenience. Both types were suitable for all the usual acid–alkali and potentiometric titrations, and a demonstration of the latter was given showing the large deflexion at the equivalence point with one drop of a dilute solution. These instruments are especially convenient for the 'dead stop' end-point method, which is rapidly finding new fields.

The applications of the electro-titration apparatus were discussed more fully by Mr. R. J. Carter, who dealt with acid–alkali, precipitation and oxidation-reduction types in general, and with the Karl Fischer method of determining small amounts of water in some detail. Electrometric methods for acid–alkali titrations are particularly suitable where feebly dissociated acids and bases give poor end-points; accurate results can nearly always be obtained by noting the change of sign of the second differential when the E.M.F. is plotted against the volume of the reagent used. Titrations can also be carried out in non-aqueous media made conducting by the addition of lithium chloride, or by using a mixed solvent such as benzene and isopropyl alcohol with 1 per cent of water. The solvent must permit sufficient ionization of acidic materials of dissociation constants greater than 10^{-7} in water.

A method for determining the saponification number of fats and oils, which avoids the need for a blank titration, was described. The titration curve obtained, after saponifying the oil, by titrating with acid shows two breaks; the acid added in the portion between the two inflexion points on the curve is the amount required to liberate the free fatty acid, and this is equivalent to the saponification number of the oil.

A series of graphs giving the types of titration curves obtained with various non-aqueous solvents was shown, indicating that by a choice of a suitable solvent it is easy to distinguish between acids the *p*Ka (aqueous) values of which are very close together.

In many potentiometric titrations, particularly those involving the use of silver, there is a danger that the liquid from the reference cell may leak out and contaminate the test solution. This difficulty is neatly overcome by the use of the glass electrode as reference cell, provided the hydrogen ion activity of the solution does not change appreciably.

Examples were given of the titration of two ions in solution in the presence of each other, such as hydrogen sulphide and thiophenol, by titrating with *N*/10 alcoholic silver nitrate in *N*/10 alcoholic sodium acetate, a procedure comparable with the estimation of mercaptans in petroleum. Graphs were also shown of titration curves of the simultaneous determination of iodide and chloride, and of thiocyanate and chloride.

The oxidation-reduction titration by ferrous ammonium sulphate of the nitrate ion, formed by the decomposition of nitroguanidine with concentrated sulphuric acid, and its possible application to the estimation of nitrourea, were mentioned, together with the determination of fluorine in organic compounds with cerous nitrate, as interesting extensions of older methods.

Polarization end-points, discussed in principle in the third paper, were shown to have applications to already existing methods, such as the determination of dissolved oxygen in water and of ascorbic acid by means of 2·6 dichlorophenol indophenol. The method offers greater sensitivity than the starch indicator and is also capable of high accuracy in coloured solutions.

Perhaps the most outstanding use to which the method has been placed is the determination of small amounts of water by means of the Karl Fischer reagent, used for the determination of moistures. The material of which the water content is to be determined is mixed with a solution of iodine in pyridine saturated with sulphur dioxide; the water in the sample allows some of the iodine and sulphur dioxide to react, and the excess iodine is found by back titration with methanol containing a known quantity of water. The complete removal of the iodine at the end-point allows the cathode to become polarized and the galvanometer needle returns to zero. By the use of a higher polarizing E.M.F. of 1–2 volts instead of the more usual 15–20 millivolts, it has been found possible to make a direct titration, when the end-point is given by the excess iodine depolarizing the cathode and causing the galvanometer needle to be deflected.

From the amount of literature on the subject, the method appears to have almost unlimited applications, such as the estimation of organic radicals, carbonyl compounds by reaction with hydroxylamine hydrochloride, the hydration of salts, and the analysis of mixtures of primary and secondary amines,

It was a pity that Dr. D. P. Evans's paper on polarization end-points could not be given in full, owing to the lateness of the hour, as this subject is well worth careful study by those interested in improving existing titrations and also in finding new volumetric methods. A brief description was presented of the principle of the polarization end-point, which was first given proper recognition by Foulk and Bawden in the United States; the method is particularly attractive as the ease of determining the equivalence point is much greater than with the potentiometric methods, the attainment of equilibrium being almost instantaneous.

When two noble metal electrodes are immersed in a solution and are connected to a source of E.M.F. less than the maximum back E.M.F. developed by the system, a current will flow for a short time until

small quantities of oxygen and hydrogen have been deposited on the anode and cathode. The back E.M.F. developed then reduces the current to an extremely small value, so that a galvanometer connected in series with the electrodes almost immediately shows no deflexion, or at the most only a small displacement of the needle. The subsequent addition of a substance capable of depolarizing one of the electrodes gives rise to a deflexion on the galvanometer.

In order to demonstrate the method, a titration of $N/500$ sodium thiosulphate with iodine was shown. With the electrodes immersed in the solution of thiosulphate and connected to a source of E.M.F. of 15–20 millivolts, the galvanometer showed zero deflexion since the back E.M.F. of the cell is due to the polarization of the cathode; the anode remains depolarized by the reducing action of the thiosulphate. The addition of small quantities of iodine causes a temporary displacement of the galvanometer needle as the iodine partially depolarizes the cathode; but the hydrogen, which has been removed, is quickly replaced, and the needle returns to zero until an excess of iodine keeps the cathode depolarized and reduces the back E.M.F., so that the galvanometer needle is steadily deflected by the current flowing.

An inversion of the above titration allows the current to flow until the thiosulphate removes all the iodine and allows the back E.M.F. to rise, bringing the current and therefore the galvanometer needle to zero; hence the term 'dead stop' end-point.

In practice, it is considered better to adopt the former scheme whereby the electrodes remain polarized until the equivalence point, as there is not the same danger of over-running the end-point.

When working with dilute solutions such as $N/500$, an error can arise due to an insufficiency of iodide ions to depolarize the anode, so that the accidental current passing with the addition of each drop of iodine added to the thiosulphate results in polarization of the anode and, therefore, an increase in the back E.M.F. An excess of iodine must then be added to reverse the galvanometer deflexion. This error can amount to 0·16 ml. on 1 ml. of $N/500$ iodine; but by the simple expedient of adding 5 ml. of 10 per cent potassium iodide solution, results repeatable to 0·01 ml. of $N/500$ iodine can be obtained, an accuracy far beyond the capabilities of the starch indicator.

In the discussion which followed these papers, the relative merits of the galvanometer and the 'magic eye' as the detector in *p*H meters were reviewed; it was stated that while it was possible to detect changes of 2–3 millivolts on the 'magic eye', the galvanometer was considered to be rather better as changes of 1 millivolt could be noted. The mention of standard half-cells for electro-titrations brought forward the interesting application of the glass electrode for such a purpose where changes in *p*H do not take place. When such a condition could not always be obtained, it was possible to have a glass electrode made specially insensitive to *p*H changes.

After hearing the papers, it was clear that electrometric analysis should not and need not be considered as a special means to be used when others fail; suitable apparatus and well-tested methods are now available, which together can help the analyst to obtain more quickly even more accurate results. The papers presented at the meeting will be published in due course in the *Analyst*.

A. D. Elmsly Lauchlan

VENEREAL DISEASES IN GREAT BRITAIN

RELIABLE information about the incidence of venereal diseases in Britain is still lacking. This is particularly the case with gonorrhœa, where many patients, especially since the sulphonamide era, seek private treatment. Since 1931, when clinics began to record numbers of 'new' syphilis infections (of less than one year's duration), it has been possible to get a fairly accurate idea of the trend in this disease.

The increase in syphilis in the First World War was offset in the two decades that followed by the use of drugs of the arsphenamine series. For gonorrhœa there were, until comparatively recently, no comparable remedies, and the figures for this disease remained unchanged between the Wars.

The Second World War brought a marked increase in venereal diseases, but the use of sulphonamides for gonorrhœa, and, more recently, of penicillin for both gonorrhœa and syphilis, has kept the situation from degenerating to the state reached in 1918.

The incidence of early syphilis contracted in Britain declined by more than 46 per cent between 1931 and 1939, rose sharply then to reach a peak about 1943 and then started to decline slowly. An increase in 1945 suggests the importation of disease from abroad. The rate per 10,000 of population was: in 1931, 2·28; 1939, 1·21; 1943, 2·34; 1944, 2·26; 1945, 2·60.

So far as can be ascertained the increase in gonorrhœa was less than that in syphilis, and reached its peak in 1942, when it was probably about 86 per cent higher than in 1939. By 1944 it had declined to about 35 per cent higher than in 1939, but this decline was entirely accounted for by males, the rate in females actually increasing in 1944.

In 1942 the Government, in co-operation with the Central Council for Health Education, began a campaign to combat the spread of venereal diseases. Radio broadcasts, films, newspaper and magazine advertisements, posters and pictorial exhibitions were employed. Surveys suggested that the campaign was approved and understood by the public.

The introduction of Defence Regulation 33B in 1942 was the first departure from the practice of treating venereal disease on an entirely voluntary basis. The Regulation was aimed at the habitual spreader of disease and provides that any person named as a source of infection by two or more patients may be compelled to undergo examination by a special practitioner and to receive any necessary treatment until pronounced "free from venereal disease in a communicable form". Only a few thousands of cases have been thus brought under control, but even so the effort has been of importance.

There has also been increasing use of social workers by treatment centres to trace contacts and do follow-up work.

Since 1939, forty-one new treatment centres have been opened, and existing centres have held additional sessions. There was close co-operation between the civilian and the Forces venereal diseases services[1].

Specially qualified general practitioners have been appointed, especially in rural areas, to treat patients with venereal diseases, and the increased facilities ensure, so far as possible, that no patient need travel more than ten miles for treatment.

James Marshall

[1] *Nature*, 151, 46 (1943).

FORTHCOMING EVENTS

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

Monday, December 9

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at Faraday Building, 9th Floor, South Block, Knightrider Street, London, E.C.4), at 5 p.m.—Mr. C. H. Wright: "The Circuit Laboratory in War-time".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Capt. J. C. Taylor: "Marine Life-Saving Appliances" (Thomas Gray Lecture).

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Major Kenneth Gordon: "Progress in the Hydrogenation of Coal and Tar".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Mr. J. O. C. Vick: "Organisation of an Industrial Instrument Department".

CHEMICAL SOCIETY, EIRE SECTION (in the Department of Chemistry, University College, Upper Merrion Street, Dublin), at 7.30 p.m.—Prof. Harold C. Urey: "Isotopes".

Tuesday, December 10

BRITISH RHEOLOGISTS' CLUB (joint meeting with the FARADAY SOCIETY, at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. R. L. Brown: "Dilatancy" Dr. E. W. J. Mardles: "Thixotropy".

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

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Harold Spencer Jones, F.R.S.: "Three Astronomical Centenaries, 3, The Discovery of the Planet Neptune, 1846".*

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Design and Performance of Receiving Aerials for Television" (to be opened by Mr. E. C. Cook, and to which members of the Television Society are invited).

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Dr. Tracy Philipps: "The European Ethnological Composition of Canada".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, Strand, London, W.C.2), at 6 p.m.—Mr. A. Cunnington and Mr. G. W. Golds: "Railway Lighting, some Lessons from Experience and Views on the Future".

CHEMICAL SOCIETY, NORTHERN IRELAND BRANCH (in the Great Hall, Queen's University, Belfast), at 8 p.m.—Prof. Harold C. Urey: "Isotopes".

INSTITUTE OF PHYSICS, SCOTTISH BRANCH (at the University, Glasgow),—Prof. M. L. Oliphant, F.R.S.: "Betatrons".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (at the College of Technology, Manchester).—Mr. F. R. S. Smith and Mr. G. Forrest: "Aluminium Alloys, their Properties and some of their Applications to Structure".

Wednesday, December 11

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5 p.m.—Dr. W. Hubball: "The Cotton Trade's War-time Commodity Supplies".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Mr. John Gloag: "Planning Research for Industrial Design".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Basil Charles King: "The Textural Features of the Granites and Invaded Rocks of the Singo Batholith of Uganda and their Petrogenetic Significance"; Mr. Peter Colley Sylvester-Bradley: "The Shell Structure and Evolution of the Mesozoic Ostracod *Cypridea*".

INSTITUTE OF PETROLEUM (joint meeting with the INSTITUTION OF FIRE ENGINEERS, at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Symposium on "Oil Fires".

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. C. Cuffe: "Lightning Surges on Transmission Lines in Ireland".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. F. Ian G. Rawlins: "Natural Philosophy and the Fine Arts".*

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. S. P. Woodley: "Photolofting".

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Films: "Steam" (Babcock and Wilcox); "Steam" and "Furnace Practice" (Ministry of Fuel and Power).

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. M. Wishart: "The Development of Sewage Purification Processes"

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE SECTION (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. R. Belcher and Dr. C. L. Wilson: "Methods and Apparatus in Inorganic Microchemistry", including a demonstration of methods and an exhibition of apparatus.

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. D. P. Hopkins: "Fertilizers, Manures and Nutrition" Members of the Agriculture and Food Groups are invited).

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (at the Loughborough Hotel, Loughborough), at 7 p.m.—Symposium on "U.S.A. and Canada".

Thursday, December 12

SOCIETY OF DAIRY TECHNOLOGY, MIDLAND SECTION (at the North Stafford Hotel, Stoke-on-Trent), at 2 p.m.—Mr. H. B. Hawley: "Aspects of Creamery Hygiene and Process Control".

IMPERIAL INSTITUTE, MINERAL RESOURCES DEPARTMENT (in the Cinema Hall, Imperial Institute, South Kensington, London, S.W.7), at 3 p.m.—Mr. L. J. D. Fernando: "The Geology and Mineral Resources of Ceylon" (Recent Progress in Geological Investigation and Mineral Developments in the Colonies, 6).*

INSTITUTE OF FUEL, EAST MIDLAND SECTION (at the Gas Demonstration Theatre, Nottingham), at 3 p.m.—Dr. C. C. Hall: "Oil from Coal by the Fischer - Tropsch Process in Germany".

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

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "What Chemistry Owes to X-Rays, 2, Organic and Biological Chemistry".*

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. G. E. Haefely: "Growing Importance of Plastics in the Electrical Industry".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. Kenneth Gordon: "Progress in the Hydrogenation of Coal and Tar".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (joint meeting with the ILLUMINATING ENGINEERING SOCIETY, in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Dr. J. H. Shaxby: "Colour and the Eye".

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. Z. M. Rogowsky: "Mechanical Principles of the Screw Extrusion Machine".

WOMEN'S ENGINEERING SOCIETY (in Room 4, Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.30 p.m.—Exhibition of Technical Films: "Engineering in War and Peace", "The Mosquito", "Kelvin, Master of Measurement".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester 2), at 6.30 p.m.—Miss A. G. Shaw: "Motion Study".

CHEMICAL SOCIETY (in the Chemistry Department, The University, Manchester), at 7 p.m.—Scientific Papers.

ROYAL PHOTOGRAPHIC SOCIETY (joint meeting of the SCIENTIFIC AND TECHNICAL GROUP and the COLOUR GROUP, at 16 Princes' Gate, London, S.W.7), at 7 p.m.—Mr. R. G. Horner: "Requirements of Reproduction" ("How it Works in Colour Photography", 2).

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Dr. T. E. Wallis: "A Study of Pollen".

ROYAL INSTITUTE OF CHEMISTRY, TEE-SIDE SECTION (joint meeting with the NEWCASTLE SECTION of the SOCIETY OF CHEMICAL INDUSTRY, at Norton Hall, Norton, Stockton-on-Tees), at 7.15 p.m.—Dr. M. P. Applebey: "The Changing Relation of Science and Industry".

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. C. S. Whewell: "Further Developments in Scouring".

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (joint meeting with the GUILD OF PUBLIC PHARMACISTS, in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7.45 p.m.—Mr. R. G. Heppell: "Radium in the Treatment of Cancer".

Friday, December 13

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. F. Fancutt and Dr. J. C. Hudson: "The Protection of Ships' Bottoms, and the Formulation of Anti-Corrosive Compositions".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. J. P. M. Prentice: "Visual Observation of the Giacobinids, 1946"; Dr. A. C. B. Lovell, Mr. C. J. Banwell and Mr. J. A. Clegg: "Radio-echo Observation of the Giacobinids, 1946"; Mr. J. S. Hey, Mr. S. J. Parsons and Mr. G. S. Stewart: "Radar Observations of the Giacobinid Meteor Shower, 1946"; Prof. S. Chapman, F.R.S.: "Electromagnetic Forces in Solar Prominences" (discussion); Prof. T. G. Cowling: "Alfvén's Theory of Sunspots".

CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. D. Allan: "A Survey of Fat Splitting".

INSTITUTE OF FUEL, SOUTH WALES SECTION (at the Engineers' Institute, Cardiff), at 5.30 p.m.—Dr. J. H. Griffiths: "Cleaning South Wales Small Coal".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. S. J. Spilsbury and Mr. A. Felton: "A Millisecond Chronoscope"; Mr. A. Butterworth: "A Sensitive Recording Magnetometer".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. S. J. Wright: "Mechanical Engineering and Agriculture" (First Agriculture Lecture)

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Sir Alfred Egerton, F.R.S.: "Combustion of Fuels" (Andrew Laing Lecture).

INSTITUTE OF ECONOMIC ENGINEERING, LONDON REGION (at Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Mr. J. R. Kell: "Industrial Heating"

PAPER MAKERS' ASSOCIATION (TECHNICAL SECTION), NORTHERN DIVISION (at the Engineers' Club, Manchester), at 7 p.m.—Mr. Edwin Davis: "Non-Ferrous Metals in the Paper Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. R. Harington, F.R.S.: "The Body's Chemical Mechanisms of Defence".

Saturday, December 14

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, STUDENT SECTION (at Bolbec Hall, Newcastle-upon-Tyne 1), at 6.45 p.m.—Mr. Robert Hinchliffe: "50 Years of Progress in Propulsive Efficiency".

APPOINTMENTS VACANT

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

LECTURER IN BIOLOGY (with subsidiary Chemistry) at the Technical College and School of Art—The Chief Education Officer, Shire Hall, Cambridge (December 14).

TEACHER OF MECHANICAL ENGINEERING SUBJECTS in the part-time Day and Evening Classes and the Secondary Technical School of Engineering—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N.W.4 (December 14).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER for work on general information, preparation of reports, etc., a SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER for statistical work on problems connected with the carbonization of coal in coke ovens and general investigations, a SCIENTIFIC OFFICER or EXPERIMENTAL OFFICER for work at the Midland Coke Research Station, Sheffield, and LABORATORY ASSISTANTS, Grades II and I, for work at the Midland Coke Research Station, Sheffield, with experience in the Coke Oven Industry—The Secretary, British Coke Research Association, 11–12 Pall Mall, London, S.W.1 (December 16).

SENIOR EXPERIMENTAL OFFICERS (9) at the Building Research Station of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1703 (December 19).

SENIOR PRINCIPAL SCIENTIFIC OFFICER, and PRINCIPAL SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS (2), in the Road Research Laboratory of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1702 (December 19).

PRINCIPAL SCIENTIFIC OFFICERS (2), PRINCIPAL SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS (2), and SENIOR SCIENTIFIC OFFICERS (4), at the Building Research Station of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1704 (December 19).

SENIOR PRINCIPAL SCIENTIFIC OFFICER to take charge of the Physics Section of the Fuel Research Station of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1700 (December 19).

PHYSICAL CHEMISTS as Principal Scientific Officers in the Chemical Research Laboratory of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1701 (December 19).

PRINCIPAL LECTURERS, SENIOR LECTURERS and LECTURERS (permanent and temporary) in metallurgy, heat engines, machines, mechanics and materials, at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1698 (December 20).

PSYCHIATRIST, experienced and fully qualified (with good practical experience of the treatment of children)—The Hon. Medical Director, Belfast Child Guidance Clinic, Belfast Hospital for Sick Children, Belfast (December 20).

CHIEF METALLURGIST by the Ministry of Supply to take charge of the chemical, metallurgical and testing laboratories of the Royal Ordnance Factory, Woolwich—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting No. F.1257A (December 23).

LECTURER IN ORGANIC CHEMISTRY—The Principal, Brighton Technical College, Brighton 7 (December 28).

REGIONAL DIRECTORS of Extension Work (2)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (December 31).

CURATOR of the City Museums—The Town Clerk, Room 57, Civic Hall, Leeds 1, endorsed 'Curator of the City Museums' (December 31).

SENIOR LECTURER IN EDUCATIONAL PSYCHOLOGY at the Brighton Training College for Women—The Education Officer, 54 Old Steine, Brighton (December 31).

DEVELOPMENT ENGINEER—The Deputy Director, Scottish Seaweed Research Association, West Mains Road, Edinburgh 9 (January 1).

LECTURER IN CHEMICAL ENGINEERING—The Acting Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

CHEMIST with a view to being trained for spectrographic analysis—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8.

ASSISTANT LECTURER IN PHARMACOLOGY—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1.

CHEMIST, and a TECHNICAL ASSISTANT, in the Department of Chemical Pathology—The Secretary, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1.

ANALYST familiar with modern methods of organic quantitative micro-analysis—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

CHEMISTS (3, male) in the laboratories of the Plant and Animal Products Department—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

RESEARCH WORKERS to investigate problems concerning the relationship of footwear to health—The Director of Research, British Boot, Shoe and Allied Trades Research Association, 30–36 Thorngate Street, Kettering.

RESEARCH ASSISTANT IN ZOOLOGY—Prof. A. D. Peacock, University College, Dundee.

RESEARCH OFFICERS (a PHYSICIST, a PHYSICAL CHEMIST and a CHEMIST), an ASSISTANT RESEARCH OFFICER, and LABORATORY ASSISTANTS—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

GRADUATE ASSISTANT IN THE MECHANICAL ENGINEERING DEPARTMENT, with special qualifications in Thermodynamics—The Principal, Erith Technical College, Erith Road, Belvedere, Kent.

LECTURERS IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

SENIOR LECTURER IN PHYSICS—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

LECTURER IN MECHANICAL ENGINEERING in the Harris Institute—The Principal, Technical College, Corporation Street, Preston.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Society for the Protection of Science and Learning. Fifth Report, 1946. Pp. 20. (Cambridge: Westminster College, 1946.) [116

Freshwater Biological Association of the British Empire. Scientific Publication No. 11: Freshwater Biology and Water Supply in Britain. By Dr. W. H. Pearsall, A. C. Gardiner and Dr. F. Greenshields. Pp. 90. (Ambleside: Freshwater Biological Association of the British Empire, 1946.) 4*s*. [116

Journal of the British Grassland Society. Edited by H. I. Moore. Vol. 1, No. 1, March. Pp. 88. (Aberystwyth: British Grassland Society, Agricultural Research Building, 1946.) Subscription to Nos. 1–2, 10*s*. [116

Space, Time and Race: or the Age of Man in America. By Dr. R. E. G. Armattoe. Pp. 16. (Londonderry: Lomeshie Research Centre, 1946.) 1*s*. 9*d*. [116

Science and Human Welfare. The Proceedings of a Conference held in London 15th–17th February 1946, and sponsored by the Association of Scientific Workers, supported by the British Association of Chemists, the Institution of Professional Civil Servants, the Association of University Teachers, the Physical Society, the Nutrition Society, the Institution of Electronics. Pp. 72. (London: Temple Fortune Press, 1946.) 2*s*. 6*d*. [126

Other Countries

Smithsonian Institution: United States National Museum. Bulletin 188: The Fresh-water Fishes of Siam, or Thailand. By Hugh M. Smith. Pp. xi + 622 + 9 plates. 1.50 dollars. Bulletin 189: A Descriptive Catalog of the Shore Fishes of Peru. By Samuel F. Hildebrand. Pp. xi + 530. 1.25 dollars. (Washington, D.C.: Government Printing Office, 1945–1946.) [215

Occult Chemistry Investigations: a Record of the Examination by Clairvoyant Magnification into the Structure of 99 Chemical Elements and Compounds. By Annie Besant and C. W. Leadbetter. Edited by C. Jinarajadasa. Pp. 20. (Adyar, Madras: Theosophical Publishing House, 1946.) 8 annas. [275

Nigeria: Development Branch, Fisheries. Annual Report, 1945. Pp. 4. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1946.) 3*d*. [305

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 191: Studies of the Physiology and Toxicology of Blowflies. 10, A Histochemical Examination of the Distribution of Copper in *Lucilia cuprina*: 11, A Quantitative Investigation of the Copper Content of *Lucilia cuprina*. By D. F. Waterhouse. Pp. 39 + 1 plate. (Melbourne: Government Printer, 1945.) [305

Publications of the Dominion Observatory, Ottawa. Vol. 13: Bibliography of Seismology. No. 18: Items 5935–6046, July to December 1945. By Ernest A. Hodgson. Pp. 292–316. (Ottawa: King's Printer, 1946.) 25 cents. [36

Northern Rhodesia. Advisory Committee on Industrial Development, First Report. Pp. 27. (Lusaka: Government Printer, 1946.) 1*s*. [66

Panstwowa Rady Ochrony Przyrody. Nr. 56: Pamiętnik XIX zjazdu Panstwowej Rady Ochrony Przyrody odbytego w Krakowie 21 i 22 wrzesnia 1945 r. Pp. 128. 50 zl. Chronmy Przyrodę Ojczysta (Protection of Nature in Poland.) Rok 1, Nr. 2–3. Pp. 88. 25 zl. Rok 2, Nr. 1–2. Pp. 64. 25 zl. (Krakow: Panstwowa Rada Ochrony Przyrody, 1945–1946.) [66

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University (Publications de la Faculté des Sciences de l'Université Masaryk). Cis. 272: Tragacanthae novae. Scripsit G. Sirjaev. Pp. 8. Cis. 273: Sur les espaces (*L*) et sur les produits Cartésiens (*L*) (O *L*-prostorech a kartézských *L*-součinech.) Par Josef Novák. Pp. 28. Cis. 274: Racionální zborcen'a plocha stupně šestého, 1 (Eine rationale Regelfläche sechsten Grades.) Napsal František Fürle. Pp. 23. Cis. 275: Teorie grupoidu, Část první (Grupoidentheorie. Teil 1.) Napsal O. Boruvka. Pp. 17. Cis. 276: Pakomáři (Chironomidae) z léčivých pramenu Střední Evropy (Chironomids Inhabiting the Mineral Springs of Middle Europe.) Napsal Jan Zavřel. Pp. 15. Cis. 277: Energetika torsních kyvadel (Étude des oscillations non amorties d'un Système de pendules de torsion couplés.) Napsal Josef Zahradníček. Pp. 18. (Brno: A. Píši, 1939–1946.) [66

Imperial College of Tropical Agriculture. Report of the Governing Body, the Principal's Report for 1945, and the Accounts for the Year ended August 31st, 1945. Pp. 32. (Trinidad and London: Imperial College of Tropical Agriculture, 1946.) [116

Smithsonian Institution: Institute of Social Anthropology. Publication No. 2: Cherán, a Sierra Tarascan Village. By Ralph L. Beals. Pp. x + 225 + 8 plates. (Washington, D.C.: Government Printing Office, 1946.) [116

(Continued from page iii of Supplement)

FISH EXPERT REQUIRED BY THE IRAQI Government Ministry of Economic Affairs for three years in the first instance. Salary Iraq dinars 100 a month, plus high cost-of-living allowance at I.D.24 a month (1 Iraq dinar = £1 sterling). Free passages. Provident fund. Candidates must be capable of administering the Ministry's Fisheries Department and, in particular, of reorganizing arrangements for fish production and marketing with regard to both deep-sea and fresh-water fisheries. A scientific knowledge of problems of fish production and stocking is also necessary. Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/14573 on both letter and envelope.

APPLICATIONS ARE INVITED FOR THE post of Development Engineer in a laboratory in High Wycombe working on radio frequency heating and transmitting equipment. Applicants should be A.M.I.E.E. or equivalent. A sound knowledge of machine-design principles is essential. Experience should have covered several of the following subjects: R.F. induction heating, metallurgical engineering, electrical power distribution and switch gear, mechanical or production engineering, workshop practice, or high-power radio transmitting equipment. Salary would be between £550 and £650 per annum, according to qualifications. Applications should be addressed to the Personnel Manager, P.R.T. Laboratories, Ltd., Commonwood House, near Chipperfield, Herts.

THE BRITISH BOOT, SHOE, AND ALLIED Trades Research Association, 30-36, Thorngate Street, Kettering, invite applications from research workers with appropriate qualifications to investigate problems concerning the relationship of footwear to health. Examples are: The effects of shoes on poise, gait, and orthopaedic functions; also the influence, in physiological aspect, of shoe materials and construction on comfort, perspiration, and ventilation. Salary according to qualifications and experience and on a scale comparable with that of the scientific civil service. Superannuation under F.S.S.U. Applications to the Director of Research.

ASSISTANT LIBRARIAN (MALE) WANTED by the Institution of Electrical Engineers to act directly under the Librarian in the management of the Reference and Lending Libraries. Candidates must have a sound electrical engineering training and be graduate I.E.E. or hold an equivalent qualification. A knowledge of French or German is essential; library experience is desirable. Age 25 to 30. Salary £350 to £550, depending upon age and qualifications. Applications should be addressed to the Secretary of the Institution, Savoy Place, London, W.C.2.

SCIENTIFIC JOURNALIST. THE BRITISH Rubber Development Board invites applications from scientists of first-class ability, preferably with some experience of research work, capable of making intimate contacts with rubber research workers of the British Rubber Producers Research Association. Journalistic experience essential. The post would be for a probationary period of twelve months. Salary in accordance with applicant's qualifications and experience. Applications should be submitted to the Secretary, the British Rubber Development Board, 19, Fenchurch Street, London, E.C.3.

EDITORIAL ASSISTANT REQUIRED FOR the Journal of the Institution of Electrical Engineers. Engineering or science degree necessary. Experience in the preparation of scientific reports and a knowledge of foreign languages advantageous, but not essential. Age 24 to 35. Salary £400 to £550 per annum, according to age and experience. Applications should be addressed to the Secretary of the Institution, Savoy Place, London, W.C.2.

OIL COMPANY REQUIRES FOR SERVICE in its London geological research establishment: (a) Senior Geological Laboratory Assistant experienced in the preparation of fossil specimens for study and in the cutting of thin rock sections, etc. (b) Learner Laboratory Assistant for work as above. Salaries dependent on age and qualifications. Applications to Box 762, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

RESEARCH CHEMIST REQUIRED FOR development work on inorganic fluorescent materials. Experienced worker preferred, accustomed to carrying out original investigations. Salary according to qualifications. Write, stating age and particulars of experience, to Personnel Manager, E. K. Cole, Ltd., Southend-on-Sea, Essex.

METALLURGIST REQUIRED FOR LARGE oil refinery in the North West. Candidates must have first- or second-class honours degree (or equivalent) and aged not over 30. Sound knowledge of corrosion and alloy metals essential. Some previous industrial experience desirable, but not essential. Salary according to age, qualification, and experience, details of which please supply, also when available, to Box 765, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

PAINT CHEMIST REQUIRED FOR LARGE oil laboratory in the London area. Must have good university degree. Age under 30. At least two years' experience with an industrial paint firm essential. Permanent position. Salary according to age, qualifications, and experience, details of which please supply, also when available, to Box 766, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

CHEMISTS AND CHEMICAL ENGINEERS required for service at home and abroad with large petroleum organization. Vacancies exist for Research and Works Chemists. Previous industrial experience not essential, but candidates must possess first- or second-class honours degree, or equivalent, and be under 30 years of age. Salary according to age, qualifications, and experience, details of which please supply, also when available, to Box 767, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

APPLICATIONS ARE INVITED FOR THE post of General Secretary of the Chemical Society. Salary not less than £1,000 per annum. Applications (six copies) should be addressed to the Honorary Secretaries, the Chemical Society, Burlington House, Piccadilly, W.1, by December 31, stating qualifications and administrative experience. Scientific qualifications are desirable, but not essential. The names of three persons to whom reference may be made should be given.

WANTED FOR PETROLEUM RESEARCH Laboratory in London area, a graduate in physical chemistry with a few years' experience of X-ray analysis, for research on catalytic materials. Salary according to qualifications and experience. Apply in writing to Dept. H.12, Box 770, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

A VACANCY EXISTS AT THE EVANS BIOlogical Institute, Runcorn, for a young male or female University Graduate having a qualification in the biological sciences. The successful applicant will be required to undertake routine and research duties in connexion with the preparation of veterinary medical products. Applications should be addressed to the Medical Director.

PHYSICIST (25-35). FIRM OF TEXTILE manufacturers wish to appoint for their laboratory a Physicist with some chemical knowledge and a knowledge of physics as applied to textile manufacturing. Please write in first instance, giving full particulars of qualifications, experience, age, etc., to Box 771, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

LARGE COMPANY HAS SEVERAL VACANcies in India/Burma for Chemists for research on problems connected with the development of oilfields. Applicants, who should be not over 30, must have a sound knowledge of physical chemistry and some experience of application of chemistry to industry. Good terms and prospects. Four years' contract with free passages, provident and pension fund benefits. Apply with full details of experience, qualifications, etc., to Box 772, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

PRODUCTION CHEMIST REQUIRED TO assist departmental manager in chemical manufacturing firm, East London. Quals. A.R.I.C. or B.Sc. degree, with three years' experience of control and production in a chemical works. Salary £475. Position offers good prospects and is permanent. Box 773, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

ASSISTANT PETROLOGIST REQUIRED TO work on iron ores, slags, and refractories. Salary according to age and qualifications. Apply the United Steel Companies, Limited. Research and Development Department, Swinden House, Moorgate, Rotherham.

JUNIOR ASSISTANT PHYSICIST REQUIRED in the Biophysics Research Group of the Mount Vernon Hospital and Radium Institute, Northwood, Middlesex. Salary scale £350 by £25 to £400 per annum, with promotion to the Assistant Physicist scale after satisfactory service. Initial salary according to qualifications. Applications should be sent to the Secretary (from whom further particulars may be obtained) not later than December 28, 1946.

BIOLOGIST REQUIRED IN THE BIOphysics Research Group of the Mount Vernon Hospital and Radium Institute, Northwood, Middlesex, to undertake a study of the effect of radiations on dividing cells in vegetable and animal tissues. Salary up to £450 per annum, according to qualifications. Applications should be sent to the Secretary (from whom further particulars may be obtained) not later than December 28, 1946.

JUNIOR ASSISTANT PHYSICIST REQUIRED in the Clinical Physics Department of the Mount Vernon Hospital and Radium Institute, Northwood, Middlesex. Previous experience not essential. Salary scale £350 by £25 to £400 per annum. Applications to the Secretary, from whom further particulars may be obtained.

TECHNICIAN DESIGNER REQUIRED FOR the designing of rubber products. Age 24/26, with degree or higher national certificate. Apply Personnel Department (PM/LVG/102), Dunlop Rubber Co., Ltd., Erdington, Birmingham, 24.

ZOOLOGIST, B.SC. SPECIAL, ONE YEAR'S research experience, seeks post in London. Box P.227, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

RESEARCH ASSISTANT IN ZOOLOGY, pass or honours B.Sc., required. Particulars from Prof. A. D. Peacock, University College, Dundee.

OLD-ESTABLISHED FIRM IN INDIA WITH British doctor on staff would consider representation of Surgical Instrument Makers and Medicine and Drug Manufacturers. Reply Box 768, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

GLASSBLOWER (COMPETENT), WITH ability to instruct, required by Midland Firm of Control Gear Makers. Good conditions, canteen, and 5-day week. Write, with full particulars, Box No. 321, 8, Serle Street, London, W.C.2.

WANTED BY LABORATORIES IN WEST London, Junior Assistant Chemist for analytical laboratory. Box No. 874, Spottiswoodes, Regent House, Kingsway, W.C.2.

WOMAN SCIENCE GRADUATE, 12 YEARS cereal chemist, staff control, 5½ years H.M. Inspector of Factories (temporary), seeks scientific and/or industrial employment. Box P.229, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

A RESEARCH BIOCHEMIST REQUIRED immediately. Reply with full particulars to Secretary, Research Institute, 117, Grove Street, Liverpool, 7.

BACK NUMBERS OF *NATURE* WANTED as follows: 1940—From the beginning of the year to No. 3674 and Nos. 3678, 79, 80, 98, 3708. 1941—Nos. 3715, 16, 18, 19, 24, 36, 51. 1942—Nos. 3771, 3811, 12, 13, 14, 17. 1943—Nos. 3828, 38, 39, 40, 44, 45, 46, 47, 49, and the rest of the year. 1944—From the beginning of year to 3877 and Nos. 3884, 85, 86, 87, 89, 91, 92, 93, 95, 96, 97, 98, 99, 3900, 01, 02, 03, 04, 05, 06, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, and the rest of the year. 1945—From beginning of the year to No. 3952 inclusive and Nos. 3954, 62, 63, 64, 75, and the rest of the year. C. A. Reitzels Importafdeling, Norregade 20, Copenhagen, Denmark.

SCIENTIFIC SERIALS FOR SALE. *Physical Society Proceedings*,* 1907-46; *Science Abstracts*,* A and B, 1907-46; *Geographical Journal*, 1920-46; *Royal Astronomical Society Proceedings*, 1933-46; *The Observatory*,* 1919-39; *Royal Society Proceedings*, 1933-39; *Nature*, 1933-38 (February); *Journal of Scientific Instruments*, 1939 to 1946; a few parts missing. * Bound up to 1929. Offers to Box 774, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

WANTED, BACK VOLUMES OF CHEMIcal Periodicals, J.C.S., Brit. Abs. A. and B., Annual Reports, etc. Box 758, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

RELIABLE TRANSLATIONS (GERMAN-English), technical and scientific, abstracts, summaries. Long linguistic experience in Gvt. service. Dr. Apfel, 10, Birchington Road, N.W.6.

CONTRIBUTIONS INVITED ON DAIRY subjects by journal devoted to the subject. Should have technical slant. Write, with suggestions, to Box P.221, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

FOR SALE. *JOURNAL I.E.E.*, '30 TO '46, complete, unbound; *Journal I.P.O.E.E.*, '32 to '46, less July '33, unbound; *Wireless Engineer*, '33, '34, '36, '42, '44, '45, '46, complete, unbound, and '32, '35, '37, '41, '43, less 9 issues. Offers to Box P.228, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

Printed in Great Britain by Fisher, Knight & Co., Ltd., The Gainsborough Press, St. Albans, and published by Macmillan & Co., Limited, at St. Martin's Street, London, W.C.2, and The Macmillan Co., 60 Fifth Avenue, New York 11, N.Y., U.S.A.—Saturday, December 7, 1946.