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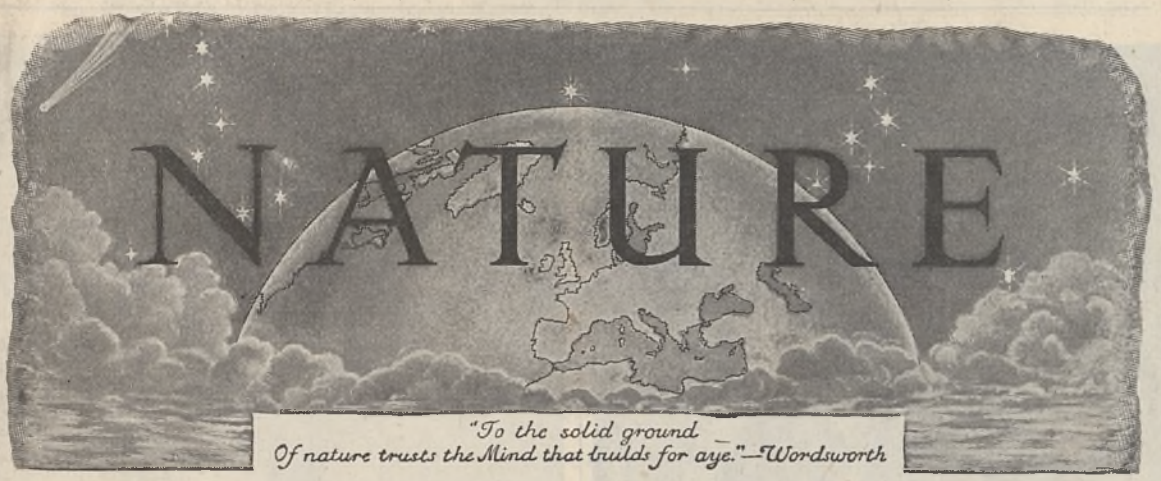

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NATURE

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INTERNATIONAL CONTROL OF NUCLEAR ENERGY

THE report on Scientific and Technical Aspects of the Control of Atomic Energy, which has been issued by the Scientific and Technical Committee of the Atomic Energy Commission*, is in some ways rather disappointing. Ignoring the possibilities of distributing denatured atomic fuel discussed by the Lilienthal Board, the report merely concludes that there is an intimate relation between the activities required for peaceful purposes and those leading to the production of atomic weapons; most of the stages which are needed for the former are also needed for the latter. Safeguards are not regarded as too difficult for the mining operations which are of special significance as the first step in these activities. Particular attention should be paid to the installations in which concentrated nuclear fuel is produced, since the product lends itself immediately to the production of bombs. Unless appropriate safeguards are taken at each of these stages, it will be difficult to ensure that no diversion of material or installation takes place.

Nevertheless, the Committee does not find any basis in the available facts for supposing that effective control is not technologically feasible; but the report does not discuss the political feasibility of control or recommend any system or systems by which effective control can be achieved. Compared with Lord Cherwell's statesman-like speech in the House of Lords on October 23, the report is strangely diffident and disappointing. There is lacking that sense of the vital necessity of reaching some working agreement to prevent the use of the atomic bomb in war which pervaded Lord Cherwell's address, like that of the utterances of so many other men of science on this subject. Lord Cherwell regards the Baruch plan as indicating a perfectly feasible approach, and he does not flinch from the difficulty that any workable scheme inevitably involves a certain surrender of that complete sovereignty which some nations are so insistent to preserve. Without international inspection, there can be no security against individual countries developing, producing and perfecting these bombs. A mere undertaking to refrain from their use will give no more security against their being used than the Kellogg Pact undertaking to refrain from war prevented the outbreak of war in 1939. Nor will a mere exchange of such information as a country chooses to divulge suffice. Either an international authority with the powers and the will to act in the case of recalcitrance must be allowed to inspect all the countries of the world, and to insist on the cessation of any obnoxious activities concerned with nuclear weapons, or we must make up our minds to an international arms race culminating almost certainly in disaster.

This central issue was very clearly put by Lord Cherwell. It is the essence of the problem which the Atomic Energy Commission has to face, and it is a

* Scientific and Technical Aspects of the Control of Atomic Energy. Pp. v+42. (Lake Success, N.Y.: United Nations Department of Public Information; London: H.M. Stationery Office, 1946.) 25 cents; 1*s*.

fundamental reason for the Atomic Energy Act, which provides for the national control and regulation necessary for international control. That much needs to be remembered, for the attention rightly given in the debates, both in the House of Lords and in the House of Commons, to certain aspects of control as it reflects research and development, may tend to cause that fundamental purpose and reason for the Act to be overlooked.

Lord Addison's remarks in regard to research and the importance of not doing anything to prevent men of science exchanging ideas and developing scientific experiments on sound lines were in line with the Prime Minister's speech in moving the second reading of the Bill, and the undertakings which the Minister of Supply gave at the Committee stage, more particularly that a system of advisory panels of men of science would be an integral part of the administration of the Act, and that the ordinary tools of the nuclear physicist should be made exempt from its secrecy provisions. Lord Cherwell, however, was looking for constructive proposals rather than at the restrictions: he was concerned with the positive methods the Minister would use to promote research and development, and rightly warned the House of the difficulty of prosecuting research under Treasury auspices. It had been universally agreed, he said, that nuclear research could only be handled effectively on university lines, giving the head of the department the same freedom that a university professor enjoys in engaging his own staff, determining their salaries within reasonable limits, and directing their activities according to their particular aptitudes and interests.

Lord Cherwell's concluding observations were once again in line with those of American men of science. He thought it reasonable for Parliament to impose restrictions on physicists for the sake of saving humanity, but he distrusted Clause 11 as it stood as appearing to inhibit discussion even among *bona fide* colleagues, except in so far as particular topics exempted by the Minister are concerned. Finally, opposing the suggestion for a special advisory committee, he remarked that while it is important that the Ministers and Civil servants responsible for governing the country should have some knowledge of science, it is not for the man of science as such to rule, and he was confident that there were sufficient people in Parliament with scientific knowledge to make a Minister's life a burden to him if he took a line in any scientific and technical matter which is repugnant to scientific opinion.

What Lord Cherwell urged regarding the positive promotion of the development of atomic energy was even more strongly supported by Lord Samuel, who inclined to an optimistic view on early developments, and urged further its value for research both in physics and medicine. While, however, what was said in the House of Commons regarding the importance of freedom for the exchange of scientific knowledge as an essential part of scientific progress without which science will languish and die, even if in the present state of the world that condition conflicts with the interests of national and international security, was fully endorsed in the House of Lords, as already suggested, this may not be the first issue at the moment. The essence of scientific progress is, as Lord Samuel observed, freedom of communication and the interchange of ideas. It is equally important to remember, as Lord Cherwell indicated, that ethical considerations may impose some limits on the use of the scientific method, and while scientific men rightly stress the imperative necessity of an early solution of the political problem of control, there is an equal duty upon them to consider the ethical issues involved, and whether in the wider interests of science itself no less than of humanity, a halt could not wisely be called in the development of atomic energy for any purposes until the governments of the world have been sufficiently wise and realistic to work out an effective system of control.

The minimum of control is that represented by the proposals of the United States, and so long as the U.S.S.R. refuses to agree to effective international inspection, suspicion will arise. Whether the U.S.S.R. agrees or not, if the scientific and technical committee decides that control can be worked from the technical point of view, the remaining governments must see that a political body with adequate powers of inspection is established. If, for example, a world commission of experts were given the proper status by selection from all nations, with appointments irremovable except for misconduct as is the rule for judges, and the special diplomatic status which would enable them to move freely in all countries, it might be no long task for the Commission to establish full confidence in its integrity, impartiality and ability even among such nations as are at present reluctant to agree.

Meanwhile Russian opposition to the idea of an international inspectorate and to the demand for sanctions, unimpeded by any veto procedure, against any nation violating the system of control, which is a highly important part of the Baruch proposals, should not lead us to overlook that the Lilienthal plan on which those proposals were broadly based may be more limited than at first appeared. The Lilienthal Board was cautious in the claims which it made for denaturing as a safeguard, and Mr. Baruch, in presenting the American proposals, said that the public had over-estimated the value of denaturing as a safety measure, and that the use of denatured materials would always require suitable safeguards. Safe activities will, in fact, probably be limited to scientific research, including the operation of low-energy piles and the use of radioactive material as tracers, in which the quantities of active material used are so small as not to be dangerous. If atomic energy is to be developed on a large scale as a source of industrial power, some fairly close system of supervision by the international authority will be essential to ensure that the denatured material which it has supplied for those economic uses is not being 're-natured' so as to make it suitable for use in a bomb.

The difficulties in providing such a system are considerable, and even a sense of urgency and a clear political field would not make it easy for the Atomic

Energy Commission to reach a rapid conclusion. The formidable extent of the task which will face the new authority will be apparent on the most cursory consideration; and while it has been freely recognized in Great Britain and in the United States that the method of carrying out the control entails some sacrifice of national sovereignty, and it is already clear that the Government would have the support of all parties in Britain in agreeing to accept such limitations, that is not yet universal. Nor is the generous gesture which the United States has made in making its proposals been fully appreciated.

It is here that the ethical question may well arise. The United States Government is entitled to urge that such a plan cannot be put into force in a day, that it can only succeed in an atmosphere of confidence, and that that confidence must be built up gradually; nor is it reasonable to expect the United States to destroy its existing stock of weapons until such confidence exists and the system is seen to be working effectively. On the other hand, it is a reasonable claim that so long as the United States retains its freedom to produce and possess bombs, other countries cannot be bound not to produce them. That in itself makes it difficult, if not impossible, for scientific men to formulate any practical code of ethics which would proscribe further work in this field until an effective scheme of control had been formulated and was working effectively.

It is significant that at the international conference of atomic scientists held at Oxford last July, Prof. J. M. Burgers expressed the hope that an international body could be formed which would emphasize that nuclear studies should be undertaken only for peaceful ends. There can be no doubt as to the value of the pressure which a united front on the part of scientific men could exert in this matter; but at the present time their professional organisations are very far from being sufficiently comprehensive and strong enough to afford the man of science the anchorage he needs to exercise such influence. None the less, to retard the development of atomic energy even for peaceful ends for a few years might well be a small price for mankind to pay if it stimulated or accelerated the elimination of the menace which the existence of the atomic bomb will represent until a system of control has begun to function smoothly.

The Oxford conference decided that the main function of an international body at this time should be to facilitate the rapid and accurate exchange of information; and there can be no question that even if such a moratorium were feasible, one condition would be that there should be no interruption of fundamental scientific research. It would be inherent in the formulation of any code of ethics for scientific men that there must be the utmost freedom of investigation and of communication, in the printed book or periodical and in personal contact. The expenditure on the improvement of scientific communications in some of the ways considered at the Empire Scientific Conference last June, or outlined in proposals before the United Nations Educational and Scientific Organisation, of a tithe of the sums at present earmarked for the development of atomic energy, might in itself make no mean contribution to the establishment of the confidence and goodwill and the general political 'climate' in which effective control of atomic energy or of other forms of warfare can function. Prof. Mumford's recent book, "Programme for Survival", and Lord Cherwell's wise speech in the House of Lords should stir men of science in general to fresh thinking on the whole problem, and to fresh endeavour in practical leadership.

A SOUTH AMERICAN ANTHROPOLOGICAL SYMPOSIUM

Handbook of South American Indians

Edited by Julian H. Steward. (Smithsonian Institution: Bureau of American Ethnology, Bulletin 143.) Vol. 1: The Marginal Tribes. Pp. xix+624+112 plates. Vol. 2: The Andean Civilizations. Pp. xxxiii+1035+192 plates. (Washington, D.C.: Government Printing Office, 1946.) Vol. 1, 2.75 dollars; Vol. 2, 4.25 dollars.

MORE than a hundred contributors, all from the Americas, have undertaken the task of producing the five volumes of this Handbook, of which the two under review are the first to appear; a volume will be devoted to each of four cultural divisions into which South America and certain regions to the north have been divided: marginal and hunting tribes from Terra del Fuego up to north-eastern Brazil; the Andean civilizations to the west; the tribes of tropical forests and savannah in the great central areas of the sub-continent and on the east coast; and the circum-Caribbean cultures to the north and up the Isthmus to Honduras and along the Antilles to Cuba. The fifth volume, designated the comparative anthropology of the South American Indians, will contain general summaries and comparisons of the various aspects of the cultures previously detailed. An arbitrary outline, arranged to a standard sequence, has been followed by the contributors of each article, to assure proportionate brevity and facility of reference.

For each tribe there is an introductory passage, often illustrated and including a geographical sketch, followed by an account of tribal divisions and history, and sections detailing the particulars of all the activities and organisation of the tribe. The work, well described in a foreword as monumental, is intended to serve as a standard work of reference to the scholar, a text-book for students and a guide to the general reader; these aims are fulfilled by the employment of specialists in each field, who combine a certain amount of new material with a revaluation of much old.

Each article presents chronologically, in the form outlined above, the data available from earliest times onwards through four hundred years of contact with White civilization: to these archæological and historical horizons is added a foreground of ethnographical description, and in consequence post-contact change and the absorption of the tribes into European civilization are revealed and traced in as much detail as possible. Where information from these three sources is more complete, and the scale of tribal existence more considerable, such as in the Andean area, it has been found possible to sketch

outlines from the earliest archæological beginnings, through the Inca period, the Spanish conquest and the post-conquest period to the present day. Such an account as this, gathering into brief but comprehensive form all the recorded knowledge on the tribe concerned, serves to present an agreeable and factual history for the purposes of all readers. In the case of certain tribes, the knowledge to be gathered is very scanty and the account necessarily brief; where, for example, interest has ceased in post-contact absorption owing to the cessation of obvious tribal custom, such an account may be contained upon one page: this, however, perfectly serves the purpose of reference.

In the first volume, the marginal tribes are put into three divisions: Indians of southern South America, Indians of the Gran Chaco, and Indians of eastern Brazil. Articles by well-known American authorities on the seven southernmost tribes include for the first time well-documented studies of the Tehuelche and Puelche of Patagonia, and a collection of the limited data available on the Poya culture. By the reproduction of illustrations from a great variety of sources, some of which are not readily available, a full presentation of archæological backgrounds is achieved, together with comprehensive historical and modern ethnographic instances. The work of Junius Bird is outstanding in this section.

One third of the first volume is occupied by a study of the Gran Chaco by Alfred Métraux. It is a full and exhaustive account of the numerous tribes of the area, including their archæology and history, and contains an extensive enumeration of sources; the many illustrations, from Métraux's material and from many other sources, help to produce an outstanding and authoritative contribution to existing works on this great area in the heart of the subcontinent. A postscript is given by an account of the present-day Indians of the Gran Chaco by Juan Belaieff.

In the remaining part of the first volume, the tribes of eastern Brazil are as painstakingly portrayed, by northern and southern American authors, the whole collection of articles using for reference a large and intricate map compiled by Curt Nimuendaju.

The second volume deals with the Andean Highlands and the Central, Southern and Northern Andes: Wendell Bennett has contributed profusely illustrated articles on the Andean Highlands and the archæology of the Central Andes, which are followed by accounts of the Cupisnique, Salinar, Mochica, Cuzco, Inca, Quechua, Aymara and Uru-Chipaya cultures. The post-contact development of Inca culture under Spanish rule is admirably analysed by George Kubler, and the modern Quechua are discussed in the light of hitherto unpublished field-work by Bernard Mishkin. In these articles the balance of archæology, history and ethnology is more evenly kept than is possible in many other instances, and examples of ancient and modern crafts and material processes are laid out in 120 plates and 48 text-figures.

Studies by Junius Bird on the North Chilean culture sequence and the historic inhabitants of the region preface accounts of the Southern Andes contributed by Bennett, Samuel Lothrop, Gordon Willey, John Cooper and other authorities. The Northern Andean region is explored in detail in articles which follow an account of Ecuador by Donald Collier, in which summaries of most recent work—including some undertaken during the Second World War—are of great interest: Collier shows, for example, on Plate 159, Cerro Narrio pottery discovered in stratigraphic testing in 1941, during which an early period and a late period were revealed, which merged into Inca. The articles on Columbia, among contributors to which is Alfred Kroeber, will be essentially supplemented by Vol. 4, dealing with the circum-Caribbean tribes, which include Lowland Columbians, Venezuelans and Antillans.

The Handbook in its entirety will prove a work of frequent reference to all interested in the study of the peoples of South America. R. W. Feachem

THEORY AND PRACTICE OF GOVERNMENT

Diplomacy by Conference

Studies in Public Affairs 1920–1946. By the Rt. Hon. Lord Hankey. Pp. 180. (London: Ernest Benn, Ltd., 1946.) 12*s.* 6*d.* net.

THE timing of publication of Lord Hankey's books is masterly. The publication of his Lees Knowles Lectures last year synchronized with debates on science and national defence in the light of the implications of atomic warfare. "Diplomacy by Conference" now appears almost simultaneously with a new White Paper, "Control Organisation for Defence", which gives expression to many ideas advocated by Lord Hankey in both books. The title, however, gives no indication that this new volume, like the first, is a contribution to the whole theory and practice of government under the searching demands not only of war but also of peace. The book is, as the sub-title indicates, a series of studies in public affairs, lucidly and vividly presented, and of profound interest to the ordinary citizen as to the historian or statesman. From the first, to which the book owes its title, to the last which looks to the future control of external affairs, they are illumined by shrewd comment, keen observation and a human touch, and should go far to assist in the formation of a sound opinion on the working of the United Nations Organisation, the machinery or organisation for defence or the reform of the Foreign Service. Diplomacy by conference, Lord Hankey believes, has come to stay, and his personal experience leads him to regard elasticity of procedure, small numbers, informality, mutual acquaintance, if not personal friendship among the principals, a proper perspective between secrecy in deliberation and publicity in results, reliable secretaries and interpreters as the most important factors in success, and which are the more essential the more delicate the subjects.

The first essay, based on a lecture to the British (now the Royal) Institute of International Affairs in November 1920 and afterwards printed in the *Round Table*, is followed by a study of the evolution of the British machinery of government on the level of the Privy Council, the Cabinet and the Committee of Imperial Defence. The third essay discusses the Cabinet Secretariat in its historical perspective, although written before the dramatic discovery by the late Sir John Fortescue of the papers, including many Cabinet Minutes, of King George III and George IV, as described in the second essay. The fourth essay, on the Committee of Imperial Defence, has much in common with the Lees Knowles Lectures of 1945, and it is interesting to note that Lord Hankey's

stout championship of this system and firm rejection of the alternative idea of a Combined General Staff finds fresh support in the commentary included in the recent White Paper, which indicates that a close study of captured German archives demonstrates the inferiority of that system owing to the dangerous antagonisms caused by the cleavage between planning and execution nullifying any theoretical advantages of the German system. The remaining four essays briefly survey the study of disarmament, the problems of international forces, the Dominions and the War and the future of imperial defence.

Through these, as through the whole book, sounds a subdued note of hope that is most opportune in a world sadly perplexed by the wranglings in the United Nations Organisation and the Peace Conference. "If success should be slow in coming," writes Lord Hankey in his foreword, "if there are setbacks or even breakdowns, we must not be disheartened. We must remember that we are tackling problems that have baffled mankind throughout the ages. The perspective and vision of the historian are in these pages joined with the vision, judgment and administrative experience which Lord Hankey has for so long brought to the service of Britain.

R. BRIGHTMAN

INFINITESIMAL CALCULUS

Vorlesungen über Differential- und Integralrechnung

Von Prof. A. Ostrowski. Band 1 : Funktionen einer Variablen. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 8.) Pp. xii+373. (Basel : Verlag Birkhäuser, 1945.) 47.50 Swiss francs.

THE book is based on a series of lectures on infinitesimal calculus given regularly for more than seventeen years in the University of Basle. This, the first volume, contains a course intended for those whose main interest is in the applications of the calculus, and to this end it is freed as far as possible from what such students might reasonably regard as 'unnecessary subtleties'. Also the proofs of certain theorems, when too lengthy, are deferred to the second volume. Nevertheless, the course is full, clear, and sound in its foundations.

It is particularly interesting to find adopted the sequence which corresponds not only with the logical but also with the historical development, namely, the introduction of the definite integral in its own right before any mention of derivatives. Thus the following are evaluated directly from the definition of a definite integral.

$$\int_{\alpha}^{\beta} (ax + b)dx, \qquad \int_{\alpha}^{\beta} \sin x dx, \qquad \int_{\alpha}^{\beta} x^{n} dx.$$

Clearly such a procedure focuses attention on the fundamental nature of the integral, and also makes a direct appeal to the student's appreciation of the problem to be solved.

There are also some interesting remarks on 'learning' and 'understanding'. The usually accepted object in learning mathematics is to understand. This last word has various meanings. One can be said to understand a mathematical rule : (1) when one can apply it ; or (2) when one has tested every link in the chain of reasoning by which it is devised ; or (3) when one can rediscover this chain of reasoning unaided. The third sense is the one properly applicable in mathematics.

The contents of the book are as follows : (1) introductory ; (2) limits ; (3) continuous functions and definite integrals ; (4) derivatives ; (5) technique of differentiation ; (6) technique of integration ; (7) applications to mathematics.

The author claims to put clarity before elegance. To say that he has succeeded might convey a false impression. In fact, he has combined felicitously both qualities.

The printing is excellent and there are plenty of reasonably easy exercises.

L. M. MILNE-THOMSON

THE CALIFORNIA GROUND SQUIRREL

The California Ground Squirrel

A Record of Observations made on the Hastings Natural History Reservation. By Jean M. Linsdale. Pp. xi+475. (Berkeley and Los Angeles, Calif. : University of California Press ; London : Cambridge University Press, 1946.) 5 dollars.

THE Californian ground squirrel, *Citellus beecheyi* (Richardson), seems to have received more attention than any other wild animal in California, probably owing to the fact that cultivation is often followed by an enormous increase in its numbers. The observations recorded in the present work were made during the period October 1937–44, mainly on the Hastings Natural History Reservation, an area of grassland in Monterey County, California, ranging from about 1,500 to 2,750 ft. in height, and free from artificial disturbance. The author studied the habitat and general behaviour of this squirrel and devoted particular attention to the manner in which it adapts itself to changes in its environment.

The species seems to have deep permanent burrows, in which it is able to survive for several months under unfavourable conditions, but when the ground is brought under cultivation the squirrel rapidly spreads and occupies new areas. It is largely diurnal in its habits, but adults may spend as long as eight months dormant in their burrows each year. In some areas there is little indication of dormancy, but on the Reservation the season when it occurred ranged from June to March and included extremes of hot-dry and cold-wet conditions.

A special chapter is devoted to methods of communication—sounds, visual signals and scent—and to the receptive senses of these squirrels ; also their mannerisms, activity and food are described in detail. This animal, like many other rodents, serves as a reservoir of the plague bacillus, but there is evidence in support of the view that latent infections do not last more than one or two months. The reproductive activities are found to be closely synchronized with seasonal changes in the climate, and only a few weeks each year are really suitable for regular activity above ground. During this period young ones appear at the surface.

The anatomy and general characters of the species are described in detail, special attention being given to the pelages and moults, as hitherto no adequate account of this has been available.

This monograph collects together a wide series of observations on very diverse aspects of the Californian ground squirrel, and the results will be

of interest to students of mammalian natural history. It is unfortunate that the reproduction of the numerous photographs in some cases leaves much to be desired.

One wonders, however, especially these days of paper shortage, whether it is necessary to record observations in such very great detail. The chapter on mannerisms, for example, comprising forty-two pages, devotes six pages to attitude, nearly three pages to locomotion, and three to scratching, with a tabular summary of the parts of the body scratched and the manner in which it is performed. This is followed by five pages on wariness, seven pages on response to trapping, etc., the chapter concluding with nearly eight pages on sanitation. This is a far cry from the original observations on the animal in Captain Beechey's account of the visit of H.M.S. *Blossom* to Monterey in 1826 (vol. 2, p. 80) that "The fields are burrowed also by the ardillo, a species of *sciurus*, rather a pretty animal, said to be good to eat". Its edibility is not mentioned in the present volume.

E. HINDLE

PENICILLIN AND ITS CLINICAL USES

Penicillin

Its Practical Application. Under the general editorship of Prof. Sir Alexander Fleming. Pp. xi + 380. (London: Butterworth and Co. (Publishers), Ltd., 1946.) 30*s*. net.

THIS is a general guide to the use of penicillin and is intended mainly for students, general practitioners and junior hospital medical officers. In order that every application may best be demonstrated, Sir Alexander Fleming has delegated to an imposing selection of experts the task of representing the specialized aspects of penicillin therapy. The book is, in effect, a collection of articles, and the authors, each in an understandable desire to present a complete picture, have overlapped considerably; and although not contradicting each other, there is an occasional discrepancy in dosage prescribed for the same condition by different people.

There are two sections; the first is an introduction with articles by Sir Alexander Fleming on the history and development of penicillin and on bacteriological control of therapy, and by others on chemistry and manufacture, pharmacy, pharmacology and methods of administration; the second section is purely clinical.

The clinical section contains twenty-one articles, some excellent, all covering adequately the chosen subjects, which range from war wounds through infective processes in every organ and viscus to animal diseases. A most useful article for its guide to dosage is that on generalized infections by Mr. R. Vaughan Hudson. There is a tendency by some of the other writers to give, in the reviewer's opinion, too small doses.

Sir Alexander Fleming says in his introduction: "It is almost impossible to give an overdose in the ordinary sense of the word. It is certainly possible to give much more than is necessary but in days of plenty that will not be a serious crime". The days of plenty have arrived; but their advent has escaped the notice of some. Readers should keep Sir Alexander's words in mind, follow the author using the largest doses (when a disease is covered in more than one article), and, when in doubt, multiply by five. The insistence on adequate dosage is reinforced by recent observations on the variations in character and constitution of commercial penicillin in the United States (*Lancet*, 2; 387; 1946), although this problem does not yet appear to have affected British products.

There is, throughout the book, a commendable reticence on the scope of penicillin therapy, and it is to be hoped that the medical men for whom the book was planned will benefit by this. Penicillin, like other remedies, has its limitations, and its thoughtless use where it cannot possibly be of value leads only to disrepute.

There is a number of minor errors in the text and index, and there is often produced an impression of haste in preparation. The book on the whole fulfils its purpose admirably, and there are no omissions in the enormous field of application. Subsequent editions would be vastly improved by reducing, or better removing, the many instances of overlapping.

J. MARSHALL

ORNAMENTAL TREES, SHRUBS AND VINES

Trees, Shrubs and Vines for the North-eastern United States

By George Graves. Pp. xi + 267. (New York, London and Toronto: Oxford University Press, 1945.) 15*s*. net.

THIS little handbook is intended for the guidance of those who are concerned with private gardens or roadside planting in the North-eastern United States; but since the plants described in it are, almost without exception, suitable for British gardens, it deserves the notice of horticulturists in Britain and elsewhere.

The main body of the text consists of an alphabetical arrangement of genera under which some seven hundred species, varieties and garden forms are discussed. The descriptions are so framed as to give an idea of the garden value of each plant rather than to serve as an aid to identification. Many suggestions for culture and propagation are included, measures for the control of pests and diseases are suggested, and the author has not hesitated to indicate specific susceptibility to injury by frost or wind.

The technical names of plants are those found in the second edition of Rehder's "Manual of Cultivated Trees and Shrubs", and in cases of recent change both old and new names are given.

Selection from the seven or eight thousand woody plants available for planting in the area concerned can have been no light task, and there are few items the inclusion of which one could reasonably question other than × *Mahoberberis Neubertii*, which the author himself frankly disavows, and *Solanum dulcamara*. On the other hand, there are interesting references to plants infrequently seen in Great Britain, such as the fastigiate forms of *Acer rubrum*, *A. platanoides* and *A. saccharum*.

Illustrations showing both habit and details of flowers and fruits are numerous and good; and chapters giving advice on the selection and purchase of nursery plants and the pruning required for their satisfactory development add interest and value to the book.

N. K. GOULD

FUNDAMENTAL PARTICLES*

By Prof. R. E. PEIERLS, C.B.E., F.R.S.

IN the last fifteen years, the situation in fundamental physics has undergone a remarkable change. Previously only very few elementary particles were known; and optimistic observers, in fact, believed that it would be a comparatively simple task to elucidate the inter-relations of these particles and to account for the values of the few dimensionless constants (such as the fine-structure constant and the ratio of proton to electron mass) derivable from them. It was even said that the end of physics might be in sight.

Since then, however, discoveries of new elementary particles have followed each other at a rapid pace. No one would feel satisfied that a list which one could make up now was likely to be complete, and a great deal of further investigation is required to understand the relations between all these particles and to determine, let alone explain, the values of all constants arising from them.

The fundamental characteristics of elementary particles are as follows: mass (in units of proton mass), charge (in units of electron charge), spin $\left(\text{unit } \hbar = \frac{h}{2\pi}\right)$, magnetic moment $\left(\text{in units of the Bohr magneton } \mu, \text{ or of the nuclear magneton } \mu_N = \frac{\mu}{1830}\right)$, processes of generation and destruction, and their relation to other particles.

Elementary particles known before, say, 1930 were:

(1) *The electron*, with a mass of $\frac{1}{1830}$, a charge of $-e$, a spin of $\frac{1}{2}$ and a magnetic moment of -1 magneton.

(2) *The proton* (or hydrogen nucleus), of mass 1, charge $+e$, spin $\frac{1}{2}$. Its magnetic moment was later found to be about $+2{\cdot}8$ nuclear magnetons. This somewhat surprising result indicates that the positions of the electron and proton are not quite analogous, since Dirac's wave equation in its simplest form would predict a magnetic moment inversely proportional to the mass. A possible explanation for this apparent discrepancy will be mentioned later.

(3) *The photon.* It may appear odd to classify the photon as a particle, but it does fall well within the list of fundamental units under discussion. It evidently has no rest mass or charge, and its spin is 1. The easiest way to justify attributing a spin of 1 unit to the photon is to remember that a photon in a given state of motion, say having given momentum and direction, is still not uniquely described unless its state of polarization is specified. There are two independent states of polarization, and one might for that reason expect the spin to be $\frac{1}{2}$, which would give rise to two orientations. More detailed analysis shows that the symmetry properties of light waves require the spin to be 1, so that the photon would have, in principle, three orientations (corresponding to the three components of the field vectors describing the wave) with one of these orientations being ruled out by the conditions that the waves are transverse.

Recent work has added the following particles to this list:

(4) *The positron* was predicted by Dirac to avoid the difficulties that would otherwise arise from the solutions of his wave equation for negative energy. He imagined a state of affairs in which all conceivable states of negative energy were already filled, thus preventing, by Pauli's principle, any fresh electrons from acquiring negative energy; but occasionally one of these states might be empty, thus resulting in a lack of negative charge (hence the presence of a positive charge) and the lack of a quantity of negative energy (thus representing a particle of positive energy). The existence of this particle in cosmic rays was discovered by Anderson, and in laboratory processes by Blackett and Ochiallini. It clearly must have a mass equal to the mass of the electron, a charge of $+e$, a spin of $\frac{1}{2}$ and a magnetic moment of $+1$ magneton. According to the theory of Dirac, the vacancy among the negative energy states, represented by a positron, can be filled if a negative electron is present which can jump into that vacant place. In other words, an electron and a positron together can be destroyed, with their kinetic energy and rest energy going into other forms of energy, such as radiation. Conservation of momentum requires for this two light quanta, unless the process takes place near a centre of force such as a nucleus. The inverse process is the generation of a pair of electrons (positive and negative) by the collision of two photons or by the passage of one photon through matter. Of these, only the second is of practical significance.

(5) *The neutron* was recognized by Chadwick in 1932 as a result of nuclear reactions. Its mass is approximately one unit, its charge, of course, is zero, its spin $\frac{1}{2}$ and its magnetic moment about $-1{\cdot}9$ nuclear magnetons. It was realized at once that the neutron was the missing constituent of all nuclei, and that all known facts about nuclei suggest that they consist of neutrons and protons.

In that case, the existence of beta-transformations, in which electrons or positrons are emitted by nuclei, has to be accounted for by assuming that these electrons do not normally exist inside the nucleus (which would be difficult to reconcile with the laws of quantum mechanics), but that they are generated in the process of emission, just as pairs of such particles can be generated in the pair creation referred to above, or as photons are generated in the emission of light by an atom. Conservation of charge requires that, upon the emission of, say, a negative electron, a neutron inside the nucleus is converted into a proton. Hence the number of neutrons and protons in a physical system is not fixed; only the sum of the number of neutrons and protons is fixed.

The simplest case of such a transformation would be the decay of a bare neutron into a proton, with the emission of a negative beta-ray. Present evidence about the mass of the neutron indicates that it is greater than that of a hydrogen atom, so that the process is energetically possible. It has not so far been observed, but conditions for observing it are extremely difficult.

(6) *The neutrino.* While conservation of charge is evidently in order in the process of beta-transformations, there is difficulty with the conservation of spin, since an electron of spin $\frac{1}{2}$ is produced; this cannot be balanced by any change in the orbital angular momentum of the emitting system, which is capable only of changing by integer units. There are also difficulties with energy conservation, since the observed beta-particles show a continuous spectrum, while the remaining nucleus appears to be in a definite quantum state. Those difficulties can be overcome by adopting Pauli's hypothesis of the

* Summary of the paper given to the Electronics Group of the Institute of Physics on October 22.

existence of a neutrino, that is, a particle of a mass at most of the order of the electron mass and probably less, of no charge, and spin ½. This would rectify the difficulty with conservation of spin, and it could clearly take up the amount of energy which appears to be missing from the balance. Experiments designed to detect any action due to neutrinos have given a negative result, and it is estimated that neutrinos would have been detected in these tests if their magnetic moment were comparable to one nuclear magneton. It is, in fact, likely that the magnetic moment of the neutrino is zero.

The free neutrino must satisfy a wave equation like Dirac's equation for the electron and, in order to avoid trouble with negative energies, one has again to assume that its negative energy states are filled. Any vacancies in those negative energy states would again mean the existence of a particle which bears the same relation to the neutrino that a positron has to the electron. If the neutrino has no magnetic moment, this 'anti-neutrino' may, in fact, be identical with the neutrino itself; if there is a magnetic moment, the anti-neutrino must have a magnetic moment of opposite sign and would, therefore, be distinguishable.

The description of the processes involving the generation of an electron (or positron) and neutrino was formulated by Fermi. The inverse process of absorption of an electron by a nucleus with the emission of a neutrino should also be possible; but estimates based on the purely statistical argument of detailed balancing show that the cross-section for this process should be extremely small, of the order of 10^{-44} cm.^{2}, so that the detection of neutrinos by this means is practically impossible. The only direct support given to the neutrino hypothesis is the fact that the lack of energy balance appears to be coupled with a lack of momentum balance, detectable by the recoil of the nucleus. The neutrino theory makes a definite prediction about the amount of the extra momentum to be expected in each case, and recent experiments appear to confirm this prediction.

(7) *The meson.* The existence of a particle of a mass of the order of 200 electron masses was first predicted by Yukawa to account for the properties of nuclear forces. Neutrons and protons in the nucleus must be held together by forces which are strongly attractive at close approach but negligible at larger distances. Since there can be no direct action at a distance, these forces must be transmitted from one particle to another by some sort of field. The only types of field equations compatible with relativity are those governing also the wave function of a particle either with or without mass. Without rest mass one would obtain equations like those of the electromagnetic field, which give the inverse square law and hence are not compatible with the properties of nuclear forces. Introducing a rest mass, one obtains equations capable of giving the right kind of law, providing the mass is chosen to be about 200 electron masses. Charged particles with masses of that order were found in cosmic rays, and support was thereby given to Yukawa's theory, according to which a proton could change into a neutron with the emission of a positive meson, and the opposite change could take place giving a negative meson, provided sufficient energy was available to make up the rest energy of the meson. In cases where this excess energy is not available, the virtual possibility of this process leads to an interaction between proton and neutron of the required type.

According to this view, a proton will spend a fraction of its time tending to become transformed into a neutron and a meson. The energy needed for accomplishing this is not available, and therefore this transformation will not actually take place; but since, when accomplished, it would lead to the existence of a particle rather lighter than the proton, with a correspondingly higher magnetic moment, the brief instant when a meson tends to appear has a substantial influence on the total magnetic moment of the system. This is likely to explain the fact referred to above, that the magnetic moment is greater than one nuclear magneton. The reverse process applied to the neutron similarly accounts for the existence of a negative magnetic moment of the neutron. The same view predicts that some fraction of the charge of the proton is spread out over the meson field surrounding it, and this should lead to observable effects in processes, such as the emission and observation of gamma-rays by nuclei of light elements, which depend on the charge and current distribution. The experimental evidence on this point is not yet, however, very clear.

If this theory is adopted, the meson must have an integer spin. Theories have been advanced in which this spin is either 0 or 1, and certain difficulties connected with the magnitude of the forces at extremely close approach can be avoided if it is assumed that the forces are due to mesons with both these values of the spin. Evidence from cosmic rays seems to indicate that mesons observed at sea-level cannot have spin 1, and if mesons of spin 1 exist they cannot survive the passage through the atmosphere.

The ordinary mesons (presumably of spin 0) are known to be beta-radioactive, and this has given rise to the suggestion that the ordinary beta-transformation, as observed in the nucleus, might be the result of a double transition in which, say, a neutron tends to transform into a proton plus a negative meson, the latter not being able to form in free space because the energy for its rest mass is not available and, therefore, transforming in turn into an electron plus a neutrino.

A quantitative study of this double transition shows, however, that the observed radioactivity of the meson is insufficient to account for the observed beta-decay constants by this double process. The suggestion has, therefore, been made that the latter is mostly due to the mesons of spin 1; there would then have to be ascribed to them a shorter life for beta-decay, which would satisfactorily account for their absence from cosmic ray observation.

There are, therefore, arguments for the existence of at least two kinds of mesons. In addition, the evidence from nuclei of light elements indicates strongly that the forces between like particles (two neutrons or two protons) is as strong as that between unlike particles, and this is hard to understand unless there exist neutral mesons as well as charged ones. Again, in all likelihood both values of spin, 0 and 1, would have to occur for each kind.

It is not settled whether the masses of mesons of spin 0 and 1 should be the same or different. Theories of the nuclear forces can be formulated with either hypothesis. There seems to be evidence from cosmic rays that not all observed mesons have the same mass. Whether it is possible to relate this difference of mass to the two spin values, or whether one has to assume independently two or more different masses for each spin and for both charged and uncharged mesons, is not as yet clear. In any event, one should not regard the meson as one fundamental particle but as a rather bewildering variety of them.

(8) *The negative proton.* For the same reasons for which Dirac's theory of the electron requires the existence of a positron, it is likely that there exists a counterpart of the proton with negative charge. This would annihilate any positive proton it collides with, and thus would not live long in the presence of ordinary matter. It cannot now be produced in the laboratory since this requires too much energy. There are reasons to think that it is contained in cosmic rays.

Lastly, it has been pointed out that, just as the wave equations of the electromagnetic field give rise to photons, and those of the nuclear force field to mesons, the gravitational field should be similarly quantized. Since gravitational forces are extremely weak if expressed in units appropriate to elementary particles, the quanta constituting the gravitational field would have only an extremely weak interaction with other particles. It is tempting to relate this to neutrinos, which are indeed extremely elusive particles ; but the idea is somewhat less attractive when it is remembered that the symmetry properties of the gravitational field are such as would correspond to particles of spin 2, and that therefore the only way of introducing neutrinos would be in terms of an elementary process consisting of the simultaneous emission or absorption of four neutrinos. It is likely that this problem will remain in the realm of speculation for a considerable time.

SIXTH INTERNATIONAL CONGRESS FOR APPLIED MECHANICS

AT the Fifth International Congress for Applied Mechanics held in Cambridge, Mass., in 1938, an invitation to hold the Sixth Congress in Paris in 1942 was accepted. Though it was not possible to adhere to the original date, Prof. Henri Villat and his colleagues started to organise the Sixth Congress as soon as the war in Europe finished. Despite great economic and other difficulties, their courageous labours were completely successful, and the Congress was held in Paris at the Sorbonne during September 22–29. About 450 members attended, including scientific people from nearly all the Allied countries as well as from Switzerland, Italy, Denmark, Sweden, Turkey and Spain. The British group was large, and included many young scientific workers who have been attracted to applied mechanics in the course of their war activities.

The programme was a very heavy one, since it included the delivery of about two hundred and fifty scientific papers. These were divided among four sections, namely : (1) structures, elasticity and plasticity ; (2) hydro- and aerodynamics and hydraulics ; (3) dynamics of solid bodies, vibrations and sound, friction and lubrication ; (4) thermodynamics, heat transfer and combustion.

So far as possible, the papers were grouped in symposia. In Section 1 there were symposia on plasticity, methods of calculation and impulsive loading ; in Section 2 on turbulence, ship resistance, hydraulics, supersonic flow, aeroplane wing theory and instruments ; in Section 3 on friction and lubrication ; in Section 4 on jet propulsion and turbines.

Meetings of the four sections were held simultaneously, so that members who had interests in more than one section were not able to hear all they would have liked. A period of twenty minutes was allotted to each paper, including discussion on it. In this way, every author was able to get a hearing. In many cases, however, the time allowed for discussion was insufficient, and animated debates were carried on after the official closing time of the session.

The papers presented fell roughly into two groups, one comprising such normal developments of pre-war lines of thought as it has been possible to carry out during the war period. The other group consisted of papers stimulated by war activities, in some cases merely as a by-product of those activities. In the former group, the work of H. L. Dryden was specially noteworthy. At the time of the 1938 Congress, the way in which the boundary layer of retarded fluid close to the surface of a body changes its character from being in steady motion to being turbulent was the subject of much discussion and uncertainty. Dryden has now shown that if the air stream in a wind tunnel is sufficiently free from turbulence, an instability of the boundary layer which had been predicted mathematically does, in fact, appear at the calculated wind-speeds, and that it has the calculated frequency and wave-length. These unstable waves are masked by larger effects in wind tunnels not specially designed to be free of turbulence.

The second group contained a number of papers which had recently been released from war-time restrictions on publication. Some of these were devoted to the theory of high subsonic and supersonic airflow, subjects which have made great progress since the Congress of 1938. Others dealt with the analysis of stress waves in plastic materials, a subject which has now been brought forward for the first time.

The Congress was entertained at receptions in the Hôtel de Ville and the Inter-Allied Club. A large proportion of the members had the privilege of staying in the Cité Universitaire, a group of splendid hostels in which live many of the foreign students of Paris.

The science of applied mechanics owes a debt to Prof. Henri Villat and his colleagues for the initiative they took in organising so successfully such an important international scientific meeting so soon after the liberation of their country.

G. I. TAYLOR

EDUCATION IN THE BRITISH ARMY

By MAJOR-GENERAL CYRIL LLOYD, C.B.E., T.D.
Director of Army Education

I : Problems Involved

WHEN thinking of the Army Education Scheme it is not unnatural that the civilian mind tends to approach the problem by comparison with some civilian education organisation, for this is the only kind of yardstick ready to his hand. The soldier, on the other hand, will feel that he is a better judge ; yet in the majority of present cases he will be able to bring to bear on the problem little more than the experience of some particular form of military organisation with which a few years' war service has made him familiar.

The Army Education Scheme was devised not as the best education scheme possible, but as the best education scheme possible in the particular circumstances in which the Army would find itself at the

end of a long period of war. It follows, therefore, that if a true appreciation of the scheme is to be effected, the critic must first have a clear picture of the conditions in which the plan was designed to operate.

Assuming as we must that there must be some central body to plan, administer and co-ordinate, and that this body can only function successfully as part of the War Office organisation, it is of course obvious that control must pass downwards along the normal chain of military command through commanders-in-chief and successively through intermediate commanders to officers commanding the units in which the bulk of the work will be done. Here we find our first variable factor. In field commands the chain runs down through corps divisions and brigades: this seems simple enough until we realize that the modern division and brigade may vary in composition according to their operational role, and that outside this apparently simple chain there are corps troops, divisional troops, lines of communication troops and base installations which vary in composition and strength from one theatre to another.

General officers commanding-in-chief (home commands) operate through districts and sub-districts, and here it would not be untrue to state that in no case is the composition of any two districts alike.

In civilian circles the functional unit of organisation is the school: in the army it must be the military unit. As a basis of calculation for many purposes a unit is taken to be a lieutenant-colonel's command; but in practice it may be anything from a handful of men in a camp reception station to a training centre fifteen hundred strong; from a R.E.M.E. group scattered in detachments over a couple of counties to a compact battalion all under the hand of its commander; from an A.T.S. company providing cooks, orderlies, clerks and typists for half a dozen separate headquarter offices to a small group of provost staff. "Somewhere in England" in 1942 there was a Petrol Can Recovery Unit with a strength of one officer and one other rank; for months it claimed 100 per cent educational efficiency, for the officer was taking a correspondence course in law and the other rank was regularly attending the local technical school. They also closely followed the Army Bureau of Current Affairs. It will therefore be seen that the mere number of units in any given area is an indication neither of the volume of educational work in progress nor of the complexity of the organisational work it will entail.

The army educational authorities are faced with the task of providing instruction which will prepare the soldier to resume the responsibilities, the tasks, and the social duties of civil life, and this involves three main types of provision: current affairs and citizenship to prepare him for his civic responsibilities, pre-vocational training to help him to set a fair course for earning his living, and added to these two there must be that something more which will open up ways to greater and more satisfying enjoyment of his leisure hours. Current affairs and citizenship cause no insuperable difficulty, for they are common to all and can be carried out in groups in which the very variety of attainment may, and usually does, prove an asset. Education of the pre-vocational type and education in hobbies or cultural things lead us into two fields as unlimited in variety as they are boundless in scope. The illiterate and near illiterate provide at one end of the scale as difficult a problem as the advanced student does at the other, and between them are men and women at every stage of progress and intellectual development. Less likely are we to realize the infinite variety of the types of subject likely to be required until we have scanned the staggering range of trades and callings against the names in any company roll we may examine.

The estimate of library- and text-books required for effective working of the Army Education Scheme exceeded 2¼ million, to say nothing of handbooks for instructors and administrators which had to be compiled, edited and printed by the hundred thousand at a time when flying bombs were steadily taking toll of the already seriously diminished facilities. Nor were books the only acute problem: equipment of all sorts must be provided for practical work of all kinds. Tools for carpentry and metal work; apparatus for the science students; material for the dressmakers; cooking and household kits for domestic science: these are but a few of the items which must be provided and provided quickly, not merely in Britain, but also at the end of long sea lines feeding all those foreign countries where British troops await their return home.

In Germany, Austria, Italy, Greece, Palestine, the Far East, troops have still heavy and arduous operational duties to perform. At home, too, young troops must be trained and hardened to replace those returning from overseas for release. Everywhere the work of servicing an army in being must go on.

It is against this background of reality that the commanding officer views the demand for six hours' education a week for every man and auxiliary, and it is small wonder that he raises his eyebrows. Let him contrive as best he may to release everyone at some time or another for six hours each week, and he is still faced with his education officer's complaint that with only one book-keeping instructor he is getting all the sixty book-keeping students at the same time, or that the six law students are separately available all on different days of the week. Let him satisfy the education officer in this respect and he may find that there is no driver for the ration van or that a working party is without N.C.O.s. If he is serving overseas he may have local climatic conditions against him—the summer noonday temperature in Baghdad touches 125° in the shade, India is little better, and in these parts of the world afternoon work is as impossible as early morning work is unpopular. Let him arrange all these things satisfactorily and he is still faced with the struggle to find suitable instructors and have them trained to fill the gaps caused by the ever-increasing demands of the release machine.

Surrounded by this sea of problems is the directing staff of the Army Educational Corps and A.T.S. officers and other ranks who are attached to formation staffs to advise commanders and administer the scheme under their direction. Theirs is the task to help commanding officers to surmount their difficulties, to arrange for co-operative effort between small units, to train replacement instructors, to keep the stream of books and equipment flowing freely. Here, too, we are faced with a fluid situation: education staff officers equally with others are released with their age and service groups, and unremitting effort alone can find and train suitable people to fill the gaps as they occur and deliver the bodies to that part of the world where their services are needed.

These, then, are some of the problems of those who planned and of those who are putting into effect

what has been described as the greatest adult education scheme in history. Great as are the difficulties, the picture need by no means be a gloomy one. To see the facts as they are and at the right angle is necessary for a true appreciation, and those who find an interest in following this experiment will also find understanding of much that would otherwise puzzle and confuse them if they will remember that the plan was made to fit the army because, with its shape constantly changing and its size diminishing, the army could not be made to fit the plan.

Education as a part of military training is not something which has come into existence only with the citizen army of the Second World War. In the Regular Army before 1939 there was educational provision for all adult soldiers, which consisted of compulsory literacy for all rank and file, and a system of examinations (reaching approximately School Certificate standard), without passing which no man could be considered for promotion to non-commissioned officer or warrant officer. This provision was the responsibility of the Army Educational Corps.

During the first year of the War, the Army Educational Corps was extra-regimentally employed, and organised education in the Army was suspended. The old peace-time system still remains in suspense, but in its place an even wider ranging system has developed, introduced to meet the needs of the period of hostilities and of the period when hostilities finally ceased. The historical development of this system may be briefly traced.

So early as December 1939, the Central Advisory Council for Adult Education in H.M. Forces, drawing its strength from a number of popular educational bodies, was instituted, and its framework of regional committees based on universities and university colleges was created. This organisation was destined to prove of great use to the Army in the years to come, as a source of civilian teachers and lecturers for classes and courses. In 1940, the next essential step was taken when a small directing staff was established at the War Office, and the Army Educational Corps was recalled to its educational role and given an increased establishment.

Until the autumn of 1941, education in the Army, drawing on the resources of the regional committees and administered by the Army Educational Corps at formation headquarters, was a voluntary affair in which men and women participated as inclination moved them and as opportunity offered. Lectures, gramophone circles, membership of local education authority evening classes, instruction in handicrafts were among the most prominent facilities; perhaps the most popular and successful service was the provision of a system of correspondence courses, at cheap rates, of which eventually tens of thousands were to avail themselves.

This voluntary system developed steadily throughout the War and has survived into the present period, though many of its activities are now conducted on a more formal basis under the auspices of the release scheme, which will be described later. Before the end of the War it had come to include provision for modern language teaching, play-reading, quiet rooms for reading and writing, debates, 'brains trusts', local study, and a variety of cultural activities. It was modified, where necessary, to meet the needs of hospitals and convalescent depots, or of illiterates whose first need was basic education, or of troopships, of detention barracks and military prisons, or of members of the A.T.S. It operated at home and abroad, though in the latter case the assistance of civilians was often lacking, and units had to rely far more upon their own resources than was the case at home.

In the last analysis, however, the voluntary system catered primarily for minority interests and affected only a minority of the troops serving. Moreover, it was in many ways more of a welfare than an educational provision, and in July 1941 education was linked with welfare in a joint directorate at the War Office, under the late Major-General Williams as director-general of welfare and education.

Since education on this scale was manifestly unequal to performing one of its major tasks, namely, that of sustaining morale and of improving efficiency throughout the Army, a separate and independent directorate, the Army Bureau of Current Affairs, was created at the same time.

From the late summer of 1941 onwards it became obligatory for units to set aside one hour of the weekly training programme for the discussion, under an officer's guidance, of current affairs. This marked an important development. An element of education was now compulsory, was regarded as part of training, and the instruction was supplied from the unit's own resources, instead of from the professional instructors of the Army Educational Corps or from outside civilian experts.

Army Bureau of Current Affairs did not immediately strike deep roots in the Army; officers capable of conducting discussion groups without some training in that art were few, and working units which had no training programmes often experienced difficulty in finding time for the weekly hour. But gradually the practice spread, and was powerfully reinforced a year later when, in November 1942, the British Way and Purpose was introduced as a system of formal instruction in domestic and foreign social and political studies. A weekly hour of B.W.P. was made compulsory in addition to A.B.C.A., and during the winter months of 1942–43 and 1943–44, 'winter programmes' of three hours compulsory education a week, of which two should be devoted to A.B.C.A. and B.W.P., were introduced. In many cases, B.W.P. proved a more successful undertaking than A.B.C.A. since, being more formally educational and only indirectly a morale-raising agent, instruction in it could be given not only by officers, but also by other ranks and civilians provided they were suitably qualified.

In summary, the war-time education scheme may be said to have had four aspects—personal or individual, military, civic and vocational. These reflected the four-fold objective of making the soldier or auxiliary a more enlightened individual, a better informed and more responsible citizen, a better soldier and a more capable bread-winner after returning to civilian life. Further, it was partly voluntary and partly compulsory—voluntary where individual tastes and interests were concerned, compulsory in matters of community interest which could be studied in common with fellow members of the community of the moment, that is, the unit or section of the unit. Finally, instruction was sought from the most convenient quarter in any particular case—from officers, non-commissioned officers or privates, whether of the Army Educational Corps or of the unit, and from a variety of civilian sources.

From the provision for these interests and the various methods of meeting them has grown the Army Education Scheme for the release period which is at present in operation. Planned during 1944–45 and operated by units as military conditions permit from within a few weeks of the end of the war with Germany, the Army Education Scheme represents the fruit of experience gathered during five years of war. In intention it is more ambitious than the war-time scheme was ; it enjoys a far more generous allocation of time, materials, accommodation and instructors ; in some directions the emphasis has shifted ; but fundamentally it is the war-time scheme writ large, and a brief account of it must now be given.

The foundation of the Army Education Scheme lies in the fact that it is compulsory ; within the framework of compulsion, however, there exists the greatest possible degree of variety.

The organisation of the Army Education Scheme is based upon the appropriate military formations or units. Army Educational Corps staff officers, concerned in administration of the scheme, are appointed down to brigade or sub-district level ; but the scheme is an Army scheme, not an Army Educational Corps scheme, and the normal unit of organisation is the lieutenant-colonel's command—say, about a thousand men or women. The scheme is, except for activities associated exclusively with one sex, co-educational.

Each unit implementing the scheme has its own library of four hundred books, its unit education officer, its own accommodation ; it supplies, so far as possible, its own instructors and, when these are not forthcoming, can borrow instructors from other units or from civilian resources. Materials, equipment and text-books are supplied on request, through normal Army channels.

The unit education staff is assisted in its tasks, not only by a series of handbooks covering organisation, libraries, equipment, materials, curricula and methods of instruction, as well as B.B.C. educational broadcasts, but also by the help and advice of the Army Educational Corps at higher formation levels. Districts conduct courses of training for unit instructors ; commands administer large lending libraries which supplement the resources of unit libraries, and are in a large measure responsible for the formation colleges. These formation colleges (three at home and two in commands overseas) offer vacancies for monthly residential courses of study in a number of faculties, and each has an instructor-training wing which trains unit instructors.

The degree of variety aimed at (as mentioned above) is faithfully reflected in the curriculum. Choice of subjects for study is restricted only in matters of community interest, and here two hours a week are compulsorily devoted to the political and social topics provided by A.B.C.A. and B.W.P. Otherwise the student may freely choose a course of study based on the graded syllabuses, which total more than a hundred and are grouped under six main heads : science, technical, domestic, humanities, commerce and professions, and art, crafts, music and drama. Every effort is made to encourage students to choose a balanced course of study—literary, manual, æsthetic—which will enable them to acquire new interests as well as to revive old ones. For the most advanced students who desire to sit for it, there is the Forces Preliminary Examination, of approximately matriculation standard, for which the Civil Service Commissioners provide the examining body.

The curriculum is wide and flexible enough to cater for those who require a general or a pre-vocational education. Those whose interests are best met by an element of vocational study can be catered for partly by the Army curriculum, and partly by additional facilities which are made available to provide them with the degree of specialized knowledge required.

II : The Army Education Scheme in the Field

Units in the field differ in respect of size, location and the work they do, and these differences undoubtedly affect the method by which, and the degree to which, they implement the Army Education Scheme.

These important factors had to be taken into account by the planners of the Army Education Scheme when they drew up a booklet of suggestions —the "Organization Handbook". At no time were the contents of this handbook considered as other than suggestions, as other than providing the framework within which units would adapt their own individual and peculiar circumstances.

In size, units may vary from a holding battalion, numbering up to five thousand men, to a salvage unit of twenty-five or an Army dental centre of three. The size of a large unit enables it to live fairly easily off its own resources. On the other hand, the size of a small unit will not necessarily mean a demand for a smaller number of subjects, but is very likely to mean a narrower choice of instructors.

In location, units may vary from the port operating company, working in a busy port, to the infantry battalion, policing a wide area of devastated Europe : from the anti-aircraft site in the hills to the Army pay office in the city. Location complicates the problem of the small unit. Normally, small units would either be grouped together to run a communal education scheme or attach themselves to a larger neighbouring unit, or take full advantage of near-at-hand civilian resources. The simple fact of isolation throws the small unit entirely upon its own resources, whereas the larger unit is relatively unaffected by these complications of location.

In work, the variety between units is even more clearly defined. The pay office and the record office are likely to be busier than they were at any time during the War. The same applies to other service and technical units, the duties of which continue in peace as in war. In contrasting the front-line operational units, it must be remembered that although much of their operational work may have ceased, they still find themselves helping the farmer, policing the town, or performing the many tasks the British Army is always expected to perform. In general terms, the large unit will have a considerable advantage over the small to the extent to which it can stagger duties. In a small unit, for example, the loss of one instructor and one group of men attending a class may in extreme cases take away 90 per cent of the unit strength and in other cases bring the work programme to a standstill.

In addition to the complication of size, location and work, all units have had to face certain common problems. Army accommodation was never specifically designed for educational activity and has had to be adapted in many ingenious ways. Nissen huts and tents have frequently been used for education as they have naturally been used for other purposes ; so too have gun operation rooms, motor transport

workshops, etc. It should be remembered, too, that no new building was permitted for educational purposes. If a unit needed another hut it had to be collected from where it was no longer required and re-erected at the unit where it was needed.

Equipment and books were initially in very short supply to the Army, as they were to the civilian world. Many units who during war had been accustomed to the speedy receipt of stores needed in battle found the initial delays of obtaining educational stores very irksome. In true Army fashion, many of them improvised; radio stores were turned over to the science room, pioneers' stores for the painting, decorating and woodwork classes; the blackout screens for the blackboard and woodwork; the sand table for the geography class. New equipment and books are now available in adequate quantities and nowhere are unit schemes impeded by shortage.

The problem which all units had to face was to leave a nucleus of instructors to run classes at the unit while others were trained in method and refreshed in matter at army schools of education, formation colleges, instructor training wings and courses run jointly by Army Educational Corps personnel and regional committees. Further difficulties have been caused by the incidence of releases, and keeping his instructors up to strength is a constant worry of every education officer. Some of them have come unskilled to teaching and have brought a freshness of outlook and originality of approach which many a trained teacher might envy.

The impact of the Army Education Scheme on a unit was naturally linked with the manner in which it was publicized to the man. The main publicity was in the hands of the unit officers, who had to explain in A.B.C.A. sessions the purpose of the Scheme. Its purpose requires somewhat subtle explanation to men and women, who will naturally judge the scheme by the use they get out of it, either as individuals, or in their work, or in their hobbies. Some units gave the aim of the Army Education Scheme as "fitting men and women for their return to civilian life". This is, of course, a perfectly proper statement of the bald aim of the scheme; but, unfortunately, some units interpreted this in a narrowly vocational manner. In many units, however, there have been outstanding examples of course-planning for individual men who thought in terms of practical trades being led to a balanced study of basic subjects which they could use in a wide variety of trades. Perhaps one of the best examples of this is the case of the men who wanted to do painting and decorating and whom the unit instructor required to calculate how much paint they required and cost a particular job (that is, elementary mathematics), order paint and equipment (that is, elementary English) and plan interior and exterior colour schemes and designs (that is, elementary art appreciation).

Units, large and small, are operating an Army Education Scheme which is broadly as outlined in the Organisation Handbook. For example, a holding battalion with an average strength of 1,800 men guarantees all of them a minimum of six hours education a week during the working day. Each day for five days a week 350 men attend unit classes. Eighteen courses are offered, ranging from home handyman, general education and commerce to plastering, bricklaying and woodwork. Each course is designed to last five complete weeks and is self-contained. All the instruction is given by twenty-one full-time unit education instructors and an approximately equal number of part-time instructors. A careful record has been maintained by the unit education officer of the age and service groups and consequently of the release dates of his instructional team, and he runs within the unit three-day courses for instructor replacements in order that he may assess the potential of his future education staff. In this manner continuity is maintained, and the smooth and effective running of the scheme is assured. The commanding officer has ensured that regimental officers regularly fulfil their duties as leaders of discussion groups, and each Friday afternoon the unit education officer holds a briefing meeting on the A.B.C.A. topic for the following week. In addition, all men of the unit who are in the age and service group next due for release are given a further half-day weekly on education.

Essentially similar but on a smaller scale is an R.A.S.C. headquarters serving outside of Great Britain which numbers forty men. Each of these men receives his six hours education a week, and many have appreciably more. This small unit has thoroughly investigated its potential instructor material and finds that it is able with the help of local civilian and unit tradesmen to offer two kinds of courses, one consisting of world history, English language and literature, music and discussion groups; the other of leatherwork, art, motor engineering, market gardening and woodwork. It is the normal practice for each of the forty men to take part in all the first course and one or more subjects of the second.

The arrangements made in these two units are typical of many.

Another unit has its troops scattered over a relatively wide area and has decided that instead of moving the students to school they will move the school to the students. So the unit has formed a mobile team of instructors who can cover between them a range of cultural and practical subjects. These instructors set up school for a day wherever the troops are. In addition, the officers on the spot conduct A.B.C.A. sessions and have made a careful survey of any instructional talent they may have. Consequently it is rare for any small pocket not to be able to offer at least one subject as a supplement to those offered by the touring team.

In interesting contrast is the device of a coast regiment of the Royal Artillery which finds itself able to provide each of its men with twenty hours education a week. This regiment is disposed on three islands, and having decided that it was in a position to provide technical, commerce and general courses, obtained a statement from each man as to which course he wished to attend and turned each of its three islands into a 'faculty' so that 'technicians' were on one island, 'generals' on another and 'commercials' on the third; the instructional staff being similarly disposed. (The commanding officer was at pains to stress that no one island is better than the others.)

A collection of small units, including an ammunition supply depot, a company of Pioneers, the staff of an R.T.O., the staff of a reception centre and a company of R.A.S.C., solved their problem in another way. The largest of these units is the ammunition supply depot, which acts as the parent unit and accounts for all educational stores. Most of the other small units provide accommodation and an instructor for at least one class. In addition, out of their combined

strength, the units manage to provide a full-time unit education officer who sees to the general organisation of the scheme. One full day a week is set aside for education, and all thirty of the instructors are part-time. On the educational day each week transport is arranged to collect the students, drop them at the unit where the classes are being held and return them at the end of the day.

It would be possible to multiply specific examples of different unit education schemes many hundreds of times. It is, however, important to recognize that there has been great variety of practice among units in implementing the Army Education Scheme both at home and abroad. It is certain that many troops will leave the Army without receiving their six hours a week education. It would be easy to lay the blame in many directions and in some cases it would be accurately laid ; but, by and large throughout the Army, there is tremendous good-will towards giving the men and women in the Forces what is, after all, nothing more than they have the right to expect—a chance to re-equip themselves for their return to civilian life ; and it is certain, too, that for many hundreds of thousands of men and women in many hundreds of ways, unit education schemes have shown a wider horizon and initiated the study of many subjects which will help the men and women in the years which lie ahead.

(To be continued)

OBITUARIES

Prof. P. F. Frankland, C.B.E., F.R.S.

We record with regret the death, at the age of eighty-eight, of Percy Faraday Frankland at his home in Argyllshire on October 28.

Born in London in 1858, he was the second son of Sir Edward Frankland, F.R.S., whose contributions to chemical theory and reactions, and whose pioneer work on the water supplies of Great Britain made him one of the outstanding scientific figures of his time. The son may be said to have followed directly in the footsteps of his father and to have attained a similar eminence. He was a pupil at University College School and at the Royal School of Mines, where he gained the Forbes Prize and won the Brackenburg Scholarship of St. Bartholomew's Hospital, at the same time graduating B.Sc. of London.

It was to the Royal School of Mines that Frankland returned in 1880 as demonstrator and lecturer in chemistry after an absence of some two years in the University of Würzburg, where he came under the influence of that great teacher, Wislicenus. The researches of Wislicenus on lactic and malic acids, and his subsequent development of the study of stereochemistry were stimulated by the work of Pasteur and by the publication in 1875 of van't Hoff's famous thesis : "La Chemie dans l'Espace". He had also followed up the work of Frankland and Duppa on acetoacetic ester and had used the zinc alkyls in his synthetic work.

While much of the early work of Wislicenus was influenced by the elder Frankland, it may be said that the son's interest in stereochemistry began while working with Wislicenus, under whom he graduated Ph.D. Little more than these relationships were needed to make Percy Faraday Frankland a life-long disciple of Pasteur. He was selected to give the Memorial Lecture on Pasteur to the Chemical Society in 1897.

The earliest researches of P. F. Frankland were on the illuminating power of burning hydrocarbons and the principles of combustion. He was, however, one of the first, after Pasteur, to study seriously the chemical reactions which occur by the agency of micro-organisms and to apply these processes in the production and isolation of pure substances. His popular book, "Our Secret Friends and Foes", was written from his expanded notes of the public lectures he gave to numerous popular audiences about 1893. Jointly with his wife, Grace, a daughter of Joseph Toynbee, F.R.S., whom he married in 1882, he published a life of Pasteur, and a volume on "Micro-organisms in Water". He continued his interest in this subject so long as he remained active, and his advice was frequently sought on the bacteriological purity of water supplies, in which field he was an acknowledged authority. The address he gave before the Society of Chemical Industry in February 1911 has long been regarded as an authoritative pronouncement on this problem.

Nevertheless, it may be said that Frankland's main contribution to the advancement of chemistry was made in the subject of stereochemistry, and his interest in this field never flagged. It was the theme also of many of his research pupils, whom he trained in the great school which he created at Birmingham. In recognition of his mastery as an investigator he was awarded the Davy Medal of the Royal Society in 1919, having been elected into the fellowship of the Society in 1891. Among his many research pupils were F. W. Aston, Thomas Turner, T. S. Price, R. C. Farmer, R. H. Pickard, T. S. Patterson, W. E. Garner, F. H. Garner, A. Slator, F. Barrow, S. R. Carter, and D. F. Twiss.

In 1888 Frankland was appointed to the chair of chemistry at University College, Dundee, and in 1894 he moved to Birmingham, where he succeeded Prof. W. A. Tilden in the chair of chemistry at Mason College. He continued to hold this chair in the University when it was founded in 1900, and the new University buildings at Edgbaston were built during this period. He was largely responsible for the design of the chemistry laboratories which his department occupied in 1909. Five years later he had to vacate them and return to Mason College to make room for the emergency military hospital which took over the buildings until the end of the First World War. During 1914–18 he was a member of the Admiralty Inventions Board and of the Chemical Warfare Committee, chairman of the Chemical Section of the Royal Society War Committee and of the Royal Society Reserved Occupations Committee. He took entire charge of tar-testing in the Midlands and advised on the production of explosives. In recognition of these services he was awarded the C.B.E. in 1920. He received honorary doctorates from the Universities of Birmingham, Dublin, St. Andrews and Sheffield ; also he was made an officer of the Italian Order of St. Maurice and St. Lazarus.

At the end of 1918 Frankland was confronted with the heavy problem of rehabilitating the Edgbaston laboratories after their occupancy by the military, and restarting his academic researches at the age of sixty. He felt this was a task for a younger man, and he resigned his chair and went to live in retirement at the House of Letterawe, Loch Awe, Argyllshire, where he could pursue his many interests amid surroundings which he loved. Here at the foot of Ben Cruachan

his house looked out over the waters of the great loch with the panorama of mountains beyond. Here he indulged his wide interests in reading and in open-air life, and from here frequently set out on foreign travel with his wife, who had predeceased him only by a few weeks. He retained to the end his fine presence and vigorous manhood. His memory will long be cherished by his pupils, who recognized his commanding place as a teacher.

P. F. Frankland was elected president of the Institute of Chemistry in 1906, and of the Chemical Society in 1911. His two presidential addresses to the latter Society, in 1912 and 1913, on stereochemistry are still of vital interest and importance in this field of study. He leaves an only son, Edward Percy Frankland, who was for some time a lecturer in chemistry in the University of Birmingham.

W. N. Haworth

We regret to announce the following deaths :

Prof. J. Shaw Bolton, emeritus professor of mental diseases, University of Leeds, on November 12, aged seventy-nine.

Dr. Dorothy Jordan Lloyd, since 1927 director of the British Leather Manufacturers' Research Association, on November 21, aged fifty-seven.

Mr. W. H. Roberts, recently city analyst at Liverpool and associate professor of public health chemistry in the University of Liverpool, on November 16, aged sixty-eight.

Mr. Charles Rodgers, O.B.E., deputy director of the British Electrical and Allied Manufacturers' Association and chairman in 1942–43 of the British Electrical and Allied Industries' Research Association, on November 5, aged seventy-one.

NEWS and VIEWS

Royal Society :

Medal Awards

His Majesty the King has been graciously pleased to approve the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows : Sir Lawrence Bragg, for his distinguished researches in the sciences of X-ray structure analysis and X-ray spectroscopy ; Dr. C. D. Darlington, for his distinguished researches in cytology and genetics.

The following awards of medals have been made by the President and Council of the Royal Society : Copley Medal to Prof. E. D. Adrian, for his distinguished researches on the fundamental nature of nervous activity, and recently on the localization of certain nervous functions ; Rumford Medal to Sir Alfred Egerton, for his leading part in the application of modern physical chemistry to many technological problems of pressing importance ; Davy Medal to Prof. C. K. Ingold, for his distinguished work in applying physical methods to problems in organic chemistry ; Darwin Medal to Sir D'Arcy Thompson, for his outstanding contributions to the development of biology ; Sylvester Medal to Prof. G. N. Watson, for his distinguished contributions to pure mathematics in the field of mathematical analysis, and in particular for his work on asymptotic expansion and on general transforms ; Hughes Medal to Prof. J. T. Randall, for his distinguished researches into fluorescent materials and into the production of high-frequency electromagnetic radiation.

Special Election

Under the Statute of the Royal Society which provides for the election of persons who either have rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society, Dr. C. J. Mackenzie, president of the National Research Council of Canada, has been elected a fellow of the Society.

National Coal Board : Director-General of Research

Dr. W. Idris Jones, in accepting the post of director-general of research for the National Coal Board, becomes the chief executive officer of Sir Charles Ellis, the scientific member. The Board is composed of functional members responsible respectively for production, marketing, labour, finance and scientific work. The scientific member's responsibility embraces problems ranging from day-to-day investigations connected with quality control to long-term research. Dr. W. Idris Jones, who is forty-six years of age, has wide scientific and technical experience to help him in this important appointment. He graduated at the University College of Wales, Aberystwyth. He was a Rhondda and Frank Smart research student of Gonville and Caius College, Cambridge, and took his Ph.D. (Cantab.) degree in 1925. After leaving Cambridge, he joined the research staff of Messrs. Synthetic Ammonia and Nitrates, Ltd. (later I.C.I. (F. and S.P.), Ltd.), at Billingham-on-Tees, and was later appointed a group manager in the Oil Division, where he was concerned with the development of the coal hydrogenation process. He was appointed director of research of the Powell Duffryn Co. in April 1933, an appointment which he has held until now.

One of the advantages of unified management of all the British coal mines is the opportunity it gives of tackling the major problems of the industry on a national scale. Dr. Idris Jones will find no lack of important objectives ; on the contrary, in the early stages, the difficulty will be to arrange them in order of precedence. The problem of fuel preparation, whether in washing and grading, or in carbonization and briquetting, or in the degree of refinement of by-products, will doubtless have prominence. On the other hand, the problems of the human element, such as the whole study of working environment, as well as occupational diseases, will engage a large proportion of the Board's research interest. Dr. Idris Jones has an immense field before him ; one that calls for the exercise of wise scientific judgment.

Mathematics at Leeds : Retirement of Prof. W. P. Milne

Prof. W. P. Milne, head of the Mathematics Department of the University of Leeds since 1919, has retired and been appointed professor emeritus. After studying at the University of Aberdeen, where he obtained a doctorate, Milne took his mathematical degree at Cambridge as fourth wrangler, and received honourable mention in the Smith's Prize examin-

ation. He then became mathematics master at Clifton College, where he stayed until he was offered the chair of mathematics at Leeds. The appointment of a school master to a university chair was an interesting experiment, and there can be no doubt about its success. During his Clifton period, Milne wrote text-books on higher algebra, projective geometry, homogeneous co-ordinates and the calculus. But his greatest contribution to mathematics has been a number of papers, published mainly in the *Proceedings of the London Mathematical Society*, dealing with the properties of plane cubic, quartic and quintic curves, and the relations between the cubic surface and quartic curves, culminating in the properties and groupings of the 2,015 conics which touch the plane quintic curve at five distinct points. The University of Aberdeen recently conferred upon him the honorary degree of LL.D.

Prof. Milne brought into the development of the Mathematics Department of the University of Leeds a profound knowledge of conditions in schools, and a deep appreciation of the need for the greatest width of knowledge combined with the mutual mental influence of different types of students sharing life in the same institution. He believed that research should be encouraged among all university mathematical students, and this has happened with some success at Leeds. He took a considerable share in the development of the University of Leeds as a whole, and during his period as pro-vice-chancellor he presided with great success over meetings of the Senate and other committees working out a scheme of post-war development. His influence in the County of Yorkshire was exercised through the Yorkshire Branch of the Mathematical Association which he founded in 1920, and through his work in connexion with the training colleges, when his Clifton experience was very valuable.

Geology at Liverpool : Prof. F. Coles Phillips

Dr. F. Coles Phillips, University lecturer in mineralogy and petrology at Cambridge, has been appointed to the George Herdman chair of geology at the University of Liverpool. Entering Cambridge from Plymouth College, he graduated in 1923, being placed in the first class in Part I of the Mathematical Tripos and in both parts of the Natural Sciences Tripos, with geology and mineralogy as his chief subjects. His first researches included investigations on the serpentines and associated rocks of the Shetlands : later, holding a research fellowship at Corpus Christi College, he was engaged in studies on progressive regional metamorphism in Cornwall and Scotland. Appointed demonstrator in mineralogy in 1928, he became University lecturer in the new Department of Mineralogy and Petrology in 1932.

More recently, Dr. Phillips has devoted his attention particularly to the field of ore microscopy, where he has developed equipment and technique for low-relief polishing of ores which have proved eminently satisfactory and have since been adopted in several research institutions at home and abroad. As an investigator in the field of structural petrology his work is well known, particularly his studies on the fabric of the Moine schists of the Scottish Highlands. These researches he is now extending into a general study of the significance of lineation in the crystalline schists of the North-West Highlands. As a teacher Dr. Phillips has been eminently successful, both in his contact with large undergraduate classes and in the post-graduate courses he has given in his special field of research. He served for many years as secretary of the Faculty Board of Geography and Geology and as member of a number of University committees connected with the work of the science faculties at Cambridge. The ripe experience in teaching, zeal for research and conspicuous organising ability which he will bring to the chair at Liverpool augur well for the future of geological studies at the University.

University of London : Appointments

The title of emeritus professor in the University of London has been conferred on Prof. C. L. Fortescue, recently professor of electrical engineering, Prof. C. H. Lander, recently professor of engineering, and Prof. E. F. Dalby Witchell, recently professor of mechanical engineering, at the Imperial College of Science and Technology.

The following appointments have been announced :

Dr. S. Tolansky, reader in physics in the University of Manchester, to the University chair of physics tenable at Royal Holloway College as from January 1, 1947.

Mr. A. J. Ayer, fellow and dean of Wadham College, Oxford, to the Grote chair of philosophy of mind and logic tenable at University College as from January 1, 1947.

Dr. John McMichael, formerly lecturer in human physiology in the University of Edinburgh and since 1936 Johnston and Lawrence Research Fellow of the Royal Society of Edinburgh and extra honorary assistant physician at the Royal Infirmary, Edinburgh, to the University chair of medicine tenable at the British Postgraduate Medical School.

Prof. G. C. Allen, since 1933 professor of economic science in the University of Liverpool, to the University chair of political economy tenable at University College as from April 1, 1947.

Dr. B. S. Platt, director of the Human Nutrition Research Unit of the Medical Research Council, to the University chair of human nutrition tenable at the London School of Hygiene and Tropical Medicine.

Dr. Kathleen Lonsdale, since 1945 Dewar Research Fellow at the Royal Institution, to the University readership in crystallography tenable at University College.

Dr. S. D. Elliott, since 1938 a Freedom Research Fellow in the Department of Bacteriology at the London Hospital Medical College, to the University readership in bacteriology tenable at the College.

The degree of D.Sc. has been conferred on Mr. Wilson Mandell, an external student.

Braunton Burrows

Braunton Burrows, on the north coast of Devon, a locality of unique characteristics and of great interest to the biologist and countryman, has been in use for military training during the War. This occupation seems likely to continue. In an article to *The Times* of November 2, a strong plea is made that this area should now be relinquished by the military authorities. For some two and a half centuries the Burrows have claimed the interest of men of science : the mobile dunes are of outstanding interest and provide materials not only for the plant and animal ecologist but also for the physicist, the geographer and the geologist. The flora, which is remarkably rich, includes species of rare occurrence.

It also affords materials for the study of adaptation to the extreme conditions presented by the wind-blown dunes. The fauna, not less attractive, contains among other things many local varieties and species of invertebrates. As the author states: "It is the whole complex of plant and animal populations and the special conditions in which they live that give this place such high scientific value both for urgently needed research and for education, and indeed make it unique in its kind".

Britain's Contribution to the War Effort

THE third and final report on Mutual Aid (Cmd. 6931. London: H.M. Stationery Office. 2*d*. net), with its record of mutual aid from July 1, 1944, to the termination of the various agreements, and with its statistical report of mutual aid throughout the War, has been published opportunely. It is fitting that this record of the magnitude of the assistance which Great Britain gave to the United States, the U.S.S.R. and other allies, as well as received, should be made public now that fresh demands are being made to avert a possible collapse of Western Germany. At the height of the War, the United Nations were aiding each other freely on the scale of about £4,500 millions a year, and over the three years up to the end of the War, mutual aid was extended by the United Kingdom to fourteen countries, and totalled £2,078,500,000. Excluding oil obtained under Lend-Lease, the value of supplies, services and capital received by the Allies amounted to 8 per cent of the national income of Great Britain and 16 per cent of her total war expenditure. The largest proportion of this—60 per cent—went to the United States, 15 per cent went to the U.S.S.R. and the remainder to European allies and China. The total value of reciprocal aid to the United States up to September 1, 1945, is estimated at £1,241,402,500, and of this total 26 per cent took the form of servicing U.S. Forces, 18 per cent is accounted for by the cost of building capital installations, the remainder being in respect of food, materials and equipment. More than half the services provided to American Forces is accounted for by shipping services.

In 1943, reciprocal aid was extended to include raw materials and foodstuffs, and from June 1943 until the end of the War, raw materials to the value of £31,351,000, two thirds of which was rubber, chiefly from Ceylon, were shipped from British Colonies to the United States on United Kingdom account. A total of 615,000 tons of bulk foodstuffs was also exported from the Colonies to the United States under reciprocal aid. Mutual aid to the U.S.S.R. totalled £318 million, of which motor transport (£118,856,000) and aircraft (£128,893,000) were the largest items. Mutual aid figures for other countries are less complete, but the estimated total of at least £519 millions includes £11 millions to China, £106 millions to France, £228 millions to Poland, £34 millions to Greece, £30 millions to Czechoslovakia, £24 millions to Belgium, £14 millions to Yugoslavia, and £32 millions to Turkey. These mutual aid arrangements have now ceased and trading is again on a cash basis. The vast flow of commodities and services exchanged and consumed in fighting the common enemy are not being left standing as monetary liabilities, but are being cancelled by common consent. This record of aid rendered by the United Kingdom provides a measure of an impressive aspect of her war effort which it is appropriate to recall at the present moment.

Health of University Students in Italy

THE substance of an address delivered by Marc Daniels at a conference held in Italy in connexion with the National Council of Research in 1945 has been published (*Ric. Sci. e Ricostruz.*, March–April 1946). He points out that university students are potentially the most precious possession of a nation, because they represent the intellectual and professional leaders of the future; but they are susceptible to various maladies during their period of study. It is remarkable that in the past so little care has been exercised on their behalf, not only in Italy but also in other countries. Daniels regards tuberculosis as the most serious problem confronting them because it is responsible for more deaths among the young people of both sexes than any other disease. During the War the mortality from tuberculosis increased considerably and in some parts of Italy was doubled, while in London it increased by 70 per cent among the young in the first year of the War. After tuberculosis, venereal disease assumed alarming proportions during the War in different countries, and there is no reason to think that Italy is an exception. A short description is given of the efforts that have been made to combat tuberculosis among students in the United States, Great Britain and France. The latter country has a special anti-tubercular service for university students, of which the author, who had first-hand knowledge of its working when it was initiated in 1932, speaks most highly. Although he does not think that in existing circumstances a national medical service in Italy is possible, he is convinced that every university in the country should regard the organisation of such a service for its students as lying within the limits of possibility. Medical attention at the beginning of a student's career and subsequent attention annually should form a chief part of the prophylactic services. Given a sufficient number of men of good will in the faculty of medicine, prepared to collaborate in the preparation of a medical programme, and given the co-operation of other faculties and also of students' organisations, the University of Rome should be able to institute a medical service for the students which would serve as a model for the assistance of the young people of Italy, on whom depends the future of the country.

A Welsh Folk Museum: St. Fagans Castle

A FULL description of the Earl of Plymouth's magnificent gift of St. Fagans Castle, together with 18 acres of land, to the National Museum of Wales appears in the *Museums Journal* of September. Following this gift (which was made this year) Lord Plymouth has arranged, "on very acceptable terms", the transfer to the Museum of an extra 80 acres of the park-land adjoining the gardens. This additional acquisition was essential in view of the development of St. Fagans as a folk museum. The establishment of a Welsh Folk Museum as an extension of the National Museum's services has been a long-felt need. In 1943 the Welsh Reconstruction Advisory Council provided an opportunity for publicly pressing the adoption of the proposal, and upon this the Museum Council submitted a recommendation that an open-air museum was an essential auxiliary to the National Museum of Wales. This recommendation was adopted by the Advisory Council, and now, in 1946, the scheme proposed materializes through the generosity of Lord Plymouth.

St. Fagans Castle dates from Norman times, and the present house, which was built within the thirteenth-century curtain wall of the fortress, is best described in the words of the report : "it is a dignified, picturesque and characteristic example of the commodious many-gabled style of Elizabethan times, containing lofty well-lighted rooms". The beautiful grounds, which will be maintained for the enjoyment of visitors, include terraced walks, formal gardens, fish-ponds and a treed hill slope. The extra 80 acres of park-land is reached through a short tunnel which runs beneath a fenced public footpath, and its higher parts overlook the Vale of Glamorgan. The policy for the Folk Museum envisages "as complete a picture of the Welsh past as possible, to create a 'Wales in miniature' where the visitor can wander in the confined area of a hundred acres through time and space, from the sixteenth century to the twentieth, from Anglesey to Monmouthshire, and see not only the old Welsh way of life but the variations in and the continuity of our culture". It will become "a centre for architectural and craft education, both visual and instructive". The house itself will be furnished in such a manner as to provide for the visitor a detailed study of the life and culture of the landed classes in Wales. The report, which contains three photographic reproductions of St. Fagans Castle with its gardens and park-lands, should be read by all those interested in the development of folk museums.

Manchester Libraries

Among points of interest in the annual report of the City of Manchester Libraries Committee for the year ended March 31, 1946, is the announcement of the impending reinstatement of the separate Technical Department in the Central Library in the room at present occupied by the Henry Watson Music Library, which will be moved to the second floor. Of the total 6,430,499 volumes issued during the year, 5,102,372 were from the home-reading adult and 819,533 from the junior libraries, and 508,594 from the reference libraries, which so far as issues are concerned have regained the ground lost during the War. Although 102,530 fewer volumes were issued than in the previous year, the average daily issue of 21,419 volumes was slightly higher. Grave concern is being caused by the continued heavy use of the already over-worked stock of the lending libraries, and the scarcity of copies of books in demand is so great that the libraries are compelled to circulate many thousands of copies which are, by pre-war standards, too shabby and dirty to justify a place on the shelves. In the reference section, where the absence of trained staff has been severely felt, the demand for library copies of prescribed books by university, college and school students is all the greater, because so many of them are out of print and unobtainable in any other way. It is embarrassing both to staff and students when some twenty students are anxious to use one copy of a set book. Again, while the total of 71,266 books added to the Libraries during the year, at an approximate cost of £20,700, is the smallest for many years, the average cost of each volume was almost three times the average before the War. The estimate for books has been increased to £30,000 for the current year, but of the 64,908 volumes withdrawn only 7,082 were replaced by new copies, due to the existing shortage of books. A feature of the year has been the increased use of the Commercial Library for all kinds of inquiries, and the value of the Information Bureau is well illustrated by examples quoted in the report.

Recent Earthquakes

During August 1946, seven distant earthquakes were recorded in New Zealand, and twenty-three were felt by persons in the Dominion. The greatest shocks had intensity 4 on the Modified Mercalli Scale, and occurred on August 1 and 12 near Lake Coleridge, on August 12 near Wanganui and on August 21 in the central parts of North Island. The United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association determined the epicentres of two shocks on August 28. The first, at 22 hr. 26·3 min. G.M.T., was an aftershock of the destructive Dominican Republic earthquake of August 4 off Samana Peninsula, and the second, at 22 hr. 28·2 min. G.M.T., occurred in Northern Chile.

During September, twenty-two earthquakes were registered at the Geophysical Observatory at Toledo in Spain, that on September 12 being in north-west Bengal, that on September 23 north of New Guinea and that on September 25 a further aftershock of the Dominican Republic earthquake (U.S. Coast and Geodetic Survey). In addition, there was an earthquake on September 18 not registered at Toledo. This happened in the Pacific Ocean off south-west Mexico (lat. 16° N., long. 101° W.).

On October 2 an earthquake had its epicentre south of Kamchatka (lat. 51° N., long. 157° E.), and on October 4 a further aftershock of the destructive Dominican Republic earthquake of August 4 occurred off the Samana Peninsula (U.S. Coast and Geodetic Survey). On October 19 an earth tremor shook Baghdad, but no damage is reported.

Lastly, on November 2, a violent earthquake took place in Central Asia. According to an official Moscow report, the earthquake was most strong in the district between Jalal-Abad in Khirghizia, and Fergana in Uzbekistan. This area is in the valley of the Syr Daria, where Uzbekistan's first steel works were built, and where there is an important hydro-electric station. A good deal of cotton is grown in the area, and this has been assisted by the construction of the Fergana Stalin Canal. The recent earthquake caused considerable material damage and loss of life, though the exact figures are not yet available.

Bibliography of Medicine

A Bibliographical Bulletin, covering medicine, veterinary science and pharmaceutical chemistry, published by the International Association of the Medical Press (71 Via M. Macchi, Milano, 300 lire ; 2 dollars yearly), gives a classified list of books in these fields published in 1945 and 1946 or in preparation, the titles being arranged alphabetically by authors in each section. There is also an author index. The Association plans in 1946 to send such a bulletin free of charge to the editors of medical reviews, and it is intended that the second edition of this catalogue shall include a summary of information regarding all periodicals, whether discontinued or in course of publication. The editor invites the managers of medical reviews to forward all the necessary information regarding such publications. The Association is also negotiating with the authorities of the Vatican City for the use of the Vatican station for regular broadcasts of sufficient length to enable

it to bring strictly scientific information from the medical press to the editors of medical reviews and to medical practitioners.

World List of Scientific Periodicals

ACTIVE preparations are being made for the issue of a third edition of the "World List of Scientific Periodicals". The second edition of this invaluable scientific reference work, issued in 1934 and covering the years 1900–33, is now out of print though still in constant demand. It contains upwards of 33,000 titles of journals and includes the holdings of some hundred and eighty libraries in Great Britain and Ireland. The new edition, which is designed to include all the scientific and technical periodicals that appeared during the period 1900–47 as well as the holdings of additional libraries, will, therefore, be considerably larger. Librarians are being asked to co-operate as before by sending particulars of all those journals on their shelves that do not appear in the second edition or are shown there as having no location in Great Britain, to the Secretary, World List of Scientific Periodicals, c/o Zoological Society of London, Regent's Park, London, N.W.8, from which office further information may be obtained.

"The Microtomist's Vademecum"

THE eleventh edition of "The Microtomist's Vademecum" is being prepared, and it is hoped that the new material will have been collected by early in the New Year. Laboratory workers are invited to submit accounts of methods which they believe should be included in the new edition to Prof. J. Brontë Gatenby, School of Zoology, Trinity College, Dublin; or to Prof. H. W. Beams, Department of Zoology, State University of Iowa, Iowa City, Iowa.

The Night Sky in December

FULL moon occurs on Dec. 8d. 17h. 52m., U.T., and new moon on Dec. 23d. 13h. 06m. The following conjunctions with the moon take place: Dec. 12d. 04h., Saturn 4° S.; Dec. 19d. 21h., Jupiter 1° S.; Dec. 20d. 02h., Venus 1° N.; Dec. 21d. 22h., Mercury 0·8° N. Mercury is a morning star, rising at 6h. on Dec. 1 and 7h. 20m. on Dec. 31, and attains its greatest westerly elongation on Dec. 9. Venus is conspicuous in the morning hours, rising at 5h. 54m., 4h. 50m. and 4h. 23m. at the beginning, middle and end of the month respectively. During this period its stellar magnitude varies between − 4 and − 4·3. The planet attains its greatest brilliance on Dec. 23 when its stellar magnitude is about − 4·4. Mars is too close to the sun for favourable observation throughout the month. Jupiter, a morning star, rises at 5h. 28m., 4h. 50m. and 4h. 05m. at the beginning, middle and end of the month respectively. The stellar magnitude of Jupiter remains nearly − 1·3 throughout December. Saturn can be seen during most of the night, rising at 20h. 28m., 19h. 30m. and 18h. 21m. on Dec. 1, 15 and 31 respectively. It is easily recognized as it is close to the star δ Cancris and cannot be mistaken for a star owing to the absence of twinkling. The following occultations of stars brighter than magnitude 6 take place in December: Dec. 1d. 18h. 36·0m., 69 Aqar. (*D*); Dec. 11d. 02h. 31·2m., 181 B.Gemi. (*R*); Dec. 11d. 04h. 13·6m., ϰ Gemi. (*D*); Dec. 11d. 05h. 14·3m., ϰ Gemi. (*R*); Dec. 13d. 23h. 27·7m., 46 Leon. (*R*). *D* and *R* refer to disappearance and reappearance respectively, and the latitude of Greenwich is assumed. Winter solstice is on Dec. 22d. 11h.

There will be a total eclipse of the moon on Dec. 8, visible at Greenwich. The circumstances of the eclipse are given below:

	Dec.			
Moon enters penumbra	8d.	15h.	11·8m.	
Moon enters umbra	8	16	10·2	
Total eclipse begins	8	17	18·8	
Middle of eclipse	8	17	48·0	
Total eclipse ends	8	18	17·2	
Moon leaves umbra	8	19	25·8	
Moon leaves penumbra	8	20	24·2	

Announcements

SIR ROBERT ROBINSON, president of the Royal Society, will deliver the Faraday Lecture of the Chemical Society on July 16, 1947, during the Society's centenary celebrations. The Faraday Lectureship was founded in 1867 to commemorate Michael Faraday. In normal times it is delivered every three years, and is the highest honour which the Chemical Society has in its power to offer. The list of names of previous Faraday Lecturers include Dumas, Cannizzaro, von Hofmann, Wurtz, Helmholtz, Mendeléeff, Lord Rayleigh, Ostwald, Fischer, Richards, Arrhenius, Millikan, Willstätter, Bohr, Debye and Rutherford. The Lecture will be delivered in the Central Hall, Westminster, and will form the principal scientific event of the Chemical Society's centenary celebrations.

DR. L. H. LAMPITT will deliver the second Sir William Jackson Pope Memorial Lecture before the Royal Society of Arts on December 4 at 5 p.m.; he will speak on Sir William Pope's influence on scientific organisation.

THE thirty-first Exhibition of Scientific Instruments and Apparatus arranged by the Physical Society is to be held in the Physics and Chemistry Departments of the Imperial College of Science and Technology and some adjoining galleries of the Science Museum, London; the provisional dates are April 9–12.

THE Radio Industry Council announces that Radiolympia—the National Radio Exhibition—will be resumed in 1947, the proposed dates being October 1–11. This exhibition will provide the first opportunity to display to the public and to the whole world the achievement of the radio industry of Great Britain in overcoming the many difficulties of reconversion to the design and production of radio, television, radar and electronic apparatus for civilian purposes.

THE wide scope of the work which has been undertaken by the British Electrical and Allied Industries Research Association is revealed by the contents of the annotated list of its published papers. This booklet, which is revised and published annually, gives abstracts of some five hundred reports covering the many aspects of electrical equipment and electricity supply, safety problems, insulating and magnetic materials, and electrical instruments and measurement.

BY a recent decision at the University of Cambridge, the professor of astrophysics is to be director of both the University Observatory and the Solar Physics Observatory. Prof. Harold Jeffreys, the newly appointed Plumian professor of astronomy and experimental philosophy, will thus not reside at the University Observatory.

LETTERS TO THE EDITORS

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

Determination of the Electronic Charge by the Oil-Drop Method

A NEW determination of the electronic charge e is being carried out using a method which is a development of the photographic method previously used[1]. Instead of vertical plates and a horizontal field, horizontal plates are used as in Millikan's experiment. The present method has several advantages over the previous one. The path of the drop is now fifty or more times the distance measured, thus making the Brownian motion effect extremely small and enabling effects due to a change in charge of the drop or evaporation readily detectable if they exist. An accurate study of the electric field can be made, and by photographing much smaller droplets a check can be made of the presence of convection currents. An interesting result has been obtained during the study of the field which may throw light on some of the previous oil-drop results, and so a brief report is made of this work.

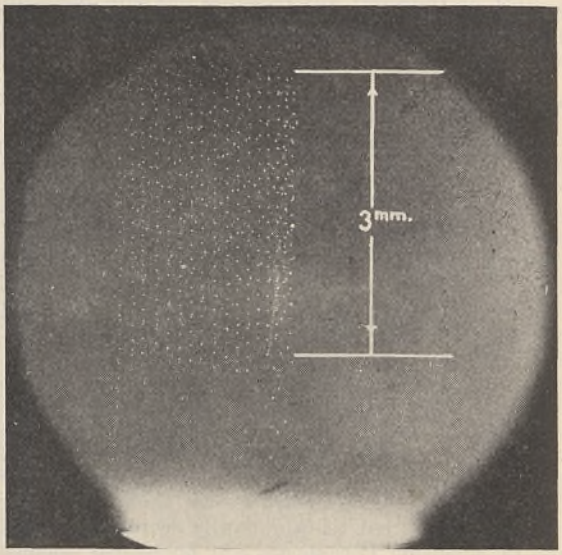

Fig. 1

For the preliminary tests the condenser consisted of two circular steel plates, 3·7 cm. in diameter, optically polished and separated by glass pillars of length 0·6573 cm. In order to study the effect of the hole in the condenser plates on the field, a relatively large hole 1 mm. in radius was used, and as will be shown later a surprisingly large variation in field was produced by it. Oil drops after passing through this hole entered the field and were illuminated by flashes of light at intervals of 0·2 sec. either by using a rotating disk and projection lamp or by triggering a discharge tube. A concave mirror reflected the light so that the drops were illuminated almost equally in opposite directions. When a drop reached a lower part of the field, a potential difference of about 5,000 volts was applied across the plates; and if the drop was satisfactorily charged it rose towards the top plate. The plates were tilted at a small angle to the horizontal about the optic axis of a viewing telescope, and this enabled the rising drop to move to a slightly different part of the visual field. When the drop reached a certain height, the electric field was removed and the drop again fell under gravity, making a new track parallel to the first. This process was repeated until the drop passed out of the field of view. Two cameras facing in opposite directions allowed simultaneous exposures to be made of the one drop, and thus any error in magnification due to slight out-of-focus in one camera was compensated by the other. An arrangement has also been devised for moving the drop until it is sharply in focus before photographs are taken. The apparatus was temperature-controlled by a warm air method[2] which also controls the temperature of the room. Thorough air circulation was obtained by four fans, and all photographs were taken late at night with the room illuminated only by a sodium lamp. The apparatus was thermally shielded by an outside shield of thick copper, and the inner space lagged with cotton wool. The frequency of illumination and the voltage were controlled to 1 part in 40,000.

Measurements of the photographs showed that although the velocity of the drop when acted on by the gravitational field remained constant, the velocity of the drop when acted on by the combined electrical and gravitational fields varied along the path, the path being slightly curved, and also the average velocity along a path over a certain length varied over successive paths. This effect was studied over the whole field of view, and it was found to be due to the influence of the hole in the plate on the electric field. From the velocity of free fall and the velocity of the drop when acted on by both the gravitational and the electric field, the electric field at any point can be estimated. The average field for each path of ascent of the drop was calculated, and it was

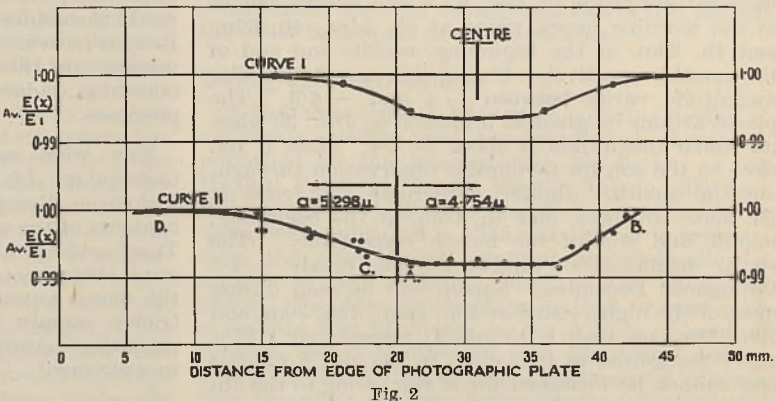

Fig. 2

Curve I. Calculated variation of average field for 1 mm. radius hole in a plane 0·66 mm. from the axis of the hole. The average field was estimated over approximately the same length of path obtained in the photograph of the drops

Curve II. Observed variation of average field for the condenser used. The lack of symmetry is due to the influence of the hole in the bottom plate, which was not directly below the top hole and the effect of which was not allowed for in drawing Curve I

From A to B, measurements from drop for which $a = 4{\cdot}754\ \mu$
From C to D ,, ,, ,, ,, ,, $a = 5{\cdot}298\ \mu$

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x	$E(x)/E_1$	$E(x,R)/E_1$
0	0·500	
0·5	0·775	0·900
1·0	0·910	0·968
1·5	0·960	
2·0	0·980	0·987
2·5	0·988	
3·0	0·993	0·995
4·0	0·997	
5·0	0·999	0·999

found that this varied by 0·8 per cent over the field of view.

Calculations have been made on the effect of holes of various size on the electric field. The accompanying table gives figures for the ratio of the actual field $E(x)$ to the field, $E_1 = V/d$, at different heights in the condenser and at two distances from the axis of the hole. The first column gives the vertical distance below the top plate in terms of $x = z/R$, where z is the measured distance and R the radius of the hole. The second column indicates the variation in field below the centre of the hole, and the third column the field below the edge of the hole.

From a study of the spread of the drops which fell through the field of view when no field was applied, it was estimated that the focus of the camera was about 0·66 mm. behind the axis of the hole. Further calculations were made to obtain the variation in field in this focal plane. Curve I (Fig. 2) plots the average field over a central 3 mm. vertical path at distances 0, 1, 2 and 3 mm. to the right and left of the centre of the hole. Curve II shows the experimentally determined variations in field. The average field for each path of ascent of a drop was estimated and plotted against the position of the path on the plate. Two drops were studied, one of which ($a = 4·754\ \mu$) moved to the right of the centre of the field and the other ($a = 5·298\ \mu$) moved to the left of the centre, the tilt of the plates being altered between the taking of the two photographs. (More than seven hundred exposures were obtained of the drop which was deflected to the left.) There was a small hole in the lower plate to avoid the collection of oil on this plate, and as this was not directly below the top hole a slight lack of symmetry in the field resulted.

An attempt was made to check whether the influence of the hole would affect previous determinations of e by the oil-drop method. In order to avoid convection currents, Millikan[3] allowed drops to fall through five minute holes each $\frac{1}{4}$ mm. in diameter in the centre of the top plate, his plates being 14·9174 mm. apart and the distance of fall 10·220 mm. In this case the above correction for field variation would be negligible. Bäcklin and Flemberg[4] do not state the diameter of the hole; they used plates 0·3787 cm. apart and measured over a distance of fall of 0·25597 cm. Assuming that the closest distance of the drops to the hole was 0·614 mm., then for $E(x)/E_1$ to be less than 0·999 at this point, the hole would need to be less than 0·614/5 mm. or 0·123 mm. in radius. Had they used a hole 0·6 mm. in diameter, the correction to e would be 4 parts in 1,000 for drops falling in line with the centre of the hole, and this corresponds to the difference between their and Millikan's value of e. Hopper and Laby[1] used vertical plates, so no correction of this type would enter into their results. Errors, however, have been detected in this work, and those results will be discussed in a later paper in which full details of the present experiment will be given.

I wish to acknowledge the assistance of Mr. F. C. Barker in the theoretical calculations and Miss A. Grant in the experimental work. This work is being financed by a grant from the Council for Scientific and Industrial Research (Australia).

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Influence of Retardation on the London–van der Waals Forces

In the course of his work on the stability of colloidal solutions, in which the attraction between the particles is ascribed exclusively to London – van der Waals forces, the repulsion being due to the interaction of electric double layers, Overbeek arrived at the conclusion that in order to account for the stability of suspensions of comparatively large particles, it is necessary to assume that for long distances the London – van der Waals energy decreases more rapidly than R^{-6}; and he pointed out that as soon as the distance becomes comparable to the wave-length corresponding to the excitation energies of the interacting atoms, the retardation of the electrostatic interaction between these atoms can no longer be neglected and will presumably lead to a decrease of the attractive force. Following Overbeek's suggestion, we have studied in detail the influence of retardation on the mutual attraction of two neutral atoms. As is well known, the usual expression for the London force is found by calculating the second order perturbation energy due to the interaction:

$$\Delta V = \frac{(\vec{q}_1\vec{q}_2)}{R^3} - \frac{3(\vec{q}_1\vec{R})(\vec{q}_2\vec{R})}{R^5}, \quad . \quad . \quad (1)$$

where q_1 and q_2 are the operators of the total dipole moments of the two atoms. Since ΔV is proportional to e^2, the London interaction is proportional to e^4. In order to account for retardation effects, it is necessary also to consider the interaction with the radiation field, and since in this case the interaction operator is proportional to e, the perturbation method must be applied to the fourth order. Although several artifices are required to make the calculation feasible and to avoid divergences, the usual formulation of quantum electrodynamics leads to an unambiguous result.

The usual formula for the London energy between two neutral atoms in ${}^0S$ states is:

$$\Delta_2 E = -\frac{12\pi}{hcR^5}\sum_{l,m}\frac{q_l^2 q_m^2}{u_l + u_m}, \quad . \quad . \quad (2)$$

with $u_l = \frac{2\pi R}{hc}E_l$, where q_l is the matrix element of the total dipole moment between the S state and a P state with index l, and E_l is the energy difference between these states. The indices l and m denote the levels of the two atoms respectively.

When the influence of retardation is taken into account, formula (2) must be replaced by:

$$\Delta_4 E = -\frac{8}{hcR^5}\sum_{l,m} q_l^2 q_m^2 \int_0^\infty \frac{u_l u_m}{(u_l^2+y^2)(u_m^2+y^2)} (y^4+2y^3+5y^2+6y+3)e^{-2y}dy. \quad (3)$$

Each term of the summation in (3) converges to the corresponding term in (2), if:

$$R \ll \lambda_l = \frac{hc}{E_l} \text{ and } R \ll \lambda_m;$$

and therefore the London energy is proportional to R^{-6} if R is very small. In the case $R \gg \lambda_l$ and $R \gg \lambda_m$ the term in (3) is proportional to R^{-7} rather than to R^{-6}.

A simple illustration of essentially the same mechanism is obtained by studying the image force between one neutral atom and a perfectly conducting plane. In this case, the interaction energy is found to decrease as R^{-4} at large distances and as R^{-3} for $R \ll \lambda_l$.

Details of the quantum mechanical calculation and of the application of our results to the problems of colloid chemistry will be published in *Physica*.

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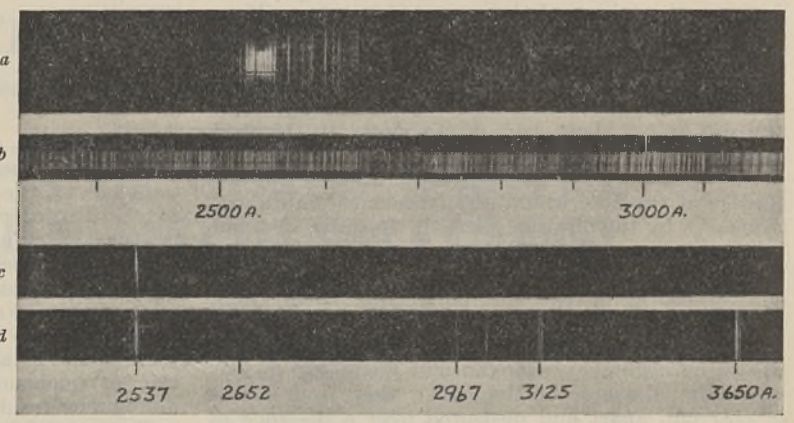
A Christiansen Filter for the Ultra-violet

The type of colour filter developed by Christiansen[1] consists of a powdered transparent solid (for example, glass) immersed in a liquid of about the same refractive index but with a different dispersion. For one particular wave-length the refractive index of the liquid and solid will be exactly the same, and this wave-length will be transmitted, while other wave-lengths for which the refractive indices are not quite the same will be scattered by the powder and so not transmitted. The theory of these filters has been discussed by Sethi[2], and Kohn and Fragstein[3] used a filter of amorphous silica in a mixture of 56 per cent benzene with 44 per cent ethanol to isolate the Hg line 3650 A. There does not appear to be any record of work farther in the ultra-violet, and it seems desirable briefly to report our attempts to develop a filter to transmit the 2537 A. line of Hg. This was required for quantitative measurements on the absorption of hydrogen peroxide produced during certain combustion processes.

Beyond 3000 A., the choice of suitable transparent solids and liquids is very limited. Attempts to make a filter using crushed fused quartz and mixtures of either chloroform, carbon tetrachloride, *n*-hexane, cyclohexane, or ethanol, were not very successful because the difference in the dispersions of the liquid and solid was insufficient. We obtained sufficient success, however, using crushed fluorite (CaF_2) in a mixture of carbon tetrachloride and ethanol. For 2537 A. we found that a cell (of fused quartz) about 0·75 cm. thick, packed with fluorite which had been sieved through a 60–120 mesh, and filled with a mixture of 43 per cent carbon tetrachloride with 57 per cent ethanol, was most satisfactory. The cell was heated in a water-bath at 18·6° ± 0·05° C.; a change of 1° C. altered the wave-length of maximum transmission about 10 A.

The cells were examined with an iron arc and a medium-size quartz spectrograph. To obtain good results it was essential to use the cell in accurately parallel light and not to place it too close to the slit. The testing set-up consisted of the arc, a quartz lens to render the light parallel, the cell, and a second lens to form an image of the arc on the slit; the lenses were focused for the ultra-violet. With this set-up the rays at the optimum wave-length formed a sharp image on the slit and gave a narrow spectrum in this region; wave-lengths slightly greater and less than the optimum gave a less well-defined image on the slit and hence a wider, less intense spectrum. The spectrum thus showed a cusp-shaped patch of light, as indicated in Fig. *a*, which may be compared with the normal arc spectrum without filter (Fig. *b*).

The filter gave a little scattered light of other wave-lengths, but the bulk of the transmission was limited to a narrow region about 50 A. broad. The transmission at the optimum wave-length was only about 1–2 per cent, but the filter did nevertheless isolate the Hg 2537 line fairly well, and it served our purpose satisfactorily. Figs. (*c*) and (*d*) show the spectrum of a quartz mercury discharge tube with and without the filter. With the mercury discharge tube no appreciable photochemical decomposition of carbon tetrachloride was detected, but with an iron arc some trouble was experienced, and it was necessary to protect the filter with another cell containing a thin layer of carbon tetrachloride which could be changed frequently. The tetrachloride used in the filter had to be carefully purified from unsaturated compounds which absorbed the near ultra-violet.



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Determination of Transverse Wave Velocities in Solids

A TECHNIQUE for finding longitudinal wave velocities in solids has already been described[1]; velocities of transverse waves can be determined with the same apparatus.

Ultrasonic waves were generated by an oscillator connected to a quartz crystal. The waves were received by another similarly cut quartz crystal. The received waves were detected and measured by a two-stage radio-frequency amplification, followed by single stages of rectification and D.C. amplification. Screening of the detector set had to be thorough, so that it would not pick up any general electromagnetic radiation from the oscillator set. In this detail, the method for transverse waves differs from the method for longitudinal waves, where sufficient leakage of electromagnetic waves into the detector had purposely to be provided[1].

The crystals were placed flat upon solid surfaces, such as of concrete, marble, iron, copper, ebonite. Thin layers of glycerine were smeared on the surfaces for maintaining 'acoustic' continuity between quartz and the solid surfaces. A frequency of 300 Kc./sec. was used. As the oscillator crystal was moved away or towards the detector crystal (of course, either can be moved, whichever is practicable), the intensity of pick-up of ultrasonics was found to pass through maxima and minima. The distances between consecutive shifts for two maxima or two minima must be the half wave-length of the sound waves. Unfortunately, the programme of research had to be broken off at this stage, and no accurate measurements of the wave-length could be made; but the approximate measurements supported the theoretical expectation that the distances measured were half wave-lengths.

This technique has the advantages over the 'lycopodium powder' method of actually marking out the sound field by differential distribution of the powder by the sound on the solid surface, that only a very weak source of ultrasonics (fraction of a watt) is necessary, accurate measurements can be made of the shift of the movable crystal, the application of the method to field measurements for extended, immovable solids, etc.

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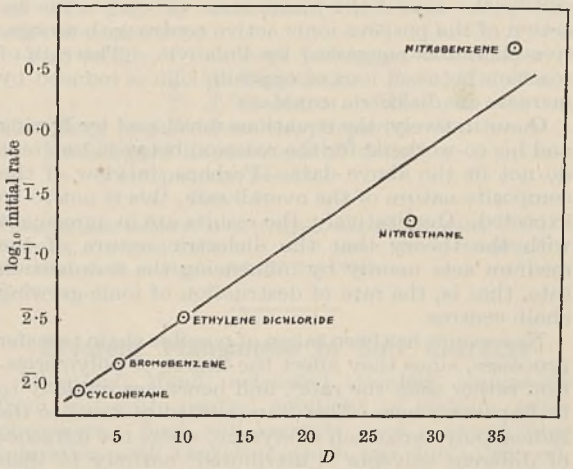
Friedel–Crafts Polymerizations

α-METHYLSTYRENE has been polymerized at 25° C., using stannic chloride as catalyst, both in solution and in undiluted monomer, giving polymers of molecular weight up to approximately 11,000. Staudinger[1], using this catalyst, obtained only a very low degree of polymerization (up to octamer), presumably due to the high temperatures reached in his experiments. The molecular weight of the polymer can be increased three-fold by polymerizing at 0° C., in agreement with the aluminium chloride-catalysed reaction[2].

The opinion is widely held[3,4,5] that polymerizations of this type (catalysed by acids, boron trifluoride, aluminium chloride, stannic chloride, etc.) proceed by an ionic chain process. Direct evidence of such a mechanism is provided by the observation that both the rate and degree of polymerization of α-methylstyrene are increased by increase in the dielectric constant of the solvent. Similar effects are well established in simple ionic reactions[6,7].



The accompanying graph shows a plot of $\log_{10}$ (initial rate) at 25° C. against dielectric constant (of the solvent) over a range from $D = 1{\cdot}9$ (cyclohexane) to $D = 36$ (nitrobenzene), for an initial concentration of monomer of 1·36 moles/litre and catalyst of 9×10^{-4} moles/litre. (Rate = disappearance of monomer in moles/litre/min.$^{-1}$.) Over this range the molecular weight (number average) increases in a similar marked fashion, as shown in the table below.

Solvent	Dielectric constant	Molecular weight
Cyclohexane	1·9	500
Ethylene dichloride	10	1200
Nitro-ethane	28	(680)
Nitrobenzene	36	8500

There is, however, some quantitative uncertainty here, as it is difficult to remove traces of monomer from the polymer.

Until the effects of monomer and catalyst concentration have been fully determined, it will not be possible to deduce the formal kinetic steps. But if it may be assumed that these are the same in all the above solvents, and also that a stationary state is established, conclusions can be drawn about their nature. For a given monomer and catalyst concentration, the rate and degree of polymerization will depend upon the specific rate constants for initiation (k_i), propagation (k_p), and termination (k_t) as follows:

$$\text{Rate} \propto \frac{k_i.k_p}{k_t};$$

$$\text{Degree of polymerization (number average)} \propto \frac{k_p}{k_t}.$$

The dielectric constant may, in principle, influence any or all of these rate constants, since all are likely to involve ionic processes. But the fact that both the rate and the degree of polymerization are similarly affected indicates that its main influence is on the ratio k_p/k_t rather than on k_i^*.

If the propagation step is the reaction of a monomer molecule with an ionic active centre, as generally assumed[4,5], then by analogy with simple reactions between neutral molecules and ions[7] we should expect k_p to be reduced by increase in dielectric constant. An increase in the ratio k_p/k_t can, therefore, only be secured by a similar but greater decrease in k_t. This

will be the case if the termination process is the reaction of the positive ionic active centre with a negative charge as suggested by Polanyi[5]. (The rate of reaction between ions of opposite sign is reduced by increase in dielectric constant[7].)

Quantitatively, the equations developed by Eyring and his co-workers[7] for the reaction between two ions do not fit the above data. Perhaps, in view of the composite nature of the overall rate, this is not to be expected. Qualitatively, the results are in agreement with the theory that the dielectric nature of the medium acts mainly by influencing the termination rate, that is, the rate of destruction of ionic-growing chain centres.

No account has been taken of possible chain transfer processes, since they affect the degree of polymerization rather than the rate[8], and hence are unlikely to be important here. This is in marked contrast to the radical polymerization of styrene, where the influence of different solvents is attributed[8] entirely to their different transfer constants.

The polymerizations were followed, and the molecular weight of the products measured, by bromination. Full experimental details will be published later.

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Cis-Trans Isomerism of Diethylstilbœstrol

Walton and Brownlee[1] have reported the conversion of pure ψ-diethylstilbœstrol (*cis* ?) into diethylstilbœstrol (*trans*) in 80 per cent yield by heating with alcoholic hydrochloric acid. Recent work in this laboratory has shown that heating with 2·5 *N* aqueous hydrochloric acid for periods of 30 min.–2 hr. converts both ψ-diethylstilbœstrol and diethylstilbœstrol into an equilibrium mixture in which, in so far as these two substances are concerned, diethylstilbœstrol preponderates in the ratio 9 : 1. The change has been followed by melting-point and colorimetric estimations[2] of the products isolated from saturated acid solutions after cooling to room temperature, and checked by comparison with the properties of suitable mechanical mixtures.

It would seem, however, that a simple binary equilibrium is not involved, and that at least one other—and presumably a more soluble and less chromogenic—substance is implicated. This may be deduced from the fact that the theoretical intensity of colour which might be expected from a 9 : 1 proportionality of the two substances is not attained in experiments involving quantitative recovery by ether extraction, and from the stability of the system over the period studied, which would seem to preclude any progressive change in the equilibrium conditions due to the gradual removal or destruction of one of the components.

The further possibility that the 9 : 1 proportionality in the solid phase may not reflect the true equilibrium ratio in the saturated liquid owing to differences in the solubilities of the *trans*- and ψ-forms, and that this ratio might be more nearly 1 : 1, which would very simply account for the low colour development, is not supported by preliminary experiments ; these show that both substances are only very slightly soluble in acid solution at room temperature and, in fact, suggest a slightly greater solubility for the *trans* form.

Œstrogen	Duration of acid treatment (min.)	Product m.pt. °C. (uncorr.)	Product Chromogenic power*[C]	Recovery % theoretical chromogenic power [%C]
Diethylstilbœstrol	0	171	100	98
,,	30	157	94·5	79
,,	90	158·5	96	80
ψ-Diethylstilbœstrol	0	149·5	56·5	104
,,	30	157	96	75
,,	90	157·5	95	76
Mechanical mixture†	—	159·5	95	100

* Expressed as a percentage pure diethylstilbœstrol colour intensity.
† Diethylstilbœstrol : ψ-diethylstilbœstrol = 9 : 1.

Typical results are summarized in the accompanying table ; they are clearly of importance in the chemical estimation or biological assay of conjugated forms of diethylstilbœstrol after acid hydrolysis.

Hexœstrol has been found to be quite stable under similar conditions of acid treatment, and to yield quantitative recoveries.

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Metallo-organic Complexes in Soil

Dion and Mann[1] have shown that, as extractants for manganese from soil, neutral sodium and potassium pyrophosphates are much more effective than the corresponding orthophosphates. Since then, Heintze and Mann[2] have shown that various organic hydroxy-acids are almost as effective as pyrophosphate, and much more effective than the corresponding unsubstituted acids, as soil-manganese extractants.

From the start of this work it was obvious that there was a close parallel between the colour of an extract and its manganese content ; pyrophosphate, malate, citrate, etc., gave dark extracts rich in manganese, while orthophosphate, succinate, tricarballylate, etc., gave light-coloured extracts poor in manganese. The original observations of Dion and Mann[1] and Heintze[3] had already led Bremner and Lees (unpublished) to explore the possibility of using pyrophosphate as an extractant for soil organic matter (the nitrogen content of an extract was used as an index of its richness in organic matter), and, as these investigations showed that pyrophosphate was in fact a good organic-matter extractant, the new observations of Heintze and Mann prompted a similar investigation into the possibility of using malate, etc., for the same purpose. The results obtained showed that the hydroxy-acids were almost as effective as pyrophosphate, and the present joint

investigation was therefore begun with the object of examining the possible correlation between the ability of an extractant to extract manganese, iron and copper from the soil, and its efficiency in dissolving soil organic matter.

The technique used was simple. One part of soil was shaken with five parts of neutral extractant intermittently during 24 hours. The extract was then filtered and its nitrogen content determined by micro-Kjeldahl, and its manganese, iron and copper contents colorimetrically by the usual methods—permanganate, dipyridyl and sodium diethyldithiocarbamate. The results given in the table are from experiments with a clay loam of medium organic nitrogen content, but comparable figures have been obtained from soils of different types.

Amount of element extracted (μgm./gm. soil)

Extractant	Copper	Manganese	Iron	Nitrogen
M/5 pyrophosphate	17	530	870	320
M/5 orthophosphate	3	trace	35	136
M/5 sodium citrate	6	520	397	360
M/5 ,, tricarballylate	—	trace	0	156
M/5 ,, malate	—	36	93	155
M/5 ,, succinate	—	trace	trace	70
M/5 ,, oxalate	7	trace	62	456
M/5 ,, tartrate	4	64	223	222
2 per cent sodium hydroxide	17	0	25	846

The results show that, on the whole, compounds that are good polyvalent-metal extractants are also good organic-matter extractants. Moreover, it is clear that these extractants are just those known to form co-ordination complexes with polyvalent metals. This suggests that some of the polyvalent metal in soil exists as an insoluble metallo-organic complex with some of the organic matter, and that, if the polyvalent metal can be removed from the complex by a suitable solvent (such as pyrophosphate), the organic matter becomes soluble. The metals in these metallo-organic complexes are not in the exchangeable form. Although a preliminary extraction of the soil with dilute hydrochloric acid removes the exchangeable manganese, iron and copper, such a pretreatment generally leads to an increase in the amount of nitrogen, manganese, iron and copper obtained in subsequent extractions by pyrophosphate, etc. The metal itself is usually extracted along with the organic matter, but that this is not necessarily so is shown by the oxalate result. It is true that 2 per cent sodium hydroxide gives an anomalous result, but there is already evidence (Bremner and Lees, unpublished) that the extracting power of sodium hydroxide may be due, at least in part, to a preliminary degradation of the high-molecular weight compounds initially present in the soil.

The metal-complex hypothesis is strengthened by our finding that when a pyrophosphate (or malate, etc.) extract is dialysed, the pyrophosphate and most of the metals are removed thereby, while the organic nitrogen which remains behind is water-soluble. The addition of manganese, copper or iron to this solution gives an immediate precipitate of the corresponding metallo-organic complex, which shows just the same type of solubility as is shown by the compounds originally present in the soil; it is far more soluble, for example, in pyrophosphate than in orthophosphate, and quite insoluble in water.

On the basis of these results we feel justified in advancing the theory that, in soil, part of the polyvalent metals is combined as co-ordination complexes with part of the organic matter, and that the presence of the metals renders the organic matter in the complexes insoluble in water, and in neutral solvents that do not themselves form complexes with the metals.

Full details of this work will be published later.

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Divalent Manganese in Soil Extracts

Dion and Mann[1] extracted trivalent manganese from soil with neutral solutions of sodium pyrophosphate. Such soil extracts gave a strong blue coloration with benzidine which was due to the trivalent manganese present. Later it was found that solutions of potassium pyrophosphate of *p*H 9·4 extracted significant amounts of manganese from soils. As the alkaline extracts gave no benzidine test, it seemed possible that the manganese present was in the divalent form. A number of soils representing different soil types were therefore extracted with *M*/5 pyrophosphate solutions at *p*H 7·0 and 9·4. Typical results are set out in Table 1, which also gives the exchangeable manganese determined by extracting the soils with *N* calcium nitrate, and the nitrogen content.

Table 1. Nitrogen content, exchangeable manganese and manganese extracted by pyrophosphate solutions at *p*H 7·0 and 9·4

Soil	Nitrogen mgm./gm. soil	Manganese (p.p.m.)		
		Exchangeable manganese	Pyrophosphate soluble *p*H 7·0	Pyrophosphate soluble *p*H 9·4
Barnfield 8·0	1·0	2	440	52
Barnfield 1·0	2·7	1	542	232
Swaffham	12·7	1	32	44
Wissington	26·0	14	49	128

The results indicate that one of the factors determining the fraction of the soil manganese extractable by alkaline pyrophosphate may be the organic matter content of the soil. Thus on a mineral soil of low organic matter content such as Barnfield 8·0, the manganese extracted with alkaline pyrophosphate is only a small fraction of that extracted by neutral pyrophosphate. On highly organic soils, such as the fen soils Swaffham and Wissington, the manganese extracted at *p*H 9·4 is higher than that extracted at *p*H 7·0. Similar results were obtained if solutions of the sodium salts of hydroxycarboxylic or polycarboxylic acids *p*H 7·0 or at *p*H 9·0 were used in place of pyrophosphate. The alkaline extracts gave a negative test with benzidine; Heintze and Mann[2] used solutions of such reagents at *p*H 7·0 for the extraction of manganic manganese from soils.

Evidence to prove that manganese extracted by alkaline pyrophosphate solution from soils is present in the manganous state was furnished by developing an observation by Lingane and Karplus[3]. It was possible to show that divalent manganese in pyrophosphate solution can be estimated by addition of excess manganese dioxide followed by estimation of the amount of trivalent manganese in solution. The reaction proceeds according to the equation $MnO + MnO_2 = Mn_2O_3$. Conditions under which this reaction takes place quantitatively have been worked out. At

*p*H 7·0, the reaction reaches completion in a few minutes with hydrated manganese dioxide, in 24 hours with commercial manganese dioxide. It does not take place at *p*H 9·4.

Some results of applying this method to alkaline pyrophosphate extracts of mineral soils are set out in Table 2.

TABLE 2. REACTION BETWEEN PYROPHOSPHATE EXTRACTS OF SOILS AND MANGANESE DIOXIDE (COMMERCIAL)

Soil	Manganese (p.p.m.) Original extract	Manganese (p.p.m.) After treatment with manganese dioxide
Barnfield 8·0	52	120
Barnfield 1·0	256	580
Clay loam high in organic matter	464	1200

In the case of mineral soils with low or only moderate organic matter content, the soluble manganese found after reaction with excess commercial manganese dioxide was slightly more than double the amount initially present in the pyrophosphate extracts. The filtrates showed by their benzidine reaction test that the manganese was present in the manganic form. If, however, hydrated manganese dioxide was used, the reaction went further than doubling the manganese content. Soils with high organic matter content gave high increases in soluble manganese with both commercial and hydrated manganese dioxide. These results suggested that the organic matter in the extracts may also reduce manganese dioxide. If the pyrophosphate extracts were dialysed to separate the manganese from the bulk of the organic matter, the dialysates reacted with manganese dioxide to give trivalent manganese in amounts much nearer the theoretical doubling of their manganese contents.

It may, therefore, be concluded that the manganese found in alkaline pyrophosphate extracts of soils is in the manganous form. It may exist in the soil in the form of co-ordination complexes with the soil organic matter in accordance with the theory put forward by Bremner *et al.*[4]. On the available evidence, however, the possibility of its formation by reduction during the extraction cannot be excluded. Manganese deficiency occurs typically on soils of high organic matter content, and it would appear possible that in these deficient soils the conditions may be such that all the divalent manganese is fixed by the organic matter in a form unavailable to the plant. Its presence in the extracts makes it necessary to reconsider whether the trivalent manganese found by Dion and Mann[1] in neutral pyrophosphate extracts occurs as such in soils, or whether the reaction $MnO + MnO_2 = Mn_2O_3$ takes place in the pyrophosphate extractant. The reaction between divalent manganese in pyrophosphate solution and manganese dioxide may be of a general nature and applicable to some of the other so-called transition elements. The occurrence of such reactions and their possible significance in soils are under investigation. Full details of the work will be published later.

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Effect on Rats of Purified Diets with Synthetic B Vitamins

DURING the early years of the War, we investigated the possibility of providing the factors of the vitamin B complex in growing rats by giving them these factors exclusively in the form of the following synthetic components: thiamine, riboflavin, pyridoxine, niacin, pantothenic acid and choline. Most of our unpublished results have been confirmed by other investigators, and may be found in the Anglo-American literature of 1940–45. Some of our experiments, however, are in essential details different from those already reported.

After weaning for three weeks, young male rats of an average weight of 31 gm. were kept on one of the following diets.

Diet A. Yellow maize 40 per cent, wheat 30 per cent, milk powder 15 per cent, casein 1 per cent, dried baker's yeast 7 per cent, cotton seed oil 2 per cent, arachis oil 2 per cent, cod liver oil 2 per cent, calcium carbonate 0·5 per cent, sodium chloride 0·42 per cent, iron ammonium citrate 0·08 per cent.

Diet B. Recrystallized sucrose 74 per cent, vitamin-free casein 18 per cent, cotton seed oil 2 per cent, cod liver oil 2 per cent, adequate salt mixture 4 per cent. Per kgm. ration were added: 2 mgm. thiamine hydrochloride, 2·5 mgm. riboflavin, 3 mgm. pyridoxine hydrochloride, 10 mgm. sodium pantothenate, 300 mgm. nicotinic acid, and 300 mgm. choline hydrochloride.

Diet C. As diet B, containing the same amount of synthetic B vitamins, but with the addition of 50 gm. dried brewer's yeast per kgm. ration.

Diet A has been used by us for several years for breeding our stock rats. It proved to be a highly satisfactory ration for normal development.

The experimental diets B and C were given during the second week of weaning to those mothers whose litters would receive it exclusively a week later on during the experiment. In this way we prevented storage of unknown factors in the young animals.

Young males only were used for the increase in weight comparison. For each diet we used a group of seven animals; their mean weight is given in Table 1.

TABLE 1

Diet group	Average weight (gm.) of the rats at the age of: 21 days	28 days	40 days	54 days	61 days
A	31	52	103	171	198
B	31	49	94	155	177
C	31	53	113	189	211

Though growth on diet B is slower than in the others, the animals showed no signs of any deficiency. An average growth of 3½ gm. a day over such a long period may be considered as really favourable.

The full-grown males on diet B, without changing their diet, were paired with seven females brought up on the same purified diet B. All seven females produced normal litters, varying from four to nine, and totalling 52 animals. 34 of them (65 per cent) died during weaning. Three females lost their whole litters, and only one litter of seven animals remained fully intact. The resulting 18 animals, which after four weeks weaning had reached the average weight of only 28 gm., were at that time separated from their mothers, and divided in two groups. One group was still given diet B, the other received diet C. This second generation grew astonishingly well, as may be seen from Table 2.

Table 2

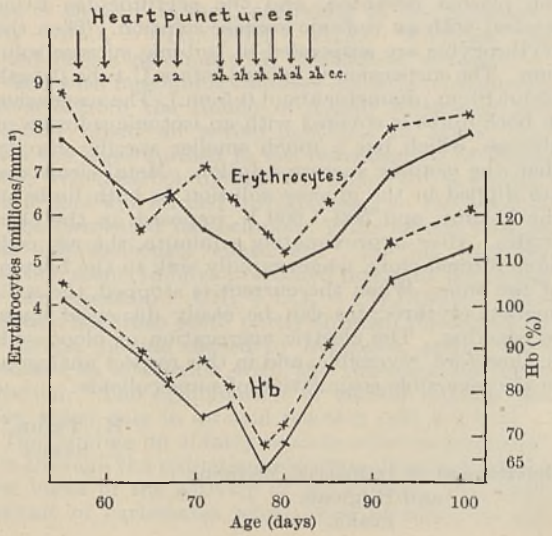
Diet group	Average weight (gm.) of the rats of the second generation aged : 28 days	40 days	54 days	68 days	82 days	96 days	105 days
B	28	60	106	146	177	194	208
C	28	70	128	180	201	208	214

As in the first generation, growth on diet C is faster than on diet B. The animals on diet C were mostly advanced in weight at ten weeks of age. They then weighed 180 gm., that is, 30 gm. more than the animals on diet B. But later on this difference diminished again, until it was of no significance at 15 weeks of age.

Simultaneously with the experiments reported above, we investigated the influence of brewer's yeast on the regeneration of blood. For these experiments we used twelve young male rats, which after a normal weaning period of three weeks were divided in two equal groups, receiving respectively diets B and C. After five weeks they had all reached a body-weight of 150–200 gm. They were then bled at intervals by heart puncture under light ether anæsthesia. After each puncture 2 c.c. salt solution was given intraperitoneally and the animals were well warmed until normal movements were regained. All animals were handled ten times in the course of 26 days, and a total of about 23·5 c.c. blood per animal was taken during that period. The total amount of blood is about 8 per cent of a rat's body weight, so that within four weeks one and a half to twice the total blood volume of the animals was taken.

Regular erythrocyte counts and hæmoglobin determinations were done in a drop of blood taken from the tail. The frequent heart punctures resulted in a decrease in hæmoglobin and the number of erythrocytes. No pathological changes in the red or white blood cells were observed. The erythrocytes were in general more basophilic than normal, and some normoblasts were seen. These are indications of active blood regeneration.

Complete regeneration to normal values for hæmoglobin and erythrocyte numbers in both groups was observed within fourteen days after the last puncture. Quantitatively there was a difference between the two groups. But it is not necessary to assume that there is an essential dietary factor for blood formation present in brewer's yeast, the complete recovery in Group B being as fast as in Group C. There was, however, a difference in body-weight between the animals of the two groups (these may be compared with the data given for the gain in weight), and therefore some difference in blood volume may be responsible for the quantitative difference observed.



Fouts *et al.*[1] found total nitrogen in blood lowered in dogs kept on synthetic diets. Total nitrogen was also determined in the blood of both our groups B and C, immediately after the last heart puncture. No difference was found between them, total nitrogen being on the average 35·3 mgm. and 34·5 mgm. per c.c. blood.

Similar experiments have been published by Kornberg *et al.*[2], who succeeded in producing anæmia only in the presence of sulphasuxidine in the diet. By using older rats bled by heart puncture, we produced anæmia without the use of a sulpha-drug. The rapid regeneration in our animals gives a good impression of the power of the bacterial synthesis of folic acid in the gut.

Summarizing the results obtained, we conclude :

(1) Normal growth and maturation of rats can be maintained during at least two generations on a simple, purified diet with vitamin B supplied by six synthetic components (B_1, B_2, B_6, niacin, pantothenic acid and choline), and a normal final weight is reached in a normal time.

(2) This growth is slower than on the same diet supplemented with 5 per cent brewer's yeast, but there are no indications that growth is suboptimal.

(3) Blood regeneration on the purified diet is as fast and as complete as in that of 5 per cent brewer's yeast.

(4) Reproduction on the purified diet is normal, but during the weaning period physiology seems to be unfavourably influenced ; perhaps some specific factor essential for lactation fails in the purified diet.

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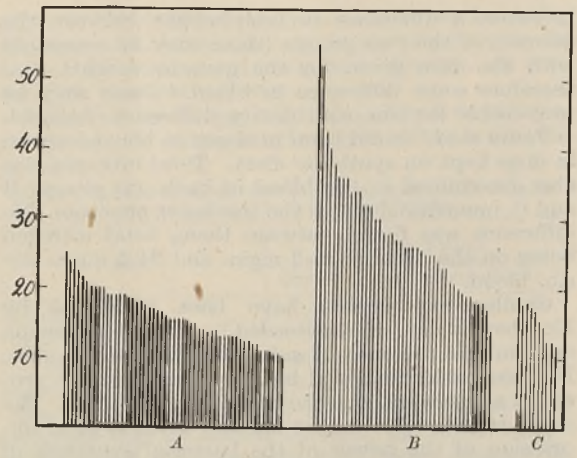
Disturbances in Oxidative Metabolism in Choline Deficiency

The common symptoms in rats on a choline-deficient diet are, as is well known, fatty liver, impeded growth, and in young animals renal hæmorrhages (for references see Best[1]). There has been discussion as to whether the vitamin character of choline is due only to its content of labile methyl groups, or if the lipotropic action has a more specific mechanism. The experiments reported below show that an impairment of oxidative metabolism is an early symptom in choline deficiency.

Young albino rats on an inbred stock, 28 days old and weighing 24–26 gm., were placed on a diet practically choline-free consisting of 40 per cent suet, 40 per cent sugar, 15 per cent purified casein, 5 per cent mineral mixture, and sufficient amounts of vitamins A, D and E, thiamine, lactoflavine, nicotinic acid, pantothenic acid, and menadiolsodium diphosphate. Controls had the same diet with the addition of 0·6 per cent choline chloride. The body weight was



TIME IN MINUTES REQUIRED FOR DECOLORIZATION OF METHYLENE BLUE *in vacuo*

A, controls; *B*, choline-deficient rats; *C*, choline-deficient rats which had been given 1 mgm. choline chloride intramuscularly 60 minutes before being killed. Every line represents the mean of two values from the same rat. Each Thunberg tube contained 1·250 γ methylene blue, dissolved in 2·5 ml. *M*/15 phosphate buffer *p*H 7·15, and 0·2 gm. of minced muscle of hind limbs.

determined every day. Every second day, four controls and four 'choline-free' rats were killed and examined for liver fat, blood sugar, bilirubin, non-protein nitrogen, and prothrombin index. The oxygen consumption of the minced muscles of the hind limbs was measured in Warburg respirometers.

In accordance with Griffith and Wade[2] and others, we found renal hæmorrhages on the seventh to ninth day followed by uræmia. At this point there was, as a rule—but not always—a slight increase in liver fat but no increased bilirubin values. Earlier, deposition of fat in the liver was observed, and two to four days before the occurrence of renal hæmorrhages the impeded growth, quite obvious on the fourth day, suggested a disturbance of a more general kind.

Considering the mechanism of action of the better known members of the B vitamins, for example, thiamine, lactoflavine and nicotinic acid, we studied the oxidative metabolism of minced muscles of the hind limbs. In choline-deficient animals oxygen consumption decreased to about two thirds of the normal values. In twenty-five animals on the test diet plus choline the oxygen consumption of 1 gm. of muscle pulp in 60 minutes was found to be $56{\cdot}4 \pm 1{\cdot}5$ mm.^{3}; in twenty-one rats on choline-deficient diet the corresponding value was $37{\cdot}1 \pm 1{\cdot}3$ mm.^{3}. The impairment of the metabolism occurred earlier than renal hæmorrhages.

The decrease in oxygen uptake corresponds to a slower decolorization of methylene blue *in vacuo* (see graph). Addition of choline in physiological concentrations to the minced muscles *in vitro* is not sufficient to normalize the metabolism. Experiments with addition of *d-l*-methionine *in vitro* have hitherto not given positive results, in spite of the prominent role of this amino-acid in transmethylation. The specificity of the impairment of the oxidative metabolism as a symptom of choline deficiency is, however, shown by the pharmacological effect of choline. If 1 mgm. of choline chloride is injected intra-muscularly only 60 minutes before the choline-deficient animal is used for experiment, the ability of its muscles to decolorize methylene blue is normal.

These experiments suggest that choline, or at least its methyl groups, are essential for intermediary metabolism, probably by being used in the formation of an unknown co-enzyme.

Detailed reports are to be published in *Acta Pharmacologica et Toxicologica*.

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Aggregation of Red Blood Cells in a Strong Electric Field

ERYTHROCYTES, when suspended in blood plasma, form 'rouleaux', in which the single erythrocytes lie parallel like a pile of coins. This phenomenon is dependent on the presence of a specific substance in the plasma. When suspended in an isotonic sugar solution, the erythrocytes settle to the bottom very slowly, without forming any characteristically shaped aggregation. On the other hand, the same suspension of blood cells, when exposed to the influence of a powerful electric field (approximately 100 V./cm.), rapidly forms macroscopically visible aggregations of red blood cells, quickly settling to the bottom. In this way, all erythrocytes are separated from the supernatant sugar solution in a few minutes.

The following interpretation of this surprising phenomenon is suggested. The erythrocytes contain a solution of different electrolytes (for example, KCl, K–Hb, etc.) and are, therefore, conductors. When suspended in a solution of a non-electrolyte, they form a dispersion of small conductors in a non-conducting medium. In a strong electric field these small conductors become oriented by electric induction. The erythrocytes become dipoles, the opposite poles of which attract each other, and form chain-like aggregates. In accordance with Stokes's law, sedimentation-rates of such red-cell aggregates will be greater than those of single non-polarized blood cells.

Experimental. Human citrated blood is centrifuged, the plasma decanted, and the erythrocytes twice washed with an isotonic sucrose solution. Then the erythrocytes are suspended in isotonic sucrose solution. The suspension is poured into a U-tube (length about 10 cm., diameter about 0·5 cm.). The suspension in both limbs is covered with an isotonic solution of glucose, which has a much smaller specific gravity than the isotonic sucrose solution. Metal electrodes are dipped in the glucose solution in both limbs of the U-tube, and 500–1,000 V. imposed on the electrodes. After approximately a minute, the red cells have formed clots, which rapidly sink to the bottom of the tube. When the current is stopped, the sedimented erythrocytes can be easily dispersed again by shaking. The electric aggregation of blood cells is, therefore, reversible, and in this respect analogous to the reversible coagulation of some colloids.

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Fermentation of Wood-dust by Cellulose Bacteria

In this laboratory, fermentation of birch, aspen and pine-dusts has been investigated by enrichment cultures of thermophilic[1], and recently also of mesophilic[2], cellulose bacteria. he Tfiner the wood was ground, the more of the cellulose was fermented. In the best cases, a fermentation of about 70 per cent of cellulose in wood was obtained with the leaf-tree dust at 60° C. Distinct fermentation could be noted only a day after inoculation. Our results have thus disproved the earlier conception that the cellulose in wood is fermented only when lignin is in some way destroyed[3], and are evidence against the supposition that cellulose and lignin are chemically bound in wood. Nevertheless there may be such a linkage, for the long cellulose molecules may be broken on grinding wood. If we presume that lignin is bound to the other end of the fibrous cellulose molecule, there would be formed from the free end of these molecules fragments which afford a suitable substrate for bacteria. As lignin is decomposed to some extent during fermentation (in one experiment with birch dust the decrease in the lignin content was 11·4 per cent, and in methoxyl content 29·2 per cent) the bonds between lignin and cellulose can also be broken, so that even the cellulose bound with lignin becomes fermentable. The assumption that a part of the cellulose in wood is bound with lignin, while a part is free, is in accord with our findings. This would also explain why the whole amount of the carbohydrates in wood-dust could not be fermented.

One of our observations made in connexion with cellulose fermentation deserves particular attention. The volume of gas first formed in the thermophilic fermentation decreased during further fermentation, if the gas trapped in the burette was in contact with the fermentation flask. Thus at the end of fermentation there might be found less carbon dioxide than was liberated from calcium carbonate by acids formed in fermentation. In such cases the gas mixture contained no hydrogen. In fermentation experiments where some carbon dioxide was developed, hydrogen was also formed in some measure. These findings and the great amount of acetic acid formed in fermentation showed that carbon dioxide is used for synthesis during fermentation. Presumably acetic acid is thereby formed, according to the equation: $4H_2 + 2CO_2 = CH_3.COOH + 2H_2O$. Wieringa[4] has noted such a reaction with *Clostridium aceticum*.

Also with mesophilic cellulose bacteria (enrichment cultures from the rumen of sheep) Koistinen[2] has recently noted an active synthesis of acetic acid from the gases formed in the fermentation of wood-dust. When carbon dioxide was added to the system, acetic acid was formed corresponding to 130 per cent of the fermented holocellulose, while carbon dioxide was simultaneously consumed. In this case the reaction seems to have proceeded primarily according to the equation: $CH_4 + CO_2 = CH_3COOH$. The reaction may also occur partly through the reduction of carbon dioxide caused by hydrogen, as has been assumed in connexion with the thermophilic fermentation. The combination of carbon dioxide has been noted only in an acid reaction (*p*H 6·0–6·5).

The building up of fatty acids in cellulose fermentation through the reduction of carbon dioxide suggests new views of the activity of the rumen. The large amount of carbonates which goes in saliva to the rumen may be used up for the synthesis of fatty acids. The amount of gas formed in the rumen may, in turn, essentially depend on this synthesis, which, again, is determined by conditions in the rumen.

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Symbiosis of *Azotobacter* with Insects

In 1912, I published (*Ber. d. bot. Ges.*) a preliminary note on the constant symbiosis of Aphides with *Azotobacter*. The entomologist, Prof. K. Šulc, of Brno, had previously (1910) found that the hitherto mysterious function of an organ in aphides and similar insects, called the pseudovitellus, was a seat of symbiotic organisms. I succeeded in isolating and identifying them as belonging to the genus *Azotobacter*, and in 1916 published the results of my studies in the Prague *Zemedelsky Archiv*.

Owing to difficult and unfavourable circumstances it was not possible for me to devote much further attention to the subject until recently, when I discovered that the organisms in the mycetocysts or mycetomes (pseudovitellus) procure for the insects free nitrogen from the air for the synthesis of proteins that are primarily necessary for producing the enormous quantity of eggs and young. I have now also found instances of *Azotobacter* symbiosis in *Lecanium Persicæ*, *Limothrips* (which absorb sugars from plants in the same way as aphides, cycades, etc.), in the larvæ of the beetle *Anobium paniceum*, in the imago of the grain beetle *Sitophilus*, in the larvæ of the moth *Sitotroga cerealella*, and in the larvæ of the 'bark-boring' beetle *Eccoptogaster rugulosus*. These insects would starve for lack of nitrogenous food were it not for mycetome symbiosis with *Azotobacter*.

I have concentrated my attention on the disastrous epidemic now raging in the spruce forests of Czechoslovakia, caused by the bark-boring beetle *Ips* (*Bostrychus*) *Typographus* L. This epidemic is a result of the ruinous economy practised during the German occupation. The beetle multiplied in the borderlands where the felled tree trunks supplied plenty of food, and from these trunks infection spread to healthy trees.

Possessing no laboratory (my Institute at the Agricultural and Forestry School was plundered by the Germans), I confined myself to microscopical examinations. The eggs and very young larvæ were found to contain large numbers of the *Azotobacter*. In this respect *Ips* resembles aphides. The method consisted in crushing and smearing material from the organs, fixing with a flame, removing fat with xylol, alcohol, water and blue cotton, and then mounting in Canada balsam.

Longitudinal sections through a young larva of *Eccoptogaster* revealed large masses of intact *Azotobacter* zooglœæ in the peripheral layers of the tissue, whereas in the digestive organ of the same larva a mass of *Azotobacter* was being digested, with the

result that older larvæ were enriched with fat and other substances. Similar observations were made with the larvæ of *Ips* (microtome sections). In 1942–44, L. Tóth and others (*Z. vergleich. Physiologie*) proved by micro-Kjeldahl determinations that preparations from twenty different species of the order Rhynchota (aphides, *Aphrophora*, *Philæmus*, *Cassidæ*, some *Lygœidæ*, etc., as well as those from *Pyrrhocoris apterus*) considerably increased their nitrogen content in a very short time. Insects with well-developed mycetomes (aphides, Homoptera) fixed free nitrogen much more energetically than the Heteroptera, which are devoid of them.

Aphides, Homoptera and Heteroptera are thus able to assimilate free nitrogen. Bark-boring and other beetles and the moth investigated have to be included in this group. This remarkable insect-symbiosis corresponds in magnitude with that in Leguminosæ. I have named these symbiosis bacteria *Azotobacter Sulci* sp. n. Details will be published shortly.

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Hypocupræmia in Cattle

The occurrence of a suspected copper deficiency in cattle in Aberdeenshire was recently reported[1], the evidence being based on the low copper content of the pastures and on the similarity of the symptoms to those of 'peat scours' in New Zealand described by Cunningham[2]. No blood copper data were given to correlate the suspected low copper status of the cattle with the low copper value of the pasture.

In a recent investigation by Bythell[3] of a severe chronic scouring disorder among a small herd of cattle in Cheshire, the following blood data were obtained in this Laboratory, the only abnormality observed being the low copper values.

Table 1. Blood analyses of affected cattle

Animal Ref. No.	Cu mgm./ 100 ml.	Hb gm./ 100 ml.	Ca mgm./ 100 ml. serum	Mg mgm./ 100 ml. serum	Acetone mgm./100 ml. serum
1	0·02	11·2	10·8	2·6	< 3
2	0·03	10·2	9·6	2·3	< 3
3	0·03	9·7	10·2	2·2	< 3
4	0·02	10·4	10·2	2·4	< 3
6	0·01	11·2	10·7	2·4	< 3
8	0·03	11·1	10·3	2·5	< 3

Normal copper values for adult bovines have been reported by Bennetts *et al.*[4] to range from 0·07 to 0·17 mgm. per cent, and Cunningham[5] gives the average normal value as 0·09 mgm. per cent. These are similar to our round value of 0·1 mgm. per cent obtained from numerous analyses at Weybridge. It will be noted that the values tabulated above are from one third to one tenth normal.

In appearance, the fields grazed by the affected animals resembled a peat bog, and because of this and the chronic scouring, the disease was thought to be similar to the 'peat scours' of New Zealand. Analysis of the pastures, however, showed normal copper contents of more than 10 p.p.m. The data on three fields are as follows (Table 2), lead, molybdenum and fluorine values being included for reasons which need not be elaborated here. Cattle scoured on fields I and II but not on field III.

Table 2. Analysis of pastures (dry matter basis)

Field No.	Cu p.p.m.	Pb p.p.m.	Mo p.p.m.	F p.p.m.
I	11·0	7·9	9·0	9·9
II	12·3	5·4	6·9	9·7
III	25·8	6·1	5·1	3·2

The disorder, therefore, differs in two respects from New Zealand 'peat scours' and the suspected copper-deficiency disorder in Aberdeenshire, both of which were associated with low copper values of the pastures and with low hæmoglobin values in the affected animals. The hæmoglobin levels in the cases reported here all fall within the normal range[6]. The blood picture resembles that of ewes in areas in Derbyshire where 'swayback' in lambs is prevalent[7], and where the ewes appear clinically normal and show no scouring. In the corresponding areas of 'enzootic ataxia' in Australia, low copper values are shown both in the pastures and in the blood of the ewes. In Derbyshire, blood copper values are low but pasture values normal.

While these cases were under investigation, blood samples were received from Blakemore[8] from cattle suspected of suffering from a copper deficiency in the Fen country. Blood copper values in seven animals ranged from 0·03 to 0·08 mgm. per cent, the average being 0·047 mgm. per cent. Pasture analyses showed normal values of 8–16 p.p.m. copper (dry matter basis), although a sample of hay was so low as 4·7 p.p.m. Clinical symptoms included stunted growth, rough coats and depressed appetite, but diarrhœa was observed only in later stages.

These two cases from widely separate areas and different soil types seem to represent the first records of bovine hypocupræmia in Britain.

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Weybridge. Oct. 31.

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The Course of the Controversy on Freedom in Science

Our attention has been directed to the passages in our recent article on this subject[1] in which we stated that the British Association (among other bodies) "began to support and even to take part in the new propaganda", and that at the meeting of its Division for the Social and International Relations of Science in September 1941, "no one was allowed to speak during the three days of the Conference except those previously chosen by the organisers, and the movement against pure science and freedom in science had free play". We gladly accept the assurance that the speakers were not selected by the Council of the Association because they held the doctrines we oppose, and that the reason why other speakers were unable to take part in the discussion was that all the time available was occupied by the speakers chosen. The Council no doubt believed that all the chosen speakers could make useful contribu-

tions to the subject of the Conference. But the result, we think, was very unfortunate. Naturally, we welcomed the entirely different atmosphere of the British Association's Conference on Scientific Research and Industrial Planning in December 1945, at which there was freedom for anyone to speak. The views that dominated the 1941 meeting no longer dominated that of 1945. On controversial as on all other matters which vitally affect the welfare of science, the British Association should provide an open forum, and we are glad to believe that this is its constant aim.

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Research and the Smaller Firm in Britain

IN *Nature* of November 2, p. 638, an account was given of the recent conference held in Manchester under the auspices of the Manchester Joint Research Council. This article gives a misleading account of my paper.

The references to the Mellon and Battelle Institutes give the impression that I am opposed to the operating principle of these institutes in all circumstances. What I did in my paper, after giving as impartial a survey as I could of the advantages and disadvantages of their methods of operation, was to give reasons why I doubted if a "Mellon Institute" is the solution in Great Britain to-day of the problem of research and the small firm. The fact quoted in the article that ". . . the Mellon Institute is largely supported by the large firms" rather than by small ones was in fact used by me in support of my argument.

The most serious misrepresentation occurs at the end of the first paragraph: "Dr. Toy's paper indicated concern as to the future of the research association in Great Britain and its ability to win the confidence of the industry it served". This question of confidence was not directly under discussion in my paper, but I may state here quite categorically that I feel no such concern: and I am not aware of any such indication in my paper.

On the specific point of *confidential* research for the smaller firm, I gave reasons why I thought the idea of doing research confidential to one firm in the research association's laboratories, *using research association personnel*, did not seem to be a really workable scheme. It clashes with the primary principle of the research association movement that research should mainly be on an industry-wide basis, and for the benefit of the industry as a whole; and it also involves the danger that the research man might find himself in the impossible position of having to carry out confidential research for a firm, and general research for the industry on the same or related subject. I said I doubted if a firm could do better than carry out confidential research on its own, and that even a small firm could do something worth while if it had the right outlook and the right man. I was also at pains to show that the problem of research and the small firm was made much easier nowadays due to the existence of the research associations, with their unequalled knowledge of the industry and its problems. In particular, two illustrations of this were given. A firm wishing to set up a research department of its own could call on the research association for help and advice on such matters as staff, equipment, etc. Alternatively, a firm not yet prepared to go so far as to set up its own research department might, I thought, be accommodated at the research association, which would supply material facilities, such as space, equipment, library and so on; supplying, in fact, many if not all the advantages of the "Mellon" system, except the staff, which in my view should be in the employment of the firm.

At the end of the article, when summarizing what Sir Edward Appleton said, occurs the following sentence: "When facilities and staff are available, the Department of Scientific and Industrial Research will be prepared to assist a small firm by arranging to carry out special investigations into specific problems, although it is not possible to offer the same facilities as the Mellon Institute or the Battelle Institute—a statement which appears to conflict with Dr. Toy's remark that the research associations themselves are not encouraged to undertake work at cost for an individual firm". The "conflict" between the two statements is more apparent than real. The hesitancy of the research associations to undertake confidential work is due to the danger to which I have already referred. This danger—quite acute in a research association limited to a single industry—would be much less and possibly non-existent in a central government laboratory operating in a much wider field, though even in this case Sir Edward did not promise "the same facilities as the Mellon Institute".

Thus there is no conflict of ideas in the suggestion that the Mellon principle, while not really workable in a research association, might *in principle* be quite feasible in a central government laboratory. Whether this is desirable is quite another matter. My own view is that the smaller firms would not make any more use of a Mellon Institute in Great Britain than they do in the United States.

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Shirley Institute,
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Nov. 11.

The Thyroid and Tuberculosis

THE results quoted by Izzo and Cicardo in their communication[1] on this subject are of great interest to us as we have had somewhat similar animal experiments under way for some time.

Izzo and Ricardo seem, however, to have misread my letter, as they state that Burger and his associates found diploicin to possess tuberculostatic activity *in vitro*. It was clearly stated by me[2] that diploicin is insoluble, and accordingly was not subjected to *in vitro* tests. The substances tested were prepared by opening the depside ring, thus solubilizing the diploicin molecule. These substances were prepared in this laboratory and tested by my colleague, Dr. P. A. McNally, in Trinity College, Dublin.

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Oct. 28.

[1] Izzo and Cicardo, *Nature*, 158, 590 (1946).
[2] Barry, *Nature*, 153, 131 (1946).

USE OF SMALL-SIZE PLOTS IN SAMPLE SURVEYS FOR CROP YIELDS

By Prof. P. C. MAHALANOBIS, F.R.S.
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OWING to absence abroad, I had missed Dr. P. V. Sukhatme's note discussing this subject[1]. The over-estimation of crop yields with sample-cuts of a very small size was reported by us in 1940, and since then a good deal of work on the subject has been done in the Indian Statistical Institute. Certain observations based on the experience gained in the course of the above work would appear to be called for in the present connexion.

The principle of random sampling in crop-cutting work was explicitly recognized for the first time by J. Hubback[2] in his experiments on paddy in Bihar and Orissa in India during 1923–24 and 1925–26 in which the size of the sample-cut was 12·5 sq. ft. or 1/3,200 acre. Following him, C. D. Deshmukh during 1928–29 and 1930–31 and P. S. Rau in 1928–29 and 1929–30 used the same size of sample-cuts in their work on paddy in the Central Provinces, of which I have recently given a brief account elsewhere[3]. Hubback's work had also influenced that of R. A. Fisher, who used sample-cuts of a small size in his work on wheat at Rothamsted[4]. H. P. V. Townend in his work on paddy in Bengal in 1938 had also used small cuts of 27·04 sq. ft.

When we first started crop-cutting work on jute in Bengal in 1939, we had collected some data for sample-cuts of five sizes ranging between 25 sq. ft. and 66 sq. ft. There was some evidence of bias, but the available material was meagre. Next year we therefore thought it advisable to investigate whether the results in any way depended on the size of cuts; and in work on jute in 1940 we used sample-cuts of various sizes ranging from 1 sq. ft. (1/43,560 acre) to 256 sq. ft. (1/170 acre approximately), and detected unmistakable evidence of over-estimation in cuts of a very small size. The results were given in considerable detail in "The Statistical Report on Crop Estimating Experiments on Jute in Bengal, 1940", which was printed for official use but was not issued to the public under war-time restrictions. The vice-chairman of the Imperial Council of Agricultural Research in India (the organisation in which Dr. Sukhatme has been working as statistician for a long time) is the *ex-officio* chairman of the Indian Central Jute Committee which financed our work and which printed my report; but I do not know whether Dr. Sukhatme has seen a copy or not of this report. I had, however, explicitly referred to the size bias in my paper, "On Large Scale Sample Surveys"[5], and had stated: "In crop-cutting work on jute it was found, for example, that mean values for all characters studied (such as number of green plants, weight of green plants, weight of dry fibre) were much higher for sample units of small size, so that it was not at all safe to work with cuts of a size less than say 25 sq. ft.".

Dr. Sukhatme has not referred to the above observation.

In explanation of the observed over-estimation with small-size cuts, Dr. Sukhatme writes: "The reason for over-estimation appears to be the human tendency to include border plants inside the plot. This factor becomes serious when the perimeter of the plot is large in proportion to its area." In the paper "On Large Scale Sample Surveys"[5] I wrote: "It was found that there was persistent over-estimation in working with units of very small size. In the case of field survey the obvious explanation is that the investigator has a tendency to include rather than to exclude plants or land which stand near the boundary line or perimeter of the grid. This boundary effect naturally becomes less and less important as the size of the grid is increased." Hence Dr. Sukhatme's explanation is identical with that put forward by me four years ago.

I must confess, however, that my own opinion has changed a good deal in the light of further work which has been done by the Indian Statistical Institute since 1942 when I first advanced the above view. The over-estimation with sample-cuts of 1 sq. ft. had been found to be very large (of the order of 62 per cent) in 1940, and it was decided to discard such extremely small sizes in future. But practically every year from 1941 to 1946 we have been conducting experiments with sample-cuts of various sizes ranging from 9 sq. ft. (1/4,840 acre) to 576 sq. ft. (1/76 acre approximately) or more, and in certain cases up to whole fields on various crops like *aus* (monsoon) and *aman* (winter) rice, jute, wheat, and sugar-cane. Each year evidence was accumulated about the extent and nature of over-estimation, and further reports were submitted to various Government departments. During my recent tour abroad, I gave a brief account of such work at Columbia University, New York, on May 7, 1946, and a somewhat fuller account before the Royal Statistical Society in London on July 16, 1946, where I presented a summary table, reproduced herewith, from which it appears that the over-estimation decreases as the size of the sample-cut is increased and becomes practically negligible for cuts of size larger than 40–50 sq. ft.

Percentage yield-rates based on sample-cuts of different sizes

Size of cut (sq. ft.)	Bengal jute, 1940 (320)	Bengal jute, 1941 (185)	U.P. wheat, 1941 (178)	U.P. wheat, 1942 (346)	Bengal rice, 1943–44 (40)	Average index (unweighted)
9	103·8	116·1	121·4	118·1	113·3	114·7
18	—	—	111·6	109·4	—	110·5
25·27	—	100·7	—	109·0	—	105·0
36	—	—	100·1	99·0	112·1	103·7
48·49	95·5	95·3	—	—	—	95·4
54	—	—	—	96·0	—	96·0
64	—	105·9	—	—	—	—
81	—	—	—	93·6	—	—
135	—	—	99·9	—	—	—
144	99·6	96·4	—	—	101·2	—
225	—	*100·0*	97·4	—	—	—
256	*100·0*	—	—	—	—	—
324	—	—	—	*100·0*	—	—
576	—	—	*100·0*	—	*100·0*	—

N.B.—The size of the sample is given within brackets at the top of each column.

Besides using various sizes of sample-cuts, we also studied the effect of using different methods of demarcating the sample-cut, such as pegs and ropes, rigid frames of triangular and square shapes, and semi-rigid frames. In 1944, Jitendra Mohan Sen Gupta, of the Statistical Laboratory, suggested obtaining circular-shaped cuts by using an arm rotating over a pivot with a light stylus attached at the end of the rotating arm to catch the plants. Several models were tried on the field, and in the present form the arm is of adjustable length so that

concentric circular cuts of three or four sizes can be harvested at each spot. Standard sizes of 12·57, 50·27, 100·88 and 201·06 sq. ft. are being used at present.

I presented experimental material before the Royal Statistical Society, from which it appears that circular cuts of 2 ft. radius (area = 12·57 sq. ft.) leads to an over-estimation of the order of 14–15 per cent on an average when the work is done on an extensive scale by a large field-staff scattered over a whole province (for example, Bengal, comprising about 70,000 sq. miles). There is, however, practically no bias when the size is increased to a radius of 4 ft. (area = 50·27 sq. ft.). For example, in the work on *aman* (winter) rice in Bengal in 1945–46 comprising 2,569 sets of three concentric cuts, the weighted average for cuts of 50·27 sq. ft. was 99·7 per cent of the weighted average for cuts of 100·88 sq. ft. Along with such extensive experiments carried out by the ordinary field-staff, arrangements were also made to study the size bias in the case of work done under the direct supervision of trained statisticians. It is interesting to observe that in one series of experiments on *aman* rice in 1945–46 at three different centres the pooled average rate of yield based on 236 cuts was 1,183 lb. of rice (not in husk) per acre for circular cuts of 12·57 sq. ft. against a pooled average of 1,168 lb. per acre for cuts of 72 ft. × 72 ft. = 5,184 sq. ft. (a little less than 1/8 acre), showing that the over-estimation had become practically negligible.

To come back to the cause of the size bias, I am now inclined to rely more on the line of explanation offered by F. Yates[6] in the paper cited by Dr. Sukhatme. Discussing the observed bias in crop yields harvested from within hoops (of area 10 sq. ft.) supposed to have been thrown at random on fields in the United Provinces, Yates suggested: "The bulk of the bias, however, is probably due to the tendency, conscious or unconscious, to cast the hoop on the good parts of the crop". The fact that the over-estimation with cuts of small size becomes practically negligible when the work is done under adequate statistical supervision, but is quite appreciable when it is done by the ordinary field-staff, suggests the following explanation. It is possible that there are patches of greater fertility distributed either in a random manner or in a mildly patterned form. In locating the sample-cuts, ordinary investigators may unconsciously tend to favour these more fertile patches by slightly shifting the exact location of the 'random point' on the field. Under adequate supervision, it is possible that the location of the 'random point' is carried out in a proper manner, thus successfully eliminating this particular source of bias. Unconscious pulling in of plants on the border line (as suggested by me four years ago and recently repeated by Dr. Sukhatme) may also be a contributing factor of importance.

It is relevant in the present connexion to mention the danger of under-estimation in using comparatively large sample-cuts demarcated on the field with pegs and ropes. It is doubtful whether the ordinary field investigators can measure the sides of the square (or of whatever other shape of cut is used) with sufficient accuracy. Sagging of stretched ropes would reduce the actual area harvested and would lead to under-estimation. Then there is a real difficulty about the allowance to be made for the boundaries (called *ail* in India) between different fields. This point is particularly important in a province like Bengal, where the average size of individual fields is less than half an acre. In fact, the concept of the 'whole-field' is difficult to define in an unambiguous manner. The subject obviously requires further investigations.

Another point deserves notice. In recent work done by our field-staff, we found an over-estimation of about 15 per cent for cuts of size 12·57 sq. ft. Yates had reported an over-estimation of 13·9 per cent (with standard deviation of mean of 2·97 per cent) for hoops of size 10 sq. ft. These two results are in broad agreement. In Dr. Sukhatme's work the over-estimation was much higher, namely, 42·4 per cent (in both the series reported in *Nature*) for sample-cuts of size 12·5 sq. ft. Dr. Sukhatme has not given the standard error, but the much higher over-estimation suggests that his field-staff had greater bias than the Bengal field-staff. This naturally raises the question of validity of the results. In the Indian Statistical Institute great importance is attached to the field survey being conducted in the form of two (or more) interpenetrating but independent networks of samples, each of which furnishes an independent estimate and hence supplies information relating to the effective margin of error. I have discussed this point elsewhere[3] and would content myself by remarking that it would appear advisable to provide such controls in the schemes which are in Dr. Sukhatme's charge. This was also the advice given by R. A. Fisher in the memorandum to which I have already referred.

[1] *Nature*, 157, 630 (1946).
[2] Hubback, J., "Sampling for Rice Yields in Bihar and Orissa", *Imp. Agric. Research Inst. Pusa, Bull.* 166 (1927), recently reprinted in *Sankhya*, 7, 3, 281.
[3] Mahalanobis, P. C., *Sankhya*, 7, 3, 272.
[4] As stated in a memorandum submitted by Prof. R. A. Fisher to the Imp. Coun. Agric. Res. (India) on March 2, 1945, and quoted by me in *Sankhya*, 7, 3, 269.
[5] Mahalanobis, P. C., *Phil. Trans.*, B, 231, 509 (p. 409).
[6] Yates, F., *Ann. Eug.*, 6, 2, 211.

MELLON INSTITUTE

ANNUAL REPORT FOR 1945

ADDITIONAL interest is lent to the thirty-third annual report of the director of the Mellon Institute, Pittsburgh, Pennsylvania, Dr. E. R. Weidlein, covering the year ended February 28, 1946, by current discussions on the possibility of developing similar institutions in Great Britain (see p. 797 of this issue of *Nature*). Since 1942, the activities of the Institute have been concerned mainly with urgent problems of war science and technology, and during the year under review there were only twenty-nine individual and fifty-three multiple fellowships operating, of which thirty-two had been proceeding for ten years or more and a further twenty-eight for five years. The industrial research staff of 261 fellows and 264 assistants is an increase of nineteen fellows and thirty-two assistants on 1944–45. Fellowships on adhesives, optical cements and silica gel began during the year, and the programme on adhesives was completed, as well as fellowships on cellulosic moulding, constructional resins, disinfectants, phenol chemistry and tar derivatives; the last two have been merged in the multiple fellowship on tar synthetics.

From this long report it is possible to select for mention only a few items illustrating the wide range of activities. An investigation on the development of a vitreous enamel coating for fixed wire-wound resistors, capable of high resistance to thermal shock

and moisture, undertaken at the instance of the War Metallurgy Committee of the National Research Council, led to the use as coating of a silicone paste originated by a fellowship of the Corning Glass Works. This fellowship has now been returned to work on porcelain enamels and has already led to the development of a high-titanium cover-coat enamel of very high opacity and resistance to acid. Another fellowship has been concerned with the reactions occurring during the sintering of iron powder compacts, while the American Iron and Steel Institute's multiple fellowship on acid recovery has completed eight years study, in co-operation with public health officials and industry, of waste pickle liquor. A multiple fellowship on magnesium is concerned with fundamental studies on magnesium and its alloying properties, with the prime purpose of producing alloys with superior properties. New nickel compounds and catalysts of special promise are being prepared under another project, and evaluated in co-operative programmes with industrial and government laboratories. This inclusive multiple fellowship is sponsored by the International Nickel Co.

Work in coal chemistry has led to the discovery that the gradual deterioration in the quality of re-cycle benzene is due to the preferential accumulation of paraffins. Many advances have been made in gas by-products, and a thorough study made of the polymerization of vinylnaphthalene which, contrary to published statements, is found to be a rapid process. New processes for purifying benzene, a novel type of 1-in. laboratory column, and a universal type 3-in. fractionating column are other achievements in this field, which includes a broad programme on alkylation and dealkylation from which the process of ethylating benzene at Koluta came.

Work in petroleum technology has included fundamental theoretical studies of distillation, particularly of rectification processes, and investigations on the physical properties of petroleum waxes, the mechanism of catalytic reactions and the nature and structure of catalyst surfaces. New and improved lubricants have been developed for aviation instruments as well as new testing methods for such products, and the report includes some information on the synthetic lubricants developed under the organic synthesis multiple fellowship of the Carbide and Carbon Chemicals Corporation, which has now operated continuously for thirty-two years. Progress in applications of 'Vinylite' resins from dispersions has been accelerated, and extensive studies of the effect of the composition of the liquid vehicle on the viscosity of the dispersion have provided a sound technical basis for formulating the coatings. Investigation of the chemistry of allyl compounds has led to industrial processes for 2 : 3-dichloropropanol, 3-chloro-1 : 2-propanediol and epichlorohydrin ; also phenylmorpholine has been produced on a sufficient scale for development. Military requirements initiated researches for non-ionic surface-active materials, and the vitamin section of the Heinz multiple fellowship on food varieties has thrown light on the effects of storage on the vitamin content of regular and fortified strained foods. The value of yeast as a therapeutic agent and as a source for vitamins, and the improvement of malt processing, have also been investigated.

A programme assigned to the Institute by the Air-Sea Rescue Agency of the Armed Services has led to the development of a treated superfine "Fiberglas" which promises to replace kapok for use in life-jackets on all naval vessels, and also for other purposes where its fire-proof qualities are of first importance. Careful studies on methods of evaluating buoyancy and of the role of packing density and column heights have led to a broader understanding of the mode of function of fibrous buoyant materials. Correlated studies of the physical and chemical properties of cotton fibres are also in progress, and during the War a continuous programme of testing threads and tapes for their ability to resist tropical conditions was carried out. A new field is being opened up in the use of recovered synthetic fibres to make textiles with desirable properties of their own. The utilization of industrial proteins, including stabilized zein resins, as shellac substitutes, and the industrial uses of a chemically modified zein, the development of improved catalysts for the synthesis of butadiene from ethyl alcohol and of organic coating compositions for lining the wing tanks of aeroplanes as well as for steel to permit its use under conditions of severe corrosion, have all received attention ; while investigations on the organosilicon compounds have led to the use of polysiloxane fluids as anti-foaming agents in petroleum products and moulding rubber and organic plastics.

Besides referring to the work of the fellowship on chemical hygiene, particularly in the study of newly available chemicals, from the point of view of hazards to health, the report includes notes on the Industrial Hygiene Foundation, which has strengthened its staff of specialists and completed a study of the control of sweeping dust in the pottery industry and of the technique of determining the safe limits of silica content in industrial dusts. Reference is again made to the synthesis of new antimalarial drugs, particularly hydroxyethyl analogues of the pamoquine series, involving the synthesis of 8-amino-6-hydroxyethoxyquinoline and the use of a new hydroxyethylating agent, by the Department of Research in Pure Chemistry. An examination of the lepidyl carbinols, the preparation of 4-(*p*-dialkylaminobenzylidene)- and 4-(*p*-dialkylaminobenzyl)-aminoquinolines and the function of alloxan in causing experimental diabetes in animals, in the course of which two colour tests for alloxan have been developed, are other subjects under investigation in the Department.

ONTARIO RESEARCH FOUNDATION

ANNUAL REPORT FOR 1945

THE annual report for 1945 of the director of research of the Ontario Research Foundation at Toronto, Dr. H. B. Speakman, refers to the transition period through which the Foundation passed during that year. Steps taken soon after the termination of hostilities to restore to normal the available space enabled the Foundation to respond to the increased demand for fellowship facilities, and before the close of the year the available laboratory space was fully occupied. Available statistics show that there are about eleven thousand industrial units in Ontario, of which only three hundred are large enough to justify the maintenance either of a research laboratory or a fellowship unit at the Foundation, and some of these consist of branch companies looking to a parent company in the United States for research and technical direction.

Besides the twenty fellowships which tax the Foundation's present facilities, many firms use the Foundation for short-term investigations; but the director, in noting that the external income of the Foundation is now about 57 per cent of the total revenue, while investment income has decreased by 18 per cent since 1938 and costs have almost doubled, points out that in consequence the Foundation's ability to initiate and sustain investigation in fields of provincial importance, rather than of immediate concern to an industry or a firm, is diminishing. He expresses his firm conviction that societies will prosper in the future in so far as they are willing to authorize research expenditure on a reasonably liberal and long-term basis.

Reviewing the work carried on during the year, the report refers to an investigation undertaken in the Division of Biochemistry to explore the possibilities of using Canadian linseed oil in the manufacture of shortening. Much effort has been devoted to the causes of the objectionable flavour developed by the hydrogenated oil on storage, and this work has led to a wider use of the Beckman ultra-violet spectrophotometer in the laboratories of the Foundation. Fellowships have been established in the Division for the investigation of problems associated with the production of sole leather, and for the development of pharmaceutical products. In the Division of Chemistry, the general organic laboratory was concerned with the investigation of short-term problems submitted by more than seventy firms. A section for statistical quality control was established at the beginning of the year in an effort to make available to industrialists in the Province methods which had proved of great value in the manufacture of munitions. Washable papers of two qualities have been developed under the Canadian Wallpaper Manufacturers' Fellowship, while in the laboratory supported by the Consumers' Gas Co. of Toronto, attention has been concentrated on more economical methods for the further purification of city gas. A dental materials research laboratory has studied reactions involved when plastics of the methyl methacrylate type are used in manufacturing dentures, and in the Moore Corporation Fellowship improved formulæ have been developed for the production of hot-melt inks for carbon paper, and a new type of ink is also being developed. The Standard Chemical Co., Ltd., has established a fellowship for the study of cellulose derivatives; the Sterling Rubber Co. Fellowship, which led to the development of pilot-plant for the manufacture of plastics from wood, was terminated in September. The facilities of the Department of Metallurgy have been radically re-arranged.

The Department of Parasitology continued its work on the blood parasites of ruffed grouse, and the strain of malaria discovered in ruffed grouse last year has been transferred to birds raised in captivity and to canaries, ducks and turkeys. In the Department of Physiography more time has been given to writing up in permanent form the results of the investigation of the physiography of southern Ontario. In the Textiles Department experience gained during the War in developing and testing fabrics for specific functions is already being used to advantage in peace-time projects. The York Knitting Mills Fellowship has concentrated attention on problems associated with the introduction to Canada of the Kray process for producing unshrinkable wool, and the Canadian Industries Ltd. Fellowship is devoted to a study of the fundamental characteristics of nylon yarn and fabrics.

PRECISION-GAUGE LABORATORIES IN THE UNITED STATES

A REPORT in *Industrial and Engineering Chemistry* of October describes an interesting and important development in the establishment of precision-gauge laboratories throughout the United States for training and inspection. This experiment should not only be noted in British plans for university expansion, but may also provide a more convincing reason for the success of the scientific instruments industry in the United States than that of the existence of large consuming firms, to which F. Rothbarth in the *Economic Journal* attributes the profitableness of the mass production of scientific instruments in the United States.

The new development goes back to the establishment of precision-gauge laboratories in the First World War to eliminate troubles due to faulty precision-machine materials through the use of inaccurate or worn gauges. At that time the idea was conceived of maintaining permanent laboratories with regular training facilities under the administration of colleges and universities. The first of these laboratories was set up at Stanford University in 1930, with surplus stocks gathered from arsenals. The success of the project led to expansion of the programme, with a second ordnance educational unit established at the University of Michigan in 1936. In 1940 there were nine laboratories in operation, and during the Second World War these were expanded and used entirely by the Ordnance Department. With the end of the War, the laboratories are once again operating in conjunction with the universities; in addition to the two mentioned, the major laboratories are located at New York University, Georgia School of Technology, University of Cincinnati, Washington University, Illinois Institute of Technology, Carnegie Institute of Technology, and Case School of Applied Science. Operations are now in progress to convert laboratories set up in the other four ordnance districts during the War to similar ordnance-educational units, as well as to establish additional organisations in the districts where use of the laboratories is especially heavy.

The precision-gauge laboratories are set up, with the institution providing space, light, heat, furniture, and security for the equipment. The schools furnish study courses on precision measurement and inspection, and they can use the equipment in research and consultation, and in standard reference laboratories for the inspection and checking of precision equipment for industry. Provision is made for co-operation in industrial research projects. As non-profit organisations the precision-gauge laboratories can act as referees in disagreements over the precision of tolerances in gauges or even in parts purchased from manufacturers. The Ordnance Department has the use of the laboratories for training students, and each institution is expected to organise an Ordnance unit, the use of the laboratory reverting exclusively to Ordnance in time of war.

One of these laboratories is administered by the Armour Research Foundation of the Illinois Institute of Technology, under the direction of N. C. Penfold, head of the Mechanical Engineering Division of the foundation. The laboratory is housed in the Engineering Building in a room air-conditioned to 68° ± 1° F. and a relative humidity of 45 per cent. Among major items of equipment are gauge blocks,

calibrated by the U.S. National Bureau of Standards, with an accuracy of four millionths of an inch. These blocks are used only as reference standards, never in actual production, and are themselves checked regularly against the Chicago laboratory's master set, used for that purpose only and accurate to two millionths of an inch. Both internal and external comparators with accuracies of ten and twenty millionths of an inch are included. Two optical contour projectors, for shadowgraph observations of profiles at magnifications of 10 to 100, can be used in measurement of radii, angles and leads on screw threads, or any contours that can be laid out. Other instruments include a length-measurement machine for determining directly diameters or lengths up to 48 inches to an accuracy of ten millionths of an inch, optical flats, supermicrometers, hardness testers, toolmakers' microscopes, height gauges, sine bars for measuring angles such as those of taper gauge plugs, and a variety of callipers, levels, and calibration instruments.

Although the Division of Physics and Electrical Engineering of the National Research Council of Canada during the War has carried out some testing and calibration of the same type, there has been no corresponding link up of such testing and training work there or in Great Britain. The growing importance of precision instruments in all fields of industrial and scientific research should stimulate similar developments in Britain; and it should be noted that at a recent conference of the Instrument Society of America the further suggestion was advanced by Dr. R. H. Muller of New York University for the establishment of an Institute for Instrument Research embracing studies in all fields of instrumentation.

SOCIAL LIFE IN ROMAN BRITAIN*

ROMAN Britain is only the prelude to the drama of English history, of which the first scene must be England after the Saxon conquest. The Romans vanished, leaving their roads, their ruins, and here and there the potent Christian seed. But they did not found England as Cæsar founded France.

The social life of the Province was divided geographically into two parts: the Civil Zone, inhabited by a partially Romanized society, dwelling among the gently undulating and fertile lands of the Midlands, the south and the east; and the Military Zone of the more barren and mountainous north and west. In the Civil Zone stood the towns and the villas that carried Roman civilization into the countryside; it was a region of peace and safety, with few armed men and few fortified dwellings. In the Military Zone, on the other hand, the army of occupation, based on the fortress towns of York, Chester and Caerleon, patrolled Wales and the Pennine moorlands, and guarded the Great Wall that stretched from Solway to the mouth of Tyne.

This distinction between the Civil and Military Zones in Roman Britain answered to the primary geographical difference between south-east and north-west, which since earliest ages had dictated the place and character of human settlement, and the speed and extent of each successive conquest of the island.

But although the south-east could show a greater number of inhabitants and a higher stage of civilization, even in that favoured half of the Province of Britain, not very much was done under the rule of the Cæsars to reclaim new lands. The heavy clay soils with their forests of oak and impenetrable tangle of underwood, and the marshy bottoms of the valleys, still prevented human settlement in regions that were afterwards the richest cornlands in England.

Indeed, taking the island as a whole, the map of human occupation was not very different in Roman times from the map of the Iron Age.

But if the denser forests set a limit to Roman agriculture, nothing could turn aside the Roman road. The Imperial highways, constructed by those indefatigable and skilled engineers, the soldiery of Rome, were the chief weapon of her military and political rule; and they were essential to the plantation of the cities which formed the chief contribution of the conquerors to the economic and social life of the barbarian island.

Combined into one society by the system of old and new roads, primitive and Romanized Briton dwelt beneath the shadow of that august Empire, international in its large, hard heart, tolerant of all save rebellion; for Rome, while she erected her own monumental civilization in cities, forts, villas, inscriptions and statues up and down the conquered land, spared to the subject his own gods, his own tribes, his chieftains and his ways of life, hoping merely that the barbarian would learn to imitate the civilized model so impressively set up before his eyes.

These little towns were planted and watered by the Government in the hope that they would grow, and soon be able to carry the weight of all this municipal building and expense. But their economic development hung fire, and the rural hinterland, itself but thinly inhabited, continued to pay in taxes for the exotic urban display. The cities remained parasitic on the countryside. Except London, with its cosmopolitan port, they were none of them great makers of wealth, and their public buildings were out of all proportion to their economic life. It is not, therefore, surprising that in the middle of the third century A.D. the cities began to decay, and Rome's policy with regard to them changed. As on the Continent of Europe at the same period, the Imperial Government began to neglect and oppress the towns that had formerly been its favourites. Henceforth the rural villa with its farm life was regarded as better than the city as a means of Romanizing a passively recalcitrant countryside.

The Roman villa stands in rural solitude, amid its own fields and woods. It is a self-contained agricultural and social unit. Its owner is a Romanized Briton. His dwelling-house, where he lives with his family and his domestic slaves, resembles one of the town houses, with red-tiled roofs, corridors, mosaic and tessellated pavements, and chambers warmed by hypocausts. The whole establishment bears some resemblance to a 'country house' with its home-farm in later England, and the owner's life, divided between field sports and directing the operations of agriculture, is not altogether unlike that of a 'squire'. But the atmosphere is less free and neighbourly, for there are no tenant farmers and there is no 'village' attached to the villa. It is all one large home-farm, a little too like one of the ill-omened *latifundia* of Italy, for it is cultivated chiefly by slaves.

* Synopsis of a Friday evening discourse by Dr. G. M. Trevelyan, O.M., delivered on November 16.

We must not suppose that the villa was the commonest, though it was the most remarkable, type of agricultural life in Roman Britain. The greater part of the population still lived, as of old, either in isolated farms of a primitive kind, or in native village communities. The inhabitants still cultivated their small, enclosed fields, the ghostly lines of which have been revealed by air-photography cutting athwart the larger fields of a later Britain.

What was the total population of Roman Britain? We do not know. Scholarly conjecture has placed it sometimes at half a million, sometimes at a million. At any rate there were many fewer inhabitants than at the end of the Saxon period, when a vast acreage of the best land had been won from the wilderness, and hundreds of villages had been planted on land that was forest or marsh when the Romans left the Island. Students of Domesday Book have calculated that there may have been a million and a half folk in England in the age of Harold and William of Normandy. Even that estimate may be incorrect, though it has something to go upon. But whatever the numbers may have been in the England of Domesday, it is certain there were many fewer in the Britain ruled by the Cæsars.

JOHANN LUDWIG STEINER AND THE HISTORY OF THE ACHROMATIC LENS

THE Naturforschende Gesellschaft in Zurich was founded on August 31, 1746 (see *Nature*, October 19, p. 559). Among the first eleven members was Johann Ludwig Steiner—perhaps the originator of the Society—a watchmaker and optician in Zurich. Goethe in his "Farbenlehre" says in a survey of the history of achromatic lenses that the practical and theoretical work of Boscovich and Steiner will not be forgotten; but Steiner's has already been forgotten. This comment by Goethe has been followed up by Prof. D. Brinkmann, of the University of Zurich, and in an article entitled "Johann Ludwig Steiner, a forgotten founder of the Naturforschende Gesellschaft in Zurich", he has published the results of his investigations (*Prisma*, No. 5, 1946).

Steiner, the watchmaker and optician, visited England as a young man and was in touch with members of the Royal Society. The impression he received never left him, and probably induced him to propose the foundation of the Swiss Society, and in one of his books, a kind of encyclopædia, which he pretends to have translated from the English, he makes this proposal. Two years later the Society was founded.

Steiner's contribution to the development of achromatic lenses is contained in his book "Abhandlungen von den Vergrösserungsgläsern" (1753), which is partly a translation of Henry Baker's book "The Microscope Made Easy" (1743). In an appendix, Steiner develops his own ideas on lenses and microscopes. Baker, who received the Copley Medal of the Royal Society for his work on crystallization in salt solutions, was a son-in-law of Daniel Defoe, with whom he edited the *Spectator and Weekly Journal*.

Steiner (1711–79) was a splendid artisan. He surpassed Vaucanson in the construction of artificial automats. He built microscopes with exchangeable lenses, rotating concave and plane mirrors and apparatus for the projection of the magnified picture on a screen. He constructed also the first magic lantern with moving pictures.

A third of Steiner's books refers to the treatise of the famous mathematician Leonhard Euler at the Academy of Science in Berlin, which for the first time showed theoretically the possibility of the construction of achromatic lenses. Newton had denied this possibility. To prove that Newton was right, the optician J. Dolland in London made a practical experiment with flint and crown glass—and constructed in this way, against his wish, the first real achromatic lens. Steiner supplemented Euler's treatise with his own experiences and inventions.

ARNOLD HAHN

NORSE CULTURE IN GREENLAND

THE first of the works[1] under notice* is an elaborate survey of all the ancient Norse buildings known in Greenland, together with a summary of the relics found in them and an estimate of the stock carried on each farm. It is a most valuable and comprehensive work, and no student can hope to understand the Norse colonization of Greenland without consulting it.

The second book[2] is a clear and valuable account of the excavation of several Norse farms in the old Eastern settlement and should be read in connexion with Aage Roussell's earlier work.

The remaining two works[3,4] are of very great anthropological and also historical importance. In them such knowledge as can be obtained from the comparatively few skeletons of the old Norse colonists which have so far been recovered is carefully examined and summarized. The conclusions arrived at by Fischer-Møller in the first work are very definite and give us a completely different picture from that suggested by the late Dr. Hansen, who examined the fragmentary human remains found at Herjolfsness in the extreme south of the country. Hansen supposed that the Norse colonists died out from malnutrition, degeneracy, disease and inability to breed. Fischer-Møller, while not denying that there may have been some degeneracy and malnutrition at Herjolfsness, is emphatically of the opinion that there is no trace of this in the northern (called 'western' by the medieval Norsemen) settlement up to the time when it was found to be abandoned about the middle of the fourteenth century. He suggests, with proper caution, that all the evidence goes to show that the population was not killed off by disease or by the Eskimos, that it did not merge in the Eskimo

*Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland.

[1] Bd. 89, Nr. 1: Farms and Churches in the Mediaeval Norse Settlements of Greenland. By Aage Roussell. Appendix: The Osseous Material from Austmannadal and Tungmeralik, by Magnus Degerbøl. (Researches into Norse Culture in Greenland.) Pp. 356. 17 kr.

[2] Bd. 90, Nr. 1: Inland Farms in the Norse East Settlement—Archæological Investigations in Julianehaab District, Summer 1939. By Christen Leif Vebæk. Appendix: Animal Bones from Inland Farms in the East Settlement, by Magnus Degerbøl. (Researches into Norse Culture in Greenland.) Pp. 120. 5.50 kr.

[3] Bd. 89, Nr. 2: The Mediaeval Norse Settlements in Greenland—Anthropological Investigations, by K. Fischer-Møller. (Researches into Norse Culture in Greenland.) Pp. 84+22 plates. 5 kr.

[4] Bd. 89, Nr. 3: The Mediaeval Norsemen at Gardar—Anthropological Investigation. By K. Bröste and K. Fischer-Møller; with Dental Notes and a Chapter on the Dentition, by P. O. Pedersen. (Researches into Norse Culture in Greenland.) Pp. 62+30 plates. 4.50 kr.

(København: C. A. Reitzels Forlag, 1941–1944.)

stock by interbreeding, but that it probably emigrated in mass. Since it did not return to the southern (eastern) settlement, or to Iceland, or to anywhere else that we know of, it seems clear that, if Fischer-Møller is right, which I feel to be most probable, it must have attempted a migration to the American continent itself. In Newfoundland or Labrador, beside the Great Lakes or Hudson Bay, we must look for traces of the Norsemen from West Greenland.

People in Britain must surely feel some pleasure at this conclusion. The dismal picture of decay and failure drawn from the interpretation of the Herjolfsness material is changed to one of expectancy and interest in a new problem. It is changed also to one of almost personal pride, for the examination of the Greenland skulls makes it clear that Celtic blood was strong in the old medieval settlers as it was also in medieval Iceland. When this last expedition rowed out westward over the cold grey waters of Baffin Bay, there were those aboard it who remembered the old tales of Tir nan og and the bright lands beyond the sunset. T. C. LETHBRIDGE

POPULATION DENSITY OF THE SHEEP BLOWFLY IN AUSTRALIA

DARCY GILMOUR, D. F. Waterhouse and G. A. McIntyre, in a paper entitled "An Account of Experiments Undertaken to Determine the Natural Population Density of the Sheep Blowfly, *Lucilia cuprina* Wied.", have endeavoured to assess the value of trapping as a means of controlling those insects (Commonwealth Coun. Sci. Ind. Research, Bull. 195; 1946). The method used was that of liberating a known number of marked flies and of sampling by means of traps the population in an area surrounding the point of release. The number of blowflies within the area was then calculated by multiplying the ratio of the unmarked to marked flies caught in the traps by the number of marked flies liberated in the trapping area. Some 102 traps were used, and these were disposed at equal intervals in a circle of 6 miles diameter. Some 40,000 flies were liberated at the centre of this circle one day before the trapping began. The marking of the blowflies was by staining them with an alcoholic solution of suitable dyes. Two treatments were given: the first with an electric power sprayer and the second with a hand atomizer. In the main experiments, the diameter of the circle was increased to 8 miles.

The results of four experiments made between November 1941 and March 1942 showed that the natural blowfly population varied between 0·3 and 5·7 flies per acre. The distribution of the stained flies was found to agree fairly well with a theoretical distribution curve based on the assumption that the flies moved outwards at random. The rate of dispersal of the stained flies varied from one experiment to another, the differences showing some correlation with meteorological conditions.

The error involved in the method of estimating population density was of the order of about 20 per cent. In addition, the possibility that an additional error has to be allowed for cannot be overlooked, since the stained blowflies did not behave exactly as the natural population. There is also a further error arising from the fact that the validity of the method of estimation is based on the assumption that, activity being uniform, the catch of each trap varies directly with the population density. This may not be the case, and there is some evidence that could be interpreted as indicating that the catches of stained flies in the central traps, where the population is high, are disproportionately large. At present the available data are insufficient to evaluate these factors; but the authors consider that the results they obtained give a tolerably reliable estimation of the true fly population. It is noteworthy that an analysis of the variation between the catches of individual traps shows that some of the variability was due to local differences in the natural population.

While the experiments were not designed to record the maximum range of flight, it is worth noting that the greatest distance from the point of release at which flies were taken was 4·7 miles—a distance which they covered in less than 30 hours.

FORESTRY IN SIERRA LEONE

WITH the end of the War has come the task of the switchover from war production to civil requirements in the case of the forestry services of the Empire. In the Report on Forest Administration of Sierra Leone for the Year 1945 (Government Printers, Freetown, 1946) we see that this process is being undertaken, one of the objects being to conserve the natural resources—forests and water—of the country wherever necessary and wherever possible.

The report states—and it has been often repeated in the past for other regions of the world—that the Colony is suffering acutely from the uncontrolled destruction of hill forests by bush and grass fires. It is held that conservation by controlling these two evils is the greatest need in the country to-day, and until it becomes effective, agriculture instead of being a thriving industry will continue its downward trend. Much of the country is already so degraded that only bare subsistence farming is possible, and that for a very short time now. Landslides and floods are becoming a serious menace to property. The cause and effect are apparent and the remedy is obvious. It will take years, says the writer, to rebuild the soil and water resources of the country; but it is possible, when effected, that a stable agriculture will ensue.

The policy of the Forestry Department has been approved by the Development Council and incorporated into the general plan of the country. It lays down a programme of work for the next ten years and provides the basis for more detailed regional planning. It has been framed in accordance with the long-term policy accepted by Government, the two main objectives being the expansion of the conservation programme, and a continuance of forest utilization started during the War, to ensure self-sufficiency in timber. Certain sums of money have been allocated to these two objectives, which are closely related.

As the report definitely states, constant vigilance will be required to ensure that the conservation programme is not sacrificed to utilization, as has been so often the case in the past. During the War, in this and other Colonies, the sacrifice was almost inevitable; but that demand has now ceased, and it should be the aim of the Department that the objects of the ten-year programme be firmly adhered to, and that in every case utilization be made subordinate to the programme of soil conservation.

FORTHCOMING EVENTS

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

Monday, December 2

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).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. H. G. Taylor: "Copper Alloy Resistance Materials".

Tuesday, December 3

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Harold Spencer Jones, F.R.S.: "Three Astronomical Centenaries, 2, John Flamsteed, first Astronomer Royal, Born 1646".*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. F. E. Warner: "Nitric Acid Production".

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. R. A. Fisher, F.R.S.: "The Present Position of the Rhesus Blood Group Factor".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. E. G. Hancock: "Synthetic Resins from Polyhydroxy Phenols".

TEXTILE INSTITUTE, BELFAST BRANCH (at the College of Technology, Belfast), at 7.30 p.m.—Mr. S. A. G. Caldwell: "Further Developments in Flax Yarn Production".

Wednesday, December 4

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Dr. C. E. P. Brooks: "The Library of the Meteorological Office"; Dr. John W. T. Walsh: "Some Problems in the Alphabetical Arrangement of Proper Names".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. L. H. Lampitt: "Sir William Jackson Pope—his Influence on Scientific Organisation" (Sir William Jackson Pope Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. H. G. Booker: "The Elements of Wave Propagation Using the Impedance Concept".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "The Application of Statistical Methods to Food Problems".

Thursday, December 5

ROYAL SOCIETY OF ARTS, INDIA AND BURMA SECTION (joint meeting with the EAST INDIA ASSOCIATION, at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. H. Seymour: "Some Supply Aspects of Rehabilitation in Post-War Burma".

CHADWICK PUBLIC LECTURE (at St. Mary's Hospital Medical School, Norfolk Place, Praed Street, London, W.2), at 4.30 p.m.—Colonel C. H. Stuart-Harris: "The Problem of Prevention of Acute Diseases of the Respiratory Tract, with particular reference to Influenza" (Malcolm Morris Memorial Lecture).*

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, 1, Physical, Inorganic and Analytical Chemistry".*

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. R. Stone: "On the Interdependence of Blocks of Transactions".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. Szwander: "Power Supply for Generating Station Auxiliary Services".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. K. Hardy: "Protection of Aircraft Against Ice".

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 7 p.m.—Mr. C. V. Ward: "Dust and Fly Control and its Relationship to Air Conditioning in the Textile Industry".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. M. Stacey: "Macromolecules Synthesised by Micro-organisms" (Tilden Lecture).

Friday, December 6

ASSOCIATION OF APPLIED BIOLOGISTS (at the Imperial College of Science and Technology, South Kensington, London, S.W.7). At 11 a.m. (in the Survey Lecture Theatre, Royal School of Mines, Prince Consort Road).—Mr. A. R. Wilson, Mr. A. E. W. Boyd, Mr. J. G. Mitchell and Mr. W. S. Greaves: "Potato Haulm Destruction, with special reference to the Use of Tar Acid Compounds"; at 2.15 p.m. (in the Main Lecture Theatre, Huxley Building, Exhibition Road).—Prof. G. E. Blackman: "Recent Developments in Chemical Methods of Weed Control".

BIOCHEMICAL SOCIETY (at the National Institute for Medical Research, Hampstead, London, N.W.3), at 1.30 p.m.—Scientific Papers.

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. R. C. Brown: "Fundamental Concepts concerning Surface Tension and Capillarity".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENTS AND TRANSMISSION SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Desirable Features of Protective Relays" (to be opened by Mr. C. Ryder and Mr. F. H. Birch).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. O. Farmer: "Free-Piston Compressor-Engines".

ROYAL STATISTICAL SOCIETY, INDUSTRIAL APPLICATIONS SECTION LONDON GROUP (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. W. Bennett: "Statistics in America—Factory Organisation".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. F. Kenneth Hare: "The Geomorphology of parts of the Middle Thames Area" (to be read by Prof. S. W. Wooldridge).

CHEMICAL SOCIETY, LIVERPOOL BRANCH (in the Lecture Theatre, The University, Liverpool), at 6.30 p.m.—Dr. J. P. Baxter: "Atomic Energy".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Manchester), at 6.30 p.m.—Members of the staff of Benger's, Ltd.: Short Papers on "Enzymes in the Food Industry".

INSTITUTE OF ECONOMIC ENGINEERING, MIDLAND REGION (in Room 7, Chamber of Commerce, 95 New Street, Birmingham), at 7 p.m.—Annual General Meeting.

TEXTILE INSTITUTE, DUBLIN BRANCH (at the Mansion House, Dublin), at 7.30 p.m.—Mr. A. T. Woods: "Fuel Problems"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Thomas Bodkin: "A New Approach to the Fine Arts in University Education".

APPOINTMENTS VACANT

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

LECTURER IN MECHANICAL ENGINEERING—The Registrar, The University, Sheffield (December 7).

LECTURERS (2) IN ZOOLOGY (Grade IIc or IIb)—The Secretary, The University, Edmund Street, Birmingham 3 (December 7).

ASSISTANT (administrative) in the Secretariat provided by the Agricultural Research Council for the Inter-Departmental Insecticide Committees—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (December 9).

ASSISTANT ANALYST (male) in the County Chemical Laboratory—The Clerk to the County Council, County Buildings, Stafford (December 10).

TEACHER (temporary) OF MECHANICAL ENGINEERING SUBJECTS in the Secondary (Technical) School, Hackney Technical Institute, Dalston Lane, London, E.8—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (December 13).

DENTAL RESEARCH TECHNICIAN for experimental work with dental techniques and materials—The Dental Assistant Dean, University of Bristol Dental Hospital, Lower Maudlin Street, Bristol 1 (December 14).

ASSISTANT LECTURER IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (December 15).

BIOCHEMIST in the Department of Pathology—The Superintendent-Secretary, Royal Infirmary, Bolton (December 17).

CHIEF MECHANICAL AND ELECTRICAL ENGINEER in the Production Department of the National Coal Board in London—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting C.659A (December 20).

PRINCIPAL SCIENTIFIC OFFICERS in the Scientific Adviser's Department of the Air Ministry to deal with operational and administrative research problems in the Royal Air Force—The Secretary, Civil Service Commissioners, 6 Burlington Gardens, London, W.1, quoting No. 1694 (December 21).

LECTURER, and an ASSISTANT LECTURER, IN PHYSIOLOGY—The Registrar, The University, Sheffield (December 21).

LECTURER IN CHEMISTRY—The Principal, Birmingham Central Technical College, Suffolk Street, Birmingham 1 (December 21).

RESEARCH PHYSICISTS on the staff of the Division of Radiophysics, Council for Scientific and Industrial Research, Sydney, for work on (*a*) radio propagation, (*b*) vacuum physics, (*c*) applications of radio and radar techniques—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting Appointment No. 1039 (December 30).

PRINCIPAL RESEARCH OFFICER (Senior Physicist), Division of Aeronautics, Council for Scientific and Industrial Research, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting Appointment No. 1034 (December 30).

READERSHIP IN GEOLOGY, and a READERSHIP IN GEOGRAPHY, both tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 31).

CHAIR OF GEOGRAPHY tenable at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 14).

PRINCIPAL—The Secretaries, Paisley Technical College, 3 County Place, Paisley (January 15).

PROFESSOR OF CHILD HEALTH—The Registrar, The University, Manchester 13 (January 21).

PROFESSOR OF FORESTRY—The Secretary and Registrar, University College of North Wales, Bangor (January 31).

CHAIR OF PHYSIOLOGY—The Bursar, Royal Veterinary College, Royal College Street, London, N.W.1 (March 1).

LECTURER IN ZOOLOGY—The Registrar, Municipal College, Portsmouth.

LECTURERS (3) IN MECHANICAL ENGINEERING at Howard College, Durban—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

PRINCIPAL PROFESSIONAL OFFICER at the Government Metallurgical Laboratory, University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

LECTURERS IN (*a*) MATHEMATICS, (*b*) PHYSICS, (*c*) CHEMISTRY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

PHYSICAL CHEMIST to conduct research on corrosion problems—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Chemistry Department'.

SENIOR LECTURER IN CHEMISTRY, and an ASSISTANT LECTURER IN CHEMISTRY, in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

LECTURER IN PHYSIOLOGY—The Registrar, University College, Nottingham.

ASSISTANT BIOCHEMIST for Physical Chemistry Department—The Secretary, Mount Vernon Hospital and the Radium Institute, Northwood, Middx.

RESEARCH CHEMIST with experience in soil science and crop nutrition to conduct and supervise research, field and laboratory work in connexion with hop research work—The Secretary-Registrar, Wye College, Wye, Ashford, Kent.

RADIOGRAPHER to take charge of X-ray Section—The Director, Medical Research Council Pneumokoniosis Research Unit, 32 The Parade, Cardiff.

EXECUTIVE SECRETARY—The Hon. Secretaries, Royal Meteorological Society, 49 Cromwell Road, London, S.W.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Society of Animal Production. Reports:—Third Meeting, 21st February 1945, General Topic: Meat; Fourth Meeting, 17th July 1945, General Topic: British Pig Production. Pp. 85. (Edinburgh: British Society of Animal Production, Imperial Bureau of Animal Breeding and Genetics, 1946.) 2*s.* 6*d.* [305

Proceedings of the Royal Irish Academy. Vol. 51, Section A, No. 1: Probability Problems in Nuclear Chemistry. By Erwin Schrödinger. Pp. 8. 1*s.* Vol. 51, Section B, No. 1: On the Relationship between the Chemiluminescence of Aryl Magnesium Halides and their Low Oxidisability in Ethereal Solution. By Henry Mackle. Pp. 8. n.p. Vol. 51, Section B, No. 2: River Liffey Survey, 7, Salmon of the River Liffey. By Arthur E. J. Went. Pp. 9–26. 1*s.* 6*d.* Vol. 51, Section B, No. 3: Additions to the Knowledge of the Irish Flora, 1939–1945. By R. Lloyd Praeger. Pp. 27–52. 1*s.* 6*d.* (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1945–1946.) [305

Ministry of Health. Nurses Salaries Committee: Mental Nurses Sub-Committee. Further Recommendations, Mental Nurses S.C. Notes, No. 6. Pp. 8. (London: H.M. Stationery Office, 1946.) 2*d.* net. [36

British Rubber Producers' Research Association. Publication No. 67: The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds, Part 11, Double Bond Movement during the Autoxidation of a Mono-olefin. By E. Harold Farmer and Donald A. Sutton. Pp. 4. (London: British Rubber Producers' Research Association, 1946.) [36

Oxford Medicinal Plants Scheme. Annual Report, 1945. Pp. 16. (Oxford: Department of Botany, 1946.) [36

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 585, Vol. 231: Mitotic Activity in the Adult Female Mouse, *Mus musculus* L., a Study of its relation to the Oestrous Cycle in Normal and Abnormal Conditions. By Dr. W. S. Bullough. Pp. 453–516 + plates 27–34. (London: Cambridge University Press, 1946.) 17*s.* [36

Colonial Office. Organisation of the Colonial Service. (Colonial No. 197.) Pp. 12. 2*d.* net. Post-War Training for the Colonial Service: Report of a Committee appointed by the Secretary of State for the Colonies. (Colonial No. 198.) Pp. 46. 9*d.* net. (London: H.M. Stationery Office, 1946.) [66

Institute of Welding. Twenty-third Annual Report of the Council. Pp. 18. (London: Institute of Welding, 1946.) [66

The Bulletin. Issued by the Egyptian Institute, London. No. 1, June. Pp. 8. (London: Egyptian Institute, 1946.) [66

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1944–1945; Programmes of Experiments, Season 1945–1946. Pp. ii + 142. (London: Empire Cotton Growing Corporation, 1946.) 3*s.* [66

City and County of Bristol: City Museum and Art Gallery. Report of the Committee for the Year ended 31 December 1945. Pp. 12 + 2 plates. (Bristol: City Museum and Art Gallery, 1946.) [116

Medical Research Council. War Memorandum No. 17: Environmental Warmth and its Measurement; a Book of Reference prepared for the Royal Naval Personnel Research Committee of the Medical Research Council. By Dr. T. Bedford. Pp. 40. (London: H.M. Stationery Office, 1946.) 9*d.* net. [116

Other Countries

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MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science.

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For particulars, apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16, Charlotte Square, Edinburgh, 2.

SCIENTIFIC CIVIL SERVICE

Applications are invited for vacancies in the grade of Senior Experimental Officer at the Building Research Station of the Department of Scientific and Industrial Research:

Nine Senior Experimental Officers: (a) To assist in investigation of mechanical plant and equipment. Candidates should have had good practical experience in handling mechanical plant and equipment, Preferably with degree in engineering or equivalent qualification. (b) To assist in research on concrete. Candidates should have had extensive experience in concrete work for constructional purposes and should preferably possess a degree in engineering or equivalent qualification. (c) For general duties in physics laboratories. Candidates should preferably have degree in physics or equivalent qualification and suitable experience of work in research laboratories. (d) One to assist in work on concrete. Candidates should preferably have degree in chemistry or equivalent qualification and have had experience in the manufacture or use of building materials, including experience of standard testing. Ability to frame reports desirable. (e) Four Observers to inspect and report on building practice and to assist with correspondence on technical problems of building referred to the station. Good experience of building, architectural or structural work, and knowledge of materials required and ability to write reports. (f) One for design and development of instruments and plant required for experimental work. The duties will involve collaboration with the research staff and the preparation of designs to meet their requirements. Good experience and technical knowledge of mechanical engineering required.

Salary scales (men), £570 per annum, rising by annual increments of £25 to £750 per annum, together with consolidation addition (at present £90 per annum in the range of salary indicated) and superannuation provision under the Federated Superannuation System for Universities. In the case of women the scales of pay are lower.

Candidates for these posts must have been born on or before August 1, 1915, and should be under fifty-five years of age. They should preferably have had not less than 15-20 years of relevant experience.

Further details, together with application forms, may be obtained from the Civil Service Commission, 6, Burlington Gardens, W.1, quoting No. 1703, with whom completed applications must be lodged by December 19, 1946.

SCIENTIFIC CIVIL SERVICE

Applications are invited for the following vacancies in the Road Research Laboratory of the Department of Scientific and Industrial Research:

(a) One Senior Principal Scientific Officer to take charge of a section for research on road-making machinery. Candidates should have high scientific or engineering qualifications, a good personality, and qualities of leadership, together with experience either of scientific research or of the practice of civil and mechanical engineering, and would be expected to have had not less than fifteen years' relevant experience since graduation.

(b) Two Principal Scientific Officers or Senior Scientific Officers, to undertake research, one into problems of traffic movement and layout of roads and one into problems of design and use of vehicles, as affecting safety of roads and their use. Candidates should be either mechanical engineers or physicists with an engineering bias, and with mathematical ability.

Salary scales: Senior Principal Scientific Officer, £1,100 per annum, rising by annual increments of £50 to £1,300 per annum; Principal Scientific Officer, £750 by annual increments of £30 to £1,020; Senior Scientific Officer, £520 by annual increments of £25 to £710; together in all cases with consolidation addition (which at present is £90 at the minimum and £120 at the maximum of the total ranges indicated) and superannuation provision under the Federated Superannuation System for Universities. In the case of women the scales of pay are lower.

Candidates for these posts must have been born on or before August 1, 1915, and should be under fifty years of age.

Further details, together with application forms, may be obtained from the Civil Service Commission, 6, Burlington Gardens, London, W.1, quoting No. 1702, with whom completed applications must be lodged by December 19, 1946.

SCIENTIFIC CIVIL SERVICE

Applications are invited for the following posts in the Building Research Station of the Department of Scientific and Industrial Research:

Two posts of Principal Scientific Officer: (a) To take charge of investigations on mechanical plant and constructional methods employed in building and civil engineering and the development of test methods. Candidates must be competent mechanical engineers with extensive experience in plant and machinery design and operation and/or research, and ability to co-operate with other organizations. (b) To take charge of the mathematical section of the station. Candidates should have high qualifications as applied mathematicians or theoretical physicists with considerable experience in mathematical research into, and analysis of, problems arising in engineering and classical physics, and with ability to supervise staff.

Two posts of Principal Scientific Officer or Senior Scientific Officer (according to qualifications and experience), for work on fundamental physical problems in heating and ventilation. A real understanding of and interest in classical physics and in one case an interest on the medical and physiological side is required.

Four posts of Senior Scientific Officer: (a) Two Civil Engineers are required with good experience in the investigation of structural and allied problems. One will be required to devote himself to research on problems associated with the use of structural steel in building, and candidates for this post should have had practical experience in constructional work. The other will be required for the investigation of problems relating to the performance of structures under such effects as vibration and wind pressure. For both posts good research experience and ability in theory of structures and in mathematics is required. (b) One Mathematician or Mathematical Physicist for work on problems of non-steady heat flow. (c) One Physicist or Physical Chemist with experience in X-ray and crystal structure work, preferably with experience also of electron diffraction methods.

Candidates for all posts must have been born on or before August 1, 1915, and should preferably be under forty-five years of age, and a high academic standard, based on initial qualifications of not less than a second-class honours degree or its equivalent, in the relative branch of science, is required.

Salary scales (men): Principal Scientific Officers, £750 per annum, rising by annual increments of £30 to £1,020 per annum; Senior Scientific Officers, £520 per annum, rising by annual increments of £25 to £710 per annum; together in both cases with consolidation addition (at present between £90 per annum and £105 in the total ranges indicated) and superannuation provision under the Federated Superannuation System for Universities. In the case of women the scales of pay are lower.

Further details, together with application forms, may be obtained from the Civil Service Commission, 6, Burlington Gardens, London, W.1, quoting No. 1704, with whom completed applications must be lodged by December 19, 1946.

SCIENTIFIC CIVIL SERVICE

Applications are invited for the following post in the Fuel Research Station of the Department of Scientific and Industrial Research:

A Senior Principal Scientific Officer to take charge of the Physics section of the Fuel Research Station. The work involves problems relating to the production and utilization of solid, liquid, and gaseous fuels, the efficiency and testing of industrial and domestic heating appliances, and development of physical instruments. Candidates must have been born on or before August 1, 1915, and should preferably be under fifty years of age and have attained a high academic standard in physics with extensive experience of research and preferably some experience of industry.

Salary scale £1,200 per annum, rising by annual increments of £50 to £1,400, plus consolidation addition (at present £120 per annum), with superannuation provision under the Federated Superannuation System for Universities. In the case of women the scales of pay are lower.

Further details, together with application forms, may be obtained from the Civil Service Commission, 6, Burlington Gardens, W.1, quoting No. 1700, with whom completed applications must be lodged by December 19, 1946.

UNIVERSITY COLLEGE, NOTTINGHAM

Department of Physiology

The Council invites applications for the appointment of Lecturer in Physiology. Initial salary £425-£700, according to qualifications and experience.

Full conditions of the above appointment and forms of application may be obtained from the Registrar.

SCIENTIFIC CIVIL SERVICE

Applications are invited from Physical Chemists for appointment as Principal Scientific Officer in the Chemical Research Laboratory of the Department of Scientific and Industrial Research, to undertake and supervise fundamental experimental research. High academic qualifications and experience in the planning, direction, and prosecution of physico-chemical research are essential.

Candidates must have been born on or before August 1, 1915, and should be under forty-five years of age. The salary scale (men) is £775 per annum, rising by annual increments of £25 to £1,060 per annum, together with consolidation addition (at present £90 at the minimum and £110 at the maximum of the scale) and superannuation provision under the Federated Superannuation System for Universities. In the case of women the scales of pay are lower.

Further details, together with application forms, may be obtained from the Civil Service Commission, 6, Burlington Gardens, London, W.1, quoting No. 1701, with whom completed applications must be lodged by December 19, 1946.

CIVIL SERVICE COMMISSION

Applications are invited for posts at the Military College of Science, Shrivenham, near Swindon, Wilts, of permanent and temporary Principal Lecturers, Senior Lecturers, and Lecturers. Vacancies in one or more of these grades exist in the following subjects: Metallurgy, heat engines, machines, mechanics, and materials. Applicants must have a university degree in an appropriate scientific subject with first- or second-class honours, or an equivalent qualification. Experience in research or design as applied to military needs would be an advantage. The inclusive scales of salary are: Principal Lecturer, £840-£1,125; Senior Lecturer, £610-£800; Lecturer, £333-£560. If, owing to the housing shortage, accommodation is unavailable, War Department quarters may be allotted at a fair rent until such time as other accommodation becomes available. Full particulars of the posts, together with a statement of the conditions of service and the intentions of the War Office regarding the Military College of Science, and a form of application, may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1698. Application forms must be returned to him by December 20, 1946. Successful applicants will be required to join for duty as early as possible in 1947.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Applications are invited for the following appointments:

1. Lecturer in Entomology. The initial salary will be £500 per annum rising by annual increments of £25 to £600 and thence on special report by £25 to £850 maximum. The appointment will carry membership of the F.S.S.U. and will take effect as from January 1, 1947. The main duties of the Lecturer will be to undertake the elementary and part of the advanced course. The applicant should be interested in and prepared to undertake field work.

2. Demonstrator in Entomology. The appointment is for one year in the first instance, subject to renewal for not more than two years, at a salary of £300. The candidate should hold an honours degree in Zoology and have special knowledge of entomology, particularly of insect morphology. The appointment will take effect as from January 1, 1947.

Applications for both posts should be made in writing as soon as possible and not later than December 9, 1946, to Secretary, Imperial College, South Kensington, S.W.7.

CITY OF BIRMINGHAM EDUCATION COMMITTEE

Birmingham Central Technical College
Suffolk Street, 1
Department of Chemistry

Applications are invited for a full-time Lecturer in Chemistry. Candidates should have an honours degree in Chemistry and some teaching and, if possible, some research or industrial experience in a branch of Applied Chemistry. The selected candidate will be expected to teach mainly inorganic and physical chemistry up to B.Sc. special chemistry standard. A knowledge of spectrographic methods of analysis would be an advantage. Salary in accordance with the new Burnham Technical Scale.

Application forms and particulars of appointment can be obtained from the College on receipt of stamped, addressed foolscap envelope.

The last day for the receipt of applications is December 21, 1946.

E. L. RUSSELL,
Chief Education Officer.

UNIVERSITY OF SHEFFIELD

Applications are invited for an Assistant Lectureship in the Department of Physiology. The appointment will be in the first instance probationary, on an annual basis. Salary £450 per annum in the first year, rising by £25 per annum to £500, with superannuation provision under the Federated Superannuation Scheme for Universities, and family allowance. The successful candidate will be expected to enter upon his duties as early in 1947 as possible.

Applications (three copies), including the names and addresses of three referees and, if possible, copies of two testimonials, should be sent to the undersigned (from whom further particulars may be obtained) by December 21, 1946.

A. W. CHAPMAN,
Registrar.

UNIVERSITY OF SHEFFIELD

LECTURER IN MECHANICAL ENGINEERING

Applications are invited for appointment as Lecturer in the Department of Mechanical Engineering. Salary £550, rising by £25 every year to £650, and then, if the appointment is renewed, £700, with superannuation provision under the Federated Superannuation Scheme for Universities and family allowance. Further particulars may be obtained from the undersigned, with whom applications (four copies) should be lodged by December 7, 1946.

A. W. CHAPMAN,
Registrar.

UNIVERSITY OF SHEFFIELD

Applications are invited for a post of Lecturer in Physiology. Salary £550, rising by £25 every year to £650, and then, if the appointment is renewed, £700, with superannuation provision under the Federated Superannuation Scheme for Universities, and family allowance. The successful candidate will be expected to enter upon his duties as early in 1947 as possible.

Applications (four copies), including the names and addresses of referees and, if desired, copies of testimonials, should be sent to the undersigned (from whom further particulars may be obtained) by December 21, 1946.

A. W. CHAPMAN,
Registrar.

UNIVERSITY OF BIRMINGHAM

Faculty of Science
Department of Chemical Engineering

Applications are invited from graduates in physics or physical chemistry for a Research Scholarship in the Rheology of Colloids.

The scholarship is tenable in the Department of Chemical Engineering and is £220 in the first year, £240 in the second year, and £260 in the third year, with remission of fees. The holder of the scholarship is eligible to study for a Ph.D. degree.

Applications, with the names of three referees, should be sent to the Director of the Department of Chemical Engineering, the University of Birmingham, Edgbaston, Birmingham, 15, before December 14, 1946.

WESTMINSTER HOSPITAL MEDICAL SCHOOL

University of London

Chemist required for post of Assistant in Department of Chemical Pathology, commencing January 1, 1947. Candidates should have a higher qualification, with research experience in organic chemistry. Biochemistry and/or microanalysis an advantage, but not essential. Duties include research, teaching, and supervision of routine work.

Salary, according to experience, up to £600 per annum, plus superannuation benefits (F.S.S.U.). Applications to Secretary, 17, Horseferry Road, London, S.W.1.

ESSEX EDUCATION COMMITTEE

South-West Essex Technical College and School of Art
Forest Road, Walthamstow, E.17

The Governors invite applications for the post of full-time Lecturer in Chemical Engineering. Candidates should have had appropriate industrial experience and some teaching experience is desirable.

Salary according to the Burnham scale, with London allowance and allowances for professional and industrial experience. There will also be an additional special responsibility allowance of £100 per annum.

Applications, by letter, should be made immediately to the Acting Clerk to the Governors at the College.

B. E. LAWRENCE,
Chief Education Officer.

County Offices,
Chelmsford.

MINISTRY OF HEALTH

Blood Transfusion Service

APPOINTMENT OF TEMPORARY SCIENTIFICALLY QUALIFIED OFFICER IN THE MIDLAND REGION

The Minister of Health invites applications for the undermentioned appointment in the Blood Transfusion Service in the Midland Region (counties of Herefordshire, Shropshire, Staffordshire, Warwick, and Worcester), with headquarters at Birmingham. 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, should be addressed to the Regional Establishment Officer, Ministry of Health Regional Offices, Market Buildings, Moat Lane, Birmingham, 5, not later than December 9, 1946.

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.

SCOTTISH SEAWEED RESEARCH ASSOCIATION

Applications are invited from qualified mechanical engineers for appointment to the Association's staff as Development Engineer at a salary of up to £600, according to qualifications and experience. Applicants must possess a university degree or equivalent and a sound knowledge of general engineering practice. Previous experience in development work on mechanical equipment desirable. The successful candidate will be engaged on the design and development of equipment for the harvesting of underwater seaweed.

Applications, giving full particulars, including age, education, qualifications, and experience, with dates, to reach the Deputy Director, Scottish Seaweed Research Association, West Mains Road, Edinburgh, 9, not later than January 1, 1947.

EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

The Governors of the College invite applications for the posts (two) of Regional Director of Extension Work, one of whom will be located in the area north of the Forth and the other south of the Forth. The salary offered is that of Grade I, £850 by £30 to £1,100, with consolidated war bonus at the rate of £105 per annum. Applicants must be graduates in agriculture and must have had experience in extension and advisory services. The successful candidates will be eligible for inclusion in the superannuation scheme presently in operation at the college.

Applications, together with copies of not more than three recent testimonials, should be lodged with the undersigned not later than December 31, 1946.

THOMAS BLACKBURN,
Secretary.

13, George Square,
Edinburgh, 8.

EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Applications are invited for the post of Chemist with a view to being trained for spectrographic analysis. Candidates should be in possession of an honours degree. Salary (Grade III) £385 by £25 to £680, with consolidated war bonus added. Further particulars may be obtained from the undersigned.

THOMAS BLACKBURN,
Secretary.

13, George Square,
Edinburgh, 8.

LEEDS UNIVERSITY

Department of Textile Industries

Applications are invited for a Fellowship of the value of £500 per annum instituted by the International Wool Secretariat. Applicants should have had research experience in some branch of chemistry, preferably organic chemistry, and the successful candidate will be expected to study the reactivity of the keratin molecule.

Applications should reach the Registrar, the University, Leeds, 2, from whom further particulars may be obtained, not later than December 31, 1946.

UNIVERSITY OF OTAGO

Dunedin, New Zealand

Applications are invited for the following positions:

Senior Lecturer in Chemistry, salary £750 (N.Z.) to £825 (N.Z.) per annum.

Assistant Lecturer in Chemistry, salary £400 (N.Z.) to £500 (N.Z.) per annum.

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

UNIVERSITY OF OTAGO

Dunedin, New Zealand

DIRECTOR OF PHYSICAL EDUCATION

Applications are invited for the position of Director of Physical Education in the University of Otago. Salary £875 per annum (N.Z. currency).

Full particulars and forms of application may be obtained on application to the High Commissioner for New Zealand, 415, Strand, London, W.C.2, with whom applications will close on December 16, 1946.

UNIVERSITY OF MANCHESTER

The University proposes to proceed to the appointment of a whole-time Professor of Child Health. Stipend within the range £1,500 to £2,500 per annum. Duties to commence, if possible, on March 25, 1947, and, in any case, not later than September 29, 1947. Any person who wishes his name to be considered should communicate with the Registrar, the University, Manchester, 13, from whom further particulars may be obtained, not later than January 21, 1947, giving the names of three persons to whom reference may be made.

UNIVERSITY OF LONDON

A course of two Lectures on "Symbiotic Nitrogen Fixation" will be given by Professor Artturi Virtanen, Ph.D. (Biochemical Institute, Helsinki), at University College (Botany Department, Gower Street, W.C.1) on December 3 and 4 at 5 p.m. At the first lecture the chair will be taken by Professor W. H. Pearsall (Quain Professor of Botany in the University of London). Admission free, without ticket.

JAMES HENDERSON,
Academic Registrar.

UNIVERSITY OF LONDON

A course of three Lectures, entitled "Abstract Deviation in Abstract Space," will be given by Professor Maurice Fréchet (Université de Paris) at University College (Gower Street, W.C.1) at 5 p.m. on December 2, 3, and 5. At the first lecture the chair will be taken by Professor H. Davenport (Astor Professor of Mathematics in the University of London). Admission free, without ticket.

JAMES HENDERSON,
Academic Registrar.

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.

GUY'S HOSPITAL MEDICAL SCHOOL

Applications are invited for the post of Assistant Lecturer in Pharmacology. Commencing salary £575 per annum with superannuation. Applications, with the names of two referees, should be sent to the Dean, Guy's Hospital Medical School, London Bridge, S.E.1.

UNIVERSITY OF LONDON

The Senate invite applications for the Chair of Geography tenable at King's College (initial salary £1,500). Applications must be received not later than January 14, 1947, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars should be obtained.

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.

WESTMINSTER HOSPITAL MEDICAL SCHOOL

University of London

Technical Assistant required in Department of Chemical Pathology, to commence January 1, 1947. Applicants should have at least Inter.B.Sc. in chemistry, with some analytical experience, or have the A.I.M.L.T. in chemical pathology.

Commencing salary £300 per annum, plus superannuation benefits (F.S.S.U.). Applications to Secretary, 17, Horseferry Road, London, S.W.1.

CHELSEA POLYTECHNIC

London, S.W.3

Applications are invited for the post of Assistant Lecturer in Physics to date from January 1, 1947, or earliest possible date.

Further particulars and application form may be obtained by sending a stamped addressed foolscap envelope to the Clerk to the Governors, Chelsea Polytechnic, S.W.3. Applications should be lodged by December 9.

CAMBRIDGESHIRE EDUCATION COMMITTEE

Cambridgeshire Technical College and School of Art

Applications are invited for the post of Lecturer in Biology with subsidiary Chemistry. Applicants should possess an honours degree. Salary will be in accordance with the Burnham scale for assistants in technical colleges.

Further particulars and forms of application, which should be returned by December 14, 1946, will be forwarded on receipt of a stamped addressed foolscap envelope by the Chief Education Officer, Shire Hall, Cambridge.

MEDICAL RESEARCH COUNCIL

The National Institute for Medical Research, Hampstead, N.W.3, has a vacancy for an Analyst familiar with modern methods of organic quantitative micro-analysis. Salary dependent upon qualifications. Apply, stating age and experience, to Administrative Officer, National Institute for Medical Research, London, N.W.3.

PLANT PROTECTION, LTD., INVITE Applications for appointments on the scientific and technical staff of their research station at Fernhurst. Appointments in both senior and junior grades are open to suitably qualified men and women, who should have a university degree and/or diploma. For the senior grades, experience in entomology or mycology as applied to agriculture and horticulture is necessary. Applications from those with foreign, especially tropical, experience will receive special consideration. Good salaries according to qualifications and experience are offered. Apply to Plant Protection, Ltd., Fernhurst Research Station, Fernhurst, Nr. Haslemere, Surrey.

THREE CHEMISTS (MALE) ARE REQUIRED in the laboratories of the Plant and Animal Products Department of the Imperial Institute. Must have B.Sc. degree (first- or second-class honours, chemistry) or equivalent qualification. Experience in analytical or research work an advantage. The duties are concerned with the investigation of Empire raw materials of plant or animal origin. Age under 30.

Salary £275 per annum, with annual increments of £18, plus consolidation addition of £78. Appointment temporary, with a view to permanent, pensionable employment. Further information from Establishment Officer, Imperial Institute, London, S.W.7.

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.

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.

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.

A LARGE CHEMICAL MANUFACTURING Company in the North West requires the services of a suitable technical man to take charge of their Patent Department and to act as a liaison with their Research Department. A chartered patent agent is preferred. Salary £800 to £1,200, depending upon qualifications and experience. Box 769, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

THE BRITISH ALUMINIUM CO., LTD., have some vacancies in their research laboratories for graduates with good honours degrees in chemistry or metallurgy, and preferably with some research experience, full particulars of which should be sent to the Director of Research, Research Laboratories of the British Aluminium Co., Ltd., Chalfont Park, Gerrards Cross, Bucks.

THE BRITISH ALUMINIUM CO., LTD., have a vacancy in Scotland for an experienced Analyst (female) able to supervise a small staff. Salary will depend upon qualifications and experience, full particulars of which should be sent to the Director of Research, Research Laboratories of the British Aluminium Co., Ltd., Chalfont Park, Gerrards Cross, Bucks.

A GRADUATE IN CHEMISTRY WITH INdustrial experience required by West London radio manufacturers to work on the use of adhesives, varnishes, and impregnating materials for transformers and motors. A knowledge of electronics useful, but not necessary. Age 23-30. Write fully, giving details of training, experience, and salary desired, to Box 761, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

THE FULMER RESEARCH INSTITUTE, Stoke Poges, Bucks, invites applications for the post of Physical Chemist, preferably with experience of research using high-temperature vacuum technique, to work on the development of a new process. Salary £500-£1,000 according to qualifications and experience.

THE *FARMERS WEEKLY* REQUIRES A Technical Assistant Editor. Applicants should have a wide experience of practical farming and knowledge of current agricultural research and sources. Salary offered £1,000 per annum (plus pension scheme), which may be increased for outstanding man. Reply to Editor, *Farmers Weekly*, 43, Shoe Lane, London, E.C.4, giving full particulars of career and references.

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.

THE PLASTICS DIVISION OF THE Research Department of the Distillers Company, Ltd., requires several Physical Chemists, preferably with experience in physical-chemical research, for work on problems in the high polymer field. Remuneration commensurate with experience. Good prospects. Applications to Controller of Research and Development, Distillers Co., Ltd., Great Burgh, Epsom, Surrey.

FOOD RESEARCH. HONOURS GRADUates in physical or organic chemistry are required for a London research laboratory engaged on academic and applied aspects of food technology. The laboratory is backed by adequate financial resources of a well-known group of food manufacturers. The research direction is capable and the laboratory equipment is of the latest. Salary will depend on qualifications and not be less than £500 per annum, with admission to a generous pension scheme. Box 763, 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.

GAS-TURBINE ENGINE MANUFACTURERS in the Midlands have vacancies for science graduates to carry out research work on the following subjects: (a) gas analysis and other chemical aspects of combustion; (b) friction and lubrication. Salaries dependent on qualifications and experience. Previous experience not essential. Box 764, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

GLASSBLOWER REQUIRED FOR Research Laboratory, West London. Good all-round knowledge of hard and soft glass technique, including lathe work. Wages according to experience. Write, stating age, experience, and full particulars, to Box 757, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

YOUNG WOMAN, PHYSICS DEGREE AND five years' experience industrial research, competent shorthand-typist, editorial and abstracting experience, seeks responsible post London. Box P.226, 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.

B.SC., SECOND-CLASS HONOURS CHEMIStry (24), with research experience, seeks change. Biochemical/pharmacological work, preferably research, London area. Box P.224, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

WANTED IN LONDON AREA, CAPABLE Research Physicist to head laboratory developing velocity-modulation valves. Starting salary, according to experience and suitability, between £800 and £900 per annum. Write Box D.6839, A.K. Advg., 212a, Shaftesbury Avenue, W.C.2.

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

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

FOR SALE, BIOLOGICAL MICROSCOPE (Perry), in case. Eyepieces 2×6, 4×10. Objectives 1/6, 2/3. Condenser with adjustable aperture. Sell at £30 or nearest. H. R. Hicks, 116, Valley Road, Ipswich, Suffolk.

MICROSCOPES. A FIRST-CLASS PETROlogical Microscope, by James Swift for sale. Very slight reconditioning necessary. On view London. MacLaren, Feocu, Truro, Cornwall.

LEITZ MATERIAL TESTING MICROSCOPE (le chatelier type), stand M.11. Complete with full equipment, including camera. Price £70. Further particulars from John Golcher, Limited, King's Hill, Wednesbury.

MICROSCOPES AND OTHER RELATIVE instruments, accessories and books on the subject. List free. Chards (established 1869), Forest Hill, S.E.23. Phone Forest Hill 5946 and Springpark 1629.

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.

FOR SALE, *SCIENCE ABSTRACTS*, A (Physics), 1928-32, 1937-45. *Nature*, 1941-45, few odd numbers in addition. Box P.225, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

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.

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